Robotic Barn Design Part 2: Principles of Robotic Barn Design on Cow Flow, Cow Comfort and Cow Health

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The Robot Room

Many popular barn layouts feature robot rooms that include more than one robot. While this is convenient for cleaning and servicing it has several disadvantages. Air and vacuum leaks and straining bearings and joints can often be heard before they can be identified in any other way, and they will be recognized and located much easier in a room with a single robot. Both the option to access a robot from more than one barn area and the option of post milking separation become more difficult when there is more than one robot in a room. Back to back robots on a single room will remain the preferred option with the system that services two mirrored milking stalls with a single commercial robot arm, and with the system that features two stalls side by side serviced by a shared arm coming in between the back legs. While post milking separation remains an option with this layout as well as with tail to tail robots, routing that allows further milking visits for the separated cow can be challenging. Robot rooms housing a single robot generally allow greater flexibility in application.

Robot rooms should be ventilated with positive pressure, constructed of easily cleanable surfaces and provided with clean access. An exit door large enough for a cow is recommended since cows have occasionally found a way in. The area around the robot room should be well lit, and equipped with a boot wash and man passes that permit easy movement around the area. Normal work routes through the barn should not require passage through the robot room.

The elevation of the floor in the robot room is somewhat a matter of preference. The cows will be most comfortable if the floor is at the same height as the milking platform. Add a 1 foot wide rubber strip in the room along the edge of the robot, to improve the footing of cows that step off the platform on this side. Lower floors will require a curb along the milking stall so cows feet don't slip into the "pit". Dairymen choose this pit approach to make it easier for them to handle the udder, and manually attach the milker, but in terms of cow behaviour and stress free handling, cows milked robotically are no longer used to this kind of handling and it should be discouraged. Needling and treating cows in the robotic milking stall should be strongly discouraged, because this needs to be a happy place that the cow wants to come back to very often.

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The Fetch Pen

With free traffic layouts a fetch pen or holding area for fetched cows is still required. An area of 80 to 100 square feet suitable for 4 or 5 cows is recommended for use with a single robot. In order to encourage cows to leave it quickly, the holding area should not have access to water, feed or freestalls. Gating is required to direct fetched cows into it with no escape routes. In free traffic barns permanent commitment pens which all cows must access prior to milking create additional stress on low ranking cows who may spend long periods in the pen with no way to leave it except through the robot which is always busy milking more aggressive cows.

Temporary holding pens, some with gates that are removed automatically when the last fetched cow is milked, have been used successfully. But the best option by far for holding and training fetched cows in a free traffic barn is the split entry holding area pioneered by DairyLogix. As shown in Figure 1, the holding area is used only for fetched cows who access the robot via a lane immediately beside the milking stall. Cows from the main barn area can still access the robot at the same time via the split entry feature.

Using this system, timid fetched cows are not stressed by boss cows coming through the fetch pen. Using the crowding gate attached to the corner of the robot room, one person can easily crowd a new heifer into the robot entry area and push her in for her first visit. Subsequently the heifer can be cornered by this same gate with a chain behind her to encourage her to go on her own. This can be followed by voluntary entry from the fetch pen which gives her a slight advantage since the robot opens to her first, and later she will likely move on to complete voluntary attendance quite quickly. Since cows in the herd have access even when fetched cows are in the holding area, the farmer can leave the barn. With other holding area designs that deny access to cows in the main herd, most farmers will end up pushing a reluctant fetched cow into the robot thus teaching her more bad habits. Split entry holding areas can also be used effectively to permit access to the robot from a separate group housed behind the robot. Farmers who have a calving pen behind the robot benefit from this layout because it is easy to move the fresh cow to the robot for milking. They benefit again when the cow is in the main herd and returns to the holding area in search of her calf.

