Robots: Who are the players

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Outline

• Robotic history to current status
• Who are robot manufacturers
• Pre-milking
• Post-milking
Objectives

• Understand importance of barn design and robotic milking
• Understand the flow of cattle in robotic barn designs
• Understand importance of monitoring records at least twice daily – maintenance and cow records
• Use the technology at your fingertips to reduce the risk of spreading mastitis causing organisms via the robot
Current status

- 1992 first installation in Netherlands
- 1999 first robot in Canada
- 1999 first robot in US (on-farm) - Wisconsin
- > 25,000 robots worldwide
- > 10,000 farms worldwide
- ~ 3,000 robots in North America
- 2017 US
  - > 650 farms
  - > 2,000 robots
  - ~ 100,000 cows
• When was robotic milking patented?
History

- DeLaval patented the idea of robotic milking in 1978
- First robot by DeLaval in 1981
- First robot in US - 1989
  - Gascoigne Melotte, a Dutch company, and the University of Maryland
  - Robot did milk cows until 1992 when economic times lead to defunding the project
  - Robot is still located at University of Maryland Ag. Experiment Station Dairy Research Farm
- Early 2000’s when robots started to take off

C. Gooch provided info on first robot
First robot – DeLaval - 1981
First robot in US
Why do producers choose robotics?

• Flexibility in schedule
  – Improved quality of life – more family time
  – Number one reason to switch to robotics

• Labor efficiency
  – Ability to work on other areas of the farm
  – Most robot farms have 2-4 robots - reducing labor may not be an option
    • If its family labor then even less of impact on reducing labor
  – Refocusing labor on reproduction, crops, calves or heifer management can be profitable
  – Labor efficiency/savings is real on large robotic dairies

• Information
  – Technology, cow management
  – Ability to manage cow sooner
    • Repro, metabolic, milk quality
Robotic trends

• Larger robotic installations
  o US - Larger robotic installations
    • ~20 installations slatted for install with 12 or more robots (2017)
  o Robotic rotary installations
  o Is this the future?
    • Even seeing economic analysis of large robotic dairies being completed by lenders
    • Large robotic dairies is where the labor savings are substantial
  o US has a couple 24 robot dairies with expansion to 48 robots
  o Largest in world in Chile – 64 robots to milk 4,500 cows - 2017

• Continue to see 2 – 4 robot installations as exit strategy for farm with no next generation to take over farm
  o Farm assumption
    • Assumption is 40 – 50% salvage value of robot with this strategy
    • Price on used robots is $45,000 - $70,000
    • 20 – 30% salvage value
  o Lender assumption
    • 10 year useful life and 20% salvage value
Who are the players

- BouMatic
- DeLaval – VMS
- GEA Farm Technologies – MonoBox and Dairy ProQ
- Galaxy Astrea
- Lely – Astronaut (A4)
Lely – Astronaut A4

• Majority of robots installed in US are Lely
• Single box
• Brush for teat prep
  o 2 brush visits required for prep in US
• Attaching arm sprays post dip
• Pura Steam – option
Equipment hygiene

- **Lely Pura Steam**
  - Reduced bacteria count by 10 fold over backflushing
    - Lely to Lely comparison
  - Lower SCC on farms with Pura Steam
    - 183,000 vs 198,000 cells/ml

- **Exterior cleaning of equipment**
DeLaval - VMS

- Single box
- Separate pre-milking teat cup
  - Pulse teat sanitizer and air
  - Vacuum to dry
  - 4 prepping options – only cleaning time adjustable
    - Forestripping and drying constant
- Attaching arm sprays post dip
- Post dip spray pattern
  - Post spray prior to prep is allowed
- Hose support arm
- Free flow and Milk first

