TIME MOTION ANALYSIS OF THE GASSER HERRINGBONE MILKING PARLOR

by

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ABSTRACT

The purpose of the present study was to analyse the milking routine in the Gasser milking parlor. The actual milking rate as well as chore times for operators were recorded and presented. A time and motion study was then performed. Causes of the low milking rate were determined for this type of parlor. Finally it was found that uniformity and reduction of cows milking time was essential to achieve a better parlor performance. Culling of slow milking cows, herd grouping and cow traffic aids, were recommended in order to improve the milking rate.

ACKNOWLEDGEMENTS

The author would like to especially thank Rolf Gasser whose cooperation and hospitality made this project possible.

Thanks are also extended to Professors Pierre J. Jutras and Eric R. Norris for their help and encouragement during the course of this project.

Finally, the author would like to thanks his assistant Mario Domingue and fellow classmates for their contributions to the different aspects of this study.

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NOMENCLATURE

ELEMENT	SYMBOL	UNITS
Available work time	AWT	min/cow
Potential performance	P	cows/hour
Mean milking time	t	min/cow
Unit time	UT	min/cow
Work routine time	WRT	min/cow
Mean milk yield	Y	Kg/cow

I INTRODUCTION

The milking process on modern dairy farms, although much improved during the past several years, still demands a high percentage of work when compared to other chores. There has always been a real interest in improving the efficiency of milking cows, since the development of milking machines and pipe line systems. A variety of parlor layouts have thus resulted.

The basic sawtooth herringbone milking parlor has gained rapid popularity due to its compact, angular arrangement of cows resulting in the placement of the udders closer together thereby reducing walking distance for the operator as compared to side opening stalls.

However, slow milking cows can hold up an entire group of cows and thus limit the number of cows milked per hour.

The present study was done to verify and understand the facts mentioned above for the double-8 herringbone milking parlor situated on the Gasser farm. The operators. work routine time as well as cow milking time were recorded and compared to standard time of similar milking parlors. A time and motion analysis was then performed to determine the causes of the low milking rate for this parlor.

Recommendations were finally made to Rolf Gasser in order to improve the efficiency of the system.

II LITERATURE REVIEW

2.1 Ideal Milking Routine

In order to fully understand the milking routine, it is important to first consider lactation in general. The secretion of milk in the udder is a continuous process in which mammocyte cells convert some chemicals of the blood into milk. These cells are surrounded by small storage units called alveoli. The alveoli are surrounded by muscles which contract and squeeze the milk into larger channels and eventually into the lower udder and teat (Noorlander,1962).

Milk let-down is controlled by the hormone oxytocin, which is secreted by the pituitary gland located in the brain. This hormone causes the alveoli and small ducts to contract, and milk is ejected into the gland and teat cisterns. Milk let-down is a conditioned reflex which is initiated when the cow is subjected to some stimulus such as suckling, handling or washing the teats. Let-down normally occurs within 0.5 minutes of the stimulus (Castle and Watkins, 1979).

Let-down is adversely affected if cows are excited or stressed, and the importance of a regular and quiet routine of washing and preparation cannot be overemphasized. If the milking is delayed unduly after let-down commences, evacuation of the udder will be incomplete regardless of the length of the milking process (Noorlander, 1962).

The rate of secretion of milk remains constant for the first 12 hours after milking and decline slowly thereafter. Milking at exactly equal intervals of 12 hours is therefore ideal to maximize milk yield, but is rarely practised on dairy farms because of the unsocial hours which it imposes on the operators (Castle and Watkins, 1979).

In order to achieve an ideal milking routine, the operators should perform the following steps for all cows entering the parlor (Babson Bros.,1976) :

1) Provide a stress-free environment for cows; handling cows gently prior and during milking is important for good milk production.
2) Washing and stimulating the cow's udder is vital for a complete milk let-down and should be done with individual towels for each cow.
3) Strip fore-milk and dry teats with individual paper towels. This relieves teat of high bacteria milk and detects cases of clinical mastitis.
4) Apply milker 45 seconds to 1 minute after stimulation. Waiting too long can lose the let-down effect and reduce milk production.
5) Adjust milker for downward and forward action. Placing downward pull on the milkers helps straighten out milk ducts in the udder for a more complete milk harvest.
6) Remove milking unit as cow milks out; this avoids overmilking which injures teat membranes and wastes time.
7) Dip teats after milking to help reduce new infection of mastitis. Bacteria are destroyed, teat end is sealed and milk is removed from end of teat.
8) Clean equipment immediately with appropriate chemicals after each milking routine.

2.2 Time Motion Analysis

2.2.1 Previous Studies

Many efforts were made in effecting time study measurements in milking parlors. Methods, such as the "Potential Performance" suggested by Clough and Quick (1967), used average values for work routine time, cows traveling time and milking time to derive this performance. But this method has its limitations since it uses only average values and no considerations were made for cows with long milking times.

In 1971, Price et al. developed a computer simulation program for milking parlors. The two types of parlors studied were; the herringbone and the side opening milking parlor. Statistics utilized by the simulation program were waiting times for cows and operators, and utilisation level of stalls and operators. Unfortunately results for a double-8 herringbone milking parlor were not reported.

Bickert et al. (1972) developed a flow diagram and mathematical model for a polygon parlor. Computer simulations were also made for a herringbone parlor using different levels of automation. It was found that for a single operator the maximum number of cows milked per hour was near 72 for a double-8 herringbone parlor. The idle time of the operator is only 5 percent. Keeping him busy for almost all the time requires a highly automated parlor. The authors conclude that the addition of automatic detachment and a crowd gate to a conventional double-8 herringbone parlor nearly doubles the simulated

milking rate in cows per man-hour.

In "Machine Milking" (Thiel et al.,1977) Clough refined his theory of "Potential Performance" to evaluate milking rates in different parlors. By using concepts such as "unit time" and "available work time" , derivation of "potential performance" was easily calculated without any computer simulation.

According to the project scope, this method of evaluating the Gasser parlor performance was considered and discussed in more detail in the next section. This method has its limitations since only average values are used, although a good estimate of cows milked per hour was found.

2.2.2 Milking Performance Theory

Milking performance was measured in terms of cows milked per hour. The maximum number of cows which can be milked per hour was found by dividing the work routine time (WRT) per cow into 60 minutes (Clough and Quick,1967).

The WRT is the time required to change units, let cows in and out, wash udders, foremilk and dip teats. Simultaneously, the cows were fed concentrates upon entering the parlor. In practice, the performance would be affected by the number of milking units used by the milker and the milking times of the cows in the herd. Any interruption of the regular repetition of routine work, which could occur should the milker have to wait for a cow to complete milking, would result in fewer cows being milked per hour (Thiel et al.,1977).

The unit time (UT) was defined as the total time a milking unit was associated with a cow ; this was the milking time of the cow plus the milking unit idle time. The maximum number of cows which could be milked per milking unit per hour would be calculated by dividing the unit time per cow into 60 minutes.

The potential performance of the installation (P) was found by multiplying the number of cows milked/unit/hour by the number of milking units (N) used. The potential performance of the milking installation would be achieved if the work routine time was less than the available work time (AWT) which was calculated by dividing the potential performance into 60 minutes (Thiel et al., 1977).

In summary, data from different milk yields and number of milking units in milking parlors with two stalls per unit were calculated from:

$$P = 60/UT \times N \quad (1)$$

$$AWT = 60/P = UT/N \quad (2)$$

The maximum performance is achieved only if WRT is less than AWT.

While it was possible for a properly organized milker to speed up certain tasks, major improvements were possible only through mechanization (Thiel et al., 1977).

III OBJECTIVES

The main objectives of this study are to :

1) Record and analyse information from the present system.
2) Perform a time and motion study in order to determine the causes of the low performance of this milking parlor.
3) Make recommendations to improve milking rates.

The scope of the present study was limited to perform hand calculations for the time and motion study. No computer simulations or modeling were used. Cost analysis was not included in this report since labor at the Gasser farm is provided by members of the family and any reduction of the milking routine time will result in more available time to perform other farm tasks.

IV OBSERVED SYSTEM

4.1 Farm Manager and Location

The farm is operated and managed by Rolf Gasser and is located at St-Pierre de Veronne, aproximately 60 km south-east of the island of Montreal (Figure 1).

4.2 Milking Parlor Description

In 1967 a double-8 herringbone milking parlor was installed in Gasser's main barn; 8 non-automatic milking units manufactured by ZERO are used to perform the milking routine (Figure 2).

The parlor consists of two rows of stalls. Each of them can accomodate groups of 8 cows at a time. The cows stand at an angle of approximately 30 degrees from the center line of the milking pit in which the operators work. In this way the distance between udders, and hence between milking units, is reduced compared to side opening stalls and one man can handle up to eight units, depending on the automation level, without an undue amount of walking (Castle and Watkins,1979).

A floor plan of the milking parlor as well as an inside view are shown in Figures 3 and 4.

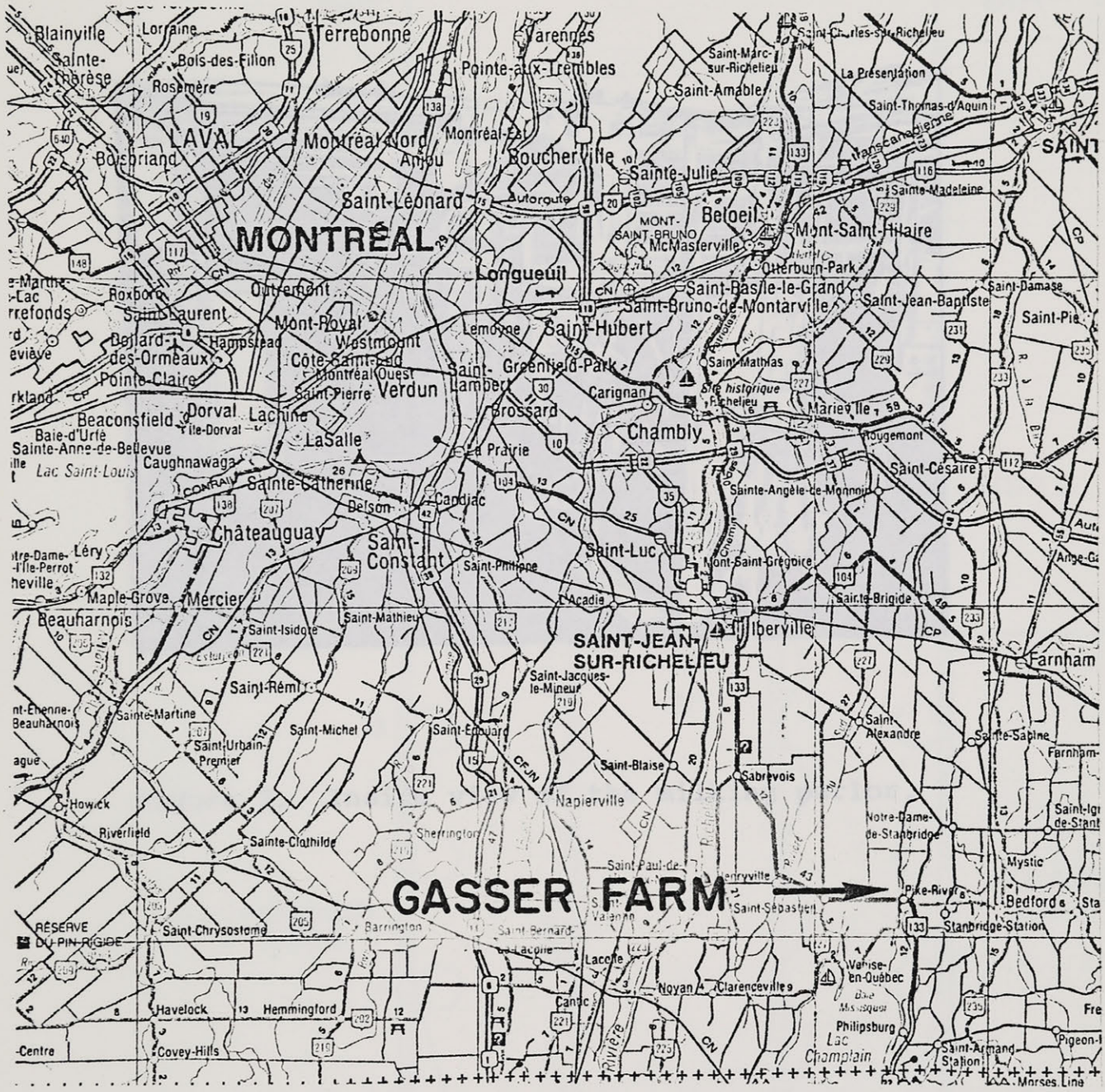

Figure 1. Gasser farm location.

