How Robotic Milking May Someday Fit Your Dairy

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Acknowledgements

For assistance and slides:

- Mark Futcher - DeLaval
- Greg Larson - GEA
- David Rubin - MiRobot
- Mike Connell - BouMatic
In the same way that mechanization and expansion have improved productivity in the last 20 years, precision technologies will drive dairy industry progress in future.
What are your next steps in milking automation?

**Staged automation**

- Semi automated prep procedure (teat scrubbers)
- Robotic post dipping
- Sort gates
- Fully automated robotic parlor
First Robot Milker (1981)
Milking robots are here to stay! – North American Data

- >2500 AMS units
- >1000 farms
- >140,000 cows
- >381,000 milkings/d
- Avg 2.5 AMS units/farm

Rodriguez, 2014
Labor on a Dairy Farm

Conventional milking

- Business management 5-10%
- Reproduction & Health 5-15%
- Feeding 10-20%
- Milk harvesting 50-60%
  or managing labor

Automatic milking

- Milk harvesting 5-10%
- Reproduction & Health 5-15%
- Feeding 10-20%
- Business management 50-60%
Why Industries Invest in Robots

• Improved product quality and consistency

• Reduce direct and overhead cost

• Improved accuracy and repeatability (cows like consistency)

• Improved quality of work for employees (higher skilled workers)

• Improved workplace health and safety (take over unpleasant, arduous or health threatening tasks)

• Reduced waste and increased yield

• Reduced turnover and recruitment difficulty
Why AMS on Larger Farms

- Milking is labor intensive: *Typically 40-50% of total labor costs*
- Labor: *20-30% of total dairy expense*
- Large parlor: *2-6 skilled workers, 3 shifts per day*
- Finding qualified workers 365/24/7: *Expensive, difficult*
- Managing labor is expensive
- Milking is a very repetitive task
- Milking requires very little decision making
- Cows thrive on consistency and predictability
Potential Benefits

• Individual cow care
• Improved animal well being
• Improved food safety
• Timely decision making
• Objective decision making
• Reduced labor
• Improved quality of life
Potential challenges

- "Plug and play," "Plug and pray," or "Plug and pay"
- Unknown ROI
- Obsolescence
- Repair costs

Adapted from Bewley, 2013
Potential AMS Advantages

Provides Data

- Milk production etc
- Over 100 measurements at every milking

Other benefits:

- Consistent milking routine
- Higher skilled labor
- Never late for work
- Never needs training
- Doesn’t need scheduling or holidays off
Automated/Robotic Milking Systems

**Box systems**
- Lely
- DeLaval
- GEA Farm Technologies
- AMS-Galaxy
- BouMatic Robotics

**Parlor systems**
- GEA Farm Technologies
- DeLaval
- MiRobot
- BouMatic Robotics
Single Box Systems
Multiple-Box Systems
GEA APOLLO SYSTEM

Slide compliments Greg Larson, GEA
GEA Robot for Rotary Parlors

DairyProQ
Fully Automated
Industrial Milking

Slide compliments Greg Larson, GEA
Milking Process – Fully Automated

Capacity depends on the number of stalls (32-80)

150-400 cows/hr.
- 1 Operator

Slide compliments Greg Larson, GEA
Visualization DairyProView

System monitoring by using communication devices.

iPad

Smartphone

Slide compliments Greg Larson, GEA
Unique Milking Cluster

- In Liner Prep
- In Liner Post Dipping
- FDA approved backflush

You tube
Dairy Pro Q
GEA

Slide compliments Greg Larson, GEA
Cow Scout
TOTAL EATING TIME

Slide compliments Greg Larson, GEA
GEA CowView

- Feeding time
- Waiting time
- Resting time
- Mounting
- Distance Covered
MiRobot version 1.0 under cow model

Slide compliments David Rubin, Microbot
Design Principles

Economical

• Uses all existing equipment and infrastructure

Maintenance

• Survivability by modern materials and flexibility

Low cost

• Essential person in the feedback loop

Slide compliments David Rubin, Microbot
The MiRobot System

- **Robot** (per stall) performs **all pre- and post-milking activities**
- **One** operator
- For **new + existing stalls**: utilizes existing infrastructure
- **Portable control unit**: remote control and supervision throughout milking process
- Small, flexible, **cow-friendly construction**
- Target end-user price: **$12,500** per stall (payback in under 3 years)

Slide compliments David Rubin, Microbot
Milestones & Funding

Seed
- Q1

R&D
- 2012

Prototyp
- Q3, 2013

Alpha
- Q1, 2014

Beta
- Q1, 2015

Slide compliments David Rubin, Microbot
DeLaval AMR™
The world’s first automatic milking rotary

• A fully integrated system-
  ✓ Milking
  ✓ Robot automation
  ✓ Herd management
  ✓ Teat sanitation
  ✓ Cow traffic
  ✓ Cow and operator safety
  ✓ Milk cooling
  ✓ Feeding

• Theoretical throughput of 1,600 milkings/day
• Practical throughput of 1,200-1,400 milkings/day based on many factors-
  • Cow traffic scenario
  • Herd and facility mgmt
  • Production level
  • Platform occupancy

Slide compliments Mark Futcher, DeLaval
Illustration of clockwise rotation set-up