<table>
<thead>
<tr>
<th>Pattern name</th>
<th>Shape</th>
<th>Quantity Delivered (1 ‘spray’ to 4 teats)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>W</td>
<td>0.41 - 0.44 Oz (12-13 ml)</td>
</tr>
<tr>
<td>Economic</td>
<td>U</td>
<td>0.31 - 0.34 Oz (9-10 ml)</td>
</tr>
</tbody>
</table>
DeLaval Prep Video
https://www.youtube.com/watch?v=24zwbJhS9kI&app=desktop - 2:30
Galaxy

- Separate pre-milking teat cup
  - Sanitizer introduced via SS ring in mouthpiece
- Multi – box
- Industrial arm
- No flow after attach then detach and stim again
- Backflush - Steam cleaning
- Spray wand from below tilts up to post dip
- Owner attends technical service school
Galaxy and BouMatic pre cleaning

• SS ring introduces teat disinfectant through ring in mouthpiece
MonoBox and Dairy ProQ Rotary same milk module

- Cleans and milks in same attachment
- Teat sanitizer, pulsation and vacuum for cleaning
- Slug of milk used to clear teat sanitizer from milk line before shifting to good milk
- 90 seconds of stimulation time
- DairyProQ by GEA
GEA teat cleaning and dipping

- GEA Dairy Pro Q teat cleaning - 1:00
BouMatic

- Separate pre-milking teat cup
  - Sanitizer introduced via SS ring in mouthpiece
- Single and double box
- Attach from behind
- Spray wand from below tilts up
# Robot pre-milk prep and abnormal milk milk

<table>
<thead>
<tr>
<th>Task</th>
<th>DeLaval</th>
<th>GEA</th>
<th>Lely</th>
<th>Galaxy</th>
<th>BouMatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-milking disinfectant</td>
<td>Iodine, Chlorhexidine</td>
<td>OxyCide AMS (hydrogen peroxide)</td>
<td>Astri-L; Hydrogen peroxide + peroxyacetic acid</td>
<td>Iodine</td>
<td>OxyPre-RBT (1.0% Hydrogen Peroxide 0.5% Lactic acid Blend)</td>
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<tr>
<td>Pre-milking prep device</td>
<td>Prep teat cup</td>
<td>Prep within milking teat cup</td>
<td>Brushes</td>
<td>Prep teat cup</td>
<td>Prep teat cup</td>
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<tr>
<td>Backflush of milking liner</td>
<td>H₂O</td>
<td>H₂O + post dip</td>
<td>H₂O + Steam</td>
<td>H₂O + Steam</td>
<td>Iobac</td>
</tr>
<tr>
<td>Abnormal milk (color)</td>
<td>Quarter</td>
<td>Quarter</td>
<td>Quarter</td>
<td>Udder</td>
<td>Udder</td>
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<tr>
<td>Temperature</td>
<td>No</td>
<td>Quarter</td>
<td>Quarter</td>
<td>No</td>
<td>No</td>
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<tr>
<td>Conductivity</td>
<td>Quarter</td>
<td>Quarter</td>
<td>Quarter</td>
<td>Quarter</td>
<td>Quarter</td>
</tr>
<tr>
<td>Milk yield</td>
<td>Quarter</td>
<td>Quarter</td>
<td>Quarter</td>
<td>Quarter</td>
<td>Quarter</td>
</tr>
<tr>
<td>Milk flow</td>
<td>Quarter</td>
<td>Quarter</td>
<td>Quarter</td>
<td>Quarter</td>
<td>Quarter</td>
</tr>
<tr>
<td>Milking time</td>
<td>Quarter</td>
<td>Quarter</td>
<td>Quarter</td>
<td>Quarter</td>
<td>Quarter</td>
</tr>
<tr>
<td>Post dip application</td>
<td>Spray - attaching arm</td>
<td>In milking teat cup</td>
<td>Spray - attaching arm</td>
<td>Spray - wand in floor</td>
<td>Spray - wand in floor</td>
</tr>
</tbody>
</table>
Lely
- Disinfect brushes with Atri-L (hydrogen peroxide and peryoxyacetic acid)
- Brushes visit teats once or twice (US)
- Disinfect brushes between each visit to teats

