Automation of Livestock Management
*Improvements for Practical Operations and Animal Care*

Our company, Osborne Industries, Inc., has been a supplier to the livestock industry for exactly 30 years. Personal acquaintance with pig production for me extends back 50 years to a typical 1950’s general-purpose farm near Osborne, Kansas. Obviously, an enormous change in the way in which pork is raised has occurred during this span of time. But even more change is coming. Today I will suggest some ideas about this future and how this new future may evolve with the use of electronic automation or what I will call Second Generation Automation (SGA).

“Automation of Livestock Management” is a very large topic. In the time allowed, only a broad framework can be developed on this topic. We can discuss why a second generation of automation is needed, how SGA differs from First Generation Automation now being used, and show a few examples of how SGA works. Perhaps this presentation will stimulate a new perspective for you on the very exciting and interesting challenges ahead for pork production.

At some point, every company chooses its own unique business strategy. This strategy is chosen either consciously or unconsciously as the best way to serve customers. At Osborne Industries, from our inception we consciously resolved to develop advanced product concepts that deliver new, and hopefully unique, value to our customers. For example, we introduced electric heat pads for supplementary heating in farrowing and nurseries 30 years ago. Before 1973, heat bulbs were the only option. Heat pads are now standard accessories. We introduced an advanced mechanical-flow all-plastic self-feeder in 1981. Within five years, this concept had captured over half of the market-share in the U.S. Its efficiency and success, even with minimum management, influenced the improvement and innovation of many novel feeder designs by other suppliers. Some of our weighing and ventilation innovations have been widely copied and some are now standard designs. We have always looked for new, practical concepts for our customers. We have always fully tested new ideas before introduction, now with modern techniques on our Demonstration Farm near Osborne. During the past 15 years we have applied this strategy to a concept of automation of pork production, based on identification and management of individual animals using industrial management-by-exception and statistical process control techniques.

**What is Second Generation Automation—SGA?**

Today I will outline for you a totally new range of concepts for managing animals using electronic automation or SGA. These SGA systems are not radical concepts. Some of these systems have been use in practical production for up to 15 years. We have tested their limits and
their value. They survive as products only if they provide 1) equal or better performance than conventional methods and 2) improve the care and well being of our animals. Our tests are all published in peer-reviewed journals. Otherwise concepts are redesigned or discarded in favor of alternative methods.

Some examples of SGA applications have been successful commercial products for a number of years, others are just reaching the market, and some remain under development and testing. In the time available I cannot cover all of these examples in detail, but I can share some of their characteristics as examples of practical electronic automation. The full economic potential for some of this automation is yet to be fully appreciated or understood.

One must understand that these new SGA methods are significantly different from the First Generation Automation (FGA) technologies on which current pork production is built. This FGA includes automated feed conveyors, gestation and farrowing crates, automated environment control, AI methods, service bureau record keeping services, PC-based management programs, and improved lean genetics. All of these technologies make modern pork production possible. A gestation crate may not be immediately considered as “automation” until one considers that these examples meet the definition of automation, i.e. “any technique, method, or system of operating or controlling a mechanical or productive process by self-regulating means.” Gestation crates certainly regulate, control, and automate the lives of gestating sows.

In the same way, we believe that SGA technologies are now ready, needed, and perhaps just as incredible as the FGA methods that we now accept as standard. But the consuming public may not allow 30 to 50 years to understand and adopt these technologies.

FGA technology was adopted in three distinct phases. From about 1970 to 1980, a New Technology phase moved pigs out of dirt lots and sorted practical, standard solutions for design of confinement production from a vast array of new and untested concepts for keeping pigs in confinement.

From about 1980 to 1990, a Standardization phase proved that raising and managing very large production units was possible, practical, and economically attractive. FGA technologies, standardized production procedures, and organized teams of trained herdsmen were validated during this phase.
From about 1990 to the present, a large-scale Integration phase occurred. Using methods and technologies from the Standardization phase, this last phase integrated standard FGA technologies with capital and marketing structures into total production systems. Desire for market-share drove rapid expansion of large production organizations during this phase and, taking a lesson from these new leaders, most smaller producers either made a rapid transition into cooperative production and marketing arrangements that mimic the new leaders or exited the business. Both segments of this new market use standardized FGA technology.