In traditional forced traffic barns with pre-selection cows eligible for milking are directed into a commitment pen, which they can only leave via the robot. The pre-selection gate already prevents these cows from going to the "other half" of the barn. There is no reason to also prevent them from having the freedom of the entire half they are restricted to. With strategic gating the commitment pen in these barns can be designed so it is only used when training a new animal.

Special Needs Area Behind the Robot

After calving it may be beneficial to keep the fresh cow separate from the main herd for 1 day to two weeks depending on her health and condition. Lame cows also benefit from separate housing to shorten their walking distances and permit greater rest in a lower stress environment. Ideally these cows should be housed in a well bedded pack area with 100 square feet of pack per cow. If this area is close to the robot and offers voluntary access many of these cows will go for milking on their own. If they do not, fetching them involves minimal time and walking distance for both the cow and the operator. This is probably the first and most valuable use of the “second group” option.

Handling Cows in a Robot Barn

Handling cows in a robotic milking herd for breeding, pregnancy checking, vaccinations, treatment, clipping hoof care etc. presents very unique challenges. In parlor herds, cows receive close scrutiny in the parlor, and they can easily be identified and sorted from the herd over a short time span in the return lane. Since they are hungry after milking, when they return to the barn they lock themselves into headlocks for handling at the manger.

In a robotic herd, milking times cannot be predicted, so sorting a cow or group of cows at milking will require up to 15 hours of lead time. Hence a good sort pen must provide the sorted cow with feed, water, a place to rest, and the opportunity to return for additional milking. Headlocks for robot barns are equally problematic because without a period away from feed many cows are not interested in going to the manger when fresh feed is delivered. As a result many robotic milking herds do treatment work by crowding cows into freestalls, chasing them into headlocks, or fetching them into the holding area strictly for timely separation. This aspect of robotic milking management is perhaps the least well defined in terms of what is an ideal handling system that minimizes operator labour and stress on the cows. Many advisors have come to the conclusion that the only viable option for handling in robotic milking herds is to include headlocks throughout the barn. Headlocks do offer a very efficient way to perform specific tasks, especially singing udders to remove excess hair. Most robot herds do this 5 or 6 times per year to increase the cleanliness of the udders and accuracy laser teat location and attachment. But just like handling and treating cows in the parlor or robot is ill advised because this is not a good place for bad experiences, the manger should be a welcoming area that cows are happy to go to often to eat large amounts of feed. Except for flaming udders, handling cows in headlocks always involves restraining and stressing cows you don't need to handle unnecessarily.

Although experience with such systems is limited, barn designs that include a large separation area offer the option of not using headlocks in the main milking cow section of the barn. This area must be designed so that cows can be directed to it from all robots, and so they can be housed for 12 to 15 hours with access to feed, water, a freestall and robot access for additional milking. It also has to provide convenient access to a working chute before returning to their main housing areas. For activities like reproductive herd health, where it is cost effective to always have the next cow ready for the veterinarian it may even be beneficial to have two working chutes side by side, or alternatively it may be desirable to include a palpation rail beside the separation area for group handling cows for flaming udders or reproductive exams. This handling area should also incorporate excellent lighting, equipment storage, hot and cold water, and a desk and computer for dealing with treatment records.

If dry cows are also housed behind the robots a freestall area with flexible gating that can be moved could be used to provide a lot of dry cow space and a few separation stalls on days when minimal sorting is taking place, and with the gates relocated, this same area could crowd the dry cows for 12 to 15 hours on days when a large group is being sorted for example for reproductive exams. This is probably the second most valuable use of the “second group option” It is tempting to revert back to headlocks for group handling in the separation area, but if cows do not see headlocks routinely in the milking barn, they may resist using the in this area that is already less familiar to them. If the separation area makes strategic use of flexible dry cow space along the manger, this area can provide room for very convenient headlocks, but if

the presence of headlocks here discourages close u dry cows from eating it could have detrimental consequences. From the standpoint of cow comfort, for group handling in the separation area either two chutes side by side or a palpation rail are more desirable options than headlocks.
A third use of robot access from a second group would be to allow voluntary lead feeding and training of heifers and inexperienced cows prior to calving as discussed earlier. In a barn with three or more robots in individual rooms surrounding a central handling area, all three applications can be included. With the exception of the robot that milks from the rear, which allows cows to enter and exit on either side, single box systems that are used to milk a second group usually involve a ninety degree turn in the exit lane for cows going to the separation pen or straw pack. Since this is the likely exit route for fresh and lame cows, efforts should be made to make this turn more gradual if possible.

