Polygon Milking Parlors
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# POLYGON MILKING PARLORS

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THE POLYGON PARLOR, developed at Michigan State University, is a four-sided milking parlor utilizing herringbone stalls. Originally, the polygon parlor was conceived as a milking parlor utilizing herringbone stalls and having anything more than two sides. But a four-sided arrangement was selected as being most convenient from the standpoints of construction and cow movement. Polygons with four, five, six, eight or ten cows per side have been constructed.

Computer simulation studies of herringbone and other milking parlors showed that the polygon would best utilize the labor-saving capabilities of mechanized equipment—equipment for improving cow movement, stimulation of milk letdown, power and automatic gate operation, post-milking treatment, and especially automatic milking machine detaching units. Because the operator in a polygon is working with four groups of cows rather than two groups as in a double herringbone, throughput* for the polygon will be greater for an equivalent number of stalls. For example, 70-80 cows/hour is common in double-8 herringbones. But the same number of stalls (and same milking units, etc.) in a 16-stall polygon would allow 90-100 cows/hour—an increase of about 25%.

## POLYGON PARLOR LAYOUT

Polygon parlors in actual use may depart from the original concept in one or more of the following ways:

1—The original design had the four sides arranged in the shape of a square. Most polygons are something other than square.

2 — The original design utilized two holding pens to serve the four sides. Many polygon parlors have a single holding pen to fit existing housing situations.

3 — Although the original design was a 24-stall polygon, smaller and larger polygons have been built also.

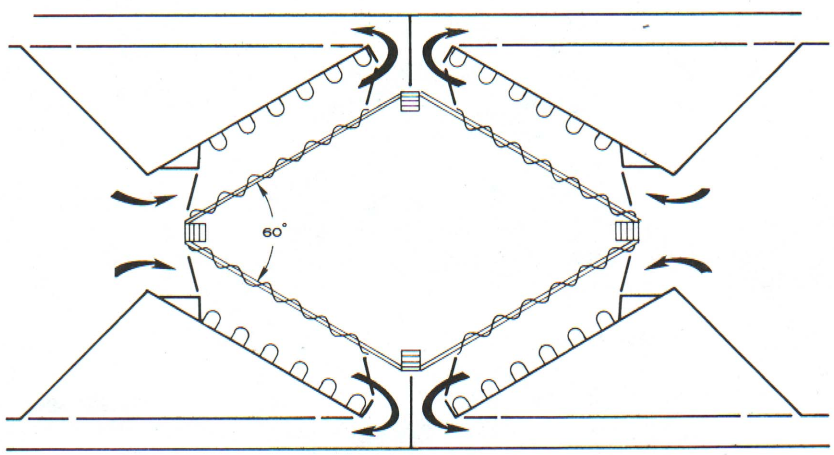
4 — The original design assumed all mechanization and was to be operated by one man. Polygons in actual use have less mechanization and most are operated by more than one man, partially because some of the mechanization is not available.

In this section polygon parlor layout will be described and some of the problems that might arise with departures from the original concept will be discussed.

### Shape of Pit

Rather than being in the shape of a square, the polygon parlor might be arranged as in Figure 1 where the angle of two adjacent sides next to a holding pen might be 60 degrees, 45 degrees or some angle other than 90 degrees. Two reasons for making such alterations are: (1) the polygon can be accommodated by a narrower building, and (2) the width of the pit is reduced. The first reason is a valid consideration, the second is not.

The pit of a polygon parlor should not be viewed in the same sense as a pit in a conventional herringbone parlor. If the operator is following a recommended routine in the polygon (see section on routines) he is working around the pit, not across the pit as he might in a herringbone. Thus, for his basic routine (for example, pre-




**A 24-stall polygon parlor with two holding pens.**

*The term, "throughput" denotes the cow/hour rate.

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paring udders and attaching milking machines), the shape of the pit has little effect on the operator's walking distance. Of course, he must cross the pit to correct malfunctions. But, while departing from a square pit decreases his walking distance in one direction, it only increases it in the other. Thus, the operator's walking distance is not reduced. In fact, it may be increased since the corners at the center of the parlor must be separated to allow good cow flow through the corners.

There are four distinct disadvantages to departing radically from a square pit:

1—If an operator is at one end of a long, narrow pit, his view of the other end of the pit is greatly diminished.

