Planning and Starting a New Milking Parlour: Software to Estimate Milking Center Costs and Performance

Douglas J. Reinemann[1], Brian Holmes[2], Ken Bolton[3], and Gary Frank[4]

[1]Professor of Biological Systems Engineering, University of Wisconsin, Milking Research and Instruction Lab, Agricultural Engineering Building, Room 232D, 460 Henry Mall, Madison WI 53706
[2] UW Extension, [3]UW-Extension, and [4]UW Center for Dairy Profitability.
Email: djreinem@wisc.edu

Take Home Message

- Investing in a milking parlor should increase the number of cows milked per person per hour. Other motivating factors include improved working conditions, increased uniformity and quality of milking, and attracting and keeping hired or family labor. These benefits must be weighed against the capital cost of the parlor.
- There are many factors that will influence the choice of parlor type and size.
- We have developed software that can be used as a decision aid to choose the size of a new parlor and the type of equipment to be installed. The software should be used to compare options, not to develop exact cost and performance figures.
- The software can be downloaded at: http://www.uwex.edu/uwmril/milk_parlor/mpmain.htm.
- The software can also be used to evaluate equipment modifications in existing parlors and improve parlor throughput. Only double sided herringbone or parallel parlors are considered as these make up the largest share of parlors being installed.

Introduction

A primary reason for investing in a milking parlor is to increase the number of cows milked per person per hour. Other motivating factors include improved

WCDS Advances in Dairy Technology (2006) Volume 18:305-315

working conditions, increased uniformity and quality of milking, and attracting and keeping hired or family labor. These benefits must be weighed against the capital cost of the parlor.

A combination of these and other factors unique to each dairy will influence the choice of parlor type and size. The parlor makes up only a small portion of the milking center. The milking center should include a holding area, return lanes, animal retention area, milk and utility rooms, and an office. The design of the milking center must be such that its components work well together. The milking center must also be integrated into all other facilities on the dairy. This will help realize the full benefit of the investment in each component.

This software is to be used as a decision aid to choose the size of a new parlor and the type of equipment to be installed. It can also be used to evaluate equipment modifications in existing parlors and improve parlor throughput. The capital cost of a milking center and freestall barn and number of cows milked per hour are calculated based on user inputs. Annualized capital costs are combined with annual labor costs to yield total annual milking cost. The annual costs of various options can then be compared. Only double sided herringbone or parallel parlors are considered as these make up the largest share of parlors being installed.

The Software Inputs

Milking center cost and performance depend on many variables such as management system, management intensity, location, climate, and others. The results obtained from this software should therefore be taken as an approximation. The software should be used to compare options, not to develop exact cost and performance figures. For most inputs the user supplies either the actual numerical value or a 'high', 'medium', or 'low' indicator (Table 1). The indicators are converted to numerical values representing a reasonable range for the corresponding variable.

Table 1. User inputs.

BUILDING AND EQUIPMENT COSTS			
Free Stall Barn Cost	2	MEDIUM	Enter actual dollar value or
Milking Center Building Cost	1	LOW	0 for none,
Milk House Equipment Cost	2	MEDIUM	1 for low,
Milking Equipment Cost	2	MEDIUM	2 for medium
Manure Handling and Storage	2	MEDIUM	3 for high

The software provides estimates of building and equipment costs. The building and equipment costs are separated into these component parts:

- free stall barn

- milking center building: including the milking parlor, a holding area, animal retention pens, milk house, office, and utility room
- milk house equipment: including the bulk milk storage tank, refrigeration system, wash vats, sinks, and automatic wash controllers
- milking equipment
- Manure handling and storage systems

Building sizes were determined from stock plans used by various milking equipment companies. Building costs on a per-square-foot basis and milking equipment costs are representative of recent construction projects in the upper Midwest. A better estimate of construction and equipment costs can be obtained from a milking equipment dealer and farm builder. Actual cost figures from these sources may be entered directly as inputs. Capital costs are annualized for depreciation, interest, repairs, taxes, and insurance.