Perimeter Feeding
Moving cows from several different groups to a central handling facility or to a separation area is simplest if cows do not have to cross a feed alley in the process. Hence robotic milking barns lend themselves well to layouts with perimeter feeding and all cows and robots located centrally. Perimeter feeding also keeps rain, sun and frost out of the cow areas further enhancing cow comfort. Some perimeter feeding barns have attempted to feed across the ends of the barn as well, but lost manger space in the corners, and at entry gates and the need for additional crossover width to accommodate water troughs across from mangers makes this somewhat impractical. It is advisable to include a 6 to 8 foot wide alley across at least one end to permit crossing over inside the barn to push up feed with a garden tractor or robotic feed pusher, or for feed delivery with a robotic system.

Robot Orientation
In a field survey of 11 herds in the Netherlands and 1 in Canada, where cows could access more than one robotic milking stall, it was found that with a variety of layouts 39% of cows used both robots 40 to 60% of the time, defined as “cross use” and 20% of cows used either one or the other robot more than 90% of the time, defined as “selective use”. In a comparison of layouts it was found that selective use was lowest when all robots faced the same way (Gerlauf et. al. 2009). We have also observed that when cows are moved from one group to another they adapt much easier if the robot in the receiving group is oriented the same as their previous experience. Hence we recommend that all robots in a dairy be oriented the same way where it is practical to do so. Back to back robots in the layout commonly described as a "tollgate" do exhibit reasonable cross use and can be a viable alternative that involves robots with opposite entry points. In a 4 robot barn using the "L" layout described later, using two left handed robots in one group and two rights in the other makes it easier to direct cows to a central handling area.

Group Size and Grouping Strategy
Although a growing number of herds have experience with group sizes ranging from up to 60 cows with one robot to up to 180 cows in a single group accessing three robots, there are no really clear answers on what is ideal. Similarly herds that have the option to group cows may opt

for early and late lactation groups, first and later lactation groups or they may include animals of all ages and stages of lactation. Benefits of keeping groups small and accessing a single robot include easier identification of fetch cows and easier fetching, more stable and simpler group dynamics and higher recognition of all group mates by cows. Benefits of two robots in a group include shorter waiting times and less disruption from washing or maintenance work. Benefits of three robots include simple barn layouts in bigger six row barns. Benefits of grouping by stage of lactation include reduced grain feeding in the TMR to lower producers, allowing more feed in the robot and better attendance, and the ability to reduce feed cost and prevent over conditioning. Benefits of grouping by age include more uniform cow size and the option to vary stall sizes accordingly. Since the answers to these questions are not entirely clear, flexible layouts that permit variation in grouping strategies may be preferred. In a two robot barn, perimeter feeding increases the ability to vary group size and choose between having two sixty cow groups accessing one robot each or one 120 cow group accessing both robots. Experience today seems to suggest that 120 cow groups of cows unselected for stage of lactation or age with access to two robots is the most practical approach to grouping.

Putting it All Together

Figure 1 presents a free traffic barn layout that includes many of the capabilities discussed above. In order to illustrate handling areas in a larger scale the ends of the barn are not shown. As illustrated in Figure 2 and Figure 3, this basic two robot barn can be expanded to up to 4 robots while retaining its handling area at the left end. By mirroring this barn to the left 8 robots with central handling are possible. A number of barns have been built using this basic “DairyLogix” design for 2, 3 and 4 robots in Canada, the Netherlands, Denmark and Finland. It is our goal to learn from the experiences of these producers and to continue to refine the concept to further enhance labour efficiency and cow comfort as we continue our quest for the ideal robotic milking barn.

