Large Dairy Development and the Role of the Veterinarian

Jack Rodenburg, Dairy Planning Consultant,
DairyLogix, 814471 Muir Line, RR# 4, Woodstock, Ontario, Canada
www.dairylogix.com

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As part of the rapid expansion in world markets for dairy products currently taking place, numerous new large dairies milking 300 to 10,000 cows are under construction and in the planning stages throughout the world. While such dairies have been part of the North American industry for many years, their rapid development in China, Eastern Europe and the Middle East suggest that there is a growing need for sound and practical advice in the area of design and subsequent management for such facilities. Such advice will need to focus on taking the broad principles of efficient dairy design, established through experience to date and adapting them to the local situation. Local variables that influence the final design and management include a wide variety of factors. These factors include agronomic considerations such as the use/non use of pasture, as well as climate in terms of the need to address heat stress and/or freezing conditions. Labour costs, the skills of the labour force and the local culture attached to farm labour will also influence design and will be a dominant influence in management protocols. Since an estimated 40% - 50% of the labour in large dairies is milking related, the introduction of robotic milking as a viable alternative, particularly where labour costs are high, represents a major new challenge for dairy planners. Other factors such as local infra- structure and environmental impact will also play a role in both design and management.

Ideally the planning of both the facility and the management protocols for new or expanding large dairies will result from a team effort. The team will consist of dairy producer/owners, engineers, building contractors, equipment suppliers, investors or lenders, and herd managers. A common weakness in many dairy development teams is that, except for the herd manager and owner, most of the team members will be “structure and hardware” oriented, rather than “function” oriented. Good dairy development plans always start with goals related to “function”, making it imperative that the team be focussed on how the facility will work in terms of flow of cows, people and materials, rather than what it will look like. As a “function” oriented development team member, a proactive and knowledgeable veterinarian can contribute value to such a team in a variety of ways. A veterinarian with large herds experience can ensure that facilities and protocols result in effective animal health management which can be accomplished with labour efficiency and minimal stress for both livestock and farm workers. The veterinarian is also a logical spokesperson for the cow, and should be prepared to ensure that cow comfort and welfare are given priority. A practical local practitioner can play a critical role in ensuring that local variables including disease pressures, climatic concerns, and other factors are not ignored by the “international experts” that often have a more prominent role on the development team. Every dairy development team should include a veterinarian specialized in large herd management, and if this team member is unfamiliar with local conditions, it should also include an experienced local practitioner.

Every plan for the development of new dairy facilities is built on four “corner stones”. As in all buildings, unless each corner is fully able to support the stresses placed upon it, failure is inevitable. The four “cornerstones” in the development of large dairies are:

1. Cow Comfort
2. Labour Efficiency
3. Cost/Value
4. Expandability/Flexibility

A good dairy development team will ensure that each of these aspects of the project, each of these “cornerstones” is given adequate attention to provide a strong and balanced foundation for the project.