Free Stall Barn Cost includes the cost of the barn (shell and concrete for floor), stalls, gates, electrical service, and waterers. The low range is typical of a wood frame, un-insulated, naturally ventilated barn with curtain sidewalls and scraped concrete alleys. The high range is representative of a barn with insulated walls and roof, sliding or tilting doors for ventilation and a slatted floor over gravity manure gutters with central collection pit.

Milking Center Building Cost includes an adequately sized holding area, catch pens, parlor area, utility and milk rooms and office. The size of the milking center building is scaled to the parlor size. The low range is typical of a building with un-insulated holding area with curtain sidewalls, and wood frame construction for the parlor, milk, and utility rooms. The high range is representative of a building with insulated holding area and concrete block wall structure in the parlor/utility area.

Milk House Equipment Cost includes equipment such as the bulk tank, refrigeration unit(s), water heater, ventilation system, vacuum pumps, and washing sink for the low range. The high range includes equipment such as an automatic washer, heat recovery equipment and well water pre-cooler.

Milking Equipment Cost includes all of the equipment in the parlor and holding area such as milking units, stalls, gates, and parlor automation. The low range is typical of a parlor and pipeline milking system with no automation i.e. manual unit removal, manual entrance and exit gates and no crowd gates. The middle range would include automation such as automatic unit removers, and powered entrance, exit, and crowd gates. The high range is representative of the medium range of automation plus computerized cow identification and milk metering and automatic backflush.

Manure Handling and Storage Cost includes all of the equipment in the barn used to collect manure, systems to transport manure to a storage pit, and the cost of the storage pit. The low range is typical of a barn which is tractor scraped into a collection pit and manure stored in and earthen pit. The middle range represents automatic alley scrapers an an earthen pit. The high range is representative of a flush system with multiple lagoons. These costs are very approximate as individual site considerations can have an enormous influence on manure handling and storage costs.

Table 2. Milking task times.

MILKING TASK TIMES		Slow	Medium	Fast	Suggested Ranges
Release/Reload side (sec/stall)	3	15	6	3	
Prep and attach units (sec/cow)	3	40	30	20	Enter actual time
Average milk-out time (min)	6.3	7	6	5	0 for none,
Detach and post dip (sec/cow)	3	12	6	3	1 for low,
Milker (operator) efficiency (%)	3	80	85	90	2 for medium
Equipment Setup and Wash (min)	3	60	45	30	3 for high
Move group from barn (min)	0	20	15	10	

Milking task times (Table 2) are separated into four functional groups:

- cow movement
- prepping cows and attaching units
- machine-on time
- post milking unit removal and/or teat dip

The time to work both sides of the parlor is calculated by adding the user-selected task times assuming an efficient milking routine. The resulting time to perform one "turn" is then used to calculate the maximum theoretical parlor throughput. This maximum theoretical throughput is then multiplied by:

- Milker Efficiency factor, representing the efficiency with which the work routine is executed.

This method produces throughput (cows milked per hour) which correspond well to actual field performance data with reasonable assumptions for milking task timing. Parlor throughput measured in cows milked per hour is the figure

most often quoted in milking parlor literature. The operator(s) often perform other tasks such as equipment set up, moving groups of cows from the housing pens to the holding pen and washing of the parlor and equipment. These additional tasks times may be added to the actual milking time to determine the total time to perform one milking. The task time ranges are based on studies of actual milking parlors and recommended milking practices. A table of the suggested range of times is presented in the spreadsheet along with the time inputs.

Release/Reload is the time required releasing a group of cows from one side of the parlor and reloading that side with the next group. Time is calculated as number of seconds per milking stall. The time required to move cows depends on the type of stalls used (single file or rapid exit), the degree of gate automation, and the cow flow pattern. The slow range corresponds to a parlor with manual entrance and exit gates, single file exit and no crowd gate in the holding area. The medium range represents a single file exit parlor with powered entrance, exit and crowd gates, and good cow flow. The high range represents a rapid exit parlor with powered gates and excellent cow flow.

Prep and attach unit is the time, in seconds, required to perform all tasks performed before and including attachment of milking units. These may include udder washing, teat pre-dipping, teat and udder drying, udder stimulation and milking unit attachment. The time may be adjusted according to which of these tasks are performed. The cleanliness of cows entering the parlor and care given to cleaning and drying udders has a great deal of influence on this time. Prep and attach time is a major factor in both parlor throughput and udder health. Reducing prep and attach time is the surest way to increase parlor throughput but may also lead to increased udder health problems.