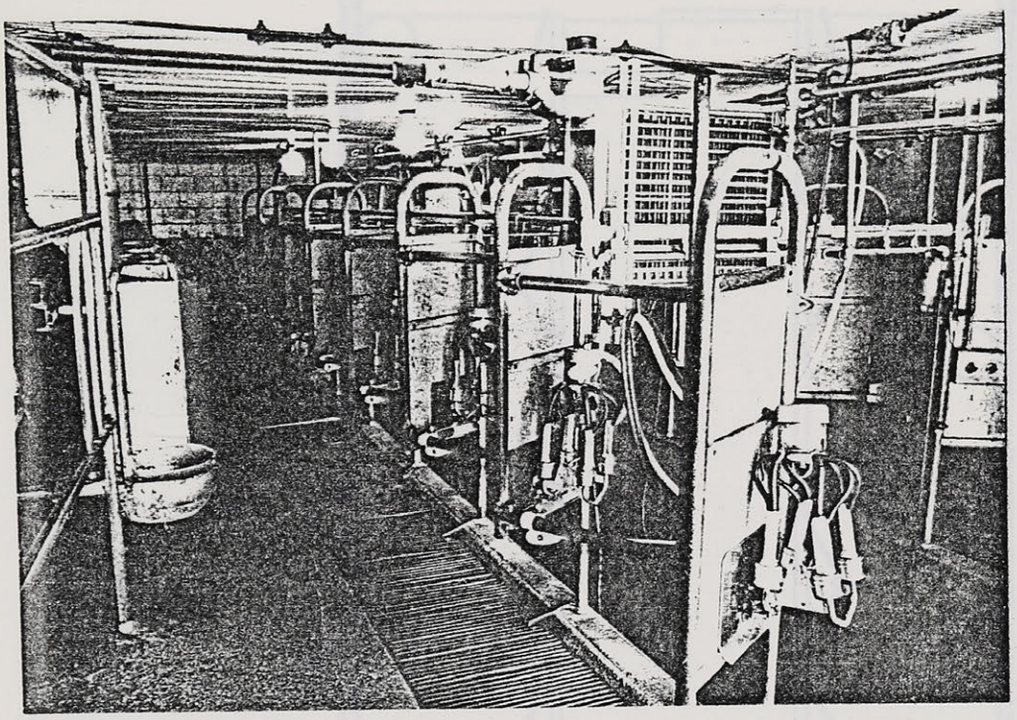

Figure 2. Inside view of the milking parlor.

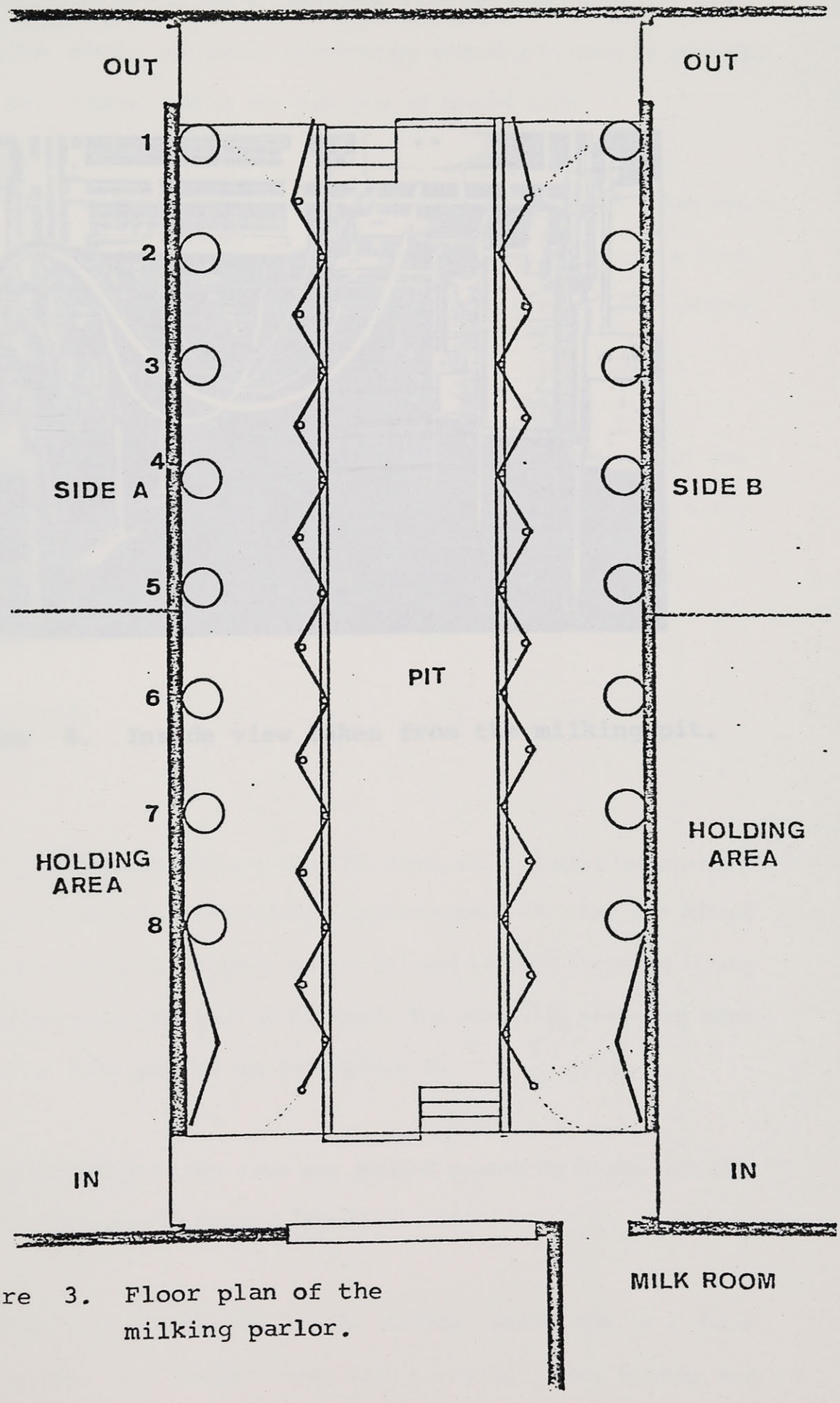

Figure 3. Floor plan of the milking parlor.

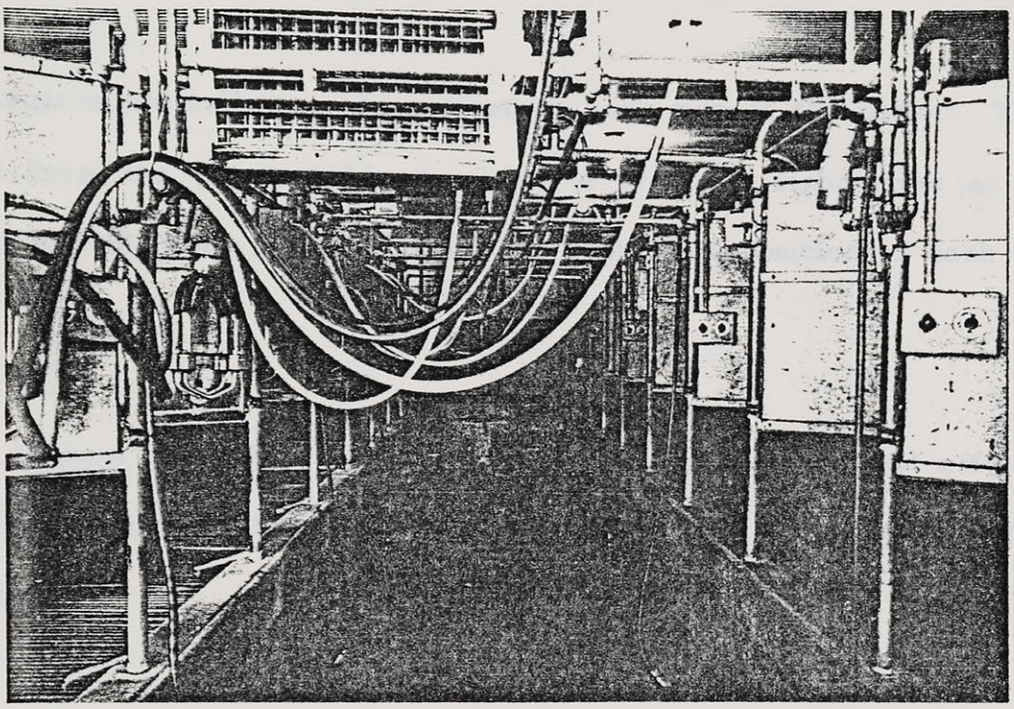

Figure 4. Inside view taken from the milking pit.

At each extremity of the stalls, feedbowls were installed permitting cows to be fed during the milking operation. Concentrate metering is done by turning a dial located on a control box at the tail part of second stall.

Headgates and tailgates are present on each side of the parlor. They are operated from the pit to hold or release a group of eight cows at a time (Figures 5 and 6). Note that the black dot represents position of each milking unit.

Air pressure operated doors are situated at the entrance and exit of cow lanes, restricting unwanted cows in the holding area from getting into the milking parlor.

4.3 Herd Information

The total herd consists of more than 300 cows, not including replacement calves which are situated in another barn. Approximately 204 cows are milked in the parlor twice a day, 32 of which are at the end of their lactation (group 1) and are located in the left part of the barn. The other 172 producing cows are situated in the right part of the barn (group 2).

The 68 heifers and 30 dry cows are grouped separately in the left side of the barn with the cows in group 1 (Figure 7).

All cows located on each side of the milking parlor rest in a warm environmental system that includes free stalls, resting areas, feeding and

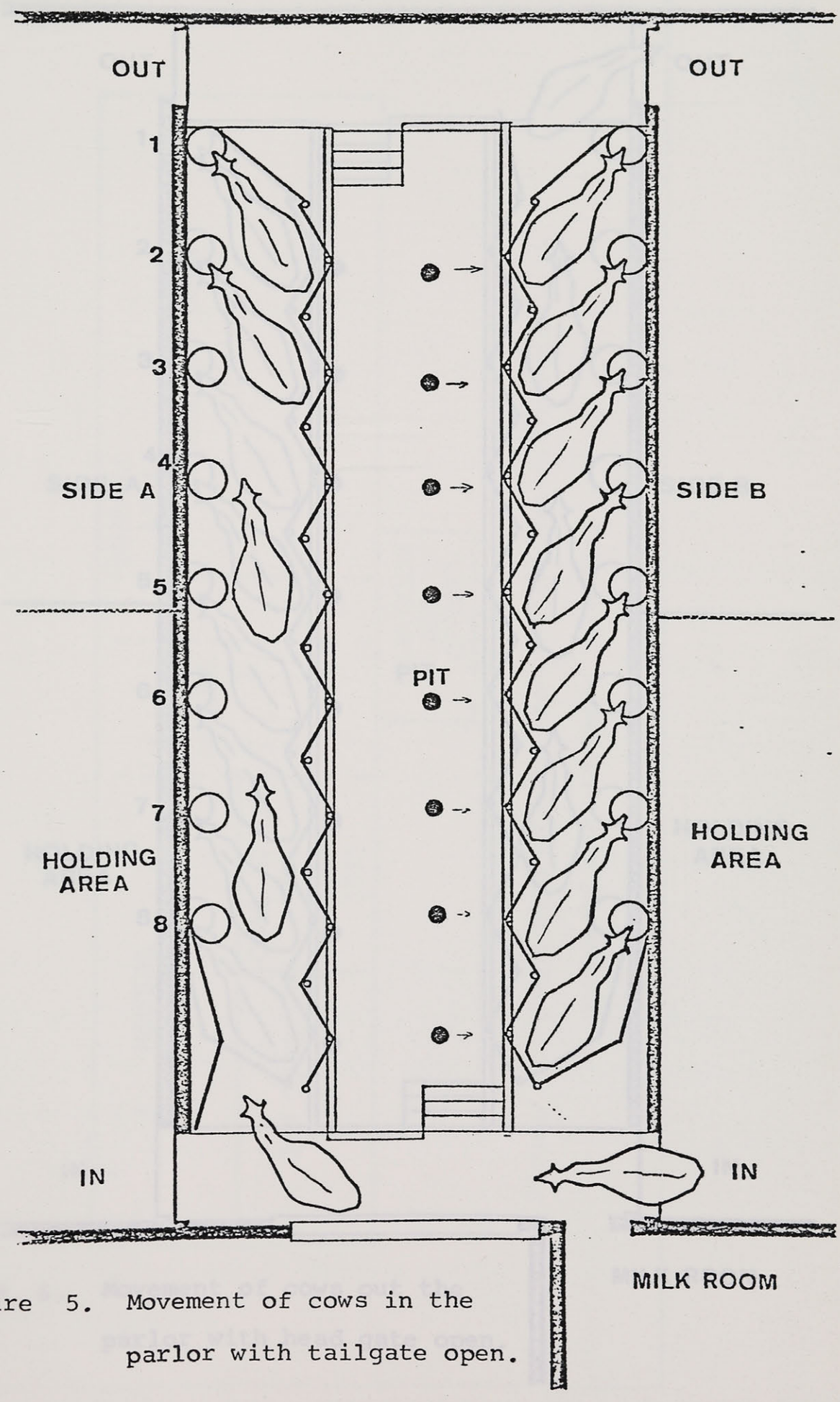

Figure 5. Movement of cows in the parlor with tailgate open.

