Success Factors for Robotic Milking

Jack Rodenburg

My son is a Lely dealer, West Coast Robotics, in British Columbia

My daughter is a small dairy farmer in Ontario and milks with a Lely robot
Robotic Milking Worldwide

- ± 20,000 dairy farms with robots, mostly 50 to 300 cow dairies in Western Europe, Canada, and the US Northeast.

- 95% Lely and DeLaval single box systems.

- GEA, BouMatic, SAC/Insentec, Fullwood, Milkomax, single, double and small multibox systems.

- Differences are much bigger than in parlor technology.

Robotic milking is popular on small dairies

**Lifestyle**

Flexible hours, less physical, more interesting work for the family.

**Economic**

A modern, labor efficient parlor is underutilized, costs almost as much as robots, and takes much more labor.
Large Dairies are Adopting Now

- ± 60 robotic milking herds with more than 500 cows milked with single box robots
- ± 20 robotic rotaries

BENEFITS:
- lower labor cost
- fewer employees to manage and less repetitive work
- Less stress on cows with no trips to the parlor
- Potential for higher production through individual “dynamic” management

American Dairy Science Association
book chapter in
“Large Dairy Herd Management”
Complete Robotics on Rotary Platforms

- 24 stalls internal rotary with 5 robot arms
- Milks 70 to 80 cows per hour, stop and go
- 9 in Europe with timed milking and 3 in Australia with voluntary milking

Complete Robotics on Rotary Platforms

Two GEA ProQ rotaries in British Columbia
This one is running 1 year at Gracemar Dairy
When I visited:
- 3/60 stalls non functioning
- 60 % of attachments were assisted
- one man with a 60 stall rotary milking 300 cows per hour

Does it work? Does it cash flow? Is there a future?
32 stall GEA milking unattended

Manual milk and failed cows are sorted and milked by the milker at the end of the group

5 – 10 % manual and 2 – 5 % failures
• My impression:

“On a rotary, sell me the prep in the claw and the dip in the claw because they offer big bang for the buck . . . .but I doubt it is a good place for robotic attachment because it does not use the equipment anymore efficiently and it misses the opportunity to make the cows life better”

Social Licence

- Less stress on cows with no group movement and crowding
- Cows have more time to eat and rest
- Cows choose when to be milked (appeals to consumers)
The cost to milk a cow with a robot in a large herd

- $140,000 robot financed over 15 years costs $1000/month in repayment @ 180 milkings/day = 18 $/milking
- Service, hydro, chem. etc. $800/month or 14 $/milking
- Labor to fetch, clean robot room, groom and clean stalls, water troughs and crossovers is 0.7 hrs per robot per day @ $15 = 6 $/milking

- Total is 38 $/milking

Midwest dairy, 3400 cows with 72 stall rotary and 560 cows on 12 robots

Robot barn takes 18 hrs. labor per day.
- 4 hrs feeding
- 2 x 4 hrs cleaning stalls and fetching
- 2 x 1 hr breeding and treating
- 4 hrs footbath, bedding, robot care and equipment maintenance
Logical Applications of Robotic Milking on Large Dairies

1. The current parlor is maxed out but there is economic opportunity in milking more cows:
   - add increments of 120 - 240 cows at a time
   - pre select cows that are ideal for robotic milking

2. The current parlor is worn out and needs to be replaced.

Changes in Management
What is different: Less labor

29% less labor on Dutch farms with robots (Bijl, 2007)
- Fewer more highly skilled employees.
- Develop routines and protocols and design gating and handling systems for one person working alone.
Milking is voluntary and milking intervals vary.

- with 4 hr. permission vs 8 hr., cows milked 3.2 vs 2.1 times/day and produced 9 % more milk (Melin 2005)
- We need to minimize long interval “fetch” cows?

