Concepts of Data Based Management Systems

1. Introduction

Intensive pig enterprises are continuously being concentrated into fewer, larger production units. The economic pressure to reduce costs and increase production efficiency is also stimulating the use of recording systems. Technology advances will continue to accelerate the scope to capture production data, eg silos on weigh cells and pig implants. These developments are changing the management structures within piggeries and are now presenting exciting opportunities to incorporate data based decision support systems.

2. Management Hierarchies

Management hierarchies vary greatly between piggeries and are mostly a consequence of the size of the production unit managed. The actual roles performed are much the same between piggeries, the variation exists only in the number of people these roles are distributed amongst.

- Managing Director
    - Business Manager
        - Administration Staff
    - Production Manager
        - Unit Manager
            - Operational Staff

Figure 1. Six Generic Management Roles.

Very small piggeries are forced to merge up to six different roles into a single person. The key problem here is overload and each role is compromised.

Very large piggeries can separate roles into individual people. The problem here is communication between staff levels and each role is again compromised.

3. Production System

Figure 2 illustrates the production process and forms the basis for delineating responsibilities between management sectors. The Managing Director is responsible for the resource, eg sheds and staff. The Business Manager is responsible for the inputs consumed by the system eg feed purchase. The Production Manager is responsible for the production process. Unit Managers ensure compliance to standard operating procedures and Operational Staff perform production tasks.

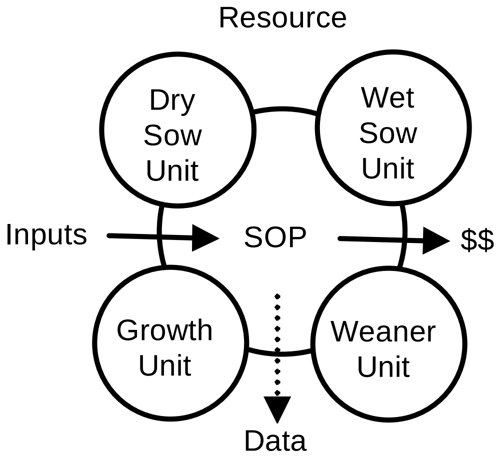

Figure 2. Production System

When all of the above works in unison the inputs poured into the resource will transform into profits. Standard Operating Procedures (SOP) are designed to assure expected performance is attained, but records are also captured from each production phase to reconcile actual results against expectations.

4. Data Structures

Records should be captured for a purpose so as to streamline the number of traits measured. Figure 3 highlights the need for only six traits required to monitor, and thus control, the number of pigs sold. Traits in the left-hand column are measured, but only those traits in the right hand column require analysis.

<u>1. No. Mated</u>
χ <u>2. Farrowing %</u>
No. Farrowed
χ <u>3. Born / litter</u>
No. Born
χ <u>4. Stillbirth %</u>
No. Born Alive
χ <u>5. PWM %</u>
No. Weaned
χ <u>6. Mortality %</u>
No. Sold

Figure 3. Primary Traits

To ensure that pig sales are efficiently derived, the size of the breeding herd has to be optimised by increasing the rate at which sows traverse through the system. This is a function of three factors; Pregnancy Length, Lactation Length and the length of time spent in an unproductive state. Pregnancy length is constant and lactation length is a matter of policy so that just leaves Non Productive Days (NPD).

NPD is comprised of Entry to First Service Interval (EFSI), Service to Re-service Interval (SRI), Weaning to Service Interval (WSI) and Removal Interval (RI). So these four additional traits will look after breeding herd efficiency, to bring the total to only 10 traits to keep an eye on.
The only other traits that need to be considered for routine analysis are those that may explain a primary trait (eg average parity), or direct inputs that impact on a primary trait (eg feed intake), or traits influencing carcase quality (eg P2 fat) or production costs (eg feed conversion ratio).

5. HACCP Plans

The data structure in figure 3 represents a very crude flow chart of production events; mated sows farrow and then return to mating while progeny are born, weaned, grown and sold. If traits 1 to 6 are constant, sales will meet expectation.

All production systems exhibit normal variation, but a portion of this variability is avoidable and can be minimised by standardising operating procedures. The general approach is to:

1. flow chart production processes.
2. identify the critical parts of the process where hazards are common.
3. develop standard operating procedures to protect critical control points from hazards.
4. introduce audit systems to enforce SOP compliance.