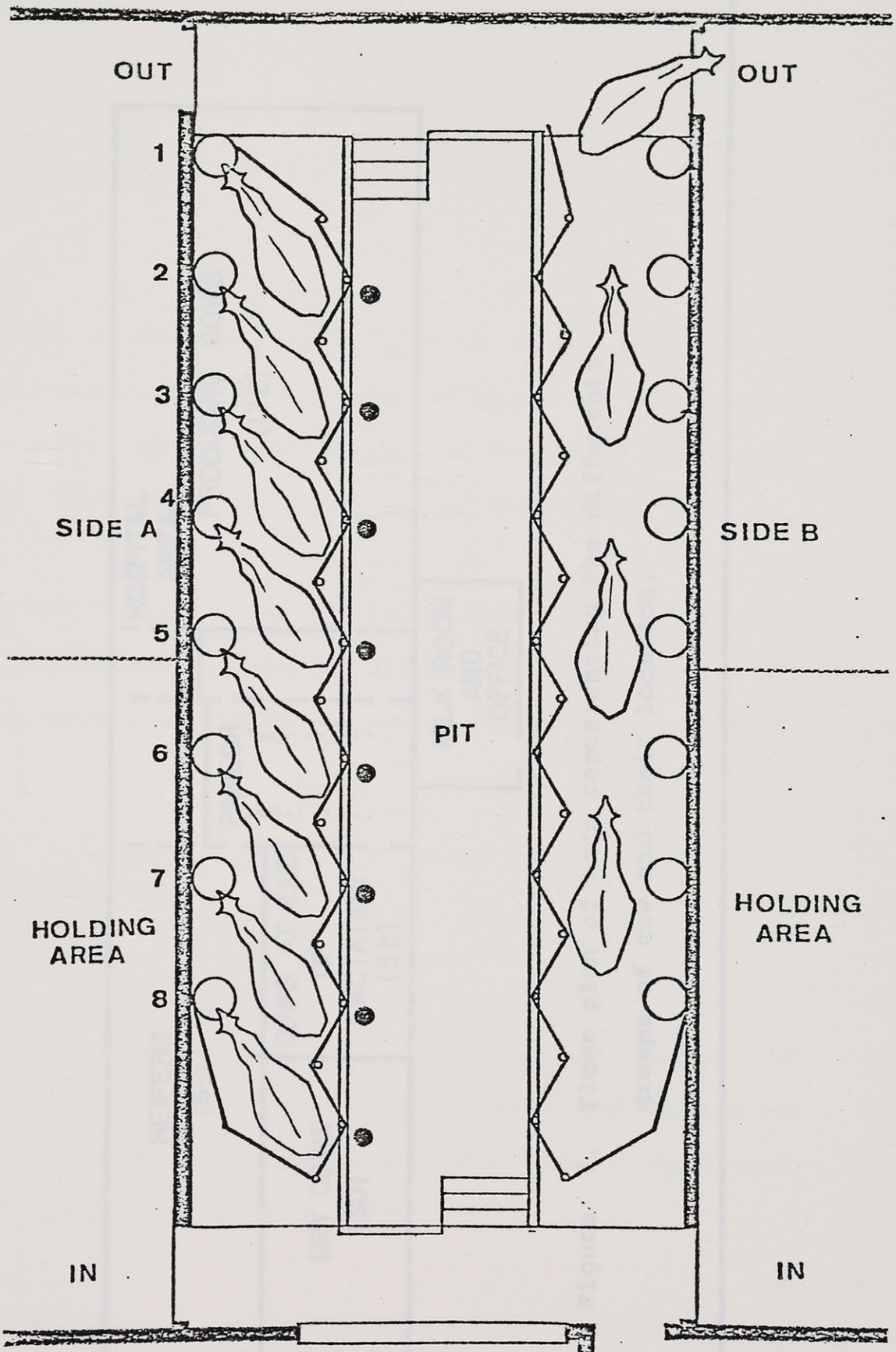

Figure 6. Movement of cows out the parlor with head gate open.

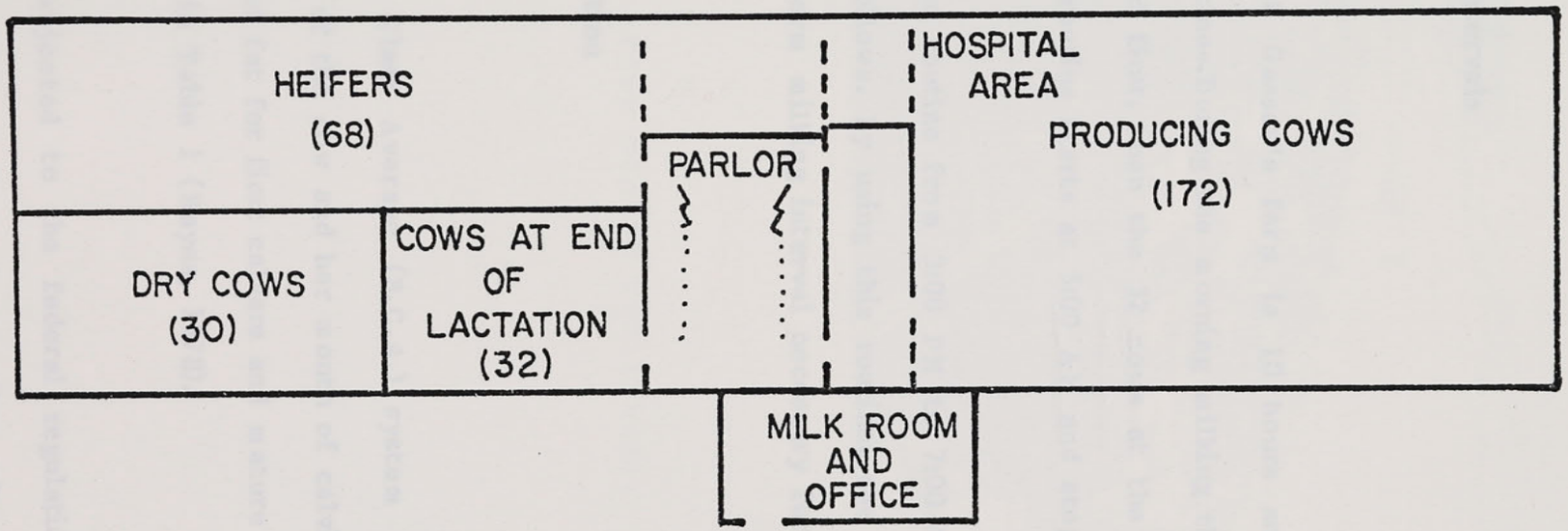

Figure 7. Floor plan of barn representing the differents groups of cow and their location.

holding areas (Figure 8).

4.4 Milking Routine Intervals

The schedule at Gasser's farm is 10 hours and 14 hours between successive milking routines.During the morning milking the 172 lactating cows in group 2 are milked first, then the 32 cows at the end of lactation are milked. Normally this routine starts at 5:00 AM and stops at 9:00 AM.

For the afternoon routine from 3:00 PM to 7:00 PM group 1 is milked first, then group 2 follows. By using this routine, the producing group (172 cows) had a more uniform milking interval necessary for a higher milk yield.

4.5 Herd Milk Production

Canada's Breed Class Average (B.C.A.) system adjusts milk and fat production for the age of the cow and her month of calving. The values of one B.C.A. point of milk and fat for first calvers and mature cows for the Holstein dairy breed are given in Table 1 (Hayes, 1978).

The herd is subjected to the federal regulation called Records of Performance (R.O.P.) which consists of recording milk and fat production of all cows in lactation every month.

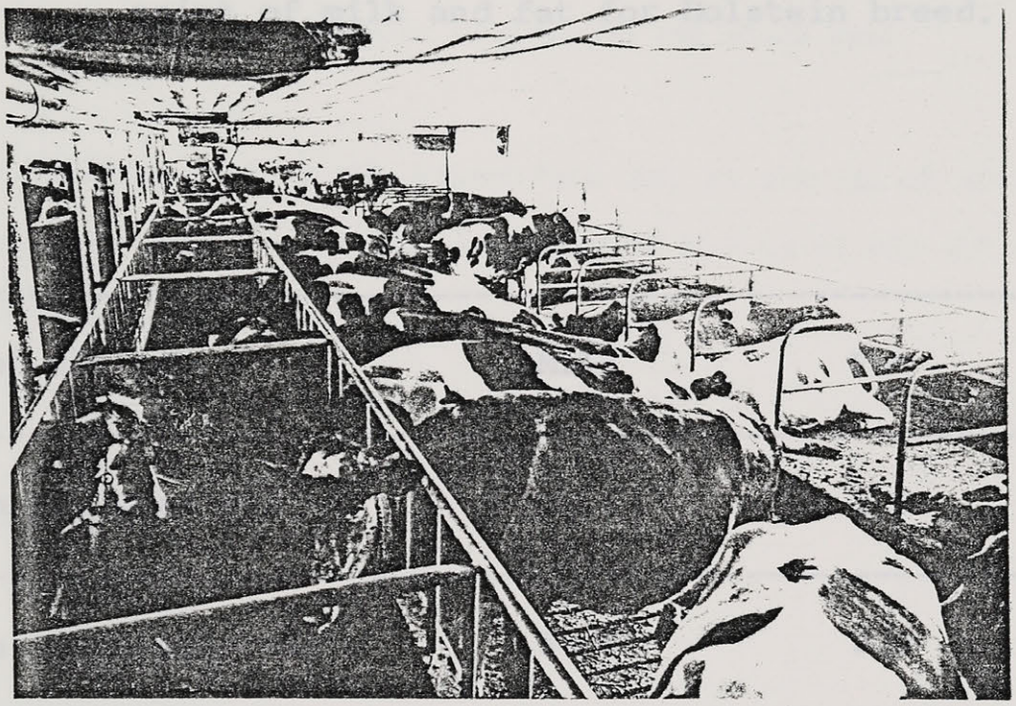

Figure 8. Free stalls facilities.

Table 1. Number of kilograms equivalent to one B.C.A. point of milk and fat for Holstein breed.

Age of the cow	Milk	Fat
For a two year old	41.5	1.5
For a seven year old	54.5	2.0

At the end of the 305 days lactation of each cow, the producer receives an official transcript certifying that the cow in question has given a certain quantity of milk and fat. He also receive another transcripton with the overall average of milk and fat production is given for the whole herd.

The Holstein herd at the Gasser farm has an average of around 135 B.C.A. which gives an average milk production of 21.2 Kg of milk per cow per day (46.7 lbs/cow/day).

4.6 Actual Milking Rate

There exist many ways to express milking rates for a given parlor; the two most frequently encountered are :

1) Cows milked per hour with respect to the daily production of milk (Cows/Hour/Daily production)
2) Mass of milk per operator per hour (Kg of milk/Operator/Hour)

In this report the first method will be used since it is the best measure of the effectiveness of the man and the installation.

Two milking routines were recorded to estimate the actual milking rate of the Gasser herringbone milking parlor. In conjunction with my assistant's schedule, the first data set was recorded in the afternoon and the second on the following morning.

The observed average milking time was 3:50 hours for a total of 204 cows

milked in the parlor. This yields a milking rate of 52 cows per hour, having a daily milk production of 21.2 Kg per cow per day.

4.7 Comparison of Milking Rates

Many types of milking parlor systems have been designed and used for the past twenty years. One of them, the herringbone, has gained popularity due to its compact arrangment and possibility for different automation levels (Babson Bros., 1976).