Estimated Production Response to Irregular Robotic Milking compared to 2x…12/12

<table>
<thead>
<tr>
<th>Cow</th>
<th>Milking intervals</th>
<th>Milkings per day</th>
<th>Production vs 2x</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5-6-6-7</td>
<td>4</td>
<td>+18%</td>
</tr>
<tr>
<td>B</td>
<td>12-7-5</td>
<td>3</td>
<td>+ 6%</td>
</tr>
<tr>
<td>C</td>
<td>15 - 9</td>
<td>2</td>
<td>- 2 %</td>
</tr>
<tr>
<td>D</td>
<td>15 - 15</td>
<td>1.6</td>
<td>- 6%</td>
</tr>
<tr>
<td>Ave</td>
<td>9.3 hrs</td>
<td>2.65</td>
<td>+ 4%</td>
</tr>
</tbody>
</table>

It will take an average of 2.4 milkings/day to match 2x , and 3.1 milkings/day to match 3x parlour milking.
Capital investment in the milking system is higher…So demand high output per robot

Standard – 4500 lbs./single box/day
  from 60 cows @75 lbs./cow
- 29 farms in Spain (Castro, 2012) 3225 lbs./day
  from 52.7 cows @62 lbs./cow Could be optimized with 16 more cows and 33% more milk
- JTP Farms in Wisconsin 5900 lbs/day
  from 62 cows @ 95 lbs/cow
- Westvale-View in Michigan, 5300 lbs per robot and 103 lbs per cow

Optimize Robot Efficiency

- Keep the box occupied with high milk flow rate cows
- Variables include number of cows, milking speed, milk yield, milking frequency, milking permission interval, prep time, attachment time and success, refusals, entry and exit times and cleaning time. (Castro, 2012)

- Optimize by milking fresh cows and high producers frequently and low producers less often, minimizing failures (clean udders free of hair), culling slow milkers.

- “dynamic milking ” to capitalize on individual variation

- Higher stocking rates increase the number of “fetch cows” and increase labor. Aim for 10% free time
Robot Efficiency and Stocking Rate

- In 13 herds with 34 to 71 cows/robot (Deming 2013), higher stocking densities were associated with lower milking frequency.

- With more than 60 cows per robot, the number of fetched cows increases. (Rodenburg and Wheeler, 2002)

![Graph showing % fetched cows and % fetched milkings vs cows per milking box]

Do we need a different cow??

Higher milking speed increases robot capacity. Reduce machine on time by 1 min/cow and increase capacity by + 12%.

Select for milking speed.

-Poor udder conformation increases attachment failures which then become fetch cows. (Jacobs and Siegfried, 2012).

Select for good udders but also wide rear teat placement.

Canadian AI studs offer “Robot Ready indexes based on these traits that have no real basis in science. The Dutch prove bulls for “daughter box time”.

But we need to do better, and we can!!
Breeding Strategies for Robotic Milking

The heritability of voluntary milking frequency is 0.16 to 0.22 depending on stage of lactation. (Konig, 2006)

The records are there, both as robot generated data and as milking intervals for milk recording samples from robotic herds.

We need to prove AI sires for their daughters “interval from milking permission to milking” as well as box time.

Success Factors: The Ration

- Hard pellets with no fines increase milkings (Rodenburg 2004)

- Pellets made from barley and oats increased daily milkings per cow 0.35 vs a corn based standard, while high fat pellets decreased visits 0.36 and grass pellets decreased visits 0.93. (Madsen 2010)

In free traffic herds pellet quality drives visits
Success Factors: The Ration

- High grain, high starch diets decrease milking frequency (Rodenburg and Wheeler 2002)

- PMR formulated for 15 lbs. milk below the group average plus 4 to 18 lbs. of pellets according to production in the robot

Success Factors: The Ration

- Using guided traffic allows greater use of home grown grain in a PMR balanced for a higher production level, and less purchased pellets in the robot.

- Feeding “according to production” in the robot improves feed efficiency and negates the gains from using cheaper home grown grain.