2 — If the pit is exceptionally long and narrow, there is less tendency for the operator to work around the pit as he must do in order to achieve the throughput potential of the particular parlor. Where polygon size and mechanization dictate the use of two operators, it is almost inevitable that they will not work around a long, narrow pit. Instead, each operator will assume responsibilities for half the parlor.

3—Reducing the width of the pit means that exiting cows must turn through a greater angle.

4—For parlors with a single holding pen, design of the cross-over area becomes more difficult.

We recommend that the included angle mentioned previously should not be less than 60 degrees.

### One Versus Two Holding Pens

In a polygon with two holding pens, each holding pen supplies cows to two sides. Holding pen capacity should at least equal the number of cows in a group in the housing unit or corral. In turn, the number of cows in a group should be related to parlor throughput such that no cow is required to stand in the holding area for more than two hours each milking. In warm climate areas or where cows are milked three times daily, it is advisable to limit the time in the holding pen to one hour per milking. Actual holding pen area should be computed on the basis of the number of cows in a group times 15 square feet per cow. For parlors that are to continue milking while outside groups are being changed, holding pen area should be increased by 25% to allow for overlap of the groups during the change.

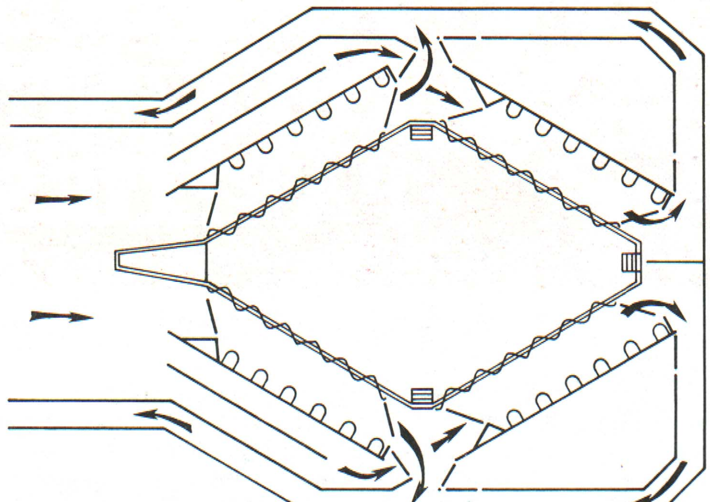
With two holding pens, the polygon is most conveniently located between groups of corrals or housing units such that approximately equal numbers of cows are housed on opposite sides of the polygon. After being milked cows return to the housing unit or corral via return lanes located on each side of the holding pen.

One holding pen may reduce costs, but will impose some problems in cow movement. Note in Figure 2 that an area on each side of the polygon is used both by cows entering a front side and by cows exiting a back side (though not at the same time). This crossover area must be designed to facilitate cow movement, to avoid the possibility of a cow getting trapped in this area and subsequently leaving the parlor without being milked and to keep the number of gates at a minimum. The most critical aspect of operation in this crossover area is that of allowing only the exact number of cows required to fill a front side to move into a crossover area.

In Figure 2, if seven cows were allowed to move through the crossover area to fill the front side, moving the seventh cow back out of the crossover area would be very difficult. The operator must be observing cow movement into a front side of the parlor and be ready to cut off the extra cow before she enters the crossover area. Alternatively, we have worked on a cow counting device that would automatically close the cut-off gate after the proper number of cows has passed. Automatic operation of these gates would be especially important in a mechanized polygon parlor intended for operation by one man.

Polygon parlors with one holding pen are usually located at one end or one side of the housing or corral area. If the holding pen is divided down the center and a separate return lane is provided for each half of the polygon, two different groups of cows may be brought into the parlor and the identity of the groups retained as the cows move out of the parlor.

The decision to use a single holding pen, a divided holding pen or two holding pens is influenced by the size of the polygon, the number of cows to be milked, group or corral size and the location of the polygon with respect to the housing or corral area. Cow movement will generally be better and operation of gates less critical in a polygon with two holding pens. As a general guideline, one holding pen should be considered only for smaller polygons and smaller herds or where necessitated by adding a polygon to existing housing facilities.



**A 24-stall polygon with ramp for operator to a single holding pen.**

### Catch Pens

As in any milking parlor, provisions should be made for sorting cows that may require treatment, breeding, etc., as they leave a polygon parlor. The otherwise unused area adjacent to one or more sides of the polygon may be used as a place to hold these cows until completion of milking (see Figures 1 and 2). No breeding or treatment of cows should be done in these areas while milking is in progress. Or, cows could be diverted into an additional lane located parallel to the return lane. In any case, it is desirable that gates used to divert cows be operated from the pit area. Also, these gates should be visible to the operator in the pit.