Cow Comfort

In large dairy development, the veterinarian is the management team expert on animal health. Taking a leading role in cow comfort aspects of barn design and management is a natural extension of this role. In the last decade, great strides have been made in the study of voluntary or “natural” behaviour in dairy cows with a focus on designing facilities that permit expression of such behaviour. This work has demonstrated that length and frequency of lying bouts and total resting time are strongly linked to stall design, and that comfortable stalls result in a lower incidence of lameness. A comfortable freestall consists first and foremost of a base that provides good grip during the process of lying down and standing up, combined with a reasonable degree of softness and resiliency for the recumbent cow. A dry bed which supports minimal growth of bacteria is critical to maintaining a high standard of udder health. With these criteria, sand is clearly the preferred stall base. Deep packs of organic bedding material provide excellent comfort but in North America these organic bedding systems are associated with a high incidence of mastitis. Some stall mattress systems including dual chamber water beds and combinations of constructed rubber, rubber crumb and felt are likely adequate but anything less than the best of these commercial products will not support normal resting times of 12 to 14 hours per day. The need for appropriate free stall design, particularly adequate stall length with a large open “lunging space” from bed level up to a height of 80 cm is also a well researched and accepted concept. Specific stall dimensions and details should be a function of cow size. For guidelines, the reader is referred to http://www.omafra.gov.on.ca/english/livestock/dairy/facts/info_fsdimen.htm which outlines recommendations originating from field experience in Ontario, Canada. Lastly the number of stalls available to a group of cows will also influence cow comfort. Since cows spend 50% to 60% of their daily time budget lying in stalls, some crowding of up to 10% more cows than stalls is not likely to be of concern. Despite this, there are a number of countries that require one stall per cow under animal welfare regulations. Crowding also reduces manger space and rather quickly increases the number of cows standing in alleys, which may interfere with cow movement. In terms of manger space, the need for adequate space for all cows to eat at the same time, which is their clear preference when given the opportunity, leads to a preference among many advisors for layouts with 2 rows of free stalls along the manger. Research data supports that this increases eating time. Since the space required for a cow to stand comfortably is more than half the width of a freestall, plans that include several wide crossovers will ensure there actually is manager space for all cows to eat at once.

The choice of a basic barn layout also has major implications for cow comfort as well as building costs. Recommendations for alley widths are usually based on the various directions of cow flow. Alleys with only cows backing out of stalls and lateral traffic are narrowest and those with cows standing and eating, backing out and moving laterally are widest, as follows:

- between an outside wall and a freestall 2.4 – 2.6 m
- between two rows of freestalls 3.0 – 3.2 m
- between a row of stall fronts and a feed manger 3.6 – 3.8 m
- between a row of freestalls and a feed manger 4.2 -4.4 m.
- in a crossover with a water trough 4.2 – 4.4 m

But while these dimensions theoretically permit the desired cow movement, they still result in wide variation in barn space as follows:

	Total m^2	Alley Space m^2	Manger Space m	Distance Stall to Wall m
6 row center drive through	8.35	4.43	0.54	0
6 row outside feed alleys	9.13	4.43	0.54	9.0
4 row tail to tail	10.20	5.29	0.71	0
4 row head to head	11.15	6.92	0.79	2.4

These differences affect both cow comfort and building costs. The preferred 4 row head to head layout has more than adequate manger space for all cows to eat at once and has 33% more total floor area, making it the most costly barn on a per stall basis. However, it is also the narrowest and has the lowest cow density, making it the easiest to ventilate. Note that there is 56 % more alley space in this barn than the six row barns. This will be reflected in much lower manure density on the floor as well as in lower cow density and more "escape room" for the timid cow. The 4 row head to head barn is especially effective in this regard because outside alleys have only half the cow traffic. High ranking cows are most likely to occupy the inside stalls close to the feed manger, dramatically reducing the number of confrontations between cows in these barns. With alleys along the outside walls, this layout also results in no rain and less sun in the stalls.

In large herds, appropriate sized groups that can be milked in one hour and the provision of a holding area so that groups are undisturbed except at milking, are critical to both cow comfort and efficient work organization. The holding area also allows stall maintenance work to be done while cows are away being milked. Since it is usually timid cows, fresh cows new to the group, and lame cows that are milked last, ensuring that milking time is under an hour is critical to the comfort of these cows. Providing a small, separate group in very comfortable housing facilities for a small group of fresh and lame cows close to the parlor so they can be milked without waiting, is also very valuable.

The other major element in the "cornerstone" of cow comfort is climate control. Choices such as tunnel or natural options, barn orientation, side wall height, fans and or sprinklers for additional cooling, and ceiling insulation will be strongly influenced by the local climate, making team leadership in this area a logical priority for the local practitioner on the team.