The task now is to identify the critical control points (CCP) that will determine the performance of the 6 key traits. An analysis of the hazards (HA being, Hazard Analysis) that are encountered at CCP's forms the basis to design SOP's to protect against production failure.

Taking Stillbirth % for example, the four hours of farrowing is the CCP and the protective SOP is to attend all farrowings, manually intervene when 20 minutes lapses from the last piglet born, and feed bran four days before farrowing to minimise constipation.

The final step in the HACCP plan is to ensure that SOP's are routinely followed by auditing these activities. This is usually a matter of completing task sheets that are independently witnessed and reconcilable by external auditors.

An analysis of the past years records in the onset will identify problematic traits which drive sales downwards. The SOP's that address these traits are the most important. An analysis of 31 piggeries in 1997 revealed that NPD's and Total Born per litter are the two weakest links in the average Australian production chain. A HACCP plan that addressed these two traits alone will deliver the lions share of benefits to industry.

6. Monitoring Trait Trends

With the "important trait" list finalised, and HACCP plans and SOP's now implemented, a mechanism is then required to detect when performance deviates from expectation. The expected level of performance can be represented by upper and lower bounds calculated from the normal pattern of weekly variation observed. Once a week strays outside of these bounds there is sufficient evidence to indicate a change in performance has occurred. Investigation could reveal the underlying reason to be categorised as:

- SOP failure, eg sows farrowed in dry sow stalls.
- A system input has changed, eg feed or temperature.
- The resource has changed, eg new staff.

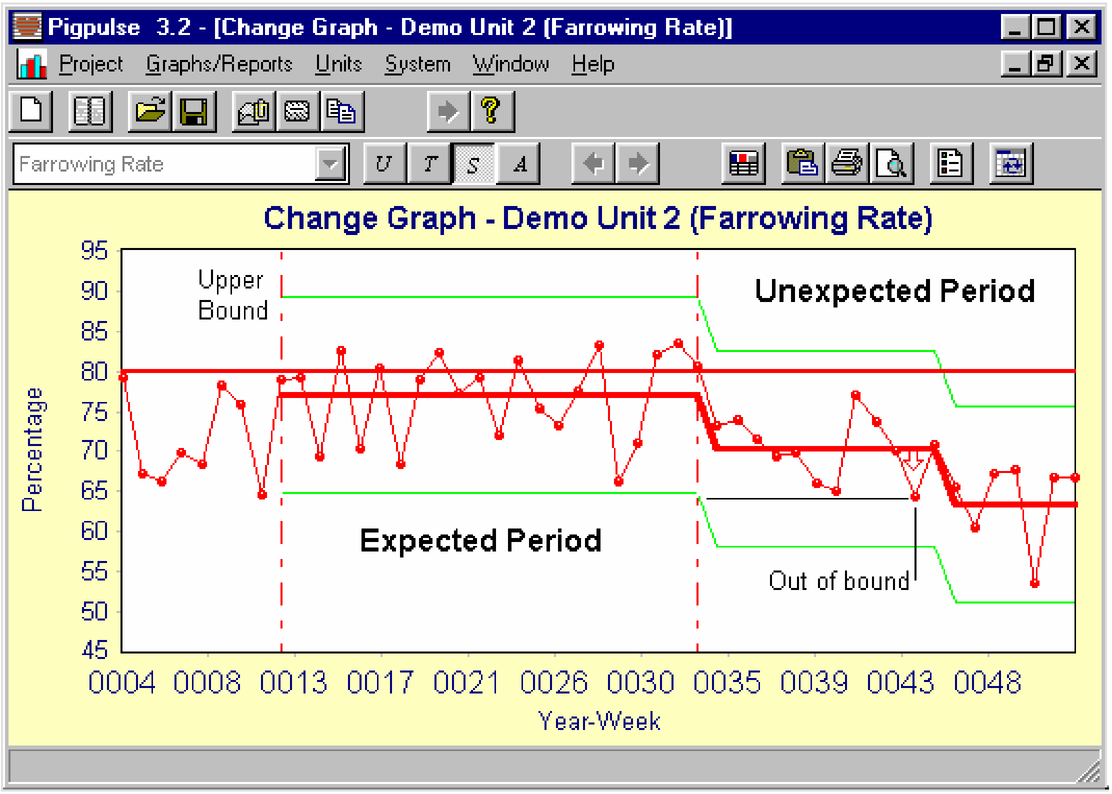

Figure 4. PrimePulse Change Graph

Figure 4 presents a PrimePulse Change graph that has detected two significant performance changes. The expected period (between vertical broken lines) has been used to calculate upper and lower bounds. A significant change is signalled in week 0043 when a single week crosses the expected bound. The bounds then shift down to bound the current change in readiness to detect the final change.