The milking rate of the herringbone double 8 parlor is in direct relation with its automation level (automatic units) and the number of milking units utilized (8 or 16 units).

A comparison of the actual milking rate with those of two other systems proposed by Surge (Babson Bros. CO.) is given in Table 2.

It was important to note that the actual milking rate in the Gasser parlor is low (52 cows/hr) compared to the Surge non-automated parlor (76 cows/hr), when the same number of milking units are used.

Table 2. Comparison of milking rates with other systems.

Element	Actual	Surge non automated	Surge automated
Milking stalls	16	16	16
Milking units	8	8	16
Operators	2-3	2	2
Milk production Avg. kg milk/cow/day	21.2	20.4	20.4
Milking rate Cows/hour	52	76	86

V MATERIALS AND METHODS

5.1 Number of Milking Routines Recorded

Two milking routines were recorded; one during the afternoon on February 11, 1983 from 15:00 PM to 18:48 PM, and the other on the following morning from 4:55 AM to 8:50 AM.

5.2 Flow Process Charts

5.2.1 Advantages of the Technique

One of the most frequently used methods of recording any process that has to be analysed as a function of time is the flow process chart. The flow chart represented in the Agricultural Materials Handling Manual (Staley, 1981) was modified and adapted to suit the milking routine operations.

After a first investigation in the parlor it was obvious that only one chart could not be used to record all the operations to be analyzed. Two flow process charts were then used to perform the task.Each side of the milking parlor was recorded simultaneously. This required two observers with synchronized stopwatches. Using this technique of recording times, work routine times and milking times were easy to calculate.

5.2.2 Flow Process Chart #1

The flow process chart #1 is presented in Figure 9. The headlines are reserved for general information such as cow group (those at the end of production or in normal lactation), side of the parlor (A or B) and observation duration.

The columns are for the description of the activities concerning cow performance in the parlor and their corresponding times of occurrence. A space is shown for taking notes if necessary.

By substraction of corresponding times these three main parameters were obtained;

1) milking time for each cow.

2) time to change unit from side to side.

3) available feeding time.

The latter representing the total time that a group of eight cows had spent in the parlor without including cow group traveling time.

FLOW PROCESS CHART # 1 PAGE: ___ OF: ___

OBSERVER:_____ COW GROUP:___ DATE:_____ SIDE: [A] [B]

MILKING STARTS AT:_____ OBSERVATION STARTS AT:_____

MILKING STOPS AT:_____ OBSERVATION STOPS AT:_____

DESCRIPTION	TIME (MINUTES)	NOTES	TIME (MINUTES)	NOTES
OPEN TAIL GATE				
CLOSE TAILGATE				
START WASH				
MILKER ON COW 1				
MILKER ON COW 2				
MILKER ON COW 3				
MILKER ON COW 4				
MILKER ON COW 5				
MILKER ON COW 6				
MILKER ON COW 7				
MILKER ON COW 8				
MILKER OFF COW 1				
MILKER OFF COW 2				
MILKER OFF COW 3				
MILKER OFF COW 4				
MILKER OFF COW 5				
MILKER OFF COW 6				
MILKER OFF COW 7				
MILKER OFF COW 8				
OPEN HEADGATE				
CLOSE HEADGATE				

Figure 9. Flow process chart #1.

5.2.3 Flow Process Chart #2

The flow process chart #2 is presented in Figure 10. The headlines are similar to those used in the previous flow chart.

The columns are for description of operators activities rather than activities concerning the cows themselves, including their corresponding times of occurrence.

By subtraction of corresponding times the following values representing cows travelling time and work routine time were found: cows in and cows out traveling times, feeding operation time, udder washing and stimulating time, hand stripping time, drying udder time and dipping teats time.

If one of these previous operations was skipped, intentionally or unintentionally, a blank was left in the chart.Therefore, percentage of occurrence of these events may be tabulated.

FLOW PROCESS CHART # 2 PAGE:____ OF:____

OBSERVER:_____ COW # :____ DATE:_____ SIDE: [A] [B]

OBSERVATIONS STARTS AT:_____

OBSERVATIONS STOPS AT:_____

DESCRIPTION	TIME (MINUTES)	NOTES	TIME (MINUTES)	NOTES
OPEN TAIL GATE				
OPEN IN-DOOR				
CLOSE IN-DOOR				
CLOSE TAIL GATE				
FEED CHOP				
WASH & STIMULATE				
HAND STRIP				
DRY UDDER				
MILKER ON				
REMOVE TEAT CUP(S)				
MILKER OUT				
DIP TEATS				
MISCELLANEOUS				
OPEN OUT-DOOR				
OPEN HEADGATE				
CLOSE HEADGATE				
CLOSE OUT-DOOR				

Figure 10. Flow process chart #2.

VI RESULTS AND DISCUSSION

6.1 Analysis of the Flow Process Charts

6.1.1 Statistical Analysis

Results from the two flow process charts were analysed using standard statistical techniques. Normal distribution was assumed to fit the population for all samples of various sizes. The following statistics were found;

1) number of observations.

2) mean.

3) standard deviation.

4) range.

5) coefficient of variability.

For some important parameters such as milking time and available feeding time, histograms were plotted to exhibit distribution characteristics.

6.1.2 Flow Process Chart #1

Previously it was pointed out that cow milking time, time to change units and available feeding time were obtained by subtraction.

Milking Times:

Table 3 summarizes all the statistical parameters for the morning and afternoon milking times.

From Table 3, it can be observed that the mean was 8.52 minutes for the morning milking times, Thiel et al.,(1977) developed a relationship between mean milking time (min /cow) and mean milking yield (Kg/cow) for 20 herds at a morning milking. The relationship was:

$$t = 2.33 + 0.362\ y \qquad (3)$$

where t is refer to mean milking time and y is mean milk yield.

It was assumed that 55 percent of the average milk yield was collected during the morning routine due to the uneven milking interval. That is 21.20 Kg/cow/day x 55%/day = 11.66 Kg/cow of milk collected in the morning.

From the preceding milk yield the mean milking time was found to be 6.55 minutes, representing a milking time of almost two minutes less than the actual average recorded during the milking routine.

This difference of average milking time could be interpreted in two ways. First, due to the relatively low automation level of the Gasser parlor and the

Table 3. Statiscal results for milking times.

Routine	Number of observations	Mean	Standard Deviation	Range		Coefficient of Variability
				Min	Max	
	N	min/cow	min/cow	min/cow		%
Morning	160	8.52	2.56	4.32	17.28	30.09
Afternoon	152	7.58	2.49	3.17	15.07	32.85

use of non-automatic milking units, it was observed that many cows were overmilked by one minute or so because the operators were occupied in performing different tasks.

Secondly, the relationship developed by Thiel et al. (1977) in Great Britain may have underestimated the cow milking times compared to those found in Canada because "The widespread use of artificial insemination to British Friesian bulls selected to improve milk yield would also result in an increase in inherent milking rates of cows in the national herd" .

In our country similar selection has been done to improve milk yields but has not yet been considered for milking rates. This may explain such a large difference (two minutes) between the estimated milking times and those observed.

It must be realized that a more carefull milking routine leads to less overmilking and therefore a potential reduction of mastitis.

Table 3 shows milking times for the afternoon routine. The mean observed milking time was 7.59 minutes. This value was lower by approximately one minute compared to the morning milking times since less milk was taken from the cows udders due to the uneven milking intervals.

A similar theoretical estimate of mean milking time developed by Thiel (1977) was done assuming that 45% (9.54 Kg/cow) of daily milk yield is collected during the afternoon, a mean milking time of 5.78 minutes was found. This calculated mean is approximately two minutes lower than the mean observed milking time.

Discussion of the morning milking times is also applicable to the afternoon milking times.

Figures 11 and 12 both represent histograms of milking times for the morning and afternoon routines respectively. It was realized for both histograms that the normal distributions were skewed to the right. This skewness represented cows which have an excessive milking time and held up the entire group to be exited from the parlor.

Since all cows entered in the parlor on a random basis, on many occasions 6 or 7 cows had finished milking and the units were placed on the corresponding cows on the opposite section. The remaining 1 or 2 cows (slow milkers) delayed the departure of the whole group (8 cows) resulting in serious time lost.

If a maximum allowable milking time was assumed not to deviate by more than one standard deviation from the mean, maximum values of 11.05 minutes and 10.08 minutes were found for morning and afternoon routines respectively. Corresponding values, representing percentages of the total herd which exceed a milking time of more than one standard deviation from the mean were found to be 19.8% for the morning routine and 24.6% for the afternoon routine.

Considering that approximately one cow out of five from the herd is a potentially slow milker and the remaining group is normally distributed, measures should be taken to divide the total herd in smaller groups in order to have a more uniform milking time associated with those smaller groups. Culling of cows having an extreme milking time, more than 14 minutes, would be a good management practice.

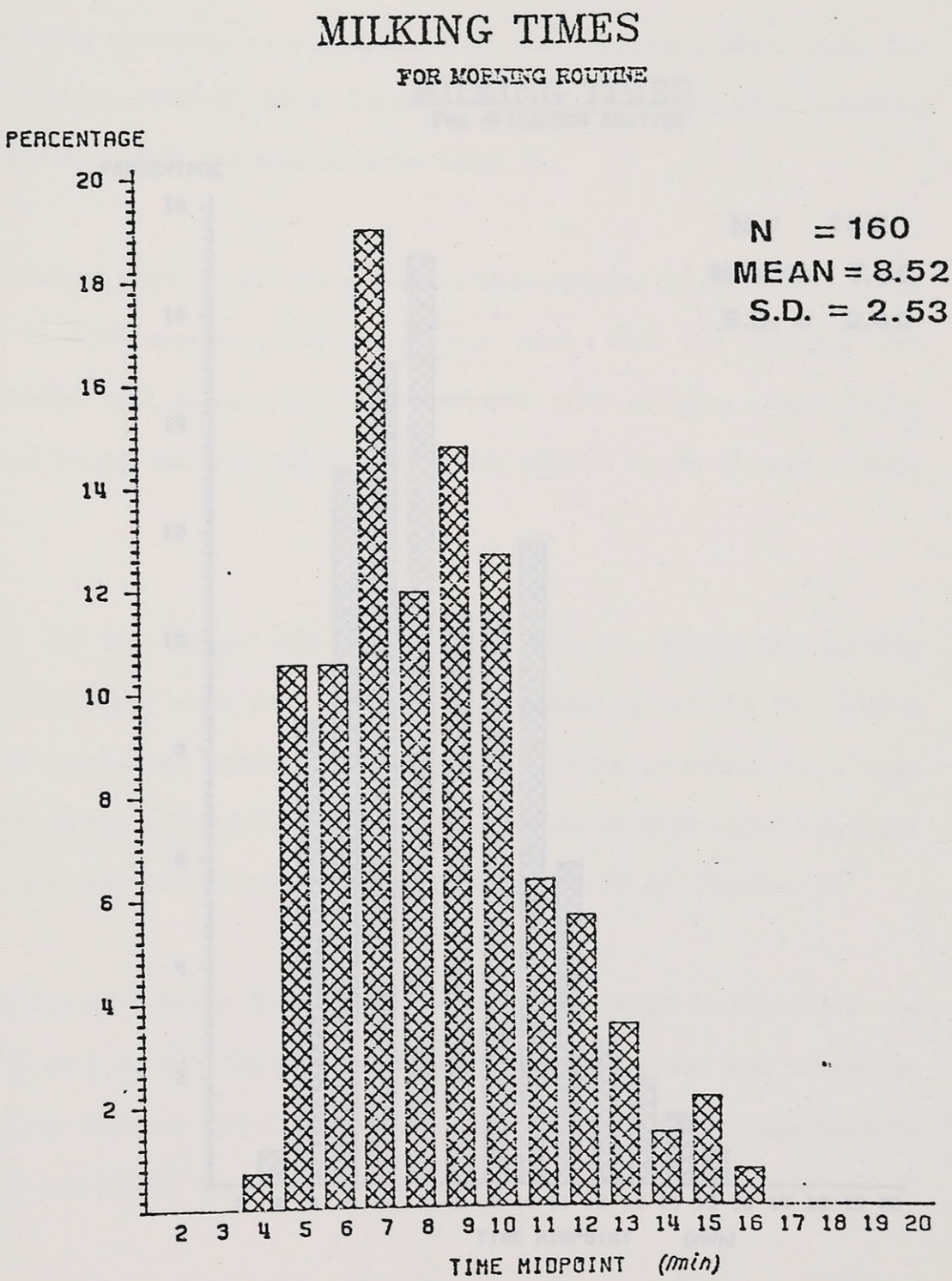

Figure 11. Histogram of milking times for morning routine.