DeLaval
- Pre-Spray teats with post dip (option)
- Chlorhexidine in prepcup

Galaxy
- SS ring in mouthpiece introduces iodine in prepcup

BouMatic
- SS ring in mouthpiece introduces hydrogen peroxide in prepcup

GEA
- Foams dip in teatcup prior to attach
Post dipping

• Lely
  o Spray 1 or 2 visits
  o Choose duration for each visit
  o Spray teats with attaching arm
• DeLaval
  o Economic, Normal and Thorough (W-motion around teats)
  o [https://www.youtube.com/watch?v=24zwbJhS9kl](https://www.youtube.com/watch?v=24zwbJhS9kl)
  o 4:40 into video
• Galaxy
  o Arm moves up out of floor to spray teats
• BouMatic
  o Arm moves up out of floor to spray teats
• GEA
  o Foams dip in teatcup prior to detach
Tat dip coverage is poor

Dip usage on robot that sprays
Post-milking teat disinfection

• Spraying and teat dip coverage

• Why do we post-dip?

• Importance of complete teat coverage

<table>
<thead>
<tr>
<th>Method</th>
<th>Dip (cup-min)</th>
<th>Dip (cup-max)</th>
<th>Foam (min)</th>
<th>Foam (max)</th>
<th>Thrifty dipper</th>
<th>Thrifty dipper and foam</th>
<th>Spray (min)</th>
<th>Spray (max)</th>
<th>Automated spraying (min)</th>
<th>Automated spraying (max)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dip</td>
<td>0.15</td>
<td>0.4</td>
<td>0.08</td>
<td>0.8</td>
<td>0.16</td>
<td>0.08</td>
<td>0.3</td>
<td>0.5</td>
<td>0.65</td>
<td>1</td>
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<tr>
<td>Thrifty dipper</td>
<td>0.16</td>
<td>0.08</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thrifty dipper and foam</td>
<td>0.08</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
3-ways to cause mastitis from a machine
• Irregular vac fluctuations – liner slips: equipment
  • quarter level not claw level in robot
• Teat damage – overmilking: equipment
  • Individual quarter level take-off in robot
• Transfer of contagious organisms: equipment/milking management
  • Number of cows/milked per milking unit versus per robot

G. Mein et. al, Storm in a Teatcup, NMC 2004
Robot myths

• Number of cow milkings/robot/day is low given that only 60 or 120 cows are being milked
  o One milking unit/60 cows

• Everything is automated in robots
  o Volume of teat disinfectant or hygiene products remaining
Milkings/robot

• Which has more milkings/milking unit...?

  o milking 120 cows 3 times daily with 2 robots

  o milking 4,500 cows 3 times daily with a 100 stall rotary
Mind-set for number of cows milked at each unit

• How does the number of milkings/robot compare to milkings per milking unit on a large dairy?
  
  o 120 cows – 2 robots 3 milkings/day = 180 milkings/robot or per milking unit
  o 120 cows – 2 robots 2.7 milkings/day = 162 milkings/robot or per milking unit
  o 100 stall rotary milking 4,500 cows 3x = 135 milkings/unit
  o 80 stall rotary milking 3,200 cows 3x = 120 milkings/unit
  o D-20 parlor milking 1,200 cows 3x = 90 milkings/unit
  o 80 cows - tie stall with 6 units milking 2x = 27 milkings/unit

• Minimize risk of robot being vector for transfer of mastitis causing organisms
Touching clean teat
Attaching concerns – Prep and attach order
Pros and cons of automated milking

**Pros**
- Cow is her control for repeated measures at the level of teat
- Consistency of routine
- Milking at level of teat

