Automatic Sorting Technology for Large Pen Finishing

Introduction

Technological advances and an enhanced understanding of the finishing pig’s needs have resulted in the application of new, innovative methods of housing and managing the finishing pig. Housing of finishing pigs in very large pens, containing 500 or more pigs, is now being practiced throughout the U.S. swine industry. Large pens can capture efficiencies of space and help alleviate problems associated with animal aggression and behavior. Application of automated sorting technology has improved animal handling within large group finishers while expanding producer opportunities to fine-tune management decisions regarding feeding, monitoring, and marketing finishing pigs. Enhanced management has allowed producers to capture economic benefits from finishing facilities while maintaining productivity and welfare of the pig. This factsheet describes the industries current understanding of automatic sorting technology.

Objectives

- Provide a scientific overview and background for large group finishing and automatic sorting technology
- Describe the potential advantages and disadvantages of automatic sorting technology
- Outline the concept of automatic sorting technology in relation to new and retro-fit facility designs and the associated equipment considerations
- Describe management requirements for large pen, automated sorting technology finishing facilities

Background

Large pen finishing barns, with groups of 80 to 200 pigs per pen, surfaced on a limited basis during the late 1990s by producers seeking associated behavior benefits and space efficiencies. Canadian studies document that pigs fight less in large pens versus small pens and regrouping in large pens results in less aggression. Social hierarchies aren’t

Figure 1. Example Packer Grid

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clearly established and individual animals do not require recognition like their small pen counterparts (Schmolke et al., 2003). Large pens require less gating and the open design may give the pig better access to space. Large pens also enable pigs to seek their desired microenvironments, i.e. moving away from crowds or resting in warmer or cooler zones.

Despite several compelling reasons for using large pens, difficulties in sorting pigs for optimal marketing may have prevented widespread adoption. However, the recent evolution of automatic sorting technology has prompted a dramatic shift toward large pens by providing a more convenient option for handling pigs and reducing the labor of sorting. Furthermore, automatic sorting technology can deliver other important benefits, including reduced sort loss; reduced labor for sorting and loading pigs; more accurate phase feeding; less pig stress and the potential for better meat quality. The technology also ties in with other technologies, such as electronic identification, to allow operators to examine individual pig growth and possible factors affecting variation in growth rate. While there are many potential advantages, producers must also understand challenges presented in managing large groups, particularly the ability to catch and treat individual pigs, the additional labor and training required to manage pigs in large pens, and challenges that may occur with maintenance of large pen equipment.

Early versions of sorting scales were used in finishing barns in pockets of the US, especially in Lancaster County, PA, and on a limited basis in Canada. However, these scales were not widely marketed or distributed. Widespread pork industry interest in automatic sorting technology occurred with the first major launch of automatic sorting systems by US swine equipment manufacturers in 2002. From that time forward, the technology has gained the attention of producers, consulting veterinarians, other advisors, and the popular swine media. Today, producers have many manufacturers and models to choose from.

**Potential benefits and challenges of automatic sorting technology**

**Sort Loss Considerations.** The National Pork Board’s 2003 Pork Quality Audit clearly stated that lack of product uniformity was the number one cost to the industry. The industry has long relied on the after-farm marketplace to create product uniformity. Like workers in a corporation’s mail room who sort items into categories for their delivery to their proper destination, packers sort carcasses into categories aimed at delivery of products that meet the desires of their customers.

To motivate producers to ship uniform loads of the desired pigs, packers developed a variety of pricing matrices or grids with incentive prices for meeting their ideal target carcass weights and substantial discounts for carcasses outside of the prescribed weight range. The carcass weight targets are sometimes referred to as the packer’s red box or grid box (Figure 1).