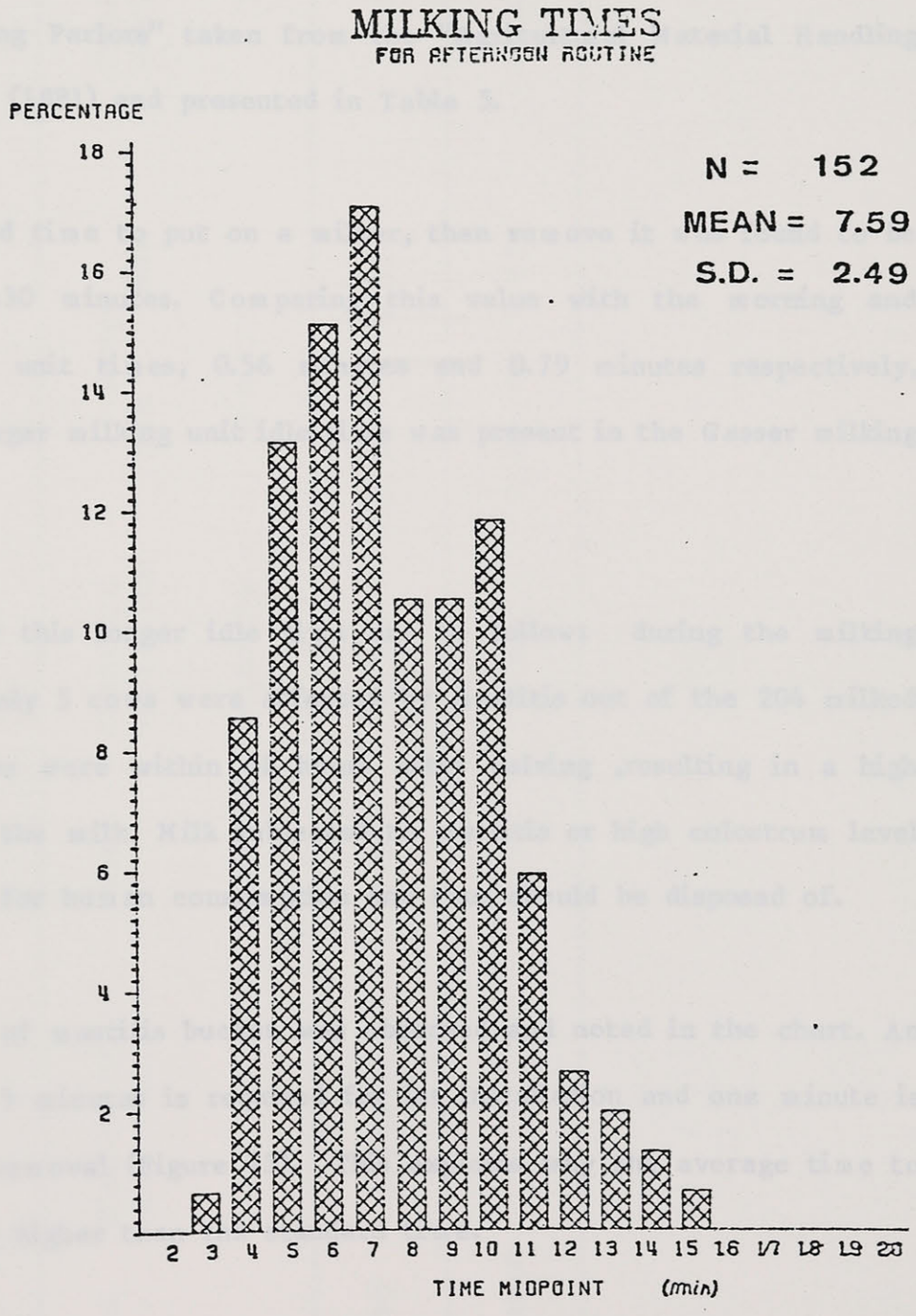

Figure 12. Histogram of milking times for afternoon routine.

Change Unit Times:

From the flow process chart #1, times to change units were obtained and summarized on Table 4. The average time to change units, for morning and afternoon milking routines, were compared to the "Standard Time Data for Herringbone Milking Parlors" taken from the "Agricultural Material Handling Manual" by Staley (1981) and presented in Table 5.

The standard time to put on a milker, then remove it was found to be 0.22 + 0.08 = 0.30 minutes. Comparing this value with the morning and afternoon change unit times, 0.56 minutes and 0.79 minutes respectively, indicates that a longer milking unit idle time was present in the Gasser milking parlor.

Reasons for this longer idle time are as follow: during the milking routine approximately 5 cows were affected by mastitis out of the 204 milked cows, and 3 cows were within 48 hours after calving ,resulting in a high colostrum level in the milk. Milk subjected to mastitis or high colostrum level must not be used for human consumption and thus should be disposed of.

Installation of mastitis bucket was observed and noted in the chart. An average of 2 to 3 minutes is required for its installation and one minute is necessary for its removal (Figure 13). This explains why the average time to change a unit was higher than the standard time.

Secondly, the maximum values encountered, were the result of milking units at idle times up to 5 or 6 minutes. This is due to the long milking times for one cow while the other cows had their milking units removed and

Table 4. Statistical results for change unit times.

Routine	Number of observations	Mean	Standard Deviation	Range		Coefficient of Variability
				Min	Max	
	N	min/cow	min/cow	min/cow		%
Morning	152	0.56	0.96	0.00	5.38	169.89
Afternoon	144	0.79	1.62	0.00	7.83	204.31

Table 5. Standard time data for herringbone milking parlor.

Element	Average min/cow
Let cow in	0.17
Feed concentrate	0.04
Let cow out	0.12
Wash udder with hose	0.21
Wash udder with rag	0.29
Strip check into hand	0.112
Teat dipping	0.067

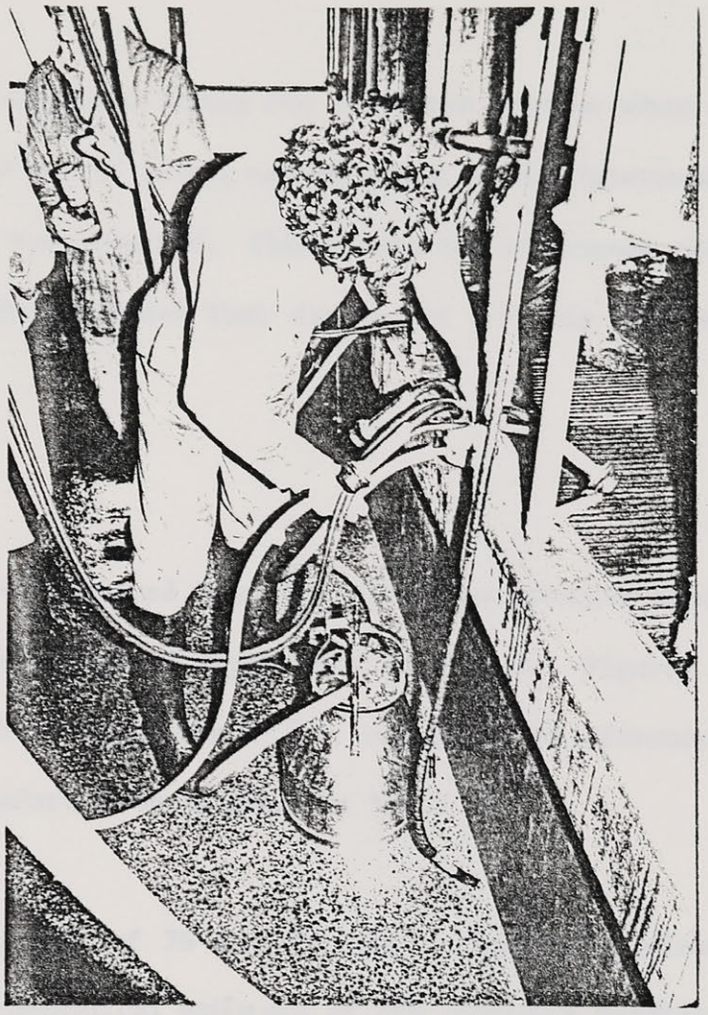

Figure 13. Installation of a mastitis bucket by the operator.

deposited next to the parlor pit.

A similar situation happened during the afternoon routine when one of the feeder metering dials was out of order, necessitating partial interruption of the milking routine, while it was repaired. This is why the afternoon average time to change units was slightly greater than during the morning routine.

Feeding Times:

The final information gathered from the first flow process chart was the available feeding time for groups of eight cows at a time. Figures 14 and 15 represent histograms of feeding times for morning and afternoon routine respectively. Complete information is given in Table 6.

Assuming a milking rate of 76 cows/hr and a time of 2 minutes to let the cows in and out. A theoretical estimate of the available feeding time can be derived from the following equation:

((60 (min/hr)/ milking rate (cows/hr)) x 8(cows/side) x 2 sides)
- Travel time (min) = available feeding time (min). (4)

A value of 10.63 minutes is found for the theoritical available feeding time for a "Surge" double-8 herringbone milking parlor.

Mean values of feeding times for both morning and afternoon routines were found to be higher by approximately 6 and 4 minutes respectively. It should be recalled that the available feeding time depends directly on the milking times of the group of eight cows and especially on the longer milker.

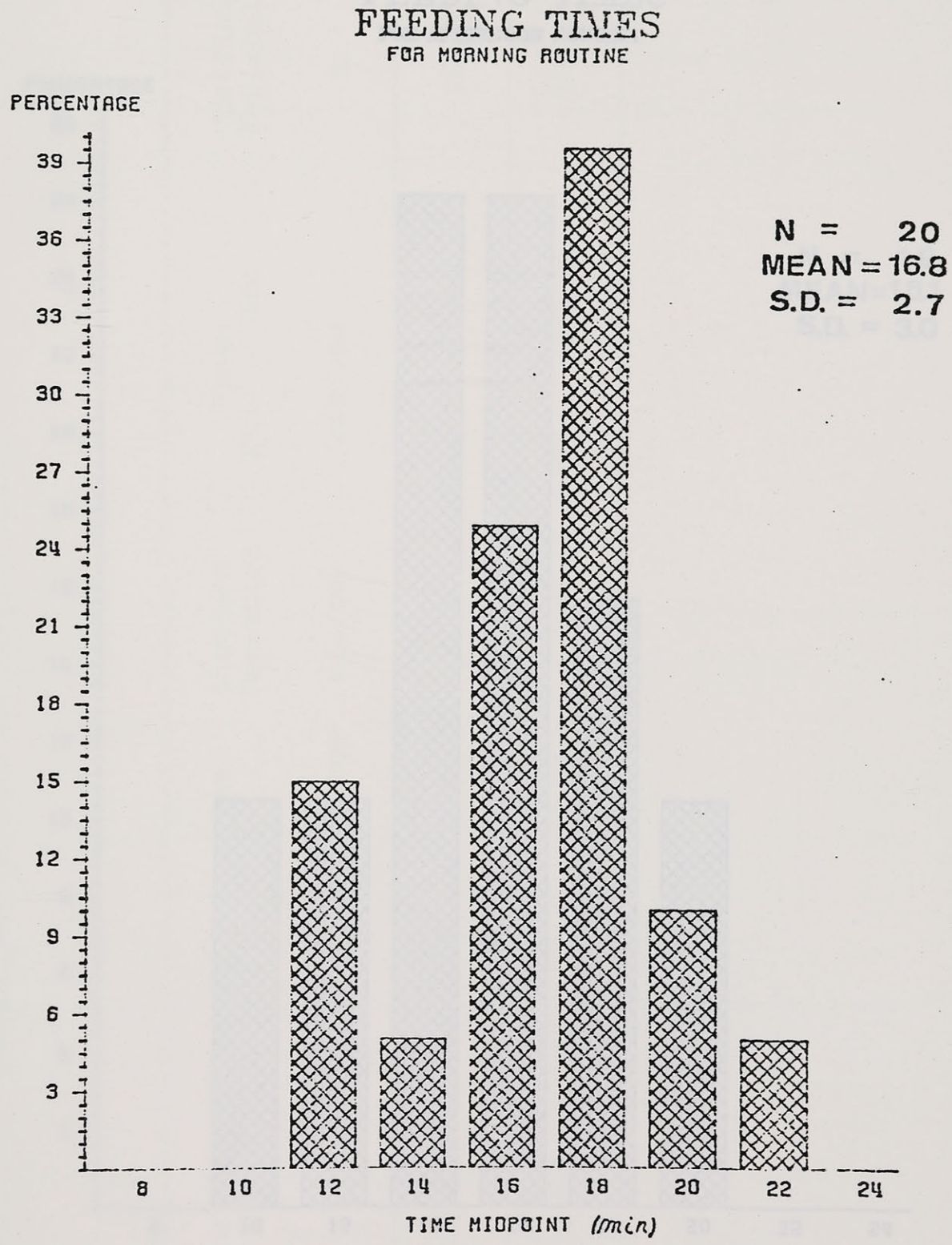

Figure 14. Histogram of feeding times for morning routine.

