Robotic Milking: The Future?

Bart Geleynse

Bou-Matic, LLC, P.O. Box 8050, Madison WI 53708
Email: bartg@boumatic.com

Take Home Message

- Some of the challenges that users of the technology face are capital cost, technical support, lifestyle, regulations, cull rates, milk quality and udder health.
- The benefits include lifestyle, low stress cow environment, labour issues, milk production, quality, and udder health.
- Robotics in one form or another will define dairies of the future.

Introduction

To speak about the future of robotics, it is necessary to briefly visit the past and review how it is that we are where we are today.

Historical Perspective

The first milking robots were installed on commercial dairy farms in the Netherlands in 1992. The real break-through in automated milking came at the end of the 90s. Today there are approximately 1200 dairy farms worldwide milking their cows automatically. Over 90 percent of all dairy farms with automated milking systems are located in northwestern Europe, with by far the largest number in the Netherlands, the birthplace of robotic milking.

The first automated milking system in Canada was installed at the University of Guelph in the late 80s, and has since ceased operation. The first commercial installation of robotic milkers occurred in Ontario as well, in the latter part of the 90s, and from there spread to Québec and Nova Scotia. Alberta is the fourth province to adopt robotic milking, with six functioning robots on three dairies. Ontario has almost fifty robots on nearly thirty dairies, while Québec lays claim to a similar number.

In the U.S. there are five states with robotic milking machines. There are a total of twenty operational robots functioning in the U.S., spread out over eight farms.

System Overview

At first glance, a robotic milking machine appears complicated and intimidating. However, after studying this piece of equipment for a time, you soon come to realize that it consists of a number of basic components, each one individually fairly simple. The reason the robot appears so complex, is because we've rolled all the systems together into a fairly compact package.

A robot, at its basic level, is no more than a one-cow milking system, with an automatic attacher hanging on the side of a feed stall. The challenge for automated milking boils down to two simple tasks. One relates to milking the cow, and the second relates to attracting the cow to the milking stall. The first is primarily a technical challenge, and the second is one of management. I believe that the technical challenges, although initially more difficult, will ultimately be the easier of the two. We will get to the point, in the very near future, when finding a teat, and attaching a cluster to it, and harvesting the available milk, will be fairly straight-forward and simple. A much more daunting challenge is to create an environment in which the dairy cow, an animal with its own sense of purpose, will feel compelled to visit the milking stall, sufficiently often in a 24-hour period.

In simple terms, the future of completely voluntary robotic milking rests as much with our ability to manage the cow and her environment, as it does with the robot itself.

■ Challenges

So why have robots not seen a more rapid, broad based acceptance?

Capital Cost

The current quarter million dollar (price tag of the average robotic milking stall quickly cools most dairymen's passion for the technology. This "sticker shock" continues to be the major stumbling block to a broader acceptance of robotic milking. However, for those who actually get past that point, to comparing the cost of putting up a comparably outfitted conventional facility, complete with labour requirements, for the same number of cows, the costs for the smaller dairies are found to be similar. (J. Rodenburg, Hoard's, 03/10/02)

Technical Support

A second key obstacle is the availability of local, technical support. By its very nature, an automatic milking machine consists of components that are more complex and technologically advanced than what we've been used to in the past. It requires a level of technical support that is beyond the scope of most traditional dairy equipment dealerships. In order for robots to become a common piece of equipment on the dairy farms of the future, this fundamental building block needs to be in place. Milking machine manufacturers are well aware of the folly of selling unsupported, high-tech equipment, so as a result are focused on building this support infrastructure very carefully one dealership at a time.

Dairy Routine

Another adjustment that a dairyman needs to be prepared to make is one of routine and availability. Although freed from the drudgery of early-morning and early-evening milkings, the owner of a robotic facility must come to grips with the fact that he is on call 24-7. For most, this is a small price to pay for a generally freer lifestyle. But for a very few, continuously being on call becomes more than they can bear.