Producers responded with a variety of hand-sorting strategies aimed at meeting the carcass weight targets. Portable scales have been used to gauge selections, but sorting was ultimately only as accurate as the sorter’s ability to eyeball an individual pig’s weight. Purdue researchers suggest that average producers often over or under estimate the weight of individual pigs or mean weights of the group by an average of 11 pounds and experienced operators misjudge weights by 8.8 pounds (Li et al., 2003). It is not surprising that the National Pork Board’s Pork Quality Audit estimated that the average producer loses $1 to $3 per pig marketed due to sort loss alone.

Automatic sorting technology shifts the control into the producer’s hands. It enables producers to effectively sort pigs into tight weight range groups to match their specific packer’s pricing matrix. The value of having the control to greatly reduce sort loss is estimated at $2.00 per head (margin over feed...
costs) for producers with a flexible marketing schedule where barn space is not a limiting factor (Connor and Lowe, 2002). Many producers using automatic sorting report achieving near zero sort loss on the first groups sold after implementing the technology.

**Optimizing marketing strategies.** Beyond reducing sort loss, automatic sorting technology has the potential for improving overall marketing results because it enables a producer to better implement his or her optimal marketing strategy. Automatic sorting technology allows producers to monitor the weights of the fastest-growing pigs to determine precisely when to sell the first load. Producers that rely on eyeballing pig weights tend to play it safe when selecting pigs for market (Li et al., 2003). For example, if the target live weight range is 240 to 280 pounds, the producer may start hand-sorting when they believe pigs weigh around 260 pounds. That way the producer can rest assured the weights are not over the top weight limit. But by not aiming for a higher average, such as 270 lbs., the producer missed some of the opportunity because pigs are being sold too light. With an accurate picture of real weights via sorting technology, producers can be more confident in pushing fast-growing pigs to the top end of the packer’s weight range without going over the limit. This leads to selling more total pounds of pork.

Automatic sorting technology can also signal when to empty the barn. Purdue researchers point out that optimum returns are found when a barn is closed out just as soon as most of the slowest gaining pigs reach the packer’s lower weight threshold (Li et al., 2003). With sorting technology, a producer can monitor weights and market more precisely.

The Purdue researchers took a broader look at how much revenue automatic sorting could return to operations vs. conventional facilities, considering both reduced sort loss and better overall marketing performance. They created a mathematical model to predict growth and return for 100 sets of 1,000 modeled pigs, marketed in four different marketing scenarios. They projected that automatic sorting technology increases revenues by $7,000-10,000 per year per 1,000-head barn. Combining the benefits of using automatic sorting technology to manage Paylean® feeding regimens, and revenues jumped to $12,000-$19,000 per year per 1000-head barn (Li et al., 2003). While producers must remember that not every operation can or will capture all of the revenue described; the Purdue modeling study describes where opportunities to increase revenue exist through the adoption of sorting technology.

**Phase feeding and use of feed additives.** Automatic sorting technology also has the potential to be a tool for improving nutritional management in finishing pigs. Phase feeding diets are customarily transitioned based on the estimated number of days the pigs will consume diet one, two, three, four, etc., or on a feed budget based on the weight of feed delivered. Automatic sorting technology allows producers to switch diets based on growth information available for the group.

Using the technology, producers can easily create two feeding groups within a large pen group, provided that the producer has the proper barn design, feeding system design, and scale design. This gives producers the option of feeding faster-growing and slower-growing groups of pigs the diet that provides a more optimal combination of pig performance and economics.

Producers may also improve the effectiveness of feed additives, such as Paylean®, other growth promoting agents and health control products. Knowledge of estimated group weights allows producers to more easily manage dosage, delivery and duration of feed additive use and more clearly determine the influence on pig performance and economic return.

**Meat Quality Considerations.** Automatic sorting may provide an opportunity to improve meat quality characteristics through two important avenues: 1) a reduction in animal stress, and 2) the opportunity to control time off feed.