Labour Efficiency

On a typical large dairy, milking represents 40 to 50% of the total labour requirement, making the choice of milking system the first and largest element of this "cornerstone". While the intricacies of parlor selection and design are beyond the scope of this presentation, a knowledgeable veterinarian with a thorough understanding of milking routine and its impact on milk quality and udder health, can and should make a contribution to the parlor selection decision and to developing management protocols for its day to day operation. As a guiding principle, the parlor selected should provide the best possible balance between labour efficiency and capital investment. Since one operator in an automated 2 x10 to 2 x14 pit parlor or an inside rotary can milk 80 to 110 cows per hour, and parlors are most efficient when they operate up to 20 hours per day, 3x herds of up to 500 to 700 cows and 2x herds of up to 800 to 1100 can maximize their efficiency with one milker per shift. Herds that are smaller than this face the difficult choice of reducing labour efficiency by reducing parlor size and degree of automation, or under utilizing their capital investment as it sits still for several hours per day. Particularly where labour costs are high, herds in this situation may increasingly turn to robotic milking as the more viable option. In western Europe as well as in Canada, there is little doubt that robotic milking is competitive in herds up to 240 cows now. Larger herds also need to rationalize their parlor choice with the capabilities of 2 or more milkers. In very large herds in North America, 60 to 72 stall external rotaries manned by 3 to 5 milkers are a common choice on dairies up to 3000 cows. Field studies in Ontario suggest commercial farms with pit parlors of 2 x 8 or greater operated by one milker, achieve an average throughput of no more than 4 turns per hour. Throughput is often over estimated in the planning phase with the result that group sizes in the barn end up too large and in some cases a (very inefficient) second operator is added to ensure that the expected throughput is realized. Perhaps the ideal role for the veterinarian in parlor planning is as the voice of reason that ensures that the capabilities of the staff are not exceeded and that a good milking routine can be achieved within the expectations for throughput. Since this routine will clearly influence parlor size and the selection of some of the equipment, milking routine and protocol should be established early in the planning process.

On large dairies, the second biggest contributor to labour (after milking) is the handling of individual cows or special groups of cows for the application of treatments, examinations and management tasks. The time invested in these activities is highly variable depending in part on the incidence of disease. In this sense, the cornerstones of cow comfort and labour efficiency are strongly linked because stress free cow environments lead to healthy cows which lead to less labour for handling and treatment. Since many of the handling functions involve veterinary attention, veterinarians on the planning team should take a lead role in this aspect of facilities design. The focus here needs to be on systems that result in humane restraint and minimal stress for the animals being handled, minimal interference with the rest of the herd, and minimal labour and a safe working environment for the handlers. As with most facilities' design issues, the planning process should start with function. In this case, the planning team should make a list of all the handling functions they can identify, such as

1. insemination
2. reproductive/pregnancy exam

3. injection/vaccination
4. change groups/cull
5. dry off
6. sick cow examination/treatment
7. hoof trim
8. calving
9. other handling activities

The design of the handling facility needs to be critiqued in relation to its ability to deal with each of these functions for each group of animals housed in an efficient and low stress manner. Self locking headgates are one option which works well for functions 1, 2 and 3 above. They can work, but not well for 4, 5 and 6, but they are of no value for hoof trimming or handling at calving. Headlocks restrain all the cows and do not identify them. In large herds with large cow groups, identifying locked up cows and taking treatment to them is time consuming and in most cases requires at least two people. Even cows that are not needed are restrained and stressed, sometimes for several hours. Headlocks do not work well when there is not enough manger space for all cows, and the cost increases linearly with herd size. The better alternative for large herds is a sort gate, and handling and treatment area adjacent to the parlor. This system saves labour because identification and sorting is automated, and only cows needed for treatment are disturbed. Sorted cows are housed temporarily in a pen and handled in a headgate, trimming stall or management rail and then returned to the group they originated from. Well thought out efficient cow routing starting with a single exit path from the parlor (this means pit parlors should have one side cross at the front) is essential to such a facility. To be fully automated, herds with many groups may need several automated sort points so that a handled cow always ends up in her group of origin. The handling facility should also be equipped with a "vet room" with a computer terminal, drug and equipment storage, and hot and cold water.

