Automated Collection of Parlor Performance Data, Part I:
Information Needed and Proposed Standardized Definitions

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Introduction

Automated individual milk weight collection from parlors has been commercially available for several years. These systems have been marketed primarily for individual cow management purposes such as grain feeding, disease detection, culling, and dry-off. However, other data are potentially available to extend the scope of utility beyond milk weights, especially in the areas of monitoring of parlor personnel and milking equipment.

This paper will discuss some of these data and propose practical definitions of useful data to monitor parlor equipment function and parlor personnel performance. A companion paper will outline some examples of management uses of these data.

General Individual Cow Measurements/Calculation

The following represent the authors' proposals for standardized definitions of some individual cow measurements and calculations. We feel these definitions are logical for management purposes as well as being practical and affordable with today's technology. These systems usually involve embedded electronics; therefore, data definitions must be carefully defined to determine if the current system is capable of capturing the needed data or if modifications will be required. As technology improves and becomes economical, there should be opportunity to refine the definitions further.

Not all manufacturers have every measurement available at this time. They also may be reporting the information using a different definition or a different precision than noted in the proposals. Caution is therefore in order when comparing across manufacturers or even within a given manufacturer with different versions.

Total Milk Weight

Proposed definition: Total milk produced by cow each time she entered parlor
Reporting precision: 0.1 pounds (or 0.1 kilogram)
Availability: All manufacturers

While 0.5-1.0 pound resolution is likely more than sufficient for normal management purposes, milk weights are usually reported to nearest 0.1 pound. However, the smallest resolution that most meters can measure is the size of one dump chamber (usually between 150 and 300 mls or .3 to .6 lbs), so this apparent precision is often misleading.

If re-attachments have occurred, this measure should reflect the total milk from all attaches during the same parlor turn. Not all manufacturers currently report the data in this manner; some report only the milk weight after the last re-attachment. However, if a cow enters the parlor again and is milked a second time within the same milking period, there should be two separate milk weights available for that cow.

Duration

Proposed definition: Length of time from claw vacuum on to claw vacuum off
Reporting precision: Nearest 0.1 minute (6 seconds)
Availability: Availability and precision variable between/within manufacturers

There are several possible ways to define this parameter, but the authors feel that length of time from claw vacuum on to claw vacuum off is both acceptable and practical for this purpose. At present some

manufacturers may report this parameter as the interval from first dump of milk to final dump of milk. This does not facilitate the electronic detection of malfunctioning automatic take-offs. Therefore, a consultant must become quite familiar about each manufacturer and even different systems within a manufacturer to ensure that this measure is defined in similar manners and to similar precision before attempting comparisons.

If re-attachments have occurred, this measure should reflect the total time the unit was actually on the cow. Not all manufacturers currently report the data this way; some report only the unit on time after the last re-attachment. This can lead to very high flow rates if the accompanying milk weight is the total for the milking. However, if a cow is actually milked twice in the same milking period, there should be two separate durations available for that cow.

Parlor Stall
Proposed definition: Unique numeric identifier for the parlor stall cow was milked in
Reporting precision: Numbered in a logical sequential manner, starting with 1
Availability: Variable depending on manufacturer

The identity of the parlor stall the cow occupied is needed if analysis of attachment patterns or of equipment function is to be performed. If a cow re-enters the parlor a second time, the new parlor stall should be recorded as well. Ideally, the stalls will be numbered sequentially from the front (as the cows fill the parlor).

Time of Day of Unit Attachment
Proposed definition: Time of day that vacuum was applied to claw prior to attach
Reporting precision: Nearest 1-3 seconds, ability to distinguish AM vs. PM
Availability: Variable depending on manufacturer

Precision of time of day of unit attachment is needed to the nearest few seconds to detect patterns and problems with unit attachment. As with duration, time of day of vacuum on to teat cups should be both acceptable and practical for this purpose. Currently some manufactures report only time of first dump of milk from meter, but this does not allow as easy analysis of early flow post-attachment as the proposed definition.