Automatic sorting reduces pig stress as a result of the system under which pigs are managed. The large
group setting can reduce within-pen fighting by allowing pigs to find their own comfort zones and the opportunity to remove themselves from competitive situations. In addition, as pigs learn to move in single file through the scales and one-way gates, they become acclimated to stressors that can occur during loading in a conventional finishing system. This acclimation reduces stress during loading and reduces in-transit and packing plant fighting that is common when pigs are commingled for delivery. Reduced sorting and transportation stress can result in reduced levels of lactic acid build-up in muscles prior to harvest. The reduced level of lactic acid prevents a sharp post-mortem decline in muscle pH, reducing the amount of pale, soft, exudative (PSE) pork produced (Cannon, 2002).

Controlled feed withdrawal prior to harvest may influence the quality of pork produced. However, time off feed and the subsequent effects are dependent on a number of other confounding factors. In general, removal of feed 8 to 18 hours prior to harvest may offer the best opportunity for reducing muscle glycogen stores and subsequently reducing the rate of post-mortem muscle pH decline, and ultimately, reducing the incidence rate of PSE. Producers must be careful to account for the time in transit and holding at the packing plant when attempting to use feed withdrawal to influence pork muscle quality (Ellis et al., 1998). In traditional facilities, withdrawing feed from sorted animals without disrupting feeding for other animals in the barn is difficult. To accommodate feed withdrawal, sell pens in automatic sorting barns can be designed without feeders or with feeders that can be turned off.

**Barn Space Utilization.** Automatic sorting technology facilitates better utilization of available barn space. Facilities can be designed with or without alleyways. Those without alleyways increase useable space by approximately 60 pig spaces, compared to traditional 1000-head barns with center alleyways. Furthermore, because large pens offer a more open design, versus a conventional 25-head per pen barn, they have fewer “blind corners” that pigs can’t access, resulting in better space utilization.

**Labor Considerations.** Many producers opt for automatic sorting facilities to reduce the work of sorting and loading pigs for marketing. Sorting pigs in conventional facilities requires one or more skilled personnel to spend significant time walking through pens, making selections and marking desired pigs. With automatic sorting facilities, the labor of sorting is reduced to a minimum because the scale and penning system performs the selection automatically. There is no need to mark pigs for marketing.

Loading pigs for harvest is often the least favorite task at finishing facilities. Loading from automatic sorting facilities is less laborious and less stressful for people as well as pigs. Pigs walk more eagerly into the load-out chute and onto the truck, likely because they are accustomed to walking single file through the sorting scale. The result is that pigs can be loaded with fewer personnel and in less time than loading from conventional facilities. Automatic sorting facilities appeal to individuals who operate a finisher by him or herself because only one person is needed for sorting and loading.

Additional labor savings are often observed when cleaning auto-sort facilities. Fewer gates and corners where accumulation occurs can shorten cleaning time considerably, and if less water is used for cleaning manure volume will be reduced.

Producers must realize that as group sizes increase, the ability to identify and treat sick or injured pigs may be more difficult. A keen eye and attention to detail are required for the workforce employed in large group finishing facilities. Equipment maintenance needs are expected to change in relation to the sophistication of the technology in the system. Scales and computers may require additional expertise if there are problems. Thus, producers may wish to evaluate the work force capabilities when considering large pens.

**Animal Welfare and Health.** Large pens and automatic sorting technology offer several pig handling and welfare advantages. The pig’s ability to flee, improved socialization and the pig’s freedom to pick his own microenvironment reduce stress in pigs housed in large pens. Less tail biting and aggression occurs, and pigs in large pens are also less fearful of people (Schmolke, et al, 2003).
Reduced stress is usually correlated with lower incidence of disease (Fangman et al., 2001). Pens stay cleaner when pigs have room to create more definite dunging, eating and sleeping areas. Cleaner pens contribute to less potential for disease and disease transmission. Caretakers in large pen systems may opt to walk through pens to check pigs more often than in traditional facilities where they have to crawl over gates. Earlier detection of disease contributes to better control of disease (Loula, 2003). Death loss during transport is reduced according to a study presented at the 2004 American Association of Swine Veterinarians annual meeting. Transportation related death loss from 17 automatic sorting facilities was two times less than losses from 49 conventional facilities (Brumsted et al., 2004).