Regulations

For U.S. dairies, at the very least, regulators still stand in the way of wholesale acceptance. For robots to gain approval for the production of Grade A milk in the U.S., milking robots must meet the requirements of the P.M.O. (Pasturized Milk Ordinance). The P.M.O. is a document produced by the F.D.A. in the U.S., which stipulates the rules and regulations that must be met in order that a dairy facility be considered acceptable for the production of Grade A milk. All of the states are required to apply the standards of the P.M.O. as a minimum, in order for milk to flow freely from one state to another. Individual states may add additional requirements, but the P.M.O. remains the minimum standard. Contained in the P.M.O. is a list of guidelines, called the 3-A standards. These are standards that stipulate manufacturing guidelines, which must be adhered to when manufacturing equipment for the harvest and transport of raw milk. In simple terms, the 3-A standards are the minimal acceptable standards by which the milking machine part of a robot will be judged. Other areas of the P.M.O. spell out requirements for teat cleaning and the effective separation of the milking facility from the animal housing area. The P.M.O. and the 3-A standards are American regulations, A parallel document for the E.U. is the Commission Directive 89/362/EEC (1989). Canada is in the process of drafting similar legislation, but no comprehensive regulations exist at the moment.

The primary challenges that arise from these regulations relate to the inspection of fore-milk, the detection of abnormalities, the diversion of unacceptable milk, the proper and effective preparation of teats prior to attach, and the separation of the milk/wash area from the animal housing area.

Since there are no humans present during the milking process, the robot needs to automatically detect and be subsequently capable of separating abnormal milk. What appears to be a relatively simple exercise gets extremely complex when we try to define what constitutes abnormal milk. Both the E.U. directives for milk production and the American P.M.O. stipulate that a visual inspection of fore milk must be performed prior to the attachment of a milking cluster. In the case of robots, the inspection of this fore milk needs to be done with electronic sensors in real time.

Equipment manufacturers are scrambling to develop sensors to detect abnormalities in milk. Early sensors only measured simple conductivity. Sensors presently under test have the ability to detect variations in milk colouration. Devices to detect butter fat, protein and progesterone, etc. are presently in development.

In order for milking machine companies to develop the correct sensors to detect abnormal milk, a precise definition of abnormal or unacceptable milk is needed. Such a definition has consequences not only for abnormal milk, but also for the amount of acceptable and therefore consumable milk. Moreover, the definition has to apply not only to robotic milking, but to conventional systems as well. The original deadline to produce such a standard, which was set for July of last year, has been postponed to July of 2004 to give ample time to come up with an acceptable conclusion. Although we use the ability of a human to inspect and evaluate the quality of milk as the "gold standard", such subjective human determination is far from consistent and accurate. Electronic sensors will soon become a much more accurate way to safeguard the quality of milk produced on our commercial dairies.

Teat preparation. The section of the P.M.O. and the equivalent E.U. directives, which state that teats must be completely dry prior to the attachment of a milking cluster, will need to be re-interpreted to reflect the realities of the automatic milking environment.

As with any dairy facility, teat preparation begins in the free stall barn. The dirtier a cow is when she enters the milking parlour, the more difficult it will be for the operator to effectively clean the teats. As true as this is in a conventional milking system, it is even more critical in a robotic facility.

Separation of the milk/wash area, The P.M.O. stipulates that a physical separation be installed between the free stall area and the milking centre, where the milking units are being automatically cleaned, in order to prevent the

admission to the milking machine of unacceptable odors or airborne contaminants, such as dust, manure, flies, etc. Not only are these contaminants a potential threat to milk quality, but can also hamper the effective performance of the robot itself, oftentimes interfering with the vision system.

What constitutes a physical barrier is up for discussion. Innovative solutions such as air curtains and positive airflow are being investigated in order to determine their effectiveness.