Other major elements in the labour efficiency cornerstone involve the handling/delivery/removal of feed manure and bedding materials. In large dairies, these functions will be mechanized and will involve large equipment. Ideally, the facilities design will make it possible to complete all of these tasks in a minimum number of straight lines through the facility.

Cost/Value

The third cornerstone of a dairy development plan that is equally essential to its success, is the management of costs to ensure the project is financially viable. Facilities that provide the ultimate in cow comfort and labour efficiency will have low operating costs and high productivity, but if the capital investment is too high, the project will surely fail. In my experience, the planning team members responsible for the money side, such as owners, investors and lenders, will work hard at keeping investment low, while engineers, builders and equipment suppliers will often encourage greater spending. Team members with no direct capital interest can ensure that the concept of investing beyond the minimum in high value elements is appropriate if a payback can be anticipated. There is no question that a focus on cow comfort will add cost to the barn. For example, in Ontario, Canada, the 4 row head to head barn with 33% more floor space than a 6 row barn would cost about $300 per cow more to build. If this investment is repaid at 16% per year over the life of the facility, it represents a cost of $0.14 per cow per day. This cost can be recaptured with the profits from roughly 1 extra litre of milk, or with the savings from culling 2% fewer cows, or with 24 seconds less labour per cow per day. Although it will be impossible to guarantee higher returns, herd management specialists such as experienced veterinarians add credibility to concepts that may increase costs but which will improve profitability through improved productivity and animal health.

