Robotic Barn Design Part 1: Conventional versus Robotic Milking Systems – Fundamental Differences

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Take Home Messages

Robotic milking will work in most barn layouts, but it will work best if cow comfort and convenient cow and materials handling are emphasized.

A large open area in front of the robot and on both sides of selection gates, a pack area with robot access for fresh and lame cows, and robots that all face the same way, contribute to cow comfort.

A split entry holding area, perimeter feeding which allows use of a central handling facility, strategic use of post milking separation, pre-calving training, simple cow routing for fetching and strategic placement of handling and record keeping tools are design factors that will improve labour efficiency.

Open alleys through the length of the barn simplify materials handling.

With less need for labour, and a different work organization it is essential that all tasks can be accomplished by one person working alone.

The capacity for a layout to accommodate logical expansion is also an important design criterion.

A Paradigm Shift

Robotic milking is one element in an emerging shift in direction for the modern dairy farm. It is only one of many examples of systems that use robotics to reduce labour requirements and that use sensor based data collection and computerized interpretation to reduce management requirements. Other precision technologies such as automation of feeding, robotic calf feeding, pedometers, rumination and temperature sensors, and in line sensors that measure components, and metabolic and hormonal parameters in milk will make it possible for a single operator to manage a much larger dairy. Some dairies using these technologies are producing 1.5 to 2 million litres of milk per person per year. But on other farms, failure to properly adapt both management and facilities means only a small portion of the potential benefits are realized.

Some Building and Renovation Principles

Milking robots are compact modular units that require minimal barn space. They can work in almost any location of a freestall or bedding pack barn, and they can be easily moved to a new

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facility in a later phase of expansion. But many renovations involve numerous compromises. Too often we become focussed on overcoming these challenges when the right decision might be to build new. Hence it is highly recommended that in the planning process every compromise be recorded on paper so that prior to construction a final review of the “renovation vs build new” decision can be undertaken.

The four goals or cornerstones that form the foundation of your building project should be cow comfort, labour efficiency, cost and value of the capital invested, and flexibility of the layout for future expansion. Since well managed robot milking barns require surprisingly little labour, almost every successful robot farmer will want to add more cows and machines within five to ten years. Hence the best barn plans will be easy to double in size while maintaining their simplicity and convenience.

One Way Gates

One way gates are used at the entrance to the holding area in a free traffic barn, in the crossover between the resting and feeding areas in forced traffic layouts. An “exit lane” one full cow length long with a one way gate at the end is recommended at the robot exit. The foot bath can be placed in this lane, but its main purpose is to let the cow exit completely before she has to deal with other cows in the barn. This reduces the likelihood that a cow will remain in the milking box after milking and also discourages other cows from approaching the exit side in search of feed. Ideally heifers should be trained to use these gates prior to calving by including one or more in the heifer barn. Saloon style gates consisting of two small gates either spring loaded or designed to close with gravity, will require less training than single bars that span the entire gap, with no opening. Vertical finger gates can be made in any width to provide a one way passage wider than a single cow and may be helpful when fetching several cows from a large group. Wider one way finger gates are also an asset in preventing bottle necks in crossovers in forced traffic barns

Training Cows for Robotic Milking

When starting a robotic milking herd, much of the labour of training cows can be eliminated if cows can have a few weeks of access to the milking box for feeding only, while milking is continued in the parlor. By introducing several cows to the stall and the feed in it when time permits these cows will learn to use the stall and others will follow. Similarly an ideal barn layout will make it possible to provide easy access for heifers about three weeks prior to calving. Familiarizing them with the milking box, with the feed it dispenses and with all of its functions except actual attachment and milking, can greatly reduce the stress on the heifer at calving and the training time required at that time.

