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Managing the growth process using real-time data

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Always focus on the front windshield and not the rearview mirror

~Colin Powell

Essential Knowledge

The rearview mirror

While driving using a review mirror for guidance isn't a very good idea, it is much better than driving with a blindfold and no guidance. Prior to all-in/all-out and the reference points in data collection all-in and all-out pig movements give us, the growth process was largely uncontrolled, as least as it related to decisions being made with any amount of evidence of what was occurring in production facilities.

The pork industry has made great progress in regards to our ability to capture data relative to the growth process. However, the data currently being captured and used in the decision process is really like driving a car using a rearview mirror. That is, when the industry uses closeout data in the decision process, it is relying on what has already happened to guide the process of growth currently on-going in production facilities.

Grow-finish records are inherently different than breeding herd records. In the breeding herd, we record individual animal events. These events occur during the biological process we are monitoring and very clearly tell us the status of the process. For example, we record inseminations, 35 day pregnancy rates, farrowing and weaning events, etc. All of these allow us to predict future events such as how many sows will most likely farrow in future weeks, how many pigs can we expect to wean at a given date, how many females do we need to maintain in our gilt pool to meet breeding targets, etc.

In essence, breeding herd records are focused on the windshield. As a result, the use of such tools as statistical process control charting and other management decision aids have become routine. The goal of these records and associated decision aids – maximizing reproductive performance as the process is occurring.

However, the use of management decision aids in the growth process is not as precise or easy as use in the breeding herd. In the breeding herd, a majority of the expected responses are yes/no (served or not served; bred or not bred; weaned or lactating, etc).

The items of interest to grow-finish records are not precise points or points that have yes/no responses. We're dealing with groups of pigs, often in more than one facility, which means individual record observations are not possible. Generally, owners, supervisors, and employees are interested in such things as daily gain, feed conversion, cost per unit of gain, etc. All of these become imprecise measures during the growth process since they are all based on pig weight, a variable that is generally not measured until the pigs are sold for slaughter.

Because grow-finish records are associated with a large number of pigs, often represented by all pigs within an all-in/all-out facility for a given period of time, the items of interest are most likely to be expressed as averages, such as average daily gain, average daily feed disappearance, average days to slaughter, etc. The use of averages masks the variation in growth that occurs in groups of pigs. Because the end point of the process is sale to slaughter, capturing data during the process, while desirable, usually does not occur.

The challenge remains though – driving forward using a rear facing mirror creates a journey that is bound to include both very small and very large mistakes.

Let's think about a growing pig in today's production facility. As caregivers, we chose the pigs pen mates, the environmental conditions (draft and temperature), the feeder space, the type of drinker, the diet, etc. The goal is to provide the pig a thermal-neutral, minimal stress environment with ad libitum feed and water access. The end result is expected to be a group of pigs with high rates of lean gain with efficient utilization of the resources provided.

Several attempts have been made to monitor the growth process as it occurs. Many production companies and producers utilize feed budgets based on projected growth. These budgets are based on previous histories of groups of pigs in similar facilities and are often corrected for season of the year. Producers using these budgets to monitor growth compare feed deliveries against projected deliveries, both for dates delivered and amounts delivered.

The challenge of using feed budgets is that producers are using 6 to 12 ton delivery load estimates of feed disappearance. Early during the growth process, when feed intake is relatively low, it may take upwards of two weeks for a group of pigs to consume one delivery of feed. As pigs approach market weight, feed deliveries become more frequent, enabling closer monitoring of the process versus projections.

However, feed deliveries to the bulk bin are only a crude indicator of intake patterns. Unknowns include whether there were disruptions to feed delivery in the facility due to bridging or equipment malfunctions, and whether the bulk bin was empty for a period of time (two hours to two days) prior to delivery of the feed (Brumm et al, 2005).

The slightly cracked windshield

In most facilities, a better predictor and monitor of performance is water disappearance (Brumm, 2006). While feed intake is dependent on feed being delivered to the feeder, and the feeder dispensing feed, water is generally under the direct control of the pigs in the facility, assuming drinker devices are maintained in working condition in each pen.

Unlike feed disappearance, it is relatively easy to monitor water disappearance on a daily basis. All that is required is a water meter installed in the drinking water line. It is important that this meter not include water used for summer cooling or cleaning activities, as these uses of water are not under the direct control of the pigs in the facility.

While many producers have begun recording daily water meter readings, few have developed methods to display the daily totals in graphic form. It is my experience that unless the data is displayed in graphic form, daily caregivers in production facilities don't readily think about changes in intake patterns. However, once displayed in graphic form, caregivers (either owners, contract growers, or employees) can readily visualize changes in disappearance.

With this in mind, a spreadsheet has been developed to create barn sheets to record and display in a graphic format daily water disappearance. This spreadsheet is available for free downloading at http://porkcentral.unl.edu.

As a general starting point, producers charting daily water disappearance should pay closer attention to pig health and behavior any time there are three days of decreased water disappearance in a row or a 30-40% decline in water disappearance from day to day. These guides are only that – a starting point for using water disappearance to monitor relative pig health and performance. As more producers and caregivers gain experience in monitoring water disappearance, and relate patterns to a variety of conditions, including season of the year and changes in climatic conditions, it is possible that at specific sites other patterns may emerge as critical predictors of pig performance and health.