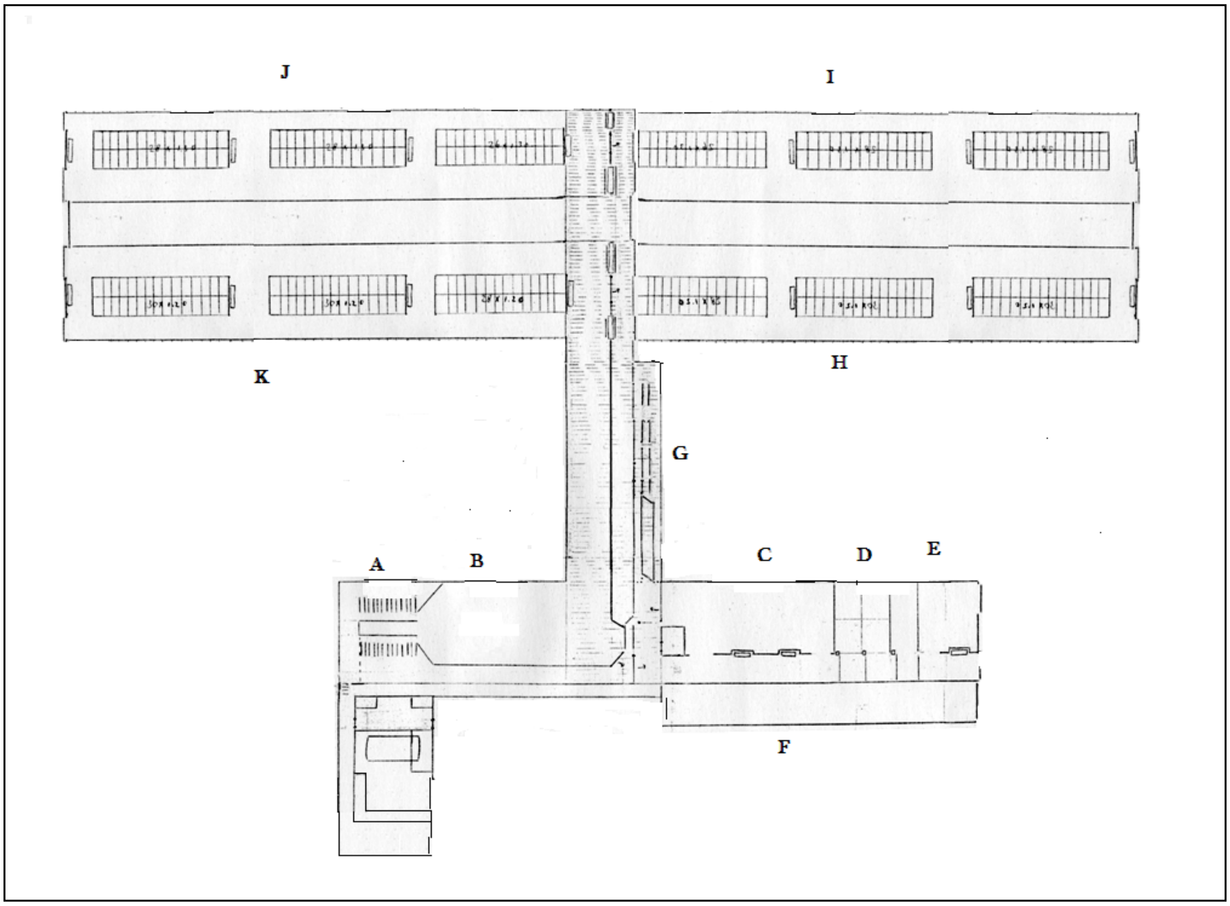
Expandability/Flexibility

The fourth cornerstone in dairy development, and the one which is most likely to be neglected is the recognition that this stage of development may not be the last. In my experience, most successful development plans become stepping stones to further expansion. Very large dairies may be the exception to this. Particularly in the case of rotary parlors, if the initial plan fully utilizes the parlor capacity, any future growth will need to be in the form of an entirely new facility. For example a 3000 cow dairy with a 72 stall rotary, milking 350 cows per hour is already at its capacity, and will not quite achieve three milkings for all cows. Any further expansion in a herd like this would have to be in the form of a second parlor, and perhaps this makes a second dairy on a separate site the more attractive altenative. For any situation where the parlor is under utilized or where expansion of the parlor is a logical option, it is important to have an expansion plan in place before you build the original facility. Where expansion is anticipated, the team should probably choose a design for at least twice the current size. When the cow comfort, labour and cost issues of this over sized barn are fully addressed, it should be possible to set half the drawing aside and build for the currently proposed cow numbers. With the expanded version on file, there will be assurances that future expansion will not create bottle necks or other management concerns. In my experience in Canada, many dairies have limited potential for expansion, because property boundaries, manure pits and bunkers are in the wrong spot, or the existing layout limits the options.

The Four Cornerstones in a Parlor Barn

The layout at Figure 1 is presented as an example of a practical barn and parlor that has been developed with appropriate attention to each of the four cornerstones. The 2 x 10 parlor at A is projected to milk 90 cows per hour with the milking protocol established for this herd. It has a front cross over so that all cows return by a common route. A group of fresh and lame cows housed in the bedding pack at C is milked first so they have no waiting time in the holding area B. A sort gate in the return lane directs these cows back to their pen after milking. The main herd is housed in 4 - 90 cow groups that can be milked in 1 hour each. They are housed in a low stress 4 row head to head layout with crossovers after each island of 15 stalls. If groups are milked in the order H, I, J, and K, they never cross paths. Once group H is in the holding area, gates can be set for group I to come up on their own so that only the last few cows in the group need to be chased up. On the return route from the parlor, cows can be sorted into a temporary holding pen and then into the management rail, hoof trimming stall or head gate at G, which are located along their route back to the cow groups in the barn. The bedding pack at E is a calving area and the pack at D is housing for close up dry cows, so that movement across these three areas is convenient. The vet room is located adjacent to both the calving area and the handling facility. If it is desirable to include far off dry cows in this barn, additional freestalls could be included in the area below drive through feed alley F. Note that manure and feed moves in simple straight lines in both the pack barn for special needs cows and in the main freestall barn. To double the herd while using the existing parlor, add an identical barn toward the top of the page by continuing the slatted cross alley. The special needs barn can be lengthened to accommodate more animals as well. To increase the size of the parlor, extend it to the left and then increase the length of each barn section to increase the group size to the new number of cows that can be milked in 1 hour. This expansion step is somewhat problematic because the holding area cannot be enlarged, but this can be addressed by holding some of the cows in the passageway and loading the holding area twice per group.