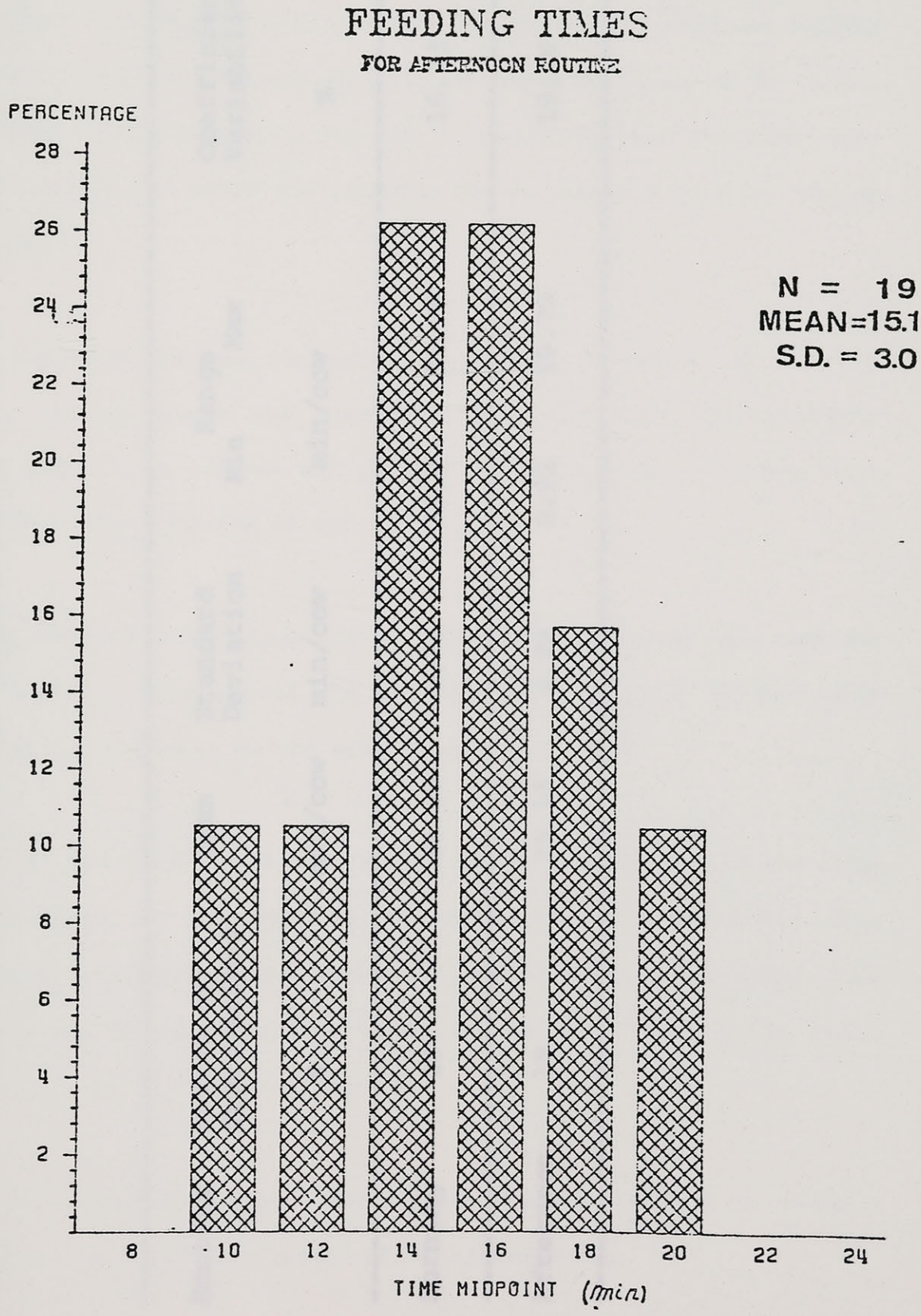

Figure 15. Histogram of feeding times for afternoon routine.

Table 6. Statistical results for feeding times.

Routine	Number of observations	Mean	Standard Deviation	Range		Coefficient of Variability
				Min	Max	
	N	min/cow	min/cow	min/cow		%
Morning	20	16.80	2.74	12.2	21.68	16.33
Afternoon	19	15.13	2.98	9.92	19.70	19.70

To illustrate this situation, Figures 16 and 17 represent the milking parlor occupied by two groups of 8 cows on side A and B respectively. Figure 16 has one of the cows being a long milker, labelled cow number 4 on side B, while all others cows have shorter milking times. Figure 17 represents the milking parlor 7 or 8 minutes later, having all units transfered to side A of the parlor except the long milking cow (B-4). The cow in question retards the entire cow group from exiting the parlor and restrains the following group from getting into the parlor.

This sitiuation has been observed for more than 80 percent of the time during the morning routine and more than 50 percent during the afternoon routine. A value of 14 minutes was assumed as an "acceptable" feeding time from both histograms (Figures 14 and 15).

It was observed a few times that the long milker not only increased the available feeding time beyond the "acceptable" values (14 min),but also influenced the feeding time on the other side of the parlor.

The cow group on the B side of the parlor is released once the slow milker is finished. The corresponding cow on the side A of the parlor , has commenced to be milked later corresponding to the rest of the group. This implies that the corresponding cow (A-4) will retard the exit of the whole group of cows from the parlor (Figure 18).

This illustrates the major inconvenience when a double-8 herringbone parlor utilizes 8 milking units instead of 16 milking units.

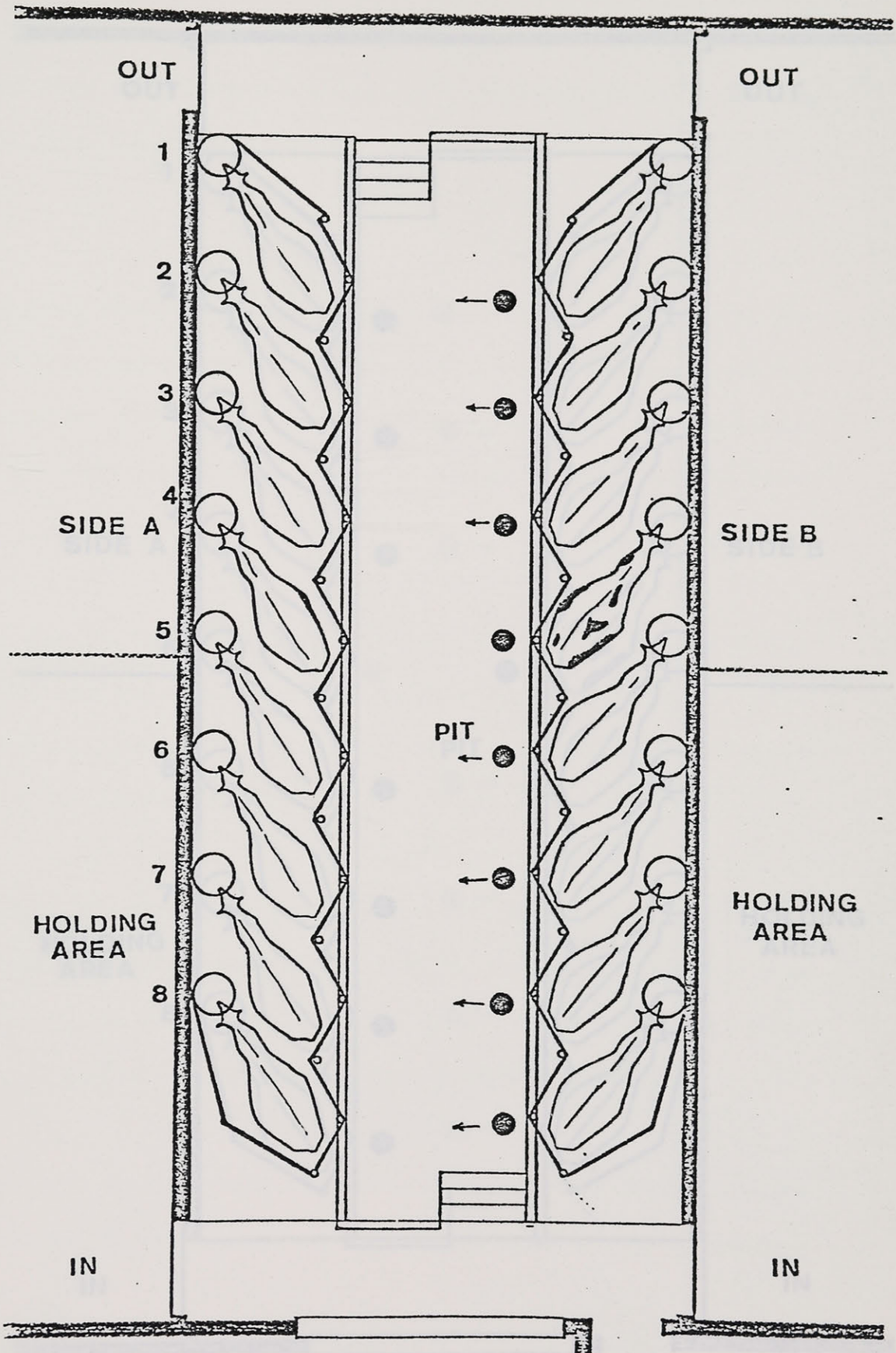

Figure 16. Representation of the long milking cow.

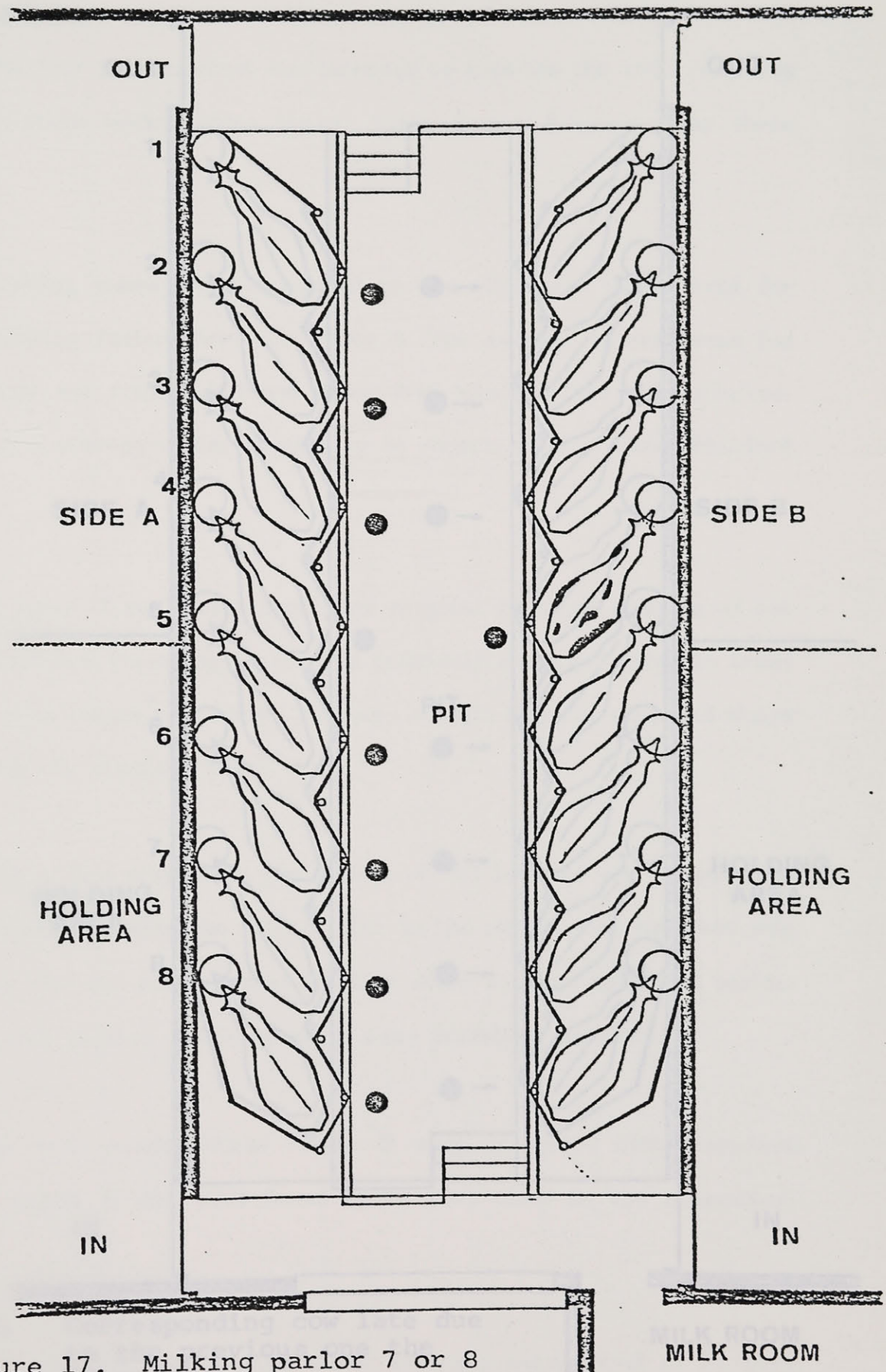

Figure 17. Milking parlor 7 or 8 minutes later ,with all units transfered on side A except the slow milking cow.