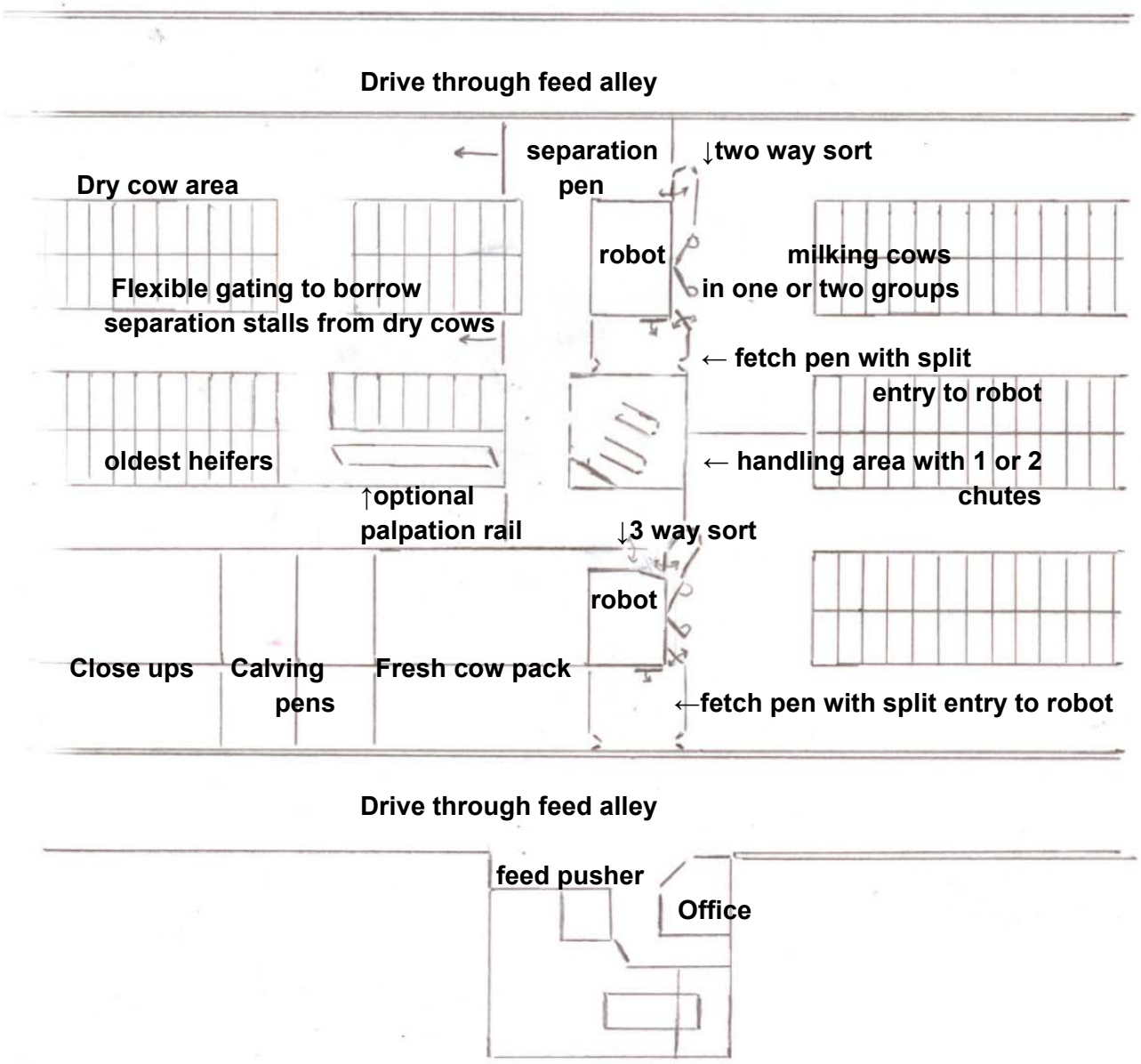

Figure 1. The robot and handling area of a 2 robot barn

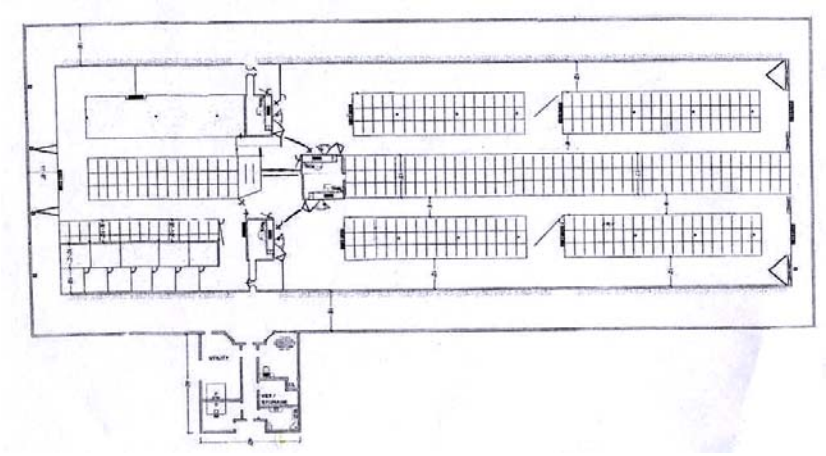

Figure 2. A 4 robot layout with handling and special needs on the left and two groups of 120 milking cows on the right.