## MECHANIZATION FOR POLYGONS

A wide range of herd sizes can be accommodated by polygon parlors either with or without various mechanization. Equipment can be installed for improving cow movement, stimulation of milk letdown, power and automatic gate operation and automatic milking machine detachment:

1—**Crowd gate:** Moves cows forward in holding pen. Should stop when it hits a cow, then restart after a preset delay. Avoid electrically-charged wires.

2—**Power gates:** Pneumatic operation of entrance and exit gates and doors. Multiple controls located at strategic points around the pit so as to reduce walking.

3—**Feedgates:** Covers over feed to assist in cow movement and reduce operator interruptions to chase cows.

4—**Stimulating sprays:** Spray nozzles located in milking stalls. Timed warm-water spray for stimulating milk letdown, not necessarily for washing the udder.

5—**Automatic detaching units:** Loosely coupled to the claw, detect end-of-milking, provide positive vacuum shut-off prior to machine removal, remove the milking machine from under the cow upon completion of milking.

This equipment may be included in a new installation, provisions may be made to add equipment at a later date (as money becomes available or as herd size increases), or there may be already-existing parlors where some of the mechanization may be used to advantage. Because labor may account for up to 80% of the annual cost of milking cows, only slight improvements in cows per manhour can offset rather extensive investments in mechanization.

Milking parlors are mechanized for various reasons. First and foremost is to reduce labor and/or increase herd size, thus reducing annual costs. Other reasons may be equally important such as promoting a good job of milking or reducing drudgery, making the milking parlor a more pleasant work place. But, just as there are valid reasons for mechanizing, there are also invalid reasons, the worst being to use lower quality labor. More highly mechanized systems may, in fact, require a more capable person in the parlor.

## RECOMMENDED OPERATOR ROUTINES

Proper operator work routines are essential to maximizing the throughput of polygon parlors. Also, the number of operators must be matched to the particular polygon size and degree of mechanization. Having a greater number of operators than necessary to carry out the functions in a particular installation can actually decrease overall throughput. This section will discuss recommended work routines in different sizes of polygon parlors with various mechanization.

The following principles are common to all routines:

1—Operators work around the pit (clockwise or counter-clockwise).

2—An operator attaches machines in a regular sequence of sides.

3—If more than one operator, only one operator attaches milking machines (especially important at the beginning of the milking period in order to initially establish the regular sequencing of sides).

Adherence to these principles is essential to effective utilization of the polygon configuration.

### No Mechanization

Polygon parlors up to 24 stalls should be operated by two men if no mechanization is installed in the parlor.

The first operator is responsible for preparing udders and attaching milking machines. The second operator detaches machines. Either operator may assist with cow movement, correct malfunctions and dip teats as he is available. But the second operator should never attach a milking machine, even at the beginning.

The first operator should wash and check the udders of three or four cows, then go back and attach machines to these cows in the same order. Good stimulation procedures call for spending 20-30 seconds in preparing udders, followed by a delay of 30-90 seconds before machine attachment. Udders should be washed and then dried with individual paper towels and a few squirts of milk should be taken from each teat before machines are attached.

Mechanization other than automatic detaching units might be added to a parlor without affecting the basic routine or operator responsibilities. For example, power-operated gates with multiple controls would be a convenience to the operators. Or, timed stimulating sprays would reduce the time for preparing udders and assure that each cow received a pre-determined amount of stimulation. Or, feedgates and a crowdgate would improve cow movement and reduce the time operators need to assist with cow movement. But in any case, two operators should be used and their routines should conform to the basic principles outlined previously.

Polygon parlors with 32 stalls and no mechanization require three operators. One operator should prepare udders and attach machines (working around the pit): the remaining operators should detach machines.

A polygon with 40 stalls should have four operators, two preparing udders and attaching machines and two detaching. But the efficiency of a 40-stall polygon may be limited by the difficulty in getting four operators to follow a coordinated routine around the pit.

### Automatic Detaching Units

Among all available mechanization, automatic detaching units have the greatest influence on the recommended routine and number of operators in a polygon. For smaller polygons (16- and 20-stall), installation of automatic detaching units eliminates the second operator. The first operator follows exactly the same routine as he would in a polygon with no mechanization and is solely responsible for assisting with cow movement, correcting malfunctions and dipping teats. Additional mechanization, particularly stimulating sprays, reduces the amount of time that the operator must devote to each cow. This is especially important if one operator is used in a 24-stall polygon. We recommend one operator in a 24-stall polygon only if the parlor has automatic detaching units, crowdgates, feedgates, power-operated gates and stimulating sprays. Equipping the parlor in this manner will maximize parlor throughput while still providing the operator with some idle time.