The Concept

Automatic sorting pens contain a loafing area and one or more food courts. Food courts contain feeders and watering devices, such as cups or nipples. Loafing areas should also contain water cups or nipples so that water is readily available throughout the barn. The sorting scale serves as the pigs’ gateway into the food courts. After a brief training period described below, the pigs learn to use the scale to access the food courts. As a pig passes through the scale, it is weighed and then directed to the right or left (heavies or lights) depending on weight. When pigs are first learning to use the scale, the scale can be left open so pigs can flow through without being sorted. When marketing pigs, the scale sorts “heavies” that are over the producer-established cut-off or sort weight into the sort pen, where they are held until loading for harvest. Sorting scales can also be used throughout the feeding period to create two feeding groups as described in the benefits section listed above. There also may be times when an operator wants to sort off a number of heavy or light pigs in order to move them to another barn.

There are two primary components of an automatic sorting facility: 1) equipment, including the sorting scale and one-way gates, and 2) proper pen layout.

Equipment. A sorting scale should be designed and constructed to withstand the harsh environment of a pig barn and rigorous use by the pigs (Photo 4). With 500 to 750 pigs per scale stocking rate, it is not uncommon for the scale to perform approximately 500,000+ weigh measurements per year. The scale should also be built to accommodate the pig’s natural curiosity and behavior and also reinforce this behavior through positive experiences using the scale. Furthermore, sorting scales should be designed for operator ease and safety.

Designs are varied. Most models are comprised of a large stainless steel or galvanized metal frame with a scale built into the base. Scale frames have pneumatic entrance and exit gates operated with compressed air. As a pig moves into the scale, the entrance gates close behind to keep other pigs from entering. The scale should provide good traction for pigs. An anti-lay down bar and solid sides help improve scale throughput. Optical sensors, weight triggers or other patented systems indicate when the scale entrance gates should close. After the pig is weighed, the front exit gate opens, allowing the pig to walk into the “heavy” or “light” pen.

Electronics control the scale, collect data and allow the scale to be interfaced with other components. Some scales models offer basic software functions or applications, such as the weight of the current pig and (or) historical information. However, the true value of the technology comes from the level of management information the scale software is capable of providing. At a minimum, producers are able to track group performance and weight variation within the pens based on the lowest and greatest weights recorded within a specified time interval. However, producers must understand that average weight reported are estimates of the true average weight of pigs within the pen because the number of times a pig enters and leaves the scale on a daily basis will vary. Advanced technology is equipped with enhanced software to provide comprehensive information such as group rate-of-gain estimates, inventory information, estimated weight averages for specific groups and a weight for pigs sorted for market. Having information in hand to determine when to sell fast-growing pigs or when to close out the barn can lead to increased throughput. With the use of electronic identification, the capabilities of the scale and
software are vastly expanded because individual information becomes available.

Additional features and graphics, such as a histogram (Photo 5) to depict the live weight distribution, are available. Some models have built-in software for predicting the sort weight (based on the group’s weight history) to create the desired number of pigs for a market load. Other software can create and maintain a desired weight split for phase feeding. When identifying a scale manufacturer or scale model, producers should take into account pig and operator-friendliness, equipment durability and software or information capabilities.

One-way gates are used to separate the food court from the large, open loafing areas and also between the scale exit gates and the food court. It is essential that one-way gates work to prevent reverse access into the scale from the food court or into the food court from the loafing areas. One-way gates must work for all sized pigs, whether at the beginning of the feeding period or at the end. There are several designs of one-way gates available and producers should evaluate the alternatives in light of their system needs.