Cows Never Leave the Barn

The design of a robotic milking barn must recognize that milking cows never leave the barn. Hence it is never convenient to move cows through the space occupied by other groups, and it is important to locate groups strategically or provide lanes for cow movement. Since the logical labour organization of a robot barn seldom allows for two people in the barn at the same time, cow movement from group to group and to the robot or handling area must be set up to be a one person job. Moving through the barn with equipment to scrape manure or bring in bedding

is also highly disruptive. Hence tractor scraping manure is not an option. Bedding delivery is done less frequently and is a less serious issue but automated bedding delivery systems may still be a wise investment in robotic milking barns. Track systems that apply chopped straw or shavings to stalls are on the market now, but can be dusty and difficult in open windy barns. Belt feeders adapted for delivering bedding to the front of the stalls are also available and auger systems with drop pipes which deliver sawdust/shavings to a central corner in front of four head to head stalls for manual distribution are in commercial use on a farm in British Columbia. Gel Mats, waterbeds or mattresses that require minimal bedding are recommended to reduce the need for bedding. Use of sand bedding will require moving through the barn with bobcats or tractors. To minimize the time involved, layouts should offer straight lines through the barn with doors at each end. Layouts with free cow traffic, wide alleys and multiple crossovers that provide simple escape routes for cows when equipment passes through the alleys are recommended.

Focus on Cow Comfort and Healthy Feet

Both experience and research have shown that well rested cows with healthy feet visit the robotic milking stall voluntarily with the highest frequency. Contributing factors include big comfortable free stalls where feet can dry while the cow rests, floors that drain liquids away from the claw, and cleaning systems and layouts that keep cows' feet clean and dry. With respect to alley scarpers, short scraper runs, wide alleys and tube scrapers allow the cow greater opportunity to step over the plow without stepping in manure and free traffic barns provide escape routes that help cows avoid the scraper. Stalls and floors that provide good grip prevent injuries that contribute to lameness. Good ventilation promotes drier floors and drier hooves.

Make the Robotic Milking Stall Attractive to the Cow

Ensuring the area around the robot is free of stray voltage by slatting it, or by including an equipotential plane in the concrete is one step toward ensuring cows are comfortable in and around the robot. Ceiling fans above the robot help to cool cows in summer and keep flies away during milking. Rubber on the floor both in the robot and beside it will improve cow comfort as will positioning the stall so that entry is level or elevated 4 inches or less. In robotic milking stalls that restrict the cow's movement with a butt plate and adjustment of the feed manger, it is important to adjust these devices so the cow has adequate space in the stall and can stand comfortably.

Foot Bathing the Robotic Herd

Since hoof health is critical to success in robotic milking the strategic use of an effective foot bathing routine is essential. But it is also problematic. Footbaths placed in the exit lanes of the milking stalls can discourage cows from visiting the robot on foot bathing day. In larger herds with free traffic this could also involve a lot of labour caring for several footbaths for a full day at a time. Experts suggest a good footbath should be at least 10 feet long so cows take two full steps when passing through it. Since many barns have limited space at the robot exit it may be advisable to add a locking feature to the one way gate at the end of the lane, that releases the cow 5 to 10 seconds after she enters the footbath. Some cows, usually the ones with healthy feet visit the robot 7 or 8 times per day, and these cows will get many more passes than lame

cows that need the bath but only show up twice when fetched. In a "tollgate" layout (see figure 4) it may be possible to use a selection gate to send only selected cows through the footbath to avoid the extra passes for the frequent visiting cow.
An alternative method of foot bathing is to build a large bath that is at least 10 feet long and the full width of a cross over at a point far from the robots. Ideally this should be a location where it can be used by all groups of cows in the barn. This bath should be hinged so that it can be stored vertically at the end of the row of freestalls and lowered and filled when needed. Once filled the entire group of cows can be walked through the bath slowly once or twice, before the bath is emptied and cleaned up. Although this does disturb the cows, there are many advantages. It keeps harsh chemicals like formaldehyde and copper sulfate far away from the milk and from the expensive robotic equipment. It increases the effectiveness of the chemicals since there is less exposure time to manure, and it results in a uniform number of passes for all cows in the group.