Average milk-out time is the time, in minutes, required for complete milk-out or 'unit on time'. It is assumed that milking units are removed upon the completion of milking by automatic detachers or manually by the operator. Note that there is not a strong correlation between production level and milk-out time. Inputs in the next section of the spreadsheet will estimate this value based on the herds average production level and other milking management factors.

Detach/ Post dip is the time, in seconds per cow, to perform any tasks after milking is completed such as post dipping, checking udders, and manual unit removal if automatic detachers are not used. Adjust time according to which tasks are manually performed by the operator(s).

Milker efficiency is the percentage of the maximum theoretical milking rate that the operator(s) achieves. Consider the physical condition and motivation level of the operators when choosing this number.

Equipment setup and wash is the time, in minutes, required to set up equipment before milking and wash it at the end of milking.

Move group from barn is the time, in minutes, required to move one milking group from their housing area into the holding area. Enter zero if the people doing the milking do not perform this task. The number of groups is automatically calculated from the size of the milking herd, estimated parlor throughput, and 1-hour maximum time in the holding area.

Capital Animalization factors are the five parameters used to determine the annual cost of the capital investment (Table 3). These factors are entered separately for buildings and equipment.

Table 3. Capital annualization factors.

Capital Annualization factors	Building	Equipment
Interest (%/year)	8.0	8.0
Depreciation (%/year)	5.0	10.0
Repairs (%/year)	2.0	5.0
Taxes (%/year)	1.5	0.0
Insurance (%/year)	0.5	0.5

Labor and capital cost and milking time analysis using the above inputs is performed for a user selected individual case (Table 4).

Table 4. Other labour and production specifics.

OTHER LABOR AND PRODUCTION SPECIFICS	
Barn Stocking Density (%)	110
Number of Cows to milk	400
Milkings Per Day	3
Milk Production (lb/cow/day)	75
Cows grouped by Milking Time? (0=yes,1=no)	1
prep/lag and detachers optimized?(0=yes,1=no)	0
Estimated average milkout time	6.3 min
Number of operators in parlor (1, 2, 3 or 4)	1
Hours per day of feeding stall work	12
Labor Cost ($/Hr) - Including benefits	$15.00
Parlor Size, Stalls Per Side	8
(use multiples of 2, from double 2 to double 32)	

Barn Stocking Density is the ratio of stalls in the freestall barn to the number of cows housed there. A 300-stall barn housing 330 cows would have a stocking density of 110 percent.

Number of Cows to milk is the total number of cows to be milked in the herd. This value will be used to size the freestall barn and determine total time for one milking for the individual case analysis. Note: this does not include an estimate of the barn space required for those cows that are not being milked (young stock, dry cows, etc). You can reduce the stocking density to account for these extra stalls if desired.

Milkings per Day is the number of times the cows are milked (2 or 3) per day.

Milk Production (lb/cow/day) average for the milking herd.

Cows grouped by Milking Time? (0=yes,1=no): This models a situation in which slow milking cows are grouped in a separate pen so that they do not impede the milking of other cows. Chose yes (0) here if you set a maximum machine-on time for your detachers.

Prep/lag and detachers optimized? (0=yes,1=no): If you have set your detachers to remove milking units early and have optimized your milking routine to make the most of the letdown response, chose yes (0).

Estimated average milk-out time: This value is calculated from the preceding 4 user inputs. If this number differs from the one you chose in the "Milking Task Timing" section you may want to adjust that input and use this calculated number.

Number of operators in parlor (1, 2, 3 or 4) is the number of people actively involved in the milking, or the number of operators in the 'pit'. This program does not model situations in which an extra person may help with part of the milking operation (e.g. people coming and going from the milking parlor to do barn work , fetch cows, etc).

Hours per day of feeding and stall work is the work done in the freestall barn by laborers that are not doing the milking task such as mixing and distributing feed, maintaining stalls and bedding and caring for special needs cows.

Labor Cost ($/Hr) is the wage paid to the operator(s) including fringe benefits in dollars per hour. Use a reasonable figure for competent help in your area if hired labor is anticipated. Consider the value of the owner/operator's time compared to time spent on other management tasks if this person is also expecting to work in the parlor.