Cull Rates

Dairymen considering robotics are also concerned about the levels of culling that may be required to make a herd robot-ready. The culling of animals from the dairy herd that don't adapt well to the robotic milking environment, can be one of the more painful realities associated with the adoption of automatic milking. Cull rates range anywhere from five to twenty percent. Reasons for culling cows when moving to a robotic facility centre on udder confirmation, mobility, and natural aggressiveness.

These same issues become critical components of breeding programs for robotic milking herds.

Milk Quality and Udder Health

Concerns about milk quality and udder health continue to dog the robotic industry. No published evidence exists that supports an improvement in these two areas, when comparing a robotic milking facility with a more conventional dairy. There are a number of reasons why robotic facilities have traditionally not performed well with respect to these two measurements. They primarily relate to milk cooling and handling procedures, C.I.P. protocols and basic milking machine performance. We understand these factors, and have been aggressively correcting deficiencies in both design and application of the product, *and* are encouraged by the fact that over the last year or so, we have seen fairly dramatic improvements, and have unpublished evidence which supports a growing shift in favour of robotic milking.

■ Benefits

So why do people continue to look at robotics as an alternative to more conventional milking systems? The first and still the most fundamental attraction for the less-than 120 cow dairies, is the issue of lifestyle. Although images of dairymen lying in meadows or lounging at the beach for weeks on end is a little over-stated, the fact that a new generation of dairy producers can

gain a greater degree of control over their daily routines, and can choose to be available for family and other-than-farm-related activities, is a huge attraction.

Cropping activities don't need to come to a halt in order to come home to do the chores, since the milking is being done by milking robots while the dairy producer is off planting or harvesting his crops. On the smaller dairies, where the owners are still involved in all aspects of the operation, this robotic alternative will become increasingly attractive.

The drudgery associated with the actual activity of milking cows drives people to look for alternatives. The majority of dairy producers I talk to today don't look forward to the actual chore of milking, and are always looking for a way to pass the job off to someone else, and are very open to discussions about a machine that will do it for them.

One of the most powerful arguments in favour of robotics, relates to the availability and cost of labour. In some areas of North America, attracting labour to perform milking chores, is a virtual impossibility. If one considers the history of robotics in Europe, one quickly recognizes that in areas of northwestern Europe where robotics really got a foothold in the 90s, parallels areas where labour was scarce and expensive.

It is important to recognize that the cost of labour is more than the actual size of the paycheck. For most, the indirect costs (i.e. managing labour, scheduling, relationship issues, privacy issues, housing...) are of greater concern.

Indirect, intuitive and not-yet-documented benefits of robotic milking may provide the key to the future success of robots in the dairy industry. These indirect paybacks relate principally to three areas: 1. Low-stress environment; 2. Repeatable and consistent routines; and 3. Improved management.

Low-Stress Cow Environment

In a robotic facility a cow is free to follow her natural biorhythm. Rather than be constrained by the schedule of the dairy operator, she is now completely in charge of when she will eat, lay down and go to be milked. No longer is the intervention of a human in her environment associated with having to get up to stand in a holding area to wait to be milked. Cows are creatures with strong social interaction. Cows will repeatedly associate with the same cows, and more timid cows tend to avoid the company of more aggressive ones. The fact that cows are now able to choose when and with whom they associate, makes for a much lower level of stress in the dairy herd. One of the most immediate sensations that a person encounters when entering a robotic dairy, is the relaxed and restful atmosphere that pervades the free stall. This low-stress environment is a very positive benefit of robotic milking. Although results are sketchy and not yet definitive, it would appear reasonable to expect that this

reduction in stress would result in increases in a herd's longevity, a cow's overall condition, and health.