Time of Day of Entrance
Proposed definition: Time of day cow was identified (assumes entrance portal antenna)
Reporting precision: Nearest 1-3 seconds, ability to distinguish AM vs. PM
Availability: Variable depending on manufacturer

Precision of time of day of parlor entrance is needed to nearest few seconds to detect patterns and problems with parlor entry as well as time spent in parlor before attachment occurred.

Individual Cow Milk Flow Pattern Measurements
In an ideal system the flow pattern of each cow could be precisely and completely described. A simplified version of the flow pattern of a well-stimulated, high producing cow is shown below in Figure#1. This pattern can be further divided into phases as shown in Figure#2. These phases can be described as:

1. Delay from attach to first flow
2. First flow to peak flow
3. Peak flow
4. Dropping flow
5. Low flow/no flow ("Dribble")

However, the required data collection system is not currently practical or affordable to collect all information routinely with presently available electronics.

Insert Figure 1 here	Insert Figure 2 here	Insert Figure 3 here
Figure#1. Simplified milk flow pattern of a well-stimulated, high producing cow.	Figure#2. Phases of flow during a milking.	Figure#3. Discreet time intervals as proxy measurements for flow phases.

A practical alternative using current electronics is the capture of milk weights during certain discreet time intervals. The weights can then be converted to flow rates and serve as proxy measurements for the flow phases. The time intervals listed below have served well for on-farm management. See Figure #3 also.

Delay from attach to first flow:	Flow in first 15 seconds
First flow to peak flow:	Flow 15-30, 30-60 seconds
Peak flow:	Flow 60-120 seconds
Dropping flow:	Calculated based on other measures
Low flow ("Dribble"):	Low flow time (minus phase 1 estimate)

Individual Cow Average Flow Rate
Proposed definition: Total milk weight/total duration
Reporting precision: 0.1 pound (or 0.1 kilogram) per minute
Availability: Variable depending on manufacturer

Overall average flow rate is useful in monitoring both udder preparation and machine settings. As noted earlier, care must be given when comparing different systems. Proposed method would be total milk weight divided by total duration (vacuum on to vacuum off), with full accounting for any re-attachments.

Peak Flow Rate

Proposed definition:	Total milk produced in second minute post-attach (60-120 secs)
Reporting precision:	0.1 pound (or 0.1 kilogram) per minute
Availability:	Variable depending on manufacturer

Peak flow rate is useful in monitoring udder preparation and machine settings. However, some dilemmas arise when attempting to define this parameter. If the definition is the dump size divided by the shortest time interval between two dumps, many situations can occur to cause two dumps to occur rapidly. Most commonly, a cow merely shifting her weight and clearing milk in hoses can falsely signal an increase in flow rates.

For detection of true differences in peak flow rates, some type of smoothed or rolling average is likely preferred over a single spike. As a compromise, a specific time interval past the time of attachment can be chosen as a portion of the "typical" time of peak flow. The amount of milk produced during that interval divided by the interval length would then be defined as "peak" flow as a smoothed average. The authors have adopted the time interval from 60-120 seconds (60 seconds total) as their operational definition of peak flow. This is not yet how all manufacturers are defining peak flow, so again care in interpretation is

necessary. In the future an additional measure reporting the highest flow over any 15 to 30 seconds time interval might be useful.

Early Flow Rates
Proposed definition: Flow rates in discrete intervals post-attachment
Reporting precision: 0.1 pound per minute (or 0.1 kg per minute)
Availability: Variable depending on manufacturer

Flow rates early in the milking are potentially useful as monitors of milk letdown and udder preparation. The authors have found the following useful:

1. Flow from attach to 15 seconds
2. Flow from 15 to 30 seconds after attach
3. Flow from 30 to 60 seconds after attach
4. Flow in first minute after attach

To calculate these flow rates, the total milk weight in the interval is multiplied by the appropriate factor (4 for 15 sec intervals, 2 for 30 sec intervals, 1 for 60 sec intervals). Care must be taken to avoid over interpretation at the individual cow level due to dumps occurring just prior to the start or end of an interval.