Parlor Size, Stalls per Side is the size of the parlor to be used for detailed individual case output. For a double-8 parlor, enter 8. *(Use multiples of 2, from double 2 to double 32)*

■ The Software Outputs

Calculations are performed using the data and information entered in the preceding sections to produce this table of output values (Table 5).

Table 5. Outputs.

OUTPUTS					
Steady Parlor Throughput (cows/hr)	80				
Time for each milking (hrs)	5.5 hours				
	Total Capital	Capital Per Cow	Total Annual	Annual Per Cow	Cost/cwt Milk
Milking Center Cost (Bldg.+Eqip.)	$291,200	$728	$51,064	$128	$0.47
Milking Labor Cost			$90,084	$225	$0.82
Milking Center + Milking Labor Cost			$141,148	$353	$1.29
Freestall Barn Cost	$560,000	$1,400	$72,800	$182	$0.66
Milking Center + Barn Cost	$851,200	$2,128	$123,864	$310	$1.13
Milking Center+Barn+Manure System Cost	$1,231,200	$3,078	$239,864	$600	$2.19
Barn Labor Cost			$65,700	$164	$0.60
Total Facilities + Labor Cost			$395,648	$989	$3.61

OTHER MEASURESE OF PARLOR EFFICEINCY	
Total Cows per Hour	80
Cows per Stall per Hour	5.0
Cows per Person per Hour	80
Turns per Hour	5.0
Pounds of Milk per Hour	2006
Pounds Milk per Person per Hour	2006

Steady-State Parlor Throughput is the number of cows milked per hour in the parlor size selected for individual case output.

Time for each milking is the length of each milking shift, in hours, for the herd selected for individual case output. This includes time for equipment setup and wash and moving cow groups to the holding area. Number of operators is the number of operators in the parlor during each milking.

Milking Center Cost is the cost of all buildings and equipment associated with the milking center and is expressed as total capital cost, capital cost per cow, total annual cost and annual cost per cow.

Freestall Barn Cost is the cost of animal housing facilities and is expressed as total capital cost, capital cost per cow, total annual cost and annual cost per cow.

Milking Center Cost + Barn Cost is the combined cost of the milking center and freestall barn expressed as total capital cost, capital cost per cow, total annual cost and annual cost per cow

Milking Labor Cost is the cost of labor expressed as total annual labor cost to milk the selected herd size and the annual labor cost per cow.

Milking Center + Milking labor Cost combines the annualized costs of the milking facility and milking labor expressed as total annual cost and annual cost per cow.

Milking Center + Barn + Milking Labor Cost combines the annualized cost of animal housing, milking facilities and milking labor and is expressed as a total annual cost and annual cost per cow. Note that these costs do not include labor and facilities for manure handling, feeding, freestall maintenance, or any other tasks and facilities not associated with milking.

A summary output graph for entire range of parlor sizes and number of operators is provided in Fig. 1. This graph is a useful visual summary of the optimal parlor size and staff for your operation.