7. Investigating Changes

Investigating contrasting periods can reveal the underlying cause and perhaps indicate the management sectors requiring intervention to rectify the situation. A diagnostic trait tree is a valuable tool used to efficiently guide these investigations. A <u>subjective</u> discussion amongst relevant staff will identify probable causal agents that may then be <u>objectively</u> confirmed by data interrogation. *"In God we trust, all others must have data".*

Figure 5 presents a simple Cause and Effect chart used to investigate a given change in Farrowing %. The C & E chart logically organises reasons explaining why sows may fail to farrow. Given that boar failure was thought to be responsible for farrowing failure, the prior "expected" period may be compared to the current "unexpected" period to investigate boar performance.

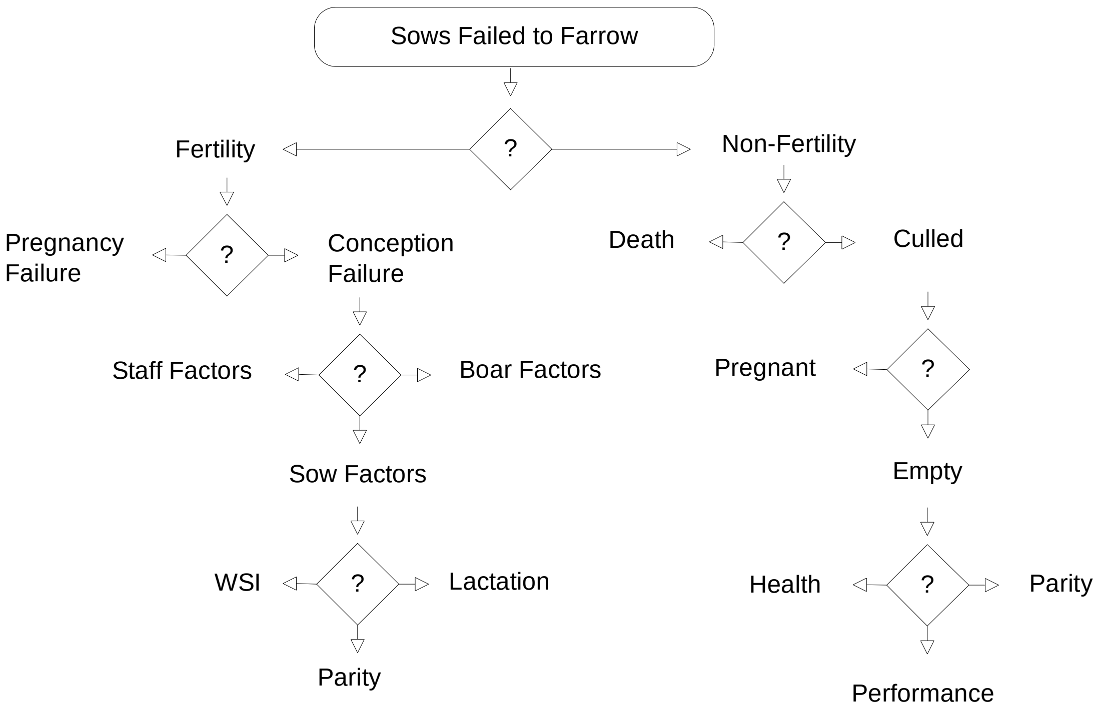

Figure 5. Farrowing % Cause and Effect Chart

Figure 6 presents a distribution of farrowing rates from 100 boars averaging 80% from the expected period. Interpret the right most bar as six boars have a farrow rate of between 90% and 100%.