Proper pen design. The second important feature of the sorting system is proper pen design (Illustration 2). Automatic sorting barns are constructed similarly to fully-slatted, standard finishing barns with natural or tunnel ventilation. Facilities are divided into super large pens with 500-750 pigs per pen. Each pen is further divided by gating into a loafing area and two food courts. Gating must be 35 inches (88.9 cm) or taller to prevent animals from going over gates. Gating in large pen buildings requires heavier end posts and bigger base plates. In barns with small pens, the gating is stabilized because it is networked together. That is not the case with the open design of larger pens. In addition, pigs in large pens appear more active and athletic than pigs in small pens. It is also recommended that gating not be anchored to the roof trusses.

Without the proper pen layout, including proper food court design, load-out area design and feeding system design, automatic sorting facilities can be difficult to manage and it can be difficult to realize all benefits of the technology. A variety of pen designs have been developed to accommodate various barn sizes, accommodate retrofitting older conventional facilities and incorporate various management styles and pigs flows, including wean-to-finish.

Loafing areas should include sections of gating to provide a “maze” effect. This helps to curb fast movement of pigs across the span of the loafing area. The gating near the scale entrance should be arranged to funnel toward the scale (Photo 6). Solid panel gates should be adjacent to the scale to aide in pig training.

Feeding plans must be considered when designing the food courts to accommodate split-sex (when using electronic identification) or split-weight (or both) feeding regimens. Food courts should be at least 12-14 feet (3.66-4.23m) wide in order to allow good pig flow around feeders. Feeders should be placed so not to obstruct pig flow. One-way gates for pigs returning to the loafing area should be at the opposite end of the court as the scale to prevent bottlenecks near the scale. Feeder design and allotted feeder space should accommodate heavy pigs as well as lights. Standard feeder space recommendations for dry feeders are 1.5-2 inches (3.8-5.1cm) of feeder space per pig. Approximately one cup or two nipples should be allotted for every 50 pigs in food courts and one cup or two nipples per 50 pigs in loafing area. When wet feeders are used, additional water cups (one cup per 50 pigs) should also be located in the loafing area.

Hospital pens or special care pens are typically designed to hold 1-2% of the pen stocking rate. They should be located to allow for easy transport and/or removal of compromised pigs. Often hospital pens are located near the barn entrance and store room for easy access by workers and for convenience to treatment storage.
Retrofitting. Conventional facilities, housing 25 to 30+ pigs per pen, can be converted into automatic sorting facilities. Barns are retrofitted by reconfiguring gating to remove the small pens and center alleyways and locating feeders in food courts and water cups in loafing area and food courts. An additional option is to convert barns without eliminating the alleyway. In one industry configuration (the FASTII Alley™ Design), much of the gating is left in the barn. However, openings are created between the original pens. Pigs are given access to the center alley where the scale is located. Because pigs are curious, they walk along the alley, through the scale and back into the pen areas where feeders and water cups are located. When sorting is desired, the producer adjusts gating slightly to create a sort pen at one end of the barn. Using this retrofitting method requires less construction investment and time than retrofitting into a single large pen. A disadvantage for this design may be that it takes longer to sort pigs.

Managing Automatic Sorting Facilities

Training pigs. Pigs should be exposed to the scale soon after they enter the barn. The scale can be in an open position and turned off so that pigs can walk through the scale without being sorted by the scale's exit gate. Additional gates between the loafing area and food court can be opened to provide more access. After pigs have had three to five days of exploration with the scale turned off, operators should begin intermittent, 24-hour sessions when the pigs must use the scale to enter the food court. After all of the pigs learn how to access the food court via the scale, the scale is activated for further training. Some models are equipped with a pre-programmed training mode that teaches pigs to exit the scale in both directions. For more specific training recommendations, producers should talk with their scale manufacturer or other advisor. As with any finishing facility, producers must avoid extended feed withdrawal during the growing period. Excessive time off feed can lead to development of ulcers that compromise pig health and performance. Training pigs early after arrival will help alleviate this concern.

Training operators. Like all electronic equipment, learning to operate the scale requires training and practice. Producers should look for equipment manufacturers and scale distributors that demonstrate experience in training operators and helping adapt the system to a variety of production facility types and management styles.