Consistent and Repeatable Routines

Unlike humans, machines are not affected by the time of day, seasons, or mood swings. You can rely on a robot to milk your cows, identically the same way, whether it's 10:00 on a Monday morning, or midnight on Christmas Eve. You can be confident that a properly functioning robot will milk your cows identically the same way every single time. This predictable consistency on the part of the robot works very well with cows, who themselves thrive in an environment that is consistent and predictable. The direct benefits of this are hard to quantify, but anyone who has milked cows realizes that, the more consistent and predictable a prep routine is, the more consistent the milk letdown reflex will be.

Improved Management

The choice between robotic and conventional milking systems is much broader than simply choosing between milking alternatives. It necessitates a choice between management styles.

The fundamental difference between robotic milking and conventional milking regimens lies in the fact that, in a conventional system, the dairy operator physically intervenes in a cow's daily routine, at specified times, to force her to the milking centre. This is fundamentally different than a totally voluntary system, which is characteristic of a robotic milking facility.

Since the success of a robotic milking facility is so dependent on a cow voluntarily attending to the milking stall, it is absolutely critical that all of the factors that contribute to a cow's contentment be well understood, and heeded. Any aspect of a cow's environment that is allowed to deteriorate, whether that relates to nutrition, ventilation, stall comfort, hoof condition, or health, etc. will quickly affect her sense of contentment, and result in a reduced desire to voluntarily attend to the milking robot. Fewer visits to the robot will translate to less milk harvested, and a less profitable animal. However, in the case of a conventional system, the same deficiencies in any of these areas result in the same suppressed milk production, and a similar general lethargy of the cow. But all of this is masked because she is forced into the milking parlour, and so a subtle change in her condition is not nearly as apparent.

Much of the grief experienced by the early adopters of robotic milking came as a result of the fact that many continued to operate the dairy operation as they had before. However, as some dairymen improved their management style to a level required for a successful robotic installation, their efforts have began to pay back through improved general herd health, lower veterinary cost,

increased longevity, and improved milk production. A heightened attention to detail, and a more disciplined approach to management, are keys to the long-term success of a robotic installation.

■ Where Will We Go From Here?

What does the future of the dairy industry look like with respect to robotics? In order to answer that question, we first have to answer the question "What is the future of the dairy industry irrespective of robotics?"

As consumers become more and more knowledgeable, and at the same time become increasingly alienated from normal farm practices, tensions between the farming community and consumers tend to increase.

Farmers of the future would be well served to pay close attention to three major issues: 1. Animal welfare; 2. Food safety; and 3. the Environment.

It is believed that by 2010, not more than five to eight retail organizations will control 70% of the world-wide retail market for dairy products. As consumers exert increasing pressure on retailers, to supply products that are in keeping with their expectations relative to animal welfare, food safety and the environment, ever more powerful retailers will pass those demands on to processors, who will pass those requirements on to producers.

Robotic solutions may help to retain the viability of smaller dairies, which would otherwise have fallen victim to concerns over lifestyle, operator health/fatigue and corporate mergers/take-overs. This reprieve for the "family farm" is welcome news for rural communities and consumers alike, since family farms tend to enjoy greater consumer favour than large, commercial, factory farms.

Animal welfare activists tend to view more favourably the low-stress, more natural life that cows in a voluntary milking environment enjoy, as compared to the life that cows in a more conventional setting have. Consumer perceptions may well pressure larger dairies in the industry to construct multiple facilities that house smaller number of animals in favour of larger facilities that house larger groups.

Although adoption of robotics has, for the most part, been restricted to smaller sized dairy farms (those with less than 120 cows), I am convinced that by far the largest application of robotic technology will be on the large and mega-dairies. This will remain true regardless of how future market pressures shape the size and configuration of cow groupings on these large dairies. As technologies improve, and the investment required per cow begins to decline, the attraction of an automatic attacher will become irresistible.

Smaller dairies will view robotics as a way to continue the family farm, and for the next generation of dairy producers to stay farming without compromising their lifestyle goals. So this part of the industry, which represents close to 30 percent of the total cows milked in North America, will continue to slowly embrace robotics, primarily as a lifestyle choice. Larger dairies will increasingly look to robotics as a way to improve efficiency and to become more competitive.