**Cons**
- Consistency if event creates a risk for mastitis
  - Then risk occurs every time said event occurs
- Post-milking teat dip coverage
- Automation leads to mindset of not having to employ manual methods
- Unnecessary cow-human interactions – free flow
- Limited pre-milking teat disinfection options
Discussion
Robots: Monitoring reports multiple times daily

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Outline

• Baselining herds
• Reports
  o Cow
  o Equipment
Considering robots

• Is farm management/ownership willing to manage cows at the level of the computer?
  o If not then robots may not be the right option
• Baselining herd
  o SCC and bacteria counts are available but.....
  o Need to know what bacteria are present on the farm
    • Bulk tank quantification
    • Aerobic culture for mastitis, high SCC and fresh cows
  o Teat evaluations (short-term and long-term), cow and environment hygiene, records analysis
Robot management

- **Barn design**
  - Determined during design phase and fixed component
  - Most permanent decision

- **Cow traffic**
  - Determined during design phase
  - Physical layout is a fixed component
  - Impacted by human-to-cow interaction

- **Robot settings**
  - Number of milkings allowed, interval between milkings, maximum box time, etc.

- **Feeding in the robot**
  - Quality of pellet

- **Daily monitoring**
  - Cow reports
  - Robot – Equipment

- **Proactive management**

- **Robot dealership technical support**

- **Limited unnecessary human-cow interactions**
Reports

• **Daily monitoring**
  o Cow reports
  o Robot – Equipment
  o 2-3 times daily reviewing reports
  o 12 hours apart
• **Color indicators**
  o Green - everything ok, excellent
  o Yellow –on the edge, caution
  o Red – not ok or not optimal, needs attention
• Compare cows current milking and 24 hour results to last 7 days
• Use of current day reports for monitoring..
  o Individual cows
  o Groups of cows
Key reports to monitor

- Milk deviation
- Abnormal milk, separated milk
  - SCC, color, conductivity
- Fetch/Collect cows
  - Long interval and low milkings/day
- Slow or long milking time
- Fetch cows or average milkings/day
- Failed milkings
- Activity
- Rumination

- Reports
  - Collect/Fetch Cows
  - Udder health Alert or Attention Report
    - 12 hour report
  - Udder health monitoring report
    - 24 hour or repeat report
  - Failed/Incomplete milkings
  - Robot performance/daily milkings
  - Alerts from robot on main screen
## Milking time parameters/robot – 60 cows

<table>
<thead>
<tr>
<th>Item</th>
<th>Target</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk Yield/milking (lbs...)</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>Milkings/robot/day</td>
<td>180</td>
<td>165</td>
</tr>
<tr>
<td>Milkings/cow/day</td>
<td>3</td>
<td>2.7</td>
</tr>
<tr>
<td>Yield/robot/day (lbs...)</td>
<td>5,000</td>
<td>4,500</td>
</tr>
<tr>
<td>Failed milkings/robot</td>
<td>≤ 3</td>
<td>≥ 5</td>
</tr>
<tr>
<td>Total cows fetched/robot</td>
<td>2</td>
<td>≥ 4</td>
</tr>
<tr>
<td>Treatment time</td>
<td>&lt; 2:00</td>
<td>&gt; 2:30</td>
</tr>
<tr>
<td>Milking time</td>
<td>&lt; 5:30</td>
<td>&gt; 6:00</td>
</tr>
<tr>
<td>Box time</td>
<td>&lt; 7:00</td>
<td>&gt; 8:30</td>
</tr>
</tbody>
</table>
Milk quality

• How do we determine if a cow has mastitis when milking in a tie stall barn or parlor?
  o Clots/flakes – abnormal milk
  o Bloody, watery or off color of milk – abnormal milk
  o Swollen or hard quarter – inflammation
  o Decreased milk production – yield response
  o Down cow – systemic mastitis
  o CMT – inflammation as indicator of SCC

• Don’t out guess the biology of the cow because there is robotic technology involved – mastitis is still the same
Milk quality - Robot