Time Spent in Low Flow
Proposed definition: Total time where flow was "low" (proposed: 2.2 lbs/min)
Reporting precision: Nearest 0.1 minute (6 seconds)
Availability: Variable depending on manufacturer

Reporting time spent in low flow is potentially useful to monitor presence of over-milking, poor letdown, overly "dry" take-off settings, or other abnormalities of flow. The authors have adopted as an operational definition of low flow as being less than 2.2 pounds (1 kg) per minute. Note this "low" flow could occur at any point in the milking, not just at the end. Again, over-interpreting individual cow data should be avoided. An additional or alternative calculation would be percent of total duration spent in low flow.

Additional Calculations
There are several other calculations that can be performed using the collected data.

Time in Actual Flow

Proposed definition: Time spent in "actual" or "high" flow (proposed: >2.2 lbs/min)
Reporting precision: Nearest 0.1 minute (6 seconds)
Availability: Variable depending on manufacturer

If low flow time is available, the time where flow was actually occurring at a reasonable rate can be calculated. This time could then be used to calculate a flowrate based not on the overall duration but the time when milk was actually flowing. This might be useful in fine-tuning machine settings. An additional or alternative calculation would be the percent of the total duration spent in high flow.

Total Time in Peak Flow

Proposed definition:	Time spent in "peak" flow phase
Reporting precision:	Nearest 0.1 minute (6 seconds)
Availability:	Variable depending on manufacturer

If the flow pattern is assumed to have a specific shape, an estimate of peak flow duration can be calculated if these data are available: Total milk, total time, second minute milk, and time in low flow. An additional or alternative calculation would be the percent of the total duration spent in peak flow.

Pounds Milk/Percent of Total Milk Given by X Minutes Post-Attachment

Proposed definition:	Cumulative pounds of milk produced by x minutes (Examples: 1 minute, 2 minutes, etc)
Reporting precision:	Nearest 0.1 pound (or 0.1 kilogram)
Availability:	Variable depending on manufacturer

An additional or alternative calculation for this measurement would be the percent of the total milk by the end of the given minute. Another would be the pounds or percent of total milk given within a designated 60 second interval.

Unit Removals and Reattachment Data

For best parlor performance, units should remain on the cows until milk-out is completed and then promptly removed. The number of cows requiring re-attachment should be minimal. Data can be collected to monitor the presence and degree of the following:

- Premature unit removal
- Prolonged over-milking
- Appropriate re-attachment
- Inappropriate re-attachment

Some manufacturers provide times and production amounts for all attaches and re-attaches. Other manufacturers provide more limited data. Minimum required data would include (production data - 0.1 lb, time data - 0.1min):

- Time from first attachment to first detachment
- Production from first attachment to first detachment
- Time from first attachment to last re-attachment
- Production from last re-attachment to end of milking

The following discussion divides unit removals and reattachments by the time of occurrence, either early after the unit attachment or at the end of the cow's milking.

Monitoring Unit Removals and Reattachments in First Two Minutes of Milking

In a well-run parlor with higher producing cows the number of units falling off, kicked off, or otherwise removed from cows within two minutes of initial attachment should be minimal (with or without a subsequent reattachment). The level of premature unit removal and any reattachments can be monitored by a combination of electronic data along with in-parlor spot checks of stripping yields and cow handling. recorded

Removals and/or reattaches in first two minutes arise for a number of reasons, including:

- Early kick-offs
- Early fall-offs
- Early detachments by automatic take-offs
- Early removal by workers

These reasons may have fundamentally different root causes.

Early Kick-offs

Early kick-offs can arise from improper or harsh handling of animals, especially fresh first-calf heifers. Attention to calm and gentle animal handling is necessary if kick-offs are a problem. Data in kick-off situations will often show the first detachments are occurring very early (usually in the first minute) with very little milk produced before the first detachment. Depending on the workers, there may be no re-attachments that follow, or multiple re-attachments. One tactic that has had some success with the occasional difficult first calf heifer is to re-attach units only once after an early kick-off. Some herds even have a "no reattach" policy for these animals. Excessive physical force seldom results in long-term success.