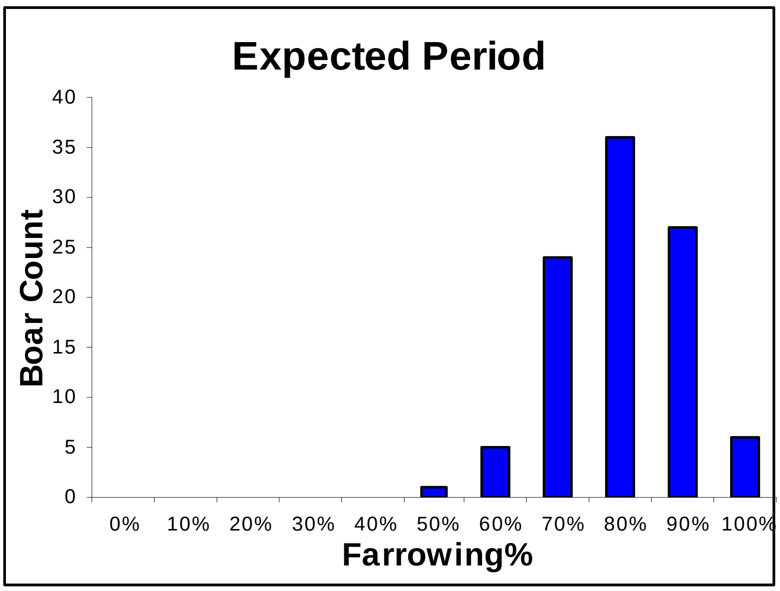

Figure 6. Expected Farrowing % distribution

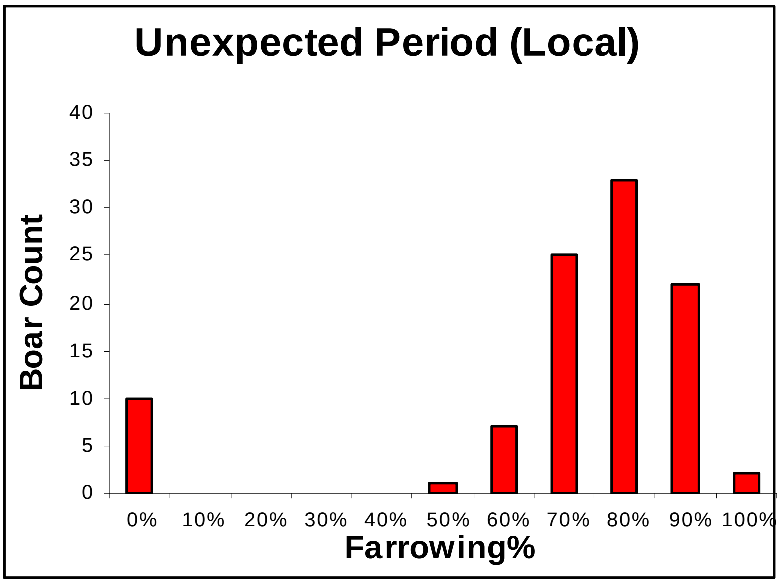

Figure 7. Unexpected Farrowing % (Local Effect)

Figure 7 presents a situation where Farrowing % has unexpectedly decreased by 10 % to now average 70%. Some boars appear to have been seriously effected whilst others remain within the expected range. In this example 10% of boars have become 100% infertile. This is either a Production Management issue if current SOP's do not include adequate fertility checks, or an Operational Staff issue if these fertility checks were not successfully conducted.

The term "Local" is used to convey that only selected production events (in this case matings) have been subjected to the causal factor. This is characterised by a change in shape of the performance distribution (broader base).

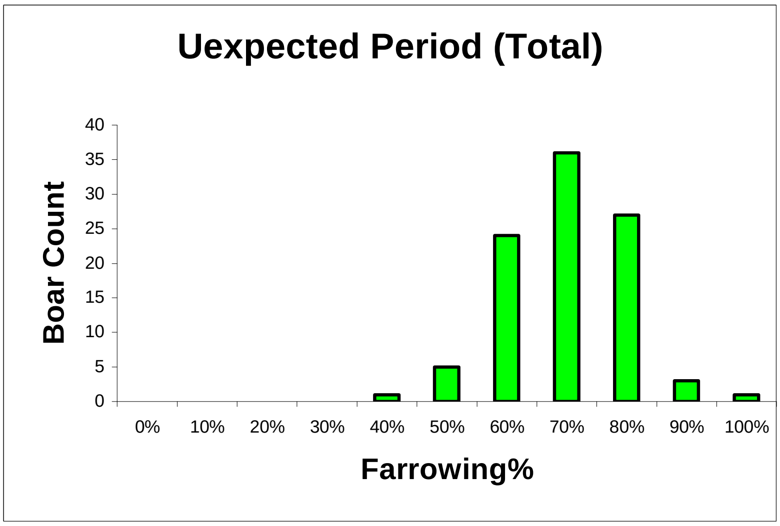

Figure 8. Unexpected Farrowing % (Total Effect)