• How does a robot indicate if a cow may have mastitis?
  o Color sensor - Bloody milk
  o Temperature of milk - Swollen or hard quarter
  o Milk deviation - Decreased milk production
  o Milking time – short or long milking time at quarter level
  o Conductivity – CMT

• Not much has changed in how we determine if there is mastitis
  o Still have to evaluate the cow to determine what caused the health alert/attention
  o Cow evaluation and/or treatment should not take place in robot
    • Evaluation/treatment in robot may be a negative experience for cow
    • Negative experience may lead to cow not willingly visiting robot
Cow as her control

• Real-time values at the level of the quarter with the cow as its control
  o Multiple repeated measurements at the level of the teat, within cow and multiple times/day
  o Monitor changes at the level of the teat within cow
  o Software compares the cow to itself when determining if she is at risk
  o Very sensitive method of indicating that something is wrong with the cow
Robot myth – milk quality

• Robots prevent or decrease incidence of mastitis?
  o Not prevention but earlier detection for proactive management
  o Proactive management should reduce severity
    • Like a vaccine
> 120 Values/cow/day from the robot: We are milking or harvesting data!!!

**Per Visit:**
- Milk Yield
- Milk Fat
- Milk Protein
- Milk Lactose
- Milk Speed
- Milk Temperature
- SCC class*
- Visit result
- Udder Scans
- Box times

**Per Milking:**
- Milk Yield
- Milk Fat
- Milk Protein
- Milk Lactose
- Milk Speed
- Milk Temperature
- SCC class*
- Visit result
- Udder Scans
- Box times

**Per Quarter:**
- Yield contribution
- Teat position
- Attachments
- Pre Milk Time
- Dead Milk Time
- Milk Time
- Conductivity
- Color

* = option

**Per 2h Activity**
- Rumination*

**Per Day:**
- Rest Feed

+ combinations of all of the above ...
+ combinations with calendar + health events.

*Slide courtesy of Lely*
Proactive management

- Conductivity, color and temperature of milk are indicators of an immune response
  - Management is responding to an immune function
  - Gather data multiple times/day at the quarter level thus the sensitivity of the parameters is high
    - Small change may be indicative of an udder issue
- Proactive not preventive management
- Management comes in the form of rapid intervention
  - Provide supportive therapy to prevent mild case of mastitis from becoming a moderate or systemic case of mastitis
  - Aerobic culture of at risk quarter to identify organisms that is the cause of milk quality issue
• Why is she a fetch cow?
  o Is she is not a normal fetch cow then she deserves an eval
Fetch cows
Fetch and dominant cows

• What can you do to get fetch cows milked with limited human interaction?
  ○ Move fetch cows at the same time that stalls are cleaned each day
    • Multiple cow interactions and tasks completed at once
Fetch and dominant cows

- Subordinate cows may need to be fetched
  - Fetch cow moved to pen and dominant cow is ready to load next
- Separate pens or you may have to move subordinate cow directly into robot – not ideal
Fetch cows

- Movement of cows from fetch pen into robot versus free flow into robot
Incomplete or failed milkings

• ≤ 3/robot/day
• Need to fetch incomplete or failed milking cows and observe why they failed
  o There is a reason why the milking failed
    • If failed milking is because of the cow then need identify what the issue or risk was
Incomplete milkings
• Cow on log-term milk alert list
  o Check robot visits or all milk quality alerts for lactation to see if this is a chronic cow
Milk alert

• Cow identified with milk alert
  o 12 hours
    • Check cow’s lactation history
      – Stage of lactation, repro status, lame, etc.
    • If udder level then collect an aseptic milk sample
  o 24 hours
    • Cow off report then the issue may not be a health alert
    • Cow still on report at 24 hours then true health alert
      – Aerobic culture
Group with special Setting