The success of these developments and the FGA technology, upon which they are based, now set the stage for Second Generation Automation (SGA). With market shares largely decided, efficiency becomes paramount. Information and its effective use are required to understand and achieve efficiency. New farms are not possible so aging farms must be renovated and improved. The same physical footprint must yield better ROI. With increased size, the activities of market leaders are no longer protected from scrutiny by public respect for a faded image of yeomen farmers raising their food. Consumer pressure demands a close review of FGA methods to avoid public perceptions of adverse effects of these methods on animal welfare and food safety. All of these forces combine to suggest that current FGA technology, in whole or in part, may soon become inadequate and obsolete.

Are SGA technologies capable of responding to the inadequacy of FGA technologies? The answer is “yes”, but SGA means that new techniques must be tested, learned, and adopted. Like our “castaway” pork producer, at first all these new technologies appear to be either nonsense or magic. But SGA is neither. Like any new technology, an initial investment in learning new techniques is necessary. You can see these technologies at work on the Osborne Demonstration Farm and on an increasing number of sites worldwide. Some early adopters have been using SGA methods for up to 15 years. SGA technologies work and are available now.

Examples of Second Generation Automation--SGA
What are these Second Generation Automation technologies? They are automated information-based management systems that extend the ability of your best-qualified personnel to understand the immediate status of every animal. Information and its immediate use is the heart of each SGA system. Information drives SGA workstations that perform specific functions. Both the fulfillment of these functions and associated biometrics are collected at the workstations.

One important by-product of dynamic use of information is the automatic collection of retrospective FGA production data for historical database records. This flow of data may, at first, seem to be overwhelming in concept, but in reality the SGA application flags for management action or attention only exceptional animals—those doing exceptionally well or poorly. Even locating and responding to these particular animals is automated.
One normally believes that new automation is expensive. In fact, SGA methods actually reduce capital investment and cost of production compared to FGA methods in every case that we have studied. SGA methods avoid the most pressing welfare issues of consumers and activists. Animals are free to move about. They can optimize their environment. They are docile and easy to move, to load, and to manage. SGA methods also minimize environmental consequences of intensive production through more efficient use of inputs. Production information is immediately available to control daily production and make on-the-go adjustments. And SGA methods also facilitate adoption of advanced quality assurance and traceability techniques that are the standard expected good-practice in almost every other industry.

How will these SGA methods be implemented into an on-going production system? First, SGA systems are deployed as stand-alone systems that perform a specific task, i.e. they automate some existing production chore with SGA technology in an otherwise FGA environment. Each SGA system is added for a specific purpose. Our FIRE® Performance Testing system is a good example of such a system. It automates all aspects of genetic performance testing, expanding the number of animals tested and accelerating genetic progress in a realistic group environment.

The second step in adoption of SGA is a single-site integration of a complete SGA system of interacting applications and the total replacement of obsolete parts of FG automation. This can now be done for reproduction with our TEAM® Sow Management system and for grow-finish with our Weight Watcher™ system. Perhaps soon we can extend this to marketing, quality, and financial control.

The third step is the progressive conversion of FGA systems to SGA systems as the FGA systems wear out, become too inefficient to be sustained, or come under public pressure. The final step is the integration of all SGA systems into a common, centralized, information-based management system that becomes the new standard production environment.

What does this Second Generation Automation look like? Some practical examples are shown in the table, Figure 5. Of course, examples of complementary systems provided by other suppliers exist and could be listed here also, but the SGA concept is the same. I will use examples that I know best, i.e. those that we have developed and tested at Osborne.