- The net difference is very small
Fetch Cows represent new labor

Number of Cows that Require Fetching

- Canadian owners reported fetching 4 to 25% of cows... large variation between herds (Rodenburg and House 2007)

- 35 free traffic herds fetched 16.2 ± 10.8% vs 8.52 ± 5.9% in the 8 guided traffic herds.

- Fetching 2 to 3% takes minimal effort... but more than 6 or 8% adds labor and is disruptive to the rest of the herd.

**Guided Cow Traffic:** Cows can only access feed after passing through the robot

Feed in the bunk and robot both attract cows
**Guided Traffic (with Pre-selection):** Eligible cows directed to robot and others to bunk

**Free vs Guided Traffic**
(Thune 2002)

<table>
<thead>
<tr>
<th></th>
<th>free</th>
<th>guided</th>
<th>pre-selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>no. milkings</td>
<td>2.0</td>
<td>2.6</td>
<td>2.4</td>
</tr>
<tr>
<td>no. of meals</td>
<td>12.1</td>
<td>3.9</td>
<td>6.5</td>
</tr>
</tbody>
</table>

Average time
- waiting at robot (minutes/day)
  - Dominant Cows: 78, 140, 124
  - Timid Cows: 95, 240, 168
Free vs Guided Traffic (DeLaval VMS)  
(Bach 2009)

<table>
<thead>
<tr>
<th>/cow/day</th>
<th>Free traffic</th>
<th>Guided Traffic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milkings</td>
<td>2.2</td>
<td>2.5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Fetched milkings</td>
<td>0.5</td>
<td>0.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>PMR intake</td>
<td>41.0 lbs.</td>
<td>38.8 lbs.</td>
<td>0.24</td>
</tr>
<tr>
<td>Manger visits</td>
<td>10.1</td>
<td>6.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Milk production</td>
<td>65.7 lbs.</td>
<td>68.1 lbs.</td>
<td>0.32</td>
</tr>
<tr>
<td>Fat %</td>
<td>3.65</td>
<td>3.44</td>
<td>0.06</td>
</tr>
<tr>
<td>Protein %</td>
<td>3.38</td>
<td>3.31</td>
<td>0.05</td>
</tr>
<tr>
<td>Fat yield</td>
<td>2.40 lbs.</td>
<td>2.34 lbs.</td>
<td></td>
</tr>
<tr>
<td>Protein yield</td>
<td>2.23 lbs.</td>
<td>2.25 lbs.</td>
<td></td>
</tr>
</tbody>
</table>

Free or Guided Traffic

- With Lely robots, free traffic yielded more milk per cow (2.4 lbs.) and per robot (148 lbs.) than guided traffic.
  (Tremblay et. al. 2016)

- Some new fetch cows are emerging cases of lameness or clinical mastitis, so fetching has a role in monitoring herd health
Free or Guided Traffic

- Both can work very well with good management

- But **when things go a little wrong:**

  - Guided traffic **COWS** suffer fewer meals and longer waiting times (and foot health and rumen health issues)

  - Free traffic **FARMERS** suffer increased fetching. (a warning to step up management)

- I design for both but for me cow comfort is key, so I have a strong preference for free traffic!

Robotic Milking calls for New Approaches to Barn Design

The classic US renovation layout for robots is a poor choice. The commitment pen on the left adds stress, and the free flow system on the right has no sort capability.
Space is critical . . . . Timid cows are afraid to come near this robot because they cannot get away.
1. Large open area in front of the milking stalls

- 20 feet from the milking box to the first freestall (also adds more manger and headlock space)
- Locate cow brushes, pasture selection gates, and computer feeders far away from this area to spread out barn activity
A one cow length exit lane improves cow flow.
All metal near the robots is smooth welded, not clamped.