• Cows with high SCC or known mastitis causing organism
  o Staph aureus positive cow
• Restrict to milk 4 hours prior to wash
• Cow to monitor and want her to milk while you are in the barn then setup to send notification to you
Robot maintenance and monitoring

1. Identify if daily, weekly, monthly maintenance tasks are being completed
2. Checking current milking settings
3. Check dashboard to look for current performance
4. Check dashboard for maintenance notifications
5. Monitor reports
6. Watch robot milk – look and listen
7. Robotic milking equipment tests – vacuum and pulsation
8. Report back to dairy operator and milking equipment dealership
Robotic equipment monitoring

- Mechanical monitoring
  - Graph pulsation
  - Teat cup vacuum
  - Daily checklists of components to monitor

- Report monitoring
  - Failed milkings
  - Increased milking time on a given robot or a given quarter

- Don’t let the thought of robotics scare you from being able to monitor the mechanics of the robot
  - Knowing what to monitor and when is just as helpful as being able to obtain a vacuum reading
Where to start? – system settings
Where to start? – dashboard
Equipment monitoring

- Monitor robot reports for equipment function
  - Front teats as compared to front teats should not differ by more than 20 seconds for milking time
  - Rear teats as compared to rear teats should not differ by more than 20 seconds for milking time
  - Multiple robots in same pen should have similar box times
- Teat in liner – low or fluctuating vacuum
- Pulsation – less B-phase, pulsator not pulsing at all, tear in pulsation hose, dirty air
Equipment monitoring

- Robot will inform you if there is a mechanical issue
- Robots will inform you of when you should change wear items
  - Liners and other rubber goods
- Robot reports
  - Daily milking reports can be a useful tool to monitor the mechanics of the robot
    - Box time, treatment time, compare milking time of front teats to front teats and rear teats to rear teats
Robot maintenance

• 8 hours/week
  o Daily, Weekly, Bi-weekly and Monthly tasks
• Cleaning lenses and area around laser
• Check that each liner is pulsating
  o Finger in liner – open and close
• Monitor for tears
  o Liners, hoses, gaskets
• Chemical levels
  o Only on manufacture notifies owner when chemical is at a low volume
  o All others notify when the wash fails – conductivity or volume error during chemical dosing
• Ocular irritation of liner from backflushing chemicals and steam
• Greasing, checking fluids, cylinders, air filters, gaskets, etc..
• Monthly – pulsators and claw vacuum
• Maintenance cost per robot cost $7,000 - $12,000 annually
  o $600/month to $1000/month
    • Hygiene and service = cost of ownership
• Service/repairs annually cost $2,000/robot
Daily robot maintenance

- 40 minutes/robot/day with 2 robots
  - Cleaning, checking chemicals, wear items, changing filters, etc
- Lely has 20 maintenance items/tasks that must be completed each day
  - Check chemicals, spray pattern, check ropes for wear
- Galaxy requires daily, weekly and monthly maintenance to be completed and documented by owner or warranty from manufacturer is voided
- DeLaval has 4, 8 and 12 month service kits to be installed for routine maintenance
  - Schedule your visit to inspect robot when service technician can be present at the farm and take equipment apart for you
Robot success

- Perform daily, weekly and monthly maintenance tasks as recommended by the manufacturer – 8 hours/week
- Monitoring reports at least 2 times daily – 3 times daily preferred
  - Cow level
  - Robot diagnostics (equipment)
- Cows will adapt quicker than people
  - Do not interfere with the flow of cattle to and from the robot
  - It’s ok if a cow hasn’t visited the robot in 10 hours
    - Give her a chance to visit on her own before getting her up and moving her to the robot
  - Go check her visually and if all looks well then give her a chance to move to the robot
  - Once you start moving cows to the robot it is hard to break the habit
- Evaluation/treatment area to monitor cow – not in robot
- Observe cows with limited cow to human interaction
- Barn design
- Feed
Why hasn’t Joe monitored reports today? I better fetch Joe!!!