Larger polygons equipped with automatic detaching units and only one or two other types of mechanization (for example, crowdgates and power-operated gates) should have two operators. In this case, the first operator could be designated the lead milker and would be responsible for preparing udders and attaching milking machines. The second operator, his assistant, would bring groups of cows to the milking parlor and return them to their corral or housing unit. The remainder of his time would be spent in the pit, assisting the lead milker with cow movement, correcting malfunctions and dipping teats. Also, the assistant may operate the parlor while the lead milker takes a break. This break is especially important to maintaining operator performance if the operators are working a straight shift.

**Table 1—Cow throughput in cows per hour* for polygon parlors with various mechanization under good management.**

| *Mechanization* | *Polygon size (no. of stalls)* | | | |
|---|---|---|---|---|
| | *16* | *20* | *24* | *32* |
| | ----cows per hour‡---- | | | |
| None† | $87^{2}$ | $102^{2}$ | $117^{2}$ | $145^{3}$ |
| Crowd gate | $94^{2}$ | $110^{2}$ | $126^{2}$ | $155^{3}$ |
| Crowd gate and stimulating sprays | $98^{2}$ | $115^{2}$ | $132^{2}$ | $161^{3}$ |
| Crowd gate and feedgates | $99^{2}$ | $116^{2}$ | $133^{2}$ | $163^{3}$ |
| Crowd gate, feedgates and stimulating sprays | $102^{2}$ | $120^{2}$ | $138^{2}$ | $169^{3}$ |
| Detaching units | $84^{1}$ | $91^{1}$ | $97^{1}$ | $141^{2}$ |
| Detaching units and crowd gate | $92^{1}$ | $99^{1}$ | $106^{1}$ | $153^{2}$ |
| Detaching units, crowd gate and stimulating sprays | $96^{1}$ | $104^{1}$ | $111^{1}$ | $159^{2}$ |
| Detaching units, crowd gate and feedgates | $97^{1}$ | $105^{1}$ | $112^{1}$ | $161^{2}$ |
| Detaching units, crowd gate, feedgates and stimulating sprays | $100^{1}$ | $108^{1}$ | $115^{1}$ | $167^{2}$ |

**Steady-state throughputs. Parlor setup and cleanup and changing groups not included.*

*†None denotes a parlor with base equipment including stalls, feeders, feed distribution and storage, pipeline milking system, power-operated gates, ventilation, plumbing, hot water, electrical, other.*

*‡Superscripts (1, 2, 3) denote number of operators milking.*

## PERFORMANCE AND COSTS

Performance of milking parlors can be assessed in various ways including cows per manhour, lbs milk per manhour, quality of milking and operator well-being. In this section performance is defined in terms of cows per hour while recognizing that any throughput figure given is only an approximation and is affected by many factors. Throughputs given are based on measured values from time studies and computer simulation.

Throughputs (cows per hour) are given in Table 1 for polygon parlors with various mechanization. Throughputs do not include the time required for parlor setup and cleanup or for changing groups. The number of operators designated for each combination of parlor size and mechanization is in accord with the section on Recommended Operator Routines. In limited instances, other possibilities than those given may exist. For example, a 24-stall polygon with automatic detaching units and other mechanization may have two operators. In this particular case, throughputs would be approximately the same as for two men in a 24-stall polygon without detachng units.

Although throughputs in lbs milk per manhour are not given in Table 1, some general comparisons can be made. With no mechanization, the more efficient herringbone parlors generally achieve 900-1,000 lbs milk per manhour. Polygons with no mechanization yield somewhat higher rates, on the order of 1,100-1,500 lbs milk per manhour. Time studies on polygons equipped with automatic detaching units and other mechanization have shown even higher rates. For example, the average rate for three 24-stall polygons, each operated by one man, was 2,800 lbs milk per manhour.

The values from Table 1 and the investment data in Table 2 form the basis for the annual milking costs in Table 3. Investments are given for (1) the building to house the milking parlor and holding pen, (2) base equipment and (3) mechanization. Mechanization includes investments for crowdgates, stimulating sprays, feedgates and automatic detaching units. Costs for the milk room and utility room are not included in construction, nor is the cost of a bulk tank included in equipment. The total investment for a particular polygon with holding pen and base equipment is the sum of values from the first two columns of Table 2. Total investment for a mechanized polygon would be the sum of values from the three columns.