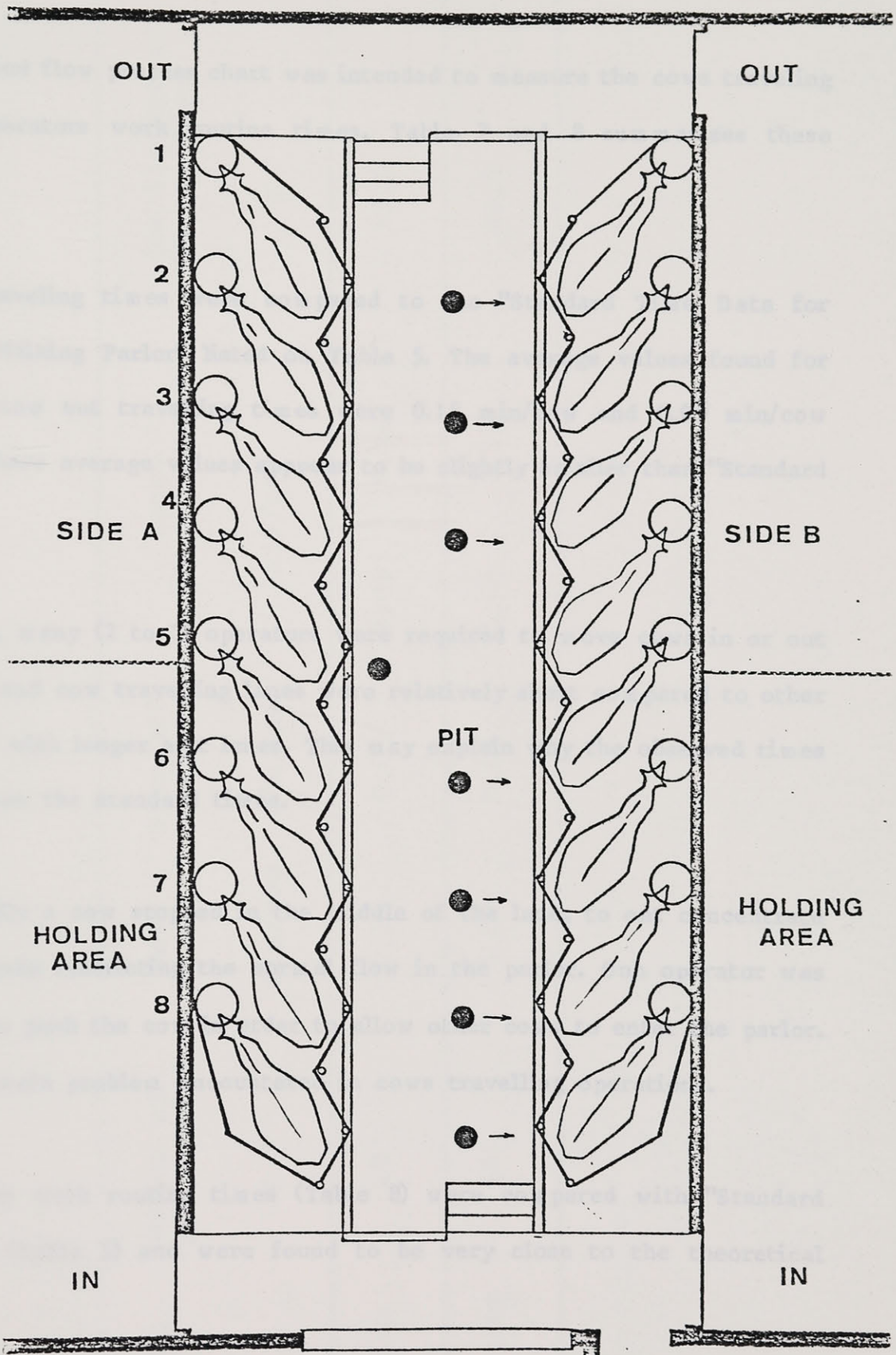

Figure 18. Corresponding cow late due to the previous one the other side.

6.1.3 Flow Process Chart #2

The second flow process chart was intended to measure the cows traveling times and operators work routine times, Table 7 and 8 summarizes these results.

Cows traveling times were compared to the "Standard Time Data for Herringbone Milking Parlor" listed on Table 5. The average values found for cow in and cow out travelling times were 0.15 min/cow and 0.09 min/cow respectively, these average values apppear to be slightly smaller than "Standard Time Data".

Actually, many (2 to 3) operators were required to move cows in or out of the parlor, and cow travelling lanes were relatively short compared to other milking parlors with longer exit lanes. This may explain why the observed times are smaller than the standard times.

Occasionally a cow stopped in the middle of the lane, to eat concentrate leftovers thereby restricting the normal flow in the parlor. One operator was then required to push the cow in order to allow other cows to enter the parlor. This was the main problem encountered in cows travelling operations.

Operators work routine times (Table 8) were compared with "Standard Time Data" (Table 5) and were found to be very close to the theoretical values.

Feeding times and teat dipping times averages were found to be very close with standard times. Their variabilities (C.V.) were small, indicating good

Table 7. Cows traveling times.

Event	Number of observations	Mean	Standard Deviation	Range Min	Range Max	Coefficient of Variability
	N	min/cow	min/cow	min/cow		%
Cow in	19	0.15	0.05	0.09	0.26	33.3
Cow out	19	0.09	0.02	0.06	0.13	26.4

Table 8. Operators work routine times.

Event	Number of observsations	Mean	Standard Deviation	Range		Occurency	Coef. Var.
				Min	Max		
	N	min/cow	min/cow	min/cow		%	%
Feeding	19	0.03	0.00	0.03	0.05	100	0.0
Washing	19	0.43	0.34	0.10	0.85	100	79.0
Foremilking	19	0.11	0.05	0.07	0.25	76	45.5
Drying	19	0.11	0.06	0.02	0.09	53	54.5
Teat dipping	19	0.07	0.01	0.07	0.08	100	14.3

uniformity of the routine. These steps were performed all the time (100% occurrency), especially the teat disinfection which is an essential element in the mastitis control routine (Castle and Watkins, 1979).

Washing average time (0.43 min) was found to be higher than the standard time (0.21 min) by a factor of two due to dirty udders that required larger washing time. The lower time values (0.10 min) for washing must be eliminated since "proper washing and stimulation of the cows udder is vital for a complete milk let-down and cleanliness" (Babson Bros., 1976).

Average times to dry udders (0.11 min) were similar to the standard time (0.112 min). Unfortunately, this routine was performed only 53% of the time. In other words one cow out of two was dried properly. The operators should realize that " after washing, the teats should be dried with disposable paper towels; tests have shown that washing the teats without drying them shows no reduction in bacterial contamination of the milk compared to no washing at all (Castle and Watkins, 1979).

Thus, to reduce mastitis and decrease bacterial counts in milk, teats must be dried for all cows before taking the foremilk.

Hand stripping times were found to be identical to the standard times. The operator skipped this operation 24% of the time during the milking routine. This situation must be corrected in order to ensure that the teat orifice is not blocked, to remove the first milk which may have a high content of bacteria, and to allow the milker to check the milk for mastitis, blood and other abnormalities (Castle and Watkins, 1979).

Finally the teat dipping operation was well performed and done all the time (100 % occurrency) since it is an essential element on the mastitis control routine (Castle and Watkins, 1979).

6.2 Time Motion Analysis

6.2.1 Assumptions

In order to perform the time motion analysis suggested by Clough and Quick,(1967) some assumptions have been made to achieve reasonable results and facilitate calculations of the potential performance of the Gasser parlor.

1) The milking time starts after the initial set up of the equipment.

2) There were two operators performing the milking routine in the parlor.

3) Four milking units are used by each operator.

4) Feeding time is not included in the work routine time since a third operator perform this task.

5) Average values of morning and afternoon routine were used for cows milking time and unit idle time.

6) Drying and foremilking of udders is performed all the time.

6.2.2 Calculations

According to the previous assumptions actual and potential performances were calculated using the techniques proposed in "Machine Milking" by Thiel et al.,(1977).

Work routine time :

The work routine time was defined as the time to change units, let cows in and out and prepare them before and after milking. A value of 0.82 minutes per cow was found as the work routine time for the Gasser double-8 herringbone parlor. The maximum performance of this parlor was derived first by calculating the milking rate in terms of cows milked per man-hours as follows :

$$\text{Milking Rate (Cows/man/hour)} = 60/WRT \qquad (5)$$

A milking rate of 73.4 (cows/hour) was found. Calculations for work routine time and milking rates are presented in appendix A.

A comparison of this maximum milking performance, based on the work routine time of the operators, was made with the milking rate of a Surge non-automated double-8 herringbone parlor (76 cows/hour) and found almost identical. From this comparison it should be understood that the limiting factor of the Gasser milking rate (52 cows/hour) was not due to the operators work routine but mainly due to the long milking cows and the number of milking units.

Unit Time :

This was defined as the total time a milking unit was associated with a cow. The unit time is equal to the milking time plus the idle time. The idle time was the time to change units from side to side of the parlor.

A unit time of 8.73 minutes was found. The maximum number of cows milked per milking unit per hour was then calculated and found to be 6.87 (cows/unit/hour). The actual potential performance was calculated from the equation (1) as follows :

$$P = 60/UT \times N \qquad (1)$$

$$P = 60/8.73 \times 8 = 55.0 \text{ (cows/hour)}$$

Where UT was the unit time and N the number of milking units used in the parlor. Unit time and potential performance calculations are presented on appendix B.

The actual potential performance (55.0 cows/hour) was found to be slightly higher than the actual milking rate (52.0 cows/hour) obtained previously (difference of 6.7 %). It should be realized that the potential performance is directly related to the cows milking time, unit idle time and number of milkers used. A reduction in time to perform these tasks will lead to a higher and more desirable milking rate for the Gasser parlor.

Available Work Time :

Was determined to verify wheter or not the actual maximum potential performance could be achieved during the milking routine. Available work time was calculated using equation (2), and found to be 1.09 minutes per cow. Since the value was obviously greater than the work routine time (0.82 minute per cow), maximum actual performance of the milking parlor was achieved.

It should be understood that the term "maximum" refers to the potential performance (55 cows/hour) and does not mean that higher milking rates of the parlor could not be achieved. The maximum performance refers to the utilisation of the operators time with respect to the available milking time set by the cows.Since the cows available milking time is greater than the operators working time, primordial importance should be oriented in order to decrease the milking time and unit idle time rather than operators work routine time.

VII RECOMMENDATIONS

7.1 Improve Milking Routine

It was previously observed that the "Ideal Milking Routine" was not always performed properly. The foremilking and udder drying were skipped too often, resulting in a non preventive mastitis control (Babson Bros.,1976).

In order to reduce mastitis, the operators should foremilk all cows to remove milk containing bacteria and dry udders to avoid risk of concentrating bacteria at the teats ends (Thiel et al.,1977).

By using these preventive measures the total herd will be under a better mastitis control program.

The results from flow process chart #1 have shown that in general all cows have been overmilked by approximately one minute. There is evidence that overmilking damages the teat lining even though there are no direct causes of infection related to overmilking (Thiel et al.,1977).