Figure 1 A typical layout for a 360 cow freestall barn with a 2 x 12 milking parlor

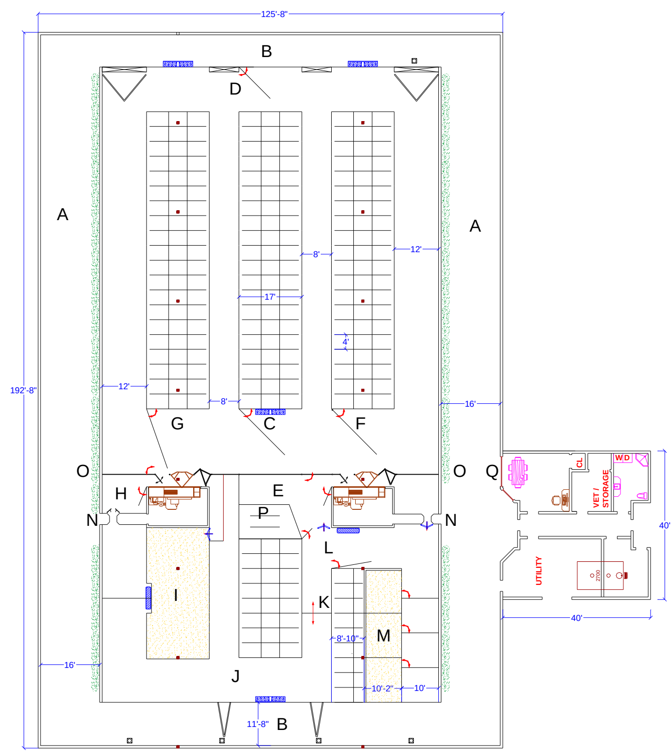


The Four Cornerstones in a Robotic Milking Barn

The layout at Figure 2 is presented to illustrate an example of a robotic milking barn that pays attention to cow comfort, labour efficiency, particularly in handling as well as to expandability. Because cows of all ranks must voluntarily approach and use the milking stalls, a large open space with a width of 16 to 24 feet in front of the stall encourages high traffic. Since cows never leave the barn, cleaning alleys with mechanical scrapers, a flush system or slatted floors is much less intrusive than tractor scraping.

Because cows are never routed to a parlor, cow movement from group to group at calving or dry off requires logical routing. Holding pens for fetched cows should be designed with a split entry to the robot so that they are exclusively used by fetch cows. Many other design issues are as yet unclear for this relatively new technology. For example, in larger herds cows can be grouped in groups of 60 with a single robot or larger groups with multiple robots, and groups can be structured randomly or by age or stage of lactation. Since there are so many unanswered questions, and since the barns we build today will be in use for several decades, flexibility in design is an important attribute for robotic milking barns. Figure 2 is a concept layout of a robotic milking barn for 120 milking cows and dry cows that combines many of the desired attributes as well as the flexibility to allow different grouping strategies.

Figure 2   A Flexible Robotic Milking Barn design for 120 milking cows and dry cows.



This plan includes 120 freestalls in 6 rows with drive through feed alleys on the outsides of the barn. This layout allows the cows in the main freestall area to be handled as one group with no gates, or as two groups with gates at both ends of the center double row of stalls. Both robots face the same way to encourage cows to use both without confusion or additional training. Ontario field experience suggests a large open area in front of the milking stalls enhances cow movement in the barn. This open area also makes it easier for cows to negotiate an exit route to either resting or feeding areas, regardless of the orientation of the milking stall. With 4 foot wide freestalls, a 12 foot crossover at the end of the barn and a 20 foot open area in front of the milking stalls, these plans provide 2 feet of manger space per cow for 56 cows per side along the drive through feed alleys at A. Since ideal handling methods for these barns are poorly defined and since headlocks may well play a role in future management schemes, it is tempting to widen the crossover an additional 4 feet to provide space for one headlock per freestall.