Using system information. Beyond sorting, the technology can offer a great deal of information to fine-tune the management of pork operations. With certain scale models and software, producers can use the scale to track inventories such as the number of animals moved into a facility, culled, dead or marketed early. The scale can also be used as a tool for scheduling market loads. Monitoring scale information via the Internet or a PC network is available from certain manufacturers to allow offsite managers or consultants to track what's happening in each barn in the system. Also, feed mill operators can monitor pig weights and determine which feed to send to the barn.

Wean-to-Finish Barns. Automatic sorting is possible in wean-to-finish facilities. Heat lamps or radiant heaters (Photo 7) can be placed in pen during starting phase. It is also recommended that gating be arranged so that smaller pens can be created during the starting phase (Illustrations 3 and 4). This allows for easier handling of young pigs and offers an option for feeding different starter diets to different weight weanlings.

Electronic Identification

The combination of radio frequency identification (RFID) and automatic sorting gives the producer the ability to measure individual pig performance and compare factors influencing growth such as genetic types, drug therapies, vaccines and other interventions. A random selection of a number of pigs can be tracked using RFID and sorting to determine if particular treatments work better than others in the same.
environment and with similar pigs. Pigs must be tagged with electronic ear tags compatible with an RFID reader connected to the sorting scale. Research is underway to identify sources of variation and ways this technology can best be incorporated into commercial operations.

Additional Considerations

Large group, auto-sort technology, like any technology adoption decision, requires producers to thoroughly evaluate the economic feasibility of the investment. Fixed costs, including investment in the building, equipment, and maintenance must be evaluated relative to both new and retro-fit options. Variable costs are related to expected changes in pig performance, labor, utilities and other contributing factors. Changes in pig performance (growth rate, efficiency, mortality, morbidity, and variability) influence cost of production and facility throughput which in turn influence overall financial feasibility. Revenue is the other critical side of the financial feasibility of new technologies. Animal space recovered by removal of an ally will increase revenue per square foot of building if additional pigs are housed in the system. Producers must clearly evaluate the expected changes in revenue following adoption and evaluate revenue relative to changes in cost of production for adoption of new technologies.

Adoption of auto-sort technology requires at least a partial substitution of penning materials for investment in scales and equipment to operate the sorting device. Also, in many instances, the cost of feed augers is reduced when food courts are centralized within a structure. The incremental cost of these investments will be different for new compared with a retro-fit construction. In addition, as mentioned previously, lifespan of the automatic sorting equipment including the scales, electrical needs, computers, and ancillary support systems must be evaluated to make an informed decision regarding adoption. Producers must discuss options and costs with the manufacturer(s) to fully evaluate the investment alternatives.

The ability for an individual producer to capture all of the potential changes outlined in this factsheet may not be possible due to the multi-faceted nature of biological and physical systems and the interactions among factors influencing outcomes. Producers must remember that automatic sort technology requires specialized labor and management when compared with conventional systems. In many cases, these changes will involve a learning curve for those adopting the technology and may influence and (or) change (plus or minus) the total time spent managing the system.

Summary

Automatic sorting technology represents a major change in the way finishing pigs are managed and housed. It offers a wide variety of potential advantages such as reduced sort loss and optimal marketing performance, improved management of phase-feeding programs, animal welfare friendly environments, better space efficiencies, reduced labor for loading and sorting and the potential for improved meat quality. Optimal use of the technology requires proper pen design and selection of equipment that is durable and user-friendly. Advanced software and electronics allow the operator to optimize throughput by determining the precise day to sell fast-growing pigs or close the barn. As advances in animal identification and tracking are made, automatic sorting technology may also play a significant role in monitoring on-farm production parameters that can be used further along the market chain.
References


Illustration 4. Layout of a 600-pig wean-to-finish facility in sort position. Gates are arranged to create a single large loafing area and two food courts for the sorting position.
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