Prompt removal of the milking unit once milk flow stops is therefore a prime requisite in good cow milking. Automatic milking units can relieve much of the pressure which a good operator is under to remove the unit at exactly the proper time.

7.2 Herd Management

The time motion analysis revealed the real causes of the low milking rate of the Gasser parlor. The performance of the parlor was found to be directly related to the average cow milking times and thus only reduction or uniformity of milking times will lead to an increased parlor performance.

In order to have uniform cow milking times, grouping appears to be the most suitable solution. Most large dairy enterprises handle their cows in groups limited to 50 to 100 cows each, depending on the herd size. The size of each group should be restricted to the number of cows that can be milked in 2 hours. This is necessary to prevent excessive stress on cows during the premilking, holding process (Babson Bros.,1972).

Where feeding is a simple matter of providing forage in yards and concentrates only in the parlor, division of the herd is of reduced importance. Actually with more complex feeding programmes it becomes increasingly important to be able to match the ration of a group of cows as closely as possible to its production level (Castle and Watkins, 1979).

Two different approaches of cow grouping are actually used in the United States ; the first consists of grouping cows by level of milk production and feeding them accordingly, and the second consists of grouping cows by stage of lactation. In both approaches there are some advantages and inconveniences.

Grouping cows by level of production appears to be the most effective way of controlling the feeding program and still achieve maximum milk

production. Wilcox et al. (1978) have found that a minimum of 3 production groups or even 4 groups was desirable. By using this procedure, fewer changes are needed during a lactation.

A controversy is associated with the fact of moving cows between groups. A social stress, inducing fighting among cows, is encountered when they are moved to different groups. This stress may reduce the feed efficiency of the animal, thus decreasing its milk production; but most dairymen move cows between groups once a month and have reported very few problems with the system (Wilcox et al.,1978).

A less controversial system of grouping cows is by stage of lactation, but the system is inconvenient since it assumes that all cows have a similar level of milk production. The only advantage is control for reproduction management.

Separation of dry cows from the remaining herd is a common practice in large herds and was followed in the observed system.

Large herd owners are encouraged to maintain a hospital herd in order to avoid getting antibiotics and other drugs into the milk supply. It was also recommended by Wilcox et al. (1978) that all cows having mastitis or other problems requiring daily treatments, should be maintained in this group. Unfortunately, on the observed dairy farm, cows having mastitis or infections were included in the unique large group.

It is strongly recommended to the farmer in order to reduce differences in milking time and to increase the parlor efficiency that the following management practices should be implemented :

1) All cows having mastitis or udder problems should be located in the hospital area.

2) Cows with a milking time of more than 12 minutes (representing 5 or 6 percent of the herd) should be culled unless carrying a very important genetic background.

3) The large and unique group should be divided into at least two smaller groups according to their level of production. The high group should include fresh cows (1 to 3 months following calving) and all cows producing a certain level of milk daily. The other group should be all remaining cows fed to a lesser amount than the high group, excluding cows at the end of their lactation.

If the manager agrees to follow these recommendations a substantial increase in the milking rate should be observed as long as good milking practices are followed. The level of production at which the cows should be subjected is related to many factors such as average milking production of the herd, feeding formulations and individual cows milking production.

In order to estimate the grouping limitation level for milk production, a careful study of all preceding subjects should be made by the herd manager himself, since he knows exactly all the cows requirements and the feeding installations limitations.

7.3 Milking System

Previously it was found in the time motion analysis that the potential milking rate could be increased if 16, rather than 8, milking units were utilized. The addition of automatic detatchment units would be highly desirable to reduce the overmilking of cows. From the Babson Bros. (1972) publication "Automation of Milking Systems" a theoritical estimate of 80 to 90 cows milked per hour is expected, as long as consistent cow movement is respected, for the same type of parlor.

The high investment costs to install 16 automatic units (more than $30,000.00) would be paid back rapidly not only in economical terms but essentially in terms of labour reduction and time spent in the parlor.

It should be clearly understood that such high milking rates will not be encountered unless an adequate herd management and milking routine are performed all the time, since the main limitation to parlor performance was due to the non-uniform cows milking times.

7.4 Cow Traffic

Occasionaly, the operator had to leave his pit to encourage cows into the parlor. This did not lengthen the average "cow in" time per cow; however it is clearly desirable that the operator remain in his pit.

In most large dairy farms of North America crowd gates, which crowd cows forward and help train them to move quickly into the parlor, were used to ease the work load of the operator. There exist many commercially available crowd gate systems. The one proposed by Surge company (Babson Bros.,1972) is represented in Figure 19 and is operated manually or automatically from the interior of the parlor.

It is recommended that such installations be made in order to avoid interruptions during the milking routine and to facilitate better cow flow. If this is possible, the construction of a custom made cow pusher without any electrically charged wire on the crowd gate is advisable, since electric pulses tends to make cows nervous (Wilcox et al.,1978).

Interruptions of operators milking routine was also observed to be caused by some cows stopping in the parlor to eat feed left in the feedbowl by a preceeding cow, restricting the normal flow of the entire group.

An automatic feed gate system (Figure 20) was developed by Danner et al. (1974) at Michigan State University. The system consist of power operated covers placed at the feeding stations in a herringbone parlor. These are designed to cover the grain when all cows in a particular batch finish milking

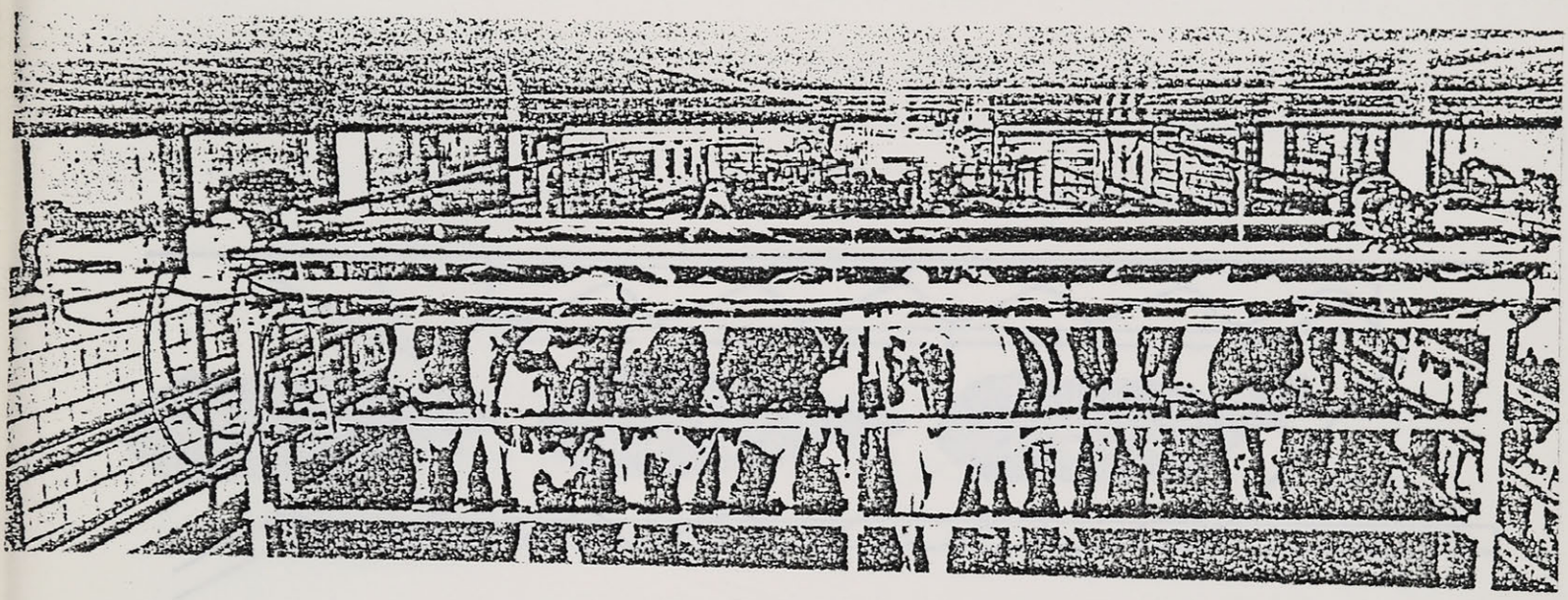

Figure 19. Surge automatic crowd gate.

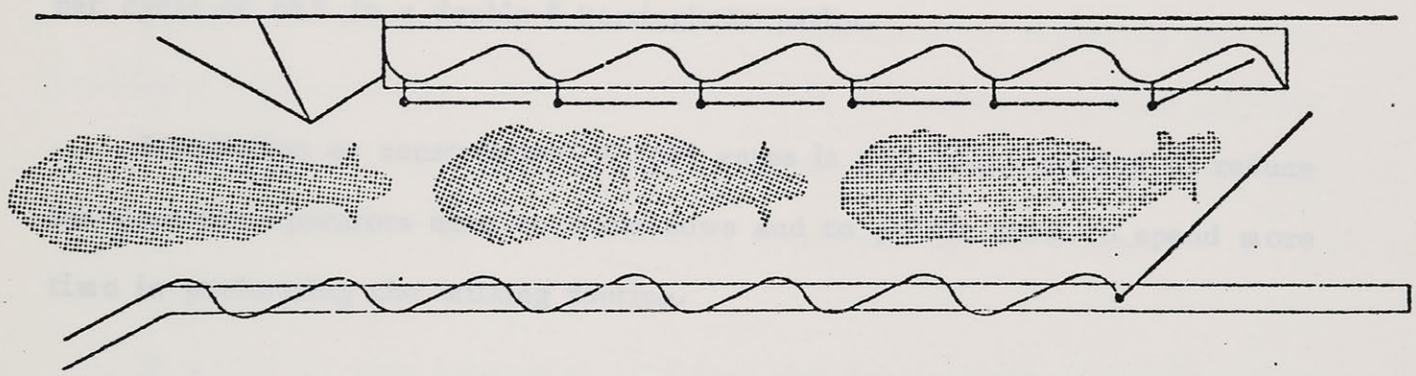

Figure 20. One side of a double-6 herringbone with feedgates, feed trough and positioning rails.

and are released. Upon entry of a new batch of cows, only the front cover is open. When the cows reach this position, she activates a switch which opens the second cover, the second cows activates a switch which opens the third cover, etc. This process continues until the last cow entering her place closes the rear gate. When it is time to exit, all cows in the batch are given a signal to leave with closing of the feed gates, rather than just the first cow in a conventional parlor with the opening of the headgate.

It was found by the researchers that the feed gates in combination with a crowd gate, produced a decrease in the average operator interruption time per cycle of 66% in a double-8 herringbone parlor.

Installation or construction of feed gates is thus recommended to reduce the time the operators need to move cows and to permit them to spend more time in performing the milking routine.

VIII SUMMARY AND CONCLUSION

The analysis of data and time motion study lead us to a better understanding of the reasons for the observed low milking rate. Only through mechanization of the parlor, and essentially with proper herd management (which includes grouping cows with respect to their level of milk production and culling of the slower one) will increased milking rates.

Upon recent news from the Gasser family, division of the large herd into two groups was effected but without entire classification regarding the milk production of each animal. Many milking machine companies have been solicited by Rolf Gasser in future plans to include 16 automatic detachment units. The installation of a crowd gate has also been considered by the owner.

It would be very interesting to follow any development or modifications which will be done on the parlor.

Finally the author would like to wish best of luck to Rolf Gasser and hopes that this paper will contribute to future decision making.

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APPENDICES

Appendix A: Calculations of work routine time and corresponding milking rates.

Work routine time: 0.82 min/cow

Element time		man-min/cow	
Avg. change units: (0.79 + 0.56)/2=		0.67	
Cow in		0.15	
cow out		0.09	
washing		0.43	
Foremilk		0.11	
Dry udder		0.11	
Dip teats		0.07	
	Total	1.64	man-min/cow

Since 2 operators

1.64/2 = 0.82 min/cow

Milking rate = 60/WRT ; 60/0.82 = 73.4 maximum cow/hour

Appendix B: Calculations of unit time and potential performance.

Unit time: 8.73 min/cow

Element time	min/cow
Idle time (0.79 + 0.56)/2 =	0.675
milking time (8.52 + 7.59)/2 =	8.055
Total	8.73 min/cow

Potential performance: 55.0 cows/hour

$$P = \frac{60}{UT} \times N \qquad (1)$$

$$P = \frac{60}{8.73} \times 8 \text{ units} = 55.0 \text{ cows/hour}$$