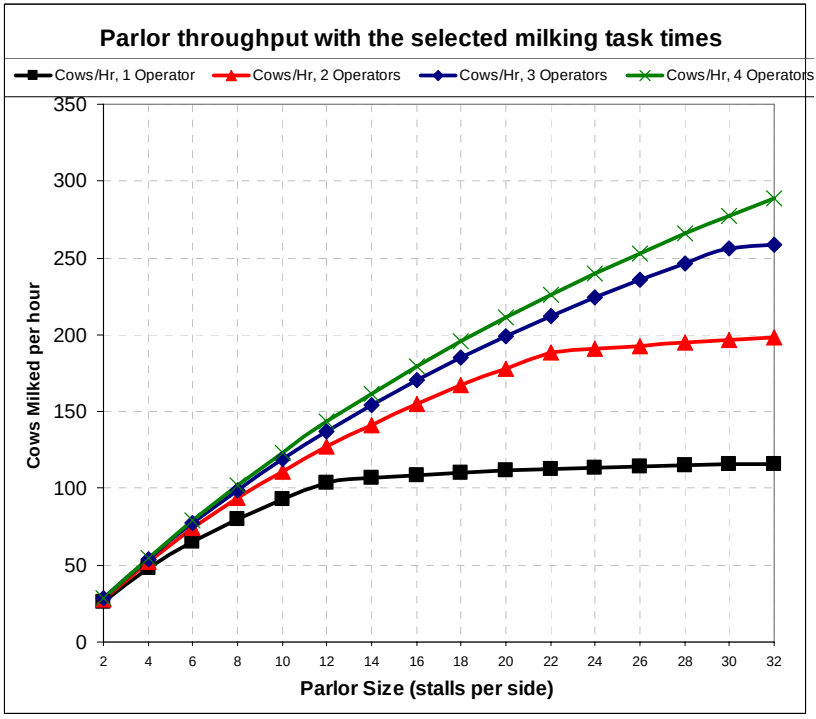

Fig. 1. Parlour throughput with the selected milking task times.

The following forms are provided in separate worksheets. They can be printed and taken to the farm to collect data on the operation of existing parlors. This information can be entered into the Milking Task Timing section of this software to help determine opportunities to improve parlor efficiency.

Milking Routine Task Timing These numbers can be used as inputs for Milking Center Advisor Software. cr Douglas J. Reinemann, UW Milking lab, 2003

Number of Stalls per side: 8

Turn Number	Parlor Side	Open Exit Gate (a) min	Open Exit Gate (a) sec	Begin Preping First Cow (b) min	Begin Preping First Cow (b) sec	Last Milking Unit Attached [c] min	Last Milking Unit Attached [c] sec	Last Milking Unit Detached (d) min	Last Milking Unit Detached (d) sec	First Cow Post Dipped (e) min	First Cow Post Dipped (e) sec	Last Cow Post Dipped (f) min	Last Cow Post Dipped (f) sec	Cow Movement Time (b-a)	Cow Movement time Per Stall seconds	Prep and Attach Time (c-b)	Prep and Attach Time per Cow seconds	Milking unit "on" time minutes	Post Dip Time (e-f)	Post Dip Time per Stall seconds
1	L	2	31	3	10	7	12	13	42	13	43	14	10	39	4.9	242	30.3	6.50	27	3.4
2																				
3																				
4																				
5																				
6																				
7																				
8																				
9																				
10																				
11																				
12																				
														Averge	4.9		30.3	6.5		3.4
														Maximum	4.9		30.3	0.11		3.4
														Minimum	4.9		30.3	0.11		3.4
														% Deviation	0%		0%	0.00		0%
															seconds		seconds	Average, max, min in minutes		seconds

Fill in all the white spaces in a row.
Turn Number 1 is given as an example.
Times recorded in seconds from beginning of the sequence (open exit gate)
Green Cells will be calculated

Description of Milking Parlor
Number of stalls
Number of operators
Type of Cow Exit Gate
Type of Crowd Gate
Describe method of Crowd Gate control

Time study for individual cows

	Cow or Stall No.	First Touch Teats		Last Touch Teats		Prep/stim time	Last Teatcup attached		PrepLag Time	Start of Low Flow		Unit detached		Machine on time	Time in Low Flow
		min	sec	min	sec	c = b - a	min	sec	e = d - b	min	sec	min	sec	h = g - d	I = g - f
1		15	12	15	45	33	16	23	38	23	34	24	25	482	51
2						0			0					0	0
3						0			0					0	0
4						0			0					0	0
5						0			0					0	0
6						0			0					0	0
7						0			0					0	0
8						0			0					0	0
9						0			0					0	0
10						0			0					0	0
11						0			0					0	0
12						0			0					0	0
13						0			0					0	0
14						0			0					0	0
15						0			0					0	0
16						0			0					0	0
17						0			0					0	0
18						0			0					0	0
19						0			0					0	0
20						0			0					0	0
21						0			0					0	0
22						0			0					0	0
23						0			0					0	0
24						0			0					0	0
25						0			0					0	0
26						0			0					0	0
27						0			0					0	0
28						0			0					0	0
29						0			0					0	0
30						0			0					0	0
	Ave					1.1			1.266667					16.06667	1.7
	Max					33			38					482	51
	Min					0			0					0	0