Most large herd operators do not milk cows themselves, and most of their operations run around the clock, so lifestyle implications are minimal. However, for these dairies, labour is the huge issue. Reliable labour is very difficult to find, expensive to train, and difficult to retain.

By way of example, when the annual, per-unit cost of labour begins to approach $ 50,000 (which is the reality for most parts of North America at the moment), the annual cost of each labour unit is equivalent to the annual costs required to support a capital investment of $ 350,000, assuming a ten-year amortization and an 8 % interest rate.

If a typical large dairy with 2,000 cows employs a total work force of 35, it is reasonable to expect that the work force could be trimmed by 40 %, if the milking chore could be fully automated. Based on some very rough calculations, a 40 % savings in labour on this 2,000-cow dairy, equates to 12 labour units, or equivalent to a net annual saving of $ 600,000, which represents an ability to finance a 4.25 million dollar expansion.

If the cost of a conventional milking centre for this size dairy, complete with holding area and return lanes, equals approximately 1 million dollars, then the total cost for this dairyman to milk conventionally is actually 5 million dollars (4M for labour, 1M for facilities).

Experience has shown that, as a minimum, one robotic stall is capable of servicing 60 cows. A 2,000-cow dairy would require a minimum of 33 robots. For robots to represent an equivalent investment to conventional milking, each robot would need to cost in the neighborhood of $ 150,000. Although this figure is lower than the cost of robots presently, it is not unreasonable to expect that the cost of each robot, when purchased in this quantity, and configured for a large herd, would settle somewhere in this range.

The advantage that one of these large installations would have, over one of its much smaller cousins (one or two robot installations) is the ability to eliminate the need for a separate milking facility for each robot. On these large commercial robot configurations, it is expected that a single very traditional low-line milking system will service all of the robots. This, in addition to shared access to common vacuum pumps, wash controls, and air compressors, help to drive down the cost of the total installation.

The preceding discussion about labour pre-supposes an ability to acquire labour. In some areas of North American this would be a bad assumption. In these areas labour is just plain not available, so for dairying to exist there, some form of automation is an absolute pre-requisite.

Hybrid Solutions

Although to date we have only witnessed examples of facilities that are either totally automated or totally conventional, the future is sure to see installations, which are a combination of both. We are looking to develop robotic solutions which take advantage of the predictable, regular, efficient and forced cow-flow of rotary milking platforms, with the labour-saving benefit of an automatic attacher. We envision replacing a number of key functions on the rotary platform, now performed by humans, with a machine. We do not expect that such automation will be restricted to rotaries, but those technologies will spill over and find application in our more traditional parallel and herringbone parlours as well.

The combination of automatic attaching with a rotary platform eliminates the concern that some cows are inherently reluctant to voluntarily attend the milking centre, and still provides some of the labour saving associated with robotic milking. A disadvantage of course lies in the fact that the low-stress cow environment is compromised, and that there still needs to be investment in a traditional rotary system, with a sufficiently large building to house the associated holding area, crowd gate and return lanes. However, the cost associated with acquiring a conventional rotary will be off-set by the need for fewer robots, since the utilization of an automatic attacher in a forced environment like in a rotary will be greater than in a totally voluntary milking setting.

■ Conclusion

These are exciting times to be a part of the dairy industry. To suggest that robotics will not play a huge role in the dairy industry in years to come would be naïve. How quickly producers will adopt robotic technologies for use on the dairies will depend on how quickly manufacturers can meet the basic requirements of reliability, predictability, affordability, availability and flexibility. The market and opportunity are there? It's simply a matter of time. I would like to recognize some of the early innovators for this technology in this area. The Degier family, the Martens family, and the Denoutstens have bravely gone where no one west of the Mississippi has gone before. I salute their courage and entrepreneurial spirit, which are the characteristics that will keep this industry and this nation strong.

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