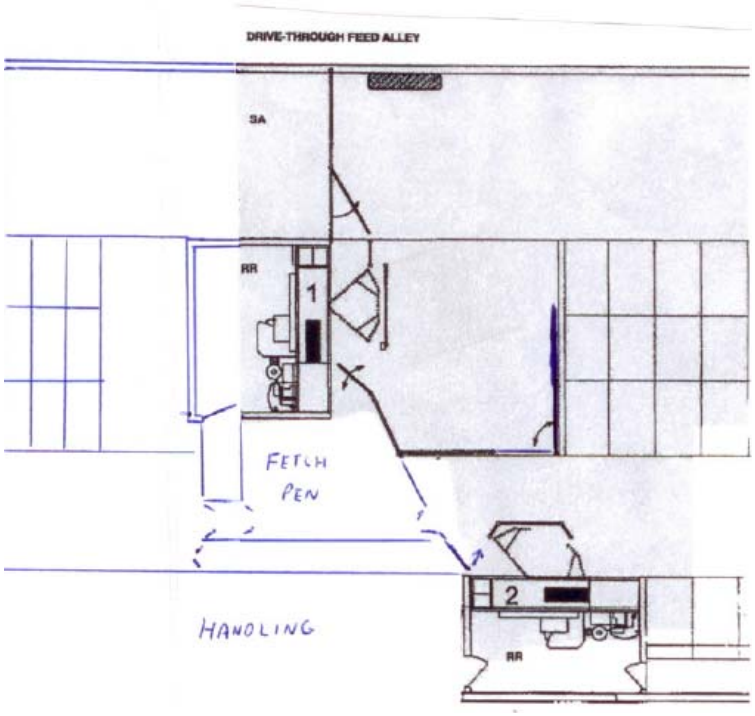

Figure 3. An illustration of two robots in one 120 cow group in an L formation. Cows from robot 2 can be separated through a lane or through the fetch pen and robot 1. Separated cows have access to robot 1 for milking.