<table>
<thead>
<tr>
<th>System</th>
<th>Description</th>
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<tbody>
<tr>
<td>e-LOG™ system</td>
<td>Automated data acquisition without paper records or keyboard data entry.</td>
</tr>
<tr>
<td>TEAM® system</td>
<td>Complete reproductive management of gilts and gestating sows kept in large-group pens including feeding, weighing, marking, estrous checking, availability tracking, auto-sorting and record keeping.</td>
</tr>
<tr>
<td>Weight-Watcher™ system</td>
<td>Automated grow-finish management including size sorting, phase feed management, market sorting, growth and health tracking, feed bin monitoring, and market planning.</td>
</tr>
<tr>
<td>FIRE® system</td>
<td>Performance testing for genetics, feed, and health.</td>
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<tr>
<td>Sentinel™ feeding</td>
<td>Production monitoring using performance testing of sample animals.</td>
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Automatic weighing and the Weight Watcher™ System
Because automated weighing has recently become an exciting topic for many producers, it is a
good and interesting example of an SGA system. We at Osborne started tests of automated
weighing seven years ago. Our ACCU-ARM® line of single animal scales has been available
for twenty years. But owing to growth in farm size, loading and unloading a scale became too
time consuming to be practical.
Our own tests showed that manually weighing a pig had a hidden cost in handling stress
and that repetitious manual weighing may only measure the tolerance of the pig to weighing,
not true growth characteristics.
We had acquired significant expertise with automated weighing with our FIRE®
Performance Testing system and knew that it was possible to acquire pig weights automatically. But doing this was too costly for small groups of production animals. Economics dictate that a large group of pigs must have the use of each scale.

So we first tested many replications of the growth performance and weight variation in progressively larger groups of grow-finish pigs. No effect of group size on performance or variation was found. We also tested various strategies to get pigs to voluntarily use a scale. No method for voluntary use of the scale succeeded.

Finally we invented and tested the Weight Watcher™ system (WWS) for pen arrangement and weighing. In a WWS, our Survey Scale weighs pigs many times each day and generates an accurate weight distribution for a pen. We use the median weight from the previous daily distribution to sort pigs each day into two size groups. Each group is then fed independently. We immediately notice that the ADG of the lightweight pigs typically exceeds that of the heavyweight pigs. Size sorting by itself helps reduce natural increase of weight variation. Avoiding this behavioral effect reduces tail-enders and enhances facilities turnover.

Figure 6. Survey Scale data. Each point is the weight of one pig on one day. ADG is shown for Median Pen Weight.

Figure 7. Typical daily weight distribution for a small group of pigs.
Next, we adjust phase feeding accurately for both lightweight and heavyweight pigs, using the quartile values from the measured distribution. Effectively, we shift changes in our six-phase ration independently for each set of pigs. At the end of finishing and before we begin market sorting into a market pen, we know the number of pigs that we expect to sort into the market pen with any weight window of our choice. We avoid the sort loss penalty without increasing variation.

With a telephone connection and our Daily Weigh™ PC software, the growth and weight information is available to a manager in graphic and tabular form at a remote office. Market planning and surveillance of growth progress for one pen or a system of pens and barns with many finish groups is possible with complete, accurate information. The ADG for the heavy and light groups in each pen can be tracked and compared between buildings or farms. Effects on gain such as heat stress are immediately evident when these graphs “flat-line”.

The WWS is consistent with animal welfare expectations because the pigs have complete freedom of movement and utilize space so efficiently that they appear to have ample open space, while actual pig space is no greater than in current small pen systems. The WWS reduces weight variation for tighter facilities turnover and better quality animals. With large finish groups, the saving in capital expense and upkeep of gating is drastically reduced. Herdsman fatigue is reduced because pen access is easy with few gates to cross. Market sorting time and stress are practically eliminated. Pigs move and load more easily.

We know that the WWS really works. We developed the WWS, using individual radio frequency identification (RFID) on each pig. We tracked the activity and growth of each pig in a large group of finish pigs. We tracked the actual time and frequency for each transit through the Survey Scale™ by each pig. We observed the individual growth curves for all pigs. We could immediately see the consequences of any modification to the system. We validated the WWS system so that it may be used without RFID.