Costs for construction and equipment are not absolutes; rather, they vary between builders and manufacturers, between localities, and even for the same type of equipment within localities. Costs given are representative and comparable. Certainly less mechanized polygons may be constructed. The situations given were chosen to illustrate the range in investments that might be expected.

Annual milking costs per cow and hours of actual milking are given in Table 3 for four sizes of polygons, with and without mechanization, and five herd sizes. The annual ownership costs of the buildings and equipment were made up of charges for depreciation, interest, repairs and insurance. The labor charge per man unit was $10,000 annually, including fringe benefits. Other annual cost details are given in footnote *, Table 3.

As a polygon is mechanized, annual milking cost generally decreases mainly because automatic detaching units allow one man to be removed from the parlor. Exceptions are noted where larger polygons are used for smaller herds—the savings in labor costs is not sufficient to offset the annual cost of the added mechanization. But a larger polygon would not be a logical choice for a smaller herd anyway. As more cows are milked in a given parlor system, annual cost per cow decreases because annual ownership costs are divided by a greater number of cows. For example, annual cost for a mechanized 20-stall polygon decreased from $91 to $57 per cow as herd size increased from 400 to 800 cows. Any parlor system must be used to capacity to attain a minimum annual milking cost per cow.

Cost information is a single input into the decision-making process of selecting a milking system. The parlor size and degree of mechanization that might be best for a particular dairyman are not necessarily those which, in combination, result in lowest annual milking cost.

**Table 2 — Investments in polygon parlors, 1976 prices.**

| *Polygon size* | *Construction** + | *Base equipment*† + | *Mechanization*‡ |
|---|---|---|---|
| 16-stall | $36.500 | $45,600 | $29,800 |
| 20-stall | 42,000 | 51,500 | 35,700 |
| 24-stall | 66,000 | 57,200 | 45,100 |
| 32-stall | 85,800 | 69,000 | 56,900 |

**Building for parlor ($15 per square foot) and holding pen ($8 per square foot). (Two holding pens for 24- and 32-stall polygons.)*

†*See footnote †, Table 1, for base equipment.*

‡*Mechanization includes crowd gate(s), stimulating sprays, feedgates and automatic detaching units.*

**Table 3 — Annual milking cost per cow in different polygon parlors, 1976 prices.***

| *Polygon size* | *Mechanization*† | *No. of operators* | *No. of milking cows* 400 | 600 | 800 | 1,000 | 1,200 |
|---|---|---|---|---|---|---|---|
| | | | ------ $/cow/yr ------ (hours/milking‡) | | | | |
| 16-stall | None | 2 | 99 (4.6) | 85 (6.9) | 78 (9.2) | | |
| 16-stall | All | 1 | 84 (4.0) | 64 (6.0) | 54 (8.0) | | |
| 20-stall | None | 2 | 96 (3.9) | 80 (5.9) | 72 (7.8) | 68 (9.8) | |
| 20-stall | All | 1 | 91 (3.7) | 68 (5.6) | 57 (7.4) | 50 (9.3) | |
| 24-stall | None | 2 | 96 (3.4) | 78 (5.1) | 69 (6.8) | 64 (8.6) | |
| 24-stall | All | 1 | 108 (3.5) | 79 (5.2) | 65 (7.0) | 56 (8.7) | |
| 24-stall | All | 2 | 122 (2.9) | 94 (4.4) | 79 (5.8) | 71 (7.3) | 65 (8.7) |
| 32-stall | None | 3 | 126 (2.8) | 101 (4.1) | 89 (5.5) | 81 (6.9) | 76 (8.3) |
| 32-stall | All | 2 | 138 (2.4) | 102 (3.6) | 84 (4.8) | 73 (6.0) | 66 (7.2) |

**Annual cost was based upon: depreciation of 12 yr for parlor and holding pen and 7 yr on all equipment, interest at 8% on unpaid balance, insurance at $4.65 per $1,000 of original investment, repairs at 2.5% for parlor and holding pen and 5% on equipment, labor charged at $10,000 per man year.*

†*None denotes base equipment only as in footnote †, Table 1. All denotes base equipment plus all mechanization as in footnote ‡, Table 2.*

‡*Parlor setup and cleanup and changing groups not included.*

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