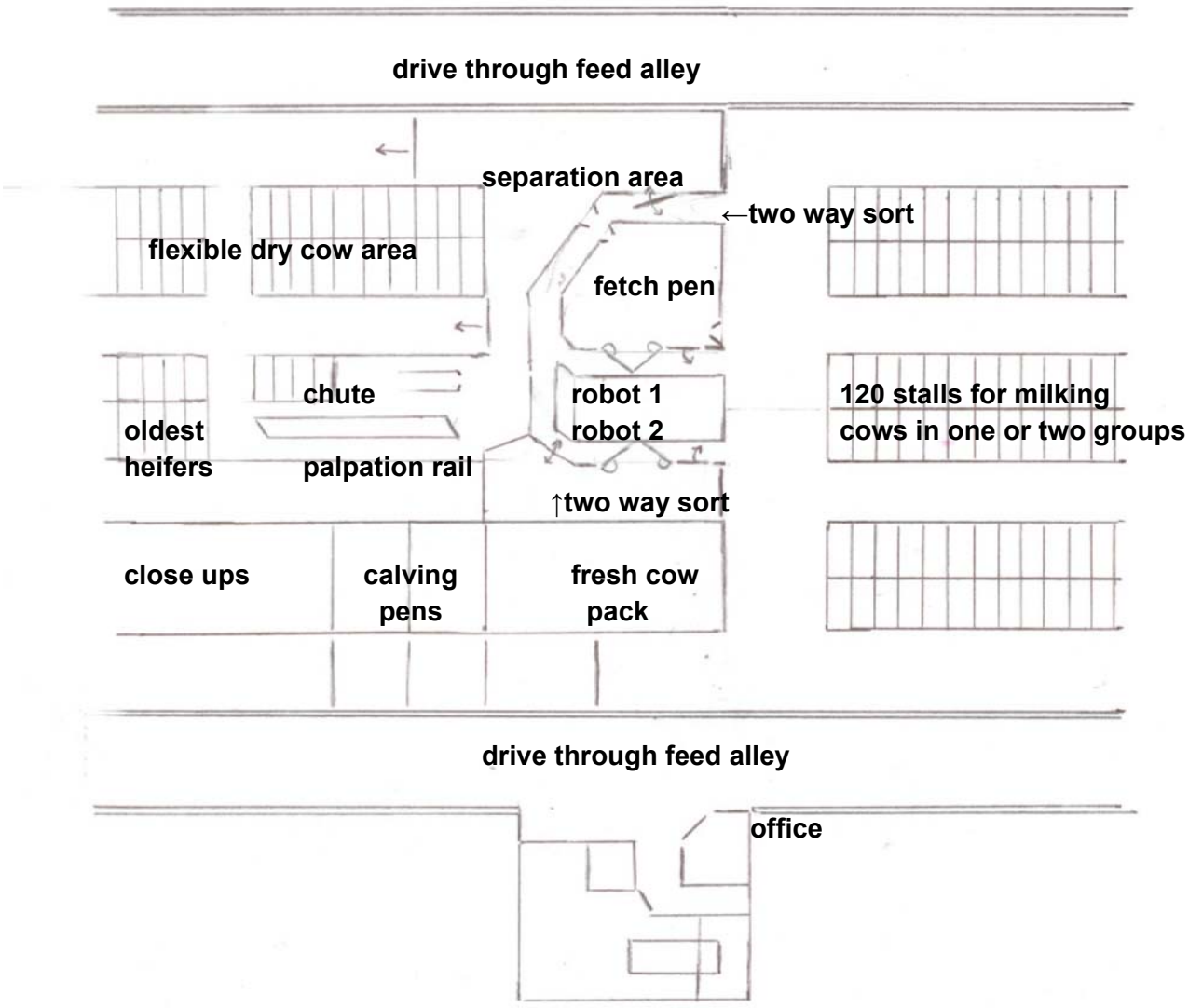

Figure 4. An illustration of two robots in a "tollgate layout"

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