Currently we continue to develop the value equation for the use of RFID on all finish pigs to collect and monitor each growth curve. For example, with RFID, the system quickly recognizes injured pigs and alerts the herdsman immediately.
or slow gaining pigs and spray marks them for removal or special care. With RFID, the WWS detects any sudden changes in environmental stress, especially effects on feed intake and warns of the need for corrective action before production stalls. With RFID and our Market Weigh™ software, groups of pigs can be categorized and sorted for selective feeding and marketing programs to optimize ROI. These values cumulatively may justify the investment in RFID and the RFID upgrade to the WWS. This level of management is possible with SGA technology.

Two additions to the Weight Watcher system are also possible: a Weight Watcher Bin Monitoring system and a Feed Truck Manager system. Together they integrate what is happening in the barn with feed mill operations. These two concepts use the information from a grow-finish barn to ensure that the right feed is delivered from the mill to the right bin for the right group of pigs at the right time. This sequence of events is routinely impossible for current FGA production technology, but is completely possible for Second Generation Automation. The payoff is reduced management frustration without erratic feed delivery, faster facilities turnover, more efficient feed utilization, and reduced waste nutrient load for the environment.

The current popular excitement over so called “autosorting” is interesting because this interest arises from its ability to avoid packer sort loss penalties. Sort loss and extreme weight variation are really by-products of FGA technology. On the other hand, the WWS uses SGA technology to reduce the need for autosorting. It attacks the causes for weight variation at their source using strategies not possible with autosorting. These strategies have been tested with RFID and time-lapse video observations of pigs on our Demonstration Farm using the Survey Scale in a Weight Watcher system. The Weight Watcher strategy is totally consistent with normal pig behavior.

**Sow Management in Groups with the TEAM® System**

Another important SGA system is the TEAM system for managing sows in large groups. About 15 years ago we initiated a study of sow gestation and farrowing, using electronically controlled feeders. We learned...
how to make the system operate in a way consistent with normal sow behavior. We tested the system for three years with one type of genetics and then depopulated and retested the system for another three years with a different type of genetics. In each case, half of the sow herd was managed simultaneously with standard gestation and farrowing crates as the control.

We continuously improved the system, particularly the operation of the G-station sow feeder and the TEAM software. Time-lapse video was used to understand sow feeding behavior, especially when no one was present or when optional management tactics were used. The progress and difficulties experienced by early-adopter customers was also closely monitored to learn what issues were important to ensure continuous uninterrupted service from their TEAM systems.

With this SGA system, we found that we can maintain sows in much more uniform condition than with gestation crates. The system alerts the manager when any animal goes off feed, an early warning of trouble. Better condition means quicker return to estrus. Sows in large groups are more docile and calm, are easy to manage and move, and always find the best environment in the pen. These values appeal to the perceptions of the welfare-minded customer.

We also found that sows in large groups suffer far fewer shoulder and leg lesions than crated animals. These values appeal to customers concerned with meat quality as well as welfare. Animals stay in top condition on much less feed, breed back much quicker, and have better survivability than our crated controls, which means better reproductive economics. Feed intake and farrowing records are automatically retained as part of their TEAM record.

The TEAM system requires an RFID tag on each gilt or sow. Especially for large sow farms, RFID and the TEAM system provide inventory and information automation that reduces labor and organizes daily operations. The status and location of each animal is constantly monitored by the system. The manager is notified when any animal needs attention or action.
Automatic spray marking helps locate animals in large groups. Moving sows is only necessary as they approach farrowing and is easy. They stay in good condition and know how to walk.

One particularly powerful workstation in the TEAM system is the TEAM E-station. The interaction of gilts and sows with a teaser boar as they enter estrus is measured and used to generate a very accurate Heat Reference Value (HRV). The HRV is directly proportional to estrous intensity. Estrus is measured 24/7 for gilts or sows. The E-station is extremely useful for availability planning for gilt development units, for assisting in detecting first estrus in weaned sows, and for identifying return to estrus in groups of gestating animals. Our studies show that TEAM estrous detection is also extremely reliable, finding animals that otherwise would go unnoticed.