Figure 8 shows how a characteristically different circumstance can also decrease farrowing rate by 10 % to average 70%. All matings appear to have been equally effected as the entire distribution has shifted but has not changed shape. Thus, no particular boars are at fault. The search now is to find another cause (eg by continuing to work down the C&E chart, eg investigate staff next) that may exhibit a local effect similar to the boar effect shown in figure 7.

The absence of any local effect indicates that perhaps the entire system has shifted down in response to an input change (eg temperature) or resource change (eg slippery mating pens) or SOP change (eg a new Artificial Insemination program).

If a seasonal effect is proven (by comparative analysis between seasons) the issue resides within the Managing Directors domain, as only they may authorise resource allocations to install environmental control systems.

These examples demonstrate how data mining can assist to amicably resolve production issues and objectively improve communication within management hierarchies.

8. Continuous Improvement Systems

All of the processes explained herein should be maintained in perpetual evolution. If they were static, production would never improve. The whole idea is to involve all staff sections in an on site learning activity that lives and learns from the process. The most important aspects are ownership of the greater concept and the objective communication between staff sectors. Sharing the proceeds of success is similarly important.

Operational staff must contribute to Cause and Effect chart design, otherwise how are they to understand the consequence of their actions and thus dire need for SOP compliance. Every production failure should resurrect the old C&E chart for amendment. "Internal" process ownership achieved via staff training will always out perform "external" regulation and audit enforcement. A delicate balance is thus required.

Similarly, Production Management staff must realise that operational staff are "prisoners of the process" and production improvement beyond SOP compliance can only arise through improved SOP design.

Strategic and financial management must also understand the limitations of SOP design and recognise their role in considering resource allocation, or a change of inputs, to exogenously kick production levels up a step or two.

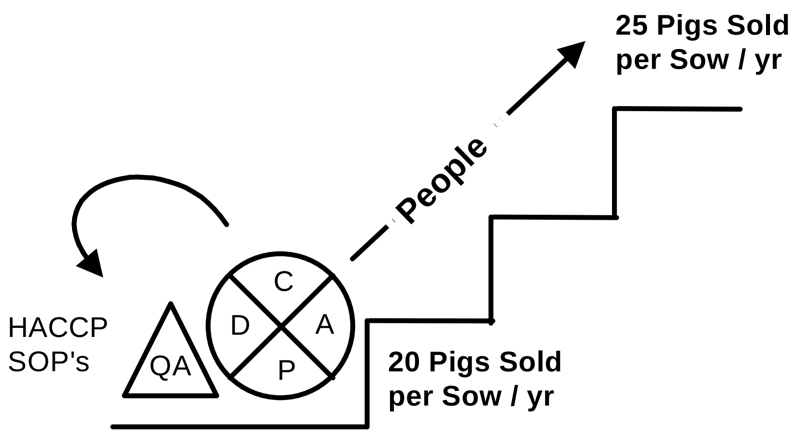

Figure 9. TQM model for Continuous Process Improvement.

Figure 9 presents a Total Quality Management (TQM) model for continuous process improvement. The objective in this model is to push the ball (production) up the stairs. With every step taken, the wedge must follow to prevent rolling back to where you've been.

The process starts by HACCP planing to create a "wedge" to lock in current (or best practice) performance and prevent future production failure. This is the Quality Assurance part. The APDC part in the ball is the bit that supplies the rev's to climb up the next step. This is achieved by Analysing the process for potential improvements, Planing the intervention, Doing the intervention and then Checking the results. Each revolution will create a new or amended SOP that makes a bigger and better wedge.

The most important concept in this model is that all levels of personnel are required to cooperate to collectively pull production up to target expectation. Any one sector performing well in isolation will struggle and tire without support from the entire management team.