Wide finger gates reduce congestion in guided traffic barns.
Robot Orientation
3 months of data from 12 herds
1165 cows (Gerlauf 2009)

% of total milking visits to robot 1

38.7 % Cross Use
19.7 % selective use

% of cows in this robot use group

Robots facing the same way result in the least selective use

Cows turn the same way to enter
Good visibility from the resting area

Cross use was high at 48.6 %
(vs 38.7% in all herds)

Selective use was lowest at 8.1 %
(vs 19.7 % in all herds)
New labor demands with robotics

- Fetching cows that don’t attend voluntarily
  - Provide simple cow routing and low stress fetch pens to get these cows milked

- Individual milking times are unpredictable
  - Provide a post milking separation area with access to feed, water, resting place and robot access.
3. Simple routing that makes all handling a one man job (a) for fetching.

3. (b) from group to group.
c. To the handling area.

Design the gating so one person working alone can move any cow to the chute

Handle individual cows in the chute
4. Low stress handling of fetch cows in a learning environment with split entry fetch pens
Progressive Teaching of voluntary milking

1. Push cow in
2. Chain the gate and leave her
3. Leave her in the fetch pen
4. Release her to the herd

Associated with higher production per robot (Heurkens 2015)

5. Maximum comfort in a bedded pack with robot access for fresh and lame cows
Fresh and lame cows need a soft unrestricted bed close to the robot

- To recover and heal
- To minimize walking distance
- To make fetching them easier
6. A stress free calving line with close up, calving and fresh side by side in packs

Success Factors: Hoof Health

Lameness decreases Robot visits and increases fetch rates (Bach 2007) (Borderas 2008). 

- Lameness is multi-factorial:
  - Nutrition
  - Cleanliness of the Barn
  - Genetics
  - Cow Comfort/Resting Time
  - Foot Bathing
  -Trimming and Treatment
Healthy claws: 4 success factors

1. Good claw quality
2. Low infection
3. Low pressure
4. Early, effective treatment

- Footbath at the robot exit discourages visits
- In free traffic, the number of passes is highly variable
A footbath in a remote crossover – once a week walk all cows through it

- Less disruptive to robot visits
- All cows get the same passes
- Fresh chemical works better
- Keeps chemical away from milk and delicate metal parts
- Combine with bedding delivery

7. Strategic foot bathing using the separation function
Footbath access from robot 2 via a refusal in robot 1
Handling individual cows in a robot barn

- Sort at the robot exit over a 12 hour period to collect cows for handling.
- Sort into a space with feed, water, resting area and milking access
- Provide a chute for hoof care and other treatments.
- Big dairies need less handling space because they will have staff dedicated to the task for quick turn around.

This “L” layout is great for sharing a footbath, and visibility and “cross use” are excellent.
8. Flexible separation area (a) gated for 2 stalls

8 (b) increased to 16 stalls on herd health day.
Far off dry cows

Big herds that handle daily need less separation space
Cows don’t leave the barn.....
....Big equipment is disruptive!

Straight wide, drive through alleys, big crossovers and free traffic minimize disruption of the cows.
Open alleys through the full length of the barn

Clean dry alleys
Discovery 120 robotic scraper for solid floors
The ten barn design criteria for robotic milking

1. Open space near the robots
2. All robots the same way
3. Simple routing to robot, group to group and handling area
4. Split entry fetch pen
5. Fresh and lame pack with robot access
6. Stress-free calving line
7. Flexible grouping
8. Flexible separation area
9. Perimeter feeding
10. Straight lines for material handling

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Links to:
World Dairy Expo lecture
Hoard’s Webinar

Expandable: 8 robots ± 500 cows
(or 12 with 180 cow groups + 750 cows)
1000 milking plus a dry cow and transition barn for 200 cows

Cross ventilated version
The Future

• Designs for single box robots are getting standardized
• Adapt for automatic feeding, bedding and robot manure scraping
• Explore group sizes for larger herds . . . Cow GPS may make bigger groups practical

Thank You!

www.dairylogix.com
jack@dairylogix.com