Early Fall-offs

Early fall-offs can arise when the equipment cannot handle the sudden rush of milk with excellent letdown. They also can occur with improper unit alignment or poor unit adjustment. Equipment faults include inadequate sizing (short milk tubes, claws, etc), restrictions to flow (excessive hose length, kinks, sensors, etc.), excessive or inadequate claw air admission, too low system vacuum settings, improper or worn liners (especially distorted mouthpieces), and single shot pulsation. Attention to proper sizing of components, removing restrictions to flow, minimizing amount of lift, proper pulsation rates and ratios, unit alignment, and adequate claw vacuum can overcome these problems.

Data from early fall-offs usually will show a detachment in the first minute or two after first attachment, with a significant amount of milk before the detachment. If a reattachment occurs, there is usually a fair amount of milk produced after the reattachment also. In the case of the occasional early fall-off, a re-attachment is probably logical. If these re-attachments are not occurring, the data will show a very low duration with a high flow rate, but lower than expected milk production.

Automatic Detachments in First Two Minutes

If automatic take offs (ATO) are removing units in the first two minutes, often the problem is inadequate stimulation for letdown. Most manufacturers have settings that prevent removal by the take-offs for a preset interval after attachment. This feature should be seldom necessary in most parlors, as the solution is primarily achieving adequate letdown and not with altering equipment settings. Monitoring the amount and percent of milk produced in first two minutes as well as reattachment data can help spot problem areas.

Monitoring Reattachments and Inappropriate Removals near End of Milking

Reattachments and inappropriate unit removals occurring after two minutes into milking may arise from a number of causes. Causes of these removals/reattaches include:

- Kick-offs
- Fall-offs
- Unequal quarter milk-outs
- Manual override of automatic take-offs
- Milker training
- Improper automatic take-off settings

Kick-Offs

Kick-offs that first occur toward the end of milking can arise when take-off settings are too "dry". Data to support this would be capturing the time spent in low flow and checking animals for stripping yields. If these are re-attached, there is usually very little milk post-reattachment.

Fall-Offs

Fall-offs occurring late into the milking can be the result of improper unit alignment/adjustment, poor unit support, and/or worn liners. These factors usually lead to teatcup slips and air admission. Reattachments may or may not occur in these situations, so electronic data may not be helpful. Time spent in low flow might be excessive. In-parlor monitoring would include observation for slips and checking for evenness of milk-outs among all quarters.

Unequal Milk-Outs of Quarters

The root causes of unequal milk-out are similar to those discusses under fall-offs. A re-attachment late in a milking with more than 2-3 pounds of milk that follows would be an indication of unequal milk-outs.

Manual Override of Automatic Take-Offs

Most manufacturers allow the user to "over-ride" the automatic take-off settings and remove the unit prior to the level set by the ATO sensor. In certain cases this can be a source of abuse while in other cases it may be an appropriate human intervention. It can arise when workers are rushing the milking, can be a sign of over-milking, or be a symptom of improperly functioning equipment. Some manufacturers have a flag available to indicate whether the manual override option has been invoked for an individual animal. The required data for examination would include the flag itself, duration, and time of day when option was used.

Milker Training

In many parlors the milkers are instructed to be sure all cows are completely milked out. Paradoxically, the most conscientious workers may be re-attaching a large number of cows inappropriately, greatly slowing the parlor. The data would show re-attaches after several minutes of initial duration, with little to no milk captured after the re-attachment. Examining the data for re-attaches with less than two pounds can help identify the problem, while hand stripping cows can help train milkers to make better decisions.

Improper Automatic Take-Off Settings

Improper settings of automatic take-offs can lead to either over-milking or under-milking. In our field research we have found that in the majority of cases the automatic take-off settings are much more prone to over-milking than to under-milking. Monitors include average flow rates, durations, and time spent in low flow.

Disabling Automatic Take-Offs to Allow Longer Unit On-Times

In many parlors the most conscientious workers will disable the automatic take-offs, either because of past mechanical malfunctions or the desire to be absolutely certain every cow is completely milked out. To monitor if this is occurring, a flag can be set to indicate that the ATO was disabled.

Summary

There is additional data available from current parlor electronics that extend the utility of parlor data collection beyond only milk weights. However, standardized definitions are needed for wider availability of the information.