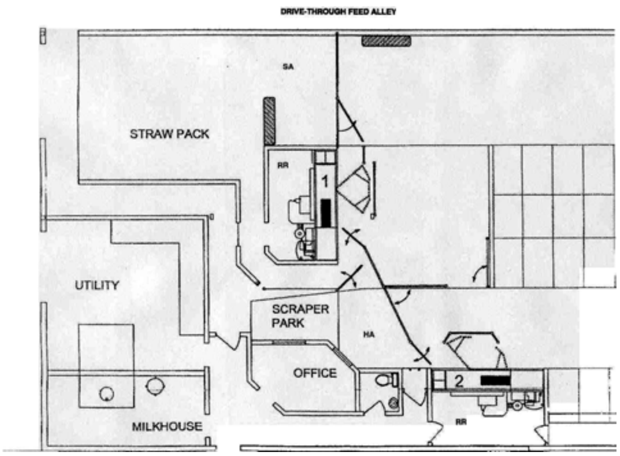
Feeding from two drive through alleys on the outside of the barn is more work than a center drive through, but makes it possible to handle the herd as one group and makes cow movement between groups and work among the cows more convenient. The outside drive alleys also keep rain and sun out of the cow area. Narrow cross alleys B at the ends of the barn permit workers and small equipment to travel around the perimeter of the cow area to push up feed. If alley scrapers are used, manure drops at the end farthest from the milking stalls and a place to "park" scrapers out of the traffic area can be incorporated under this alley. If slatted floors are used, the 24 foot post spacing is compatible with under the barn manure storage. Gates at C and D can be used to divide the herd into two 60 cow groups. To fetch cows into holding area E, close gates C and F and clean the freestalls in a counter clockwise direction, keeping fetched cows ahead of you. Close gate D when you come to it and complete cleaning stalls in this half of the barn. Repeat this in the other half of the barn by closing gate G and opening gate D as you pass it. Once the fetched cows are in the holding area, all gates can be opened. Since the holding areas E and H are only used to house fetched cows, access to the milking boxes for other cows via the "split entry" is unrestricted. High ranking cows from the main milking groups are kept out of the holding areas, reducing stress for the usually more timid fetched cows. Note there is a gate in the holding area behind each milking stall which can be used to direct and "squeeze" an inexperienced cow into the milking stall.

A bedding pack for fresh and lame cows at I has access to the milking stall beside it through holding area C in Figure 1 and F in Figure 2. With a post milking sort gate, these cows are returned to the pack. Far off dry cows housed in the freestalls in the center area J have manger access beside the cows in the bedding pack. A movable gate in the interior alley at K separates far off dry cows from close up cows in area L, which eat at the manger behind the other milking stall. The close up cows have free access to the milking stall beside them for lead feeding and training purposes, and a post milking selection gate will return them to their pen area. At calving, close up cows can be moved into one of three bedded pens in area M.

Clean access to the milking stalls is via a bridge with a 36 inch gap at N. To segregate and restrain a cow for individual handling, she can be fetched into the holding area, and post selected through the milking stall. If the bridge at L is gated, the segregated cow can be restrained in a headlock at O, treated and released back to the main barn. Handling and especially hoof trimming, could also be incorporated at P, a spot that is readily accessible to all cow groups. Cows can be easily moved from group to group through a lactation cycle, and all feeding is along the two mangers on the sides of the barn. The bedding pack and calving pens can be cleaned from the end of the barn. The office gives a good view of both the area in front of the robots and the calving area. With a sliding window at Q and a turntable for the computer screen and keyboard, clean and dirty access to the computer can be provided.