Slide compliments Mark Futcher, DeLaval
The AMR™ milking process

10 steps

- AMR™ may be CW or CCW
- Rotation 1 stall/move- not continuous motion
- Five (5) robotic arms
- Robot function if CW rotation-
  - #1 preps left teats
  - #2 preps right teats
  - #3 attaches rear teats
  - #4 attaches front teats
  - #5 individual teat spray
- Possibility for easy manual attach if/when desired

Slide compliments Mark Futcher, DeLaval
Gala Farm- Tasmania
“Voluntary” cow traffic with AMR™ in a grazing environment...– ‘Gala’ Farm
Laprom Farm- Germany
”Batch milking ”Involuntary ” cow traffic with AMR™
Herd Navigator

**Reproduction** - Progesterone

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**Feeding**

Beta Hydrox butyrate (BHB) + Urea

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**Udder health**

Lactate Deshydrogenase (LDH)

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Slide compliments F Rodriguez

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Herd Navigator™

Ultimate in Herd Management and the brain does the thinking!

Sensor (captures data)

Analyser reporting concise information

Action SOPs made to take action

Slide compliments F, Rodriguez
BouMatic Robotics

Photo courtesy Four Clover Dairy Inc. The Van Wierens
BouMatic Product Development

- Rear attaching milking units
- 1\textsuperscript{st} for rotary parlors
- 2\textsuperscript{nd} for parallel parlors
Other Considerations
Options for Existing Dairies

• Robots to supplement existing milking system
  – Select cows well adapted to AMS system
  – Milk early lactation cows more often

• Challenge
  – Managing two different milking systems
  – Training time
# Free Flow vs Guided Flow

<table>
<thead>
<tr>
<th>Item</th>
<th>Free Flow</th>
<th>Guided Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fetch rate (labor)</td>
<td>16%¹</td>
<td>8.5%¹</td>
</tr>
<tr>
<td>Initial investment</td>
<td>lower</td>
<td>higher</td>
</tr>
<tr>
<td>Level of mgmt complexity</td>
<td>lower</td>
<td>higher</td>
</tr>
<tr>
<td>Feeding complexity</td>
<td>higher</td>
<td>lower</td>
</tr>
</tbody>
</table>

¹Rodenburg, 2007
Batch vs voluntary milking

**Batch**
- Labor in barn 24/7/365
- Control over milking frequency
- Pens are empty for activities

**Voluntary**
- Flexible milking frequency
- Flexible labor
- Feed changes have impact on visits
- Fetch cows in each pen
## Feed Costs of Robot vs. Conventional

<table>
<thead>
<tr>
<th>Production</th>
<th>Parlor</th>
<th>Robot</th>
</tr>
</thead>
<tbody>
<tr>
<td>120 lbs</td>
<td>$8.87</td>
<td>$9.40</td>
</tr>
<tr>
<td>90 lbs</td>
<td>$7.53</td>
<td>$7.85</td>
</tr>
<tr>
<td>70 lbs</td>
<td>$6.80</td>
<td>$6.50</td>
</tr>
<tr>
<td>50 lbs</td>
<td>$5.63</td>
<td>$5.18</td>
</tr>
<tr>
<td>AVG</td>
<td>$7.21</td>
<td>$7.23</td>
</tr>
</tbody>
</table>

**Ration data from 5/1/12**
(CS-$50/ton, Hlg-$60/ton, HMSC-200/ton, SBM-$430/ton, Cottonseed-$300/ton)

Slide compliments – Chad Keifer
Feed Costs of Robot vs. Conventional

• Cheaper to feed the later lactation lower producing cows and more expensive to feed early lactation higher producing cows in a robot.

But… The benefits:

• Will NOT over-condition cows because you are feeding them for what they need

• Rewarding the high cows with the energy they need

• More cows in a positive energy balance and gaining weight faster post calving

Slide compliments – Chad Keifer
Factors affecting AMS Success
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 3.3 milkings/day to match 3x parlor milking.

Rodenberg, 2013
Labor comparison

- AMS dairies (all single box units)
  - 485 to 1410 lbs milk per man hour

- Parlor dairies
  - >500 cows, 772 to 922 lbs milk per man hour
  - 100-300 cows, 551 to 771 lbs milk per man hour

Caution Preliminary survey results
Unpublished, Piktaranta, 2014
# Labor cost comparison

<table>
<thead>
<tr>
<th>Year</th>
<th>Labor Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009-2011 (before robots)</td>
<td>$2.22/cwt</td>
</tr>
<tr>
<td>2012</td>
<td>$1.89/cwt</td>
</tr>
<tr>
<td>2013</td>
<td>$1.60/cwt</td>
</tr>
</tbody>
</table>

*Labor cost are for cows and replacements for a 5 robot dairy*
Other factors for success

• Cow Comfort
  – Overcrowding limits cow movement
  – Lameness decreases visits and increases fetch rates (Bach, 2007) (Borderas 2008)

• Design so one person can manage cows
  – Gates and drovers lanes are your friend
  – Headlocks

• Excellent ventilation and fly control to minimize bunching
Stocking Rate

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

- When there are more than
  - 60 cows per AMS,
  - the number of fetch cows increases.
  - (Rodenburg and Wheeler, 2002)
Cow selection for AMS success

- Rear teats that do not cross

- Fast milking speed
  - Reduce box time by 1 minute/cow increases capacity by 12%
Summary

• Milking process fits well with robotic technology
• AMS parlor systems are rapidly being developed
• Adoption rate in U.S. will depend on:
  – Availability of labor
  – Cost of labor
  – Cost of technology
• May be several types of milking options available
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