One interesting aspect of TEAM estrus detection that we continue to study is the shape and intensity of the HRV charts. Both of these measureables seem to be individual traits that are characteristic of each animal. If this idea can be firmly established as true, then the HRV charts are even more useful. We are now collecting these charts for every gilt during their 60-day isolation. We will compare their HRV charts with their future productivity. If a correlation is found, then these charts become early markers for future productivity and can be used to identify and cull less productive gilts before they enter the herd. If the shape of the HRV curve is also a lifetime characteristic for each animal, then this shape can be stored and used to optimize the timing of AI.

**Data Management with the Osborne e-LOG™ System and the ID Logger™.**

The TEAM record-keeping system can be automatically ported to historical sow farm record databases to eliminate keyboard entry. With the e-LOG™ system and the ID Logger hand-held data logger, all data entry is done in the barn. The sow RFID automatically puts the user in the correct fields for entry of production data so errors are practically eliminated. The contents of the ID Logger can be synchronized with any historical management program so those files can be transferred and reconciled electronically at the end of the day.
eliminates paper sow cards, tedious keyboard transcription, and permits the entire history of each animal to accompany the herdsman to the barn where it can be used in daily production. Tests of the ID Logger design and utility have continued for nearly 10 years.

Other Examples of Second Generation Automation

FIRE® performance testing, Sentinel™ feeding for detailed production testing, VIA™ visual image analysis of conformational growth, Weight Watcher™ bin monitor, and e-VENT™ climate management are additional systems that join the suite of Osborne SGA products. All are electronic, microprocessor-based systems that respond and interact with their environment to provide information that can be used immediately for animal care and system control. All can be integrated into a complete information system. Other functional SGA applications supplied by other companies include automated dispensing and recording of animal health treatments and automated feed milling and diet control, based on real-time information from the Weight Watcher system.

Of course, not all of our attempts to develop useful SGA application have succeeded. For example, we attempted to find a way to objectively and automatically measure the condition of a sow. We discovered that weighing at frequent defined intervals is insufficient. Measuring back-fat levels is also insufficient. Visual imaging analysis of a top view of the sow’s body is also insufficient. Our study suggested that one must acquire all three measurements simultaneously to clearly measure condition. The cost and reliability of a solution for this task exceeds the value of the goal. Of the three measurements, automating back-fat measurements was the most difficult.

Measuring livestock odor continuously, objectively, and automatically is also a very interesting challenge. Our concept for this application led to the evaluation of a novel instrument that could be conveniently mounted at the four corners of a property. Odor values could be continually recorded and saved as a history file. Changes in odor could be detected and deviations above preset levels could alert management to take corrective action. Odor histories could provide some protection against arbitrary actions and subjective judgments by neighbors. Unfortunately our system was too sensitive to changes in humidity and failed. We are still working on this one.

Visual image analysis initially was evaluated as a means for estimating weights of pigs without the need for mechanical scales. Essentially a computer with a video image of a pig replaces the skilled herdsman in pig judging. While the system does work, so far it does not work reliably enough to meet standards that we set for this solution. We continue to work closely with Silsoe Research Institute in England in developing this technology.
In summary, you can begin to see that Second Generation Automation puts the farm manager in command of information so that action, based on accurate information, is immediately possible. Animals benefit because they can be managed more accurately, quicker, and according to their individual needs, even in very large production environments. The customer benefits from better quality assurance, traceability, and a positive perception of the care and welfare of the animals. And finally the producer benefits from lower cost, tighter control, and improved profitability.

For more information on any of these systems, simply contact an Osborne System Consultant or ask Osborne Customer Service for copies of peer reviewed research publications from Osborne or arrange to visit the Osborne Demonstration Farm.