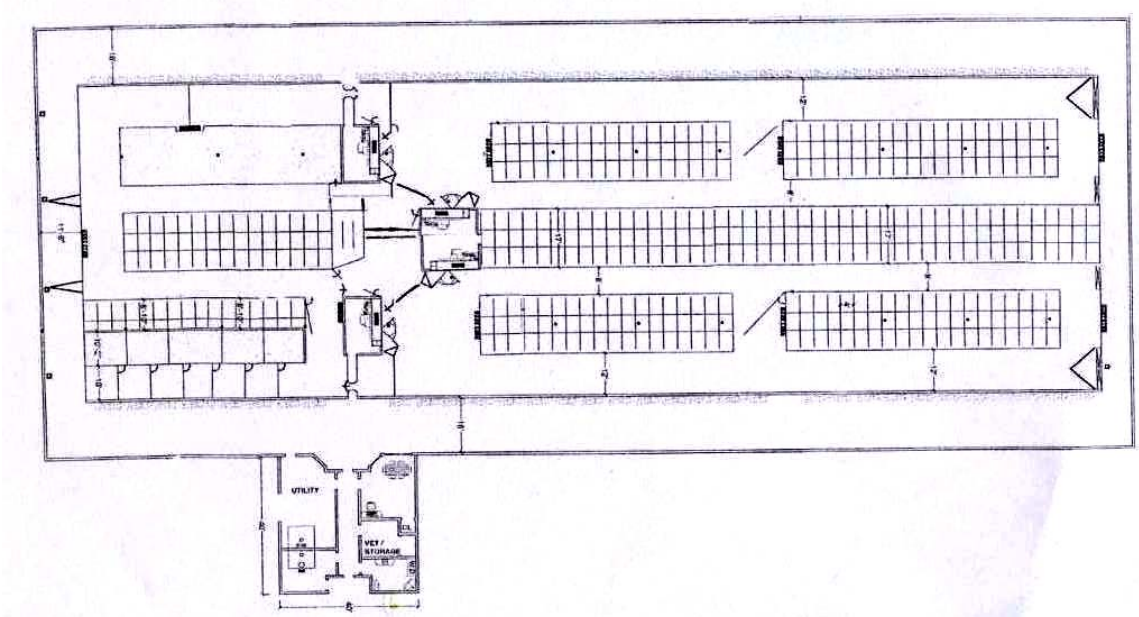
To double the herd size, three options are suggested. It is possible to mirror image the barn on the end used for dry cows, and create a barn with 4 robot rooms, located at the corners of a central handling area. Moving far off dry cows to another facility would keep the central handling facility more compact. This option leaves all the grouping possibilities intact, but it does require clean out of the bedded areas from the side of the barn. Back to back milking stalls with no separation and handling facilities combined with another barn with at least one milking stall set up for training and handling, is a second option. If the choice is made to work with a minimum group size of two milking stalls and 120 cow groups, Figure 3 provides a configuration combining two same sided milking stalls. Fetched cows collected in holding area HA are milked in milking stall 1. Separation cows milked in stall 1 are sorted into separation area SA, and can access the holding area and milking stall via a lane behind the robot room. Cows separated in milking stall 2 sort into the holding area, are subsequently refused in milking stall 1 and directed into SA.

Figure 3 An ideal layout for two milking stalls in a single group of cows



In Figure 4, this configuration is used to double the length of each end of the barn, and add a single robot room with two back to back milking stalls. This layout could also be mirrored so that 480 cows milked with 8 robots access a central handling facility in the middle of the barn.

Figure 4 An illustration of a barn for 240 milking cows with 2 robots per group



There will be many other cost effective layouts that combine cow comfort, labour efficiency and expandability in an equally effective manner, which may be better suited to specific management styles. When dairy development projects are planned by effective teams that focus on function, and address the four cornerstones of planning outlined above, the resulting facilities will be appreciated by the owner and his employees as well as by the cows that live in the facility. Veterinary expertise particularly as related to cow comfort, to handling facilities and to management protocols can and should play an important role in the dairy development planning process.