The challenge for manual water charting as described above is that people responsible for daily care of growing pigs don't always record water usage at the same time each day. This means variations in daily water usage are due in part to variations in the time period associated with each daily logging. In addition, these charts are located in production facilities meaning they are not readily accessible to pig owners, production supervisors and consulting veterinarians unless they visit the individual sites.

The next generation of windshields

In response to this need for monitoring of the inputs associated with the growth process in a large number of production facilities, there are a growing number of internet based data acquisition and reporting systems. These systems may have stand-alone logging capabilities (www.dicamusa.com), be associated with ventilation controllers as the on-site data capture device (www.e2eresolutions.com and www.growtrac.com) or may use the computer capabilities of other devices such as sorting scales (www.herdstar.com). There are also computer-to-computer based systems (www.phason.ca and www.osborne-ind.com).

In the near future, data acquisition systems will not only log data such as temperature, fan and furnace run times, feed bin weights, etc. but will also be programmed to compare the data to a series of prediction algorithms. The goal is internal benchmarking of the inputs and outputs of the growth process.

For most production record systems, current benchmarking in the grow-finish phase consists of comparing closeouts among peer groups, among contract growers, etc. While this gives users of the data some reference points, it is restrictive in that it doesn't challenge management decisions involved in the growth process as these decisions are made on a daily basis. The better method is to compare use of inputs and the resulting outputs to predicted outcomes as the process is occurring.

A simple example is propane usage in wean-finish facilities. Many of today's data capture systems record barn temperatures and furnace and fan run times along with other items of interest to production managers. Alarms are often set with regard to thermal-neutral temperatures. That is, alarms are sent out whenever temperatures are outside of user defined ranges. The problem with this is that there is no recognition of the inputs that are involved in maintenance of temperature within the user defined range. Often recognition of an out-of-control temperature maintenance issue doesn't occur until receipt of one or more months of propane bills.

Tables 1 and **2** show a model of balance point temperatures in a 1200 head wean-finish curtain sided facility. Pig heat production is based on the equations of Brown-Brandl et al (2004) and facility heat loss computations are based on MWPS (1977). The balance point temperature is the estimated incoming ventilation air temperature whereby heat removal is balanced with heat production. If incoming ventilation air is cooler than this temperature, either the ventilation system must reduce the amount of heat exhausted, or heat must be provided via propane furnaces or zone heaters such as heat lamps or infrared brooders.

The basic idea of these equations is that it is possible to predict furnace run times (and propane usage) and fan run times in wean-finish facilities. In the future, data logging systems will not only report temperatures and fan run times, but will also report these items versus a

Table 1: Ventilation configuration for modeling balance point temperatures for a 1200 head curtain sided wean-finish facility.

	Ventilation configuration				Controller settings		
Stage	Fans (#)	Diameter (in)	cfm/fan	Variable speed?	Bandwidth	Differential	Minimum
1	2	24	6,000	yes	2		50%
2	2	24	6,000	yes	2	1	50%
3	1	36	12,000	no		2	

Table 2: Modeling balance point temperatures for a 1200 head curtain sided wean-finish facility.

		Degree F balance point[A]				
		Stage 1 (cfm/pig)		Stage 2 (cfm/pig)		Stage 3 (cfm/pig)
Pig wt (lb)	Set point temp (•F)	5 (50%)	10 (100%)	15 (50%)	20 (100%)	30
50	70	25	45	54	61	67
100	68	-4	29	42	51	60
150	65	-27	14	31	42	52
200	63	-47	2	22	34	46

[A]At outside air temperatures between stages, the next larger stage will be cycling on/off. The balance point is the outside air temperature at which the indicated stage operates 100% of the time. This temperature estimate doesn't take into account wind or other location specific factors.

prediction algorithm. How much propane and electricity was consumed versus the predicted usage becomes the new benchmark. This puts the user of the data capture system in a position to control propane usage (and cost) as the growth process and usage of propane is occurring, rather than reacting after the fact.

While not currently commercially available, data capture systems in the future will not only log daily water and feed, but they will compare these logged amounts to predictions of what should be occurring. When the swine industry gets to this point, we will be monitoring the inputs of growth versus our predictions of what the input usage should be, a system of internal benchmarking.

Parsons et al (2007) have experimented with a growth control system based on a mechanistic growth model. The input for the growth model included daily feed intake and pig weight estimated by visual image analysis. In their publication, they discuss the possibility of using data capture systems for advanced detection of health and welfare problems.

It is my belief that ultimately we will be using such tools as pig scales randomly located in facilities to capture random pig weights. When combined with the algorithms for the inputs involved in the growth process, it will be possible to know the status of the growth process as it is occurring, rather than examining the process after it occurs. Compared to today's method of using closeout information to benchmark the decision process, this new method of benchmarking both the inputs and outputs of the growth process as they occur will shift our focus from the rearview mirror to the windshield. When we begin driving the production system thru the windshield, the results can be expected to be even more dramatic than those that occurred when we removed the blindfold and went to driving with a rearview mirror.

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