Fetching Cows
Routing for fetching cows should be simple and logical, ideally so that this task can be combined with cleaning freestalls. When it is done this way fetching requires very little time, however the task grows exponentially if management breaks down and there are many cows to fetch. Gates at the robot and in crossovers should be designed to eliminate escape routes and it should be possible to close and open them along the fetch route without backtracking.

The Barn Office
Robotic milking will increase the amount of management time in the office, so a well designed office is an asset on these farms. Windows overlooking the area in front of the robot, the calving area and the outside approach to the barn will provide an excellent overview of the barn and farmstead. Raising the office floor 2 to 3 feet will improve the view. If you choose a second floor office build it on top of the milk house or over the handling area, so that you can see the area in front of the robots, rather than directly on top of a robot room, where the most important view is obscured. There are two distinct components to working with computer data. One involves sitting down for an extended period of time to manage data, and for this you want a clean comfortable work area with a good overview of the barn. The other involves looking up or inputting task related information, which you will want to do close to your handling area, standing up with boots on. Strategically locating a second computer terminal in the barn, near your work area will make these tasks much more convenient.

Free Or Forced Cow Traffic
Numerous research studies have compared these management strategies. Most agree with the findings illustrated in Table 1. As shown the shortcoming of free traffic is that cows are milked less frequently. Other studies also report that cows in free traffic barns are more likely to require fetching. In one Canadian survey (Rodenburg 2007) free traffic herds reported fetching 16.2% of cows while guided traffic herds fetched 8.5%. In some cases fetching a cow that normally attends voluntarily in a free traffic setting can be an early warning of health problems. Since forced traffic gives the cow just two options (visit and eat or don't eat) such a warning may come too late in a forced traffic situation. Although cows in forced traffic barns were milked more

frequently, the shortcomings of this system involve long waiting times for milking, especially for timid cows and also fewer meals. In some herds, acidosis related to fewer meals and stress from longer standing times have contributed to a greater incidence of lameness. Robotic milking equipment and the management around it have improved in recent years and field experience shows us that excellent results can be achieved with either system. But when management is less than ideal, with forced traffic the cow suffers the consequences, while with free traffic it is the farmer who is most affected. While there is clearly room for personal preference and priorities in this choice, when the choice is between giving priority to labour efficiency or cow comfort I will choose for cow comfort and hence for free traffic.

Table 1. A Comparison of Cow Behaviour with Free and Forced Cow Traffic (Thune et.al. 2002)

	Free	Forced	Forced (with pre-selection)
No. milkings	2.0	2.6	2.4
No. of meals	12.1	3.9	6.5
Average time waiting at robot (minutes/day)			
Dominant Cows	78	140	124
Timid Cows	95	240	168

Space in Front of the Robot and on Both Sides of Selection Gates

A decade ago the basic philosophy in robotic barn design was to guide or funnel the cows toward the robot, by placing it along a route from the freestalls to the manger and eliminating escape routes using gating and narrow passages. Field observation in these barns established that timid cows that required fetching seldom approached the robot voluntarily. Newer barn designs for voluntary milking provide a large open area 20 to 24 feet wide measured from the face of the robot, with access to both alleys, where cows can congregate without fear of entrapment. It would appear that orientation of the robot within this space is unimportant as long as cows can easily see it and the space in front of it, from their resting and eating areas. Since the area near the robot will be populated by cows waiting for milking, computer feeders and cow brushes do not belong in the same area. With the exception of a water trough, other devices should be placed in open areas far from the milking stall.

Just as a large open space in front to the robot is beneficial, forced traffic barns should be planned so that there is open space on both sides of selection gates making cows more confident about approaching them. In rare cases where it is desirable to position cows in a consistent order a single lane will be preferred. One example of this would be a priority lane used only for a small number of timid cows which offers preferential access to the forced traffic milking stall.

Forced traffic barns should always strategically reduce the traffic from cows not eligible for milking in and around the robot, with at least a pre-selection gate at the entry to the holding area and one additional selection point per 60 cows, in a crossover away from the robot area.