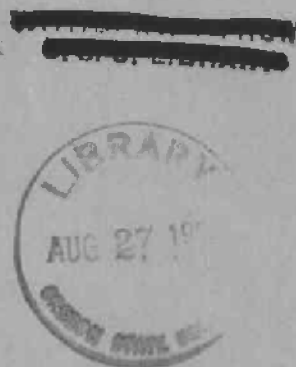# How to . . .

Improve Operating Efficiency
In Food Processing Plants

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This report presents some simple procedures for improving operating efficiencies and reducing costs in food processing plants. These procedures cover two areas: (1) measuring and improving efficiency of labor, (2) comparing alternative methods of performing an operation so the least-costly technique may be selected.

Although examples and illustrations used in this report have been drawn from the pea-freezing industry, procedures presented here have application in all food processing plants.

IMPROVING LABOR EFFICIENCY

Recent cost and efficiency studies conducted in pea processing plants of the Northwest show wide differences in labor efficiency between plants. For example, in 50-pound-box-forming and -filling operations, 12 percent of the total time was spent in "idle" or "wait" time in plant A, as compared to 43 percent in plant D (Table 1). This idle time includes personal delay other than scheduled rest breaks. It includes short periods of break in product flow and short periods of equipment downtime, but excludes lengthy breaks in product flow or long periods of equipment downtime.
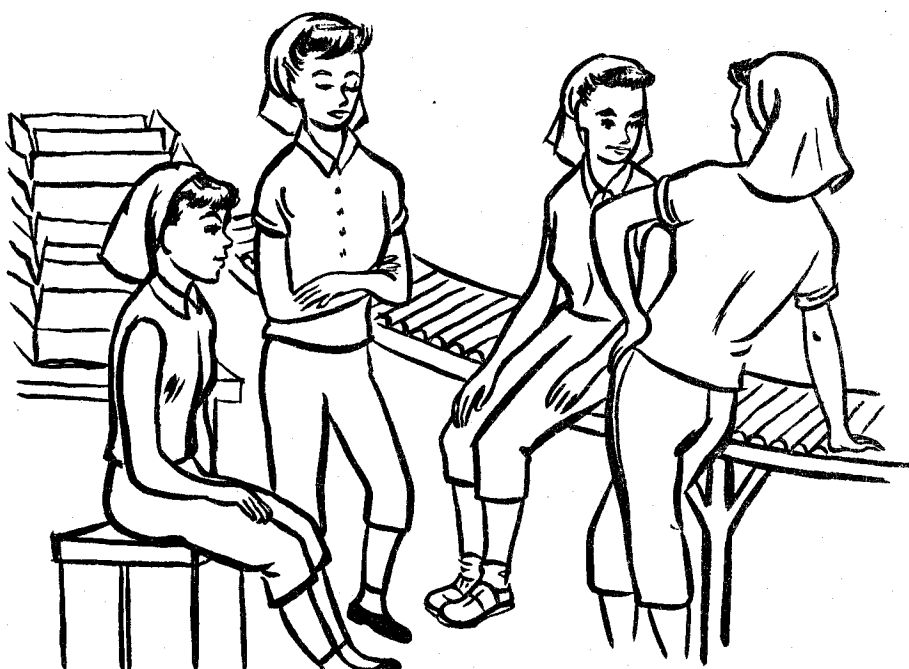
Table 1. Idle Time for Forming and Filling 50-Pound Bulk Boxes

Plant	Percentage of total time waiting
A	12
B	23
C	33
D	43
E	31
F	29
G	16
Average	27

What causes a higher percentage of "idle" time and can anything be done to reduce it? Excessive "idle" time may be caused by many things, for example erratic product flow, too many workers in relation to product flow, or an inefficient job layout which provides inadequate working space for all employees.
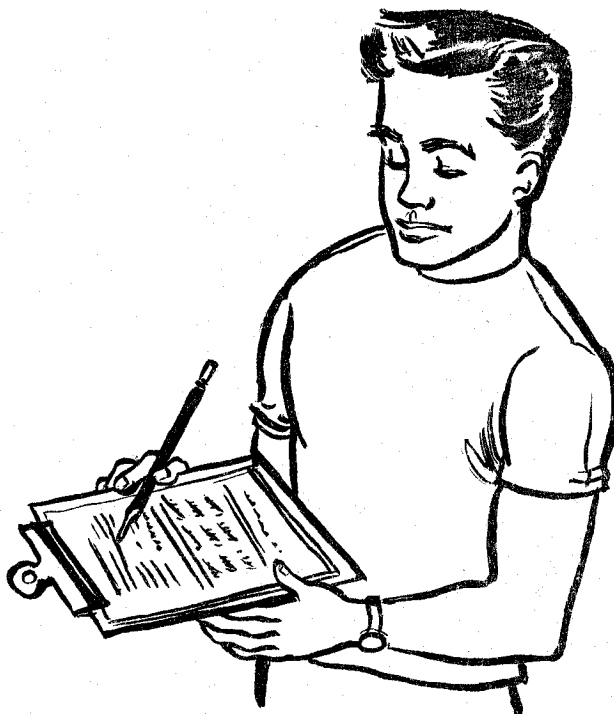

How to Make a Work-Measurement Study

Measurement of "idle" time as an indication of operating efficiency is made relatively easy by industrial engineering techniques. Procedures are simple and inexpensive and give accurate information.

Efficiency of a case-forming crew, for example, can be found by determining percentage of total time spent in nonproductive or "idle" time. Make several short studies of 20 or 30 minutes each in duration. Use a minimum of equipment--clip board, pencil, watch with a sweep-second hand and simple forms (see Figure 1 for a sample). The person doing the studies places himself away from the immediate work area, but close enough to see all crew members. He glances up every 30 seconds or so and records actions of each worker into two classifications, either "work" or "idle." /1 For example, if there are five workers, he makes five marks for every observation--one per worker. The marks may be kept separately for each worker so the "work" and "wait" time for each is determined, or they may be combined as they are in the following example and only the "work" and "wait" for the job determined.

/1 It is important before beginning such studies to clearly define the job--its beginning and ending. The complexity of operation and number of workers influence length of the interval. However, the more observations taken per minute, the more accurate the results from studies of a fixed duration.

If, for a partic-
ular observation, four
employees were working
and one was idle, he
would mark down four
"work" marks and one
"idle" mark. Five marks
would be recorded every
30 seconds, or 10 per
minute. If these stud-
ies were carried on for
30 minutes, there would
be a total of 300 marks
for the study. Assume
for a particular study
100 of the 300 marks
were "idle" marks, then
one-third or 33 1/3 per-
cent of the total time
of this crew would have
been spent in "idle"
time. Of course this
plant manager would want
to make several such
studies, and he would
want to make them at different times of day and on different days of the
season. The average of these several studies would provide an accurate
estimate of "idle" time for this operation.

An allowance of 20 percent "idle" time has been considered adequate
for most jobs by industrial engineers making labor studies. This allow-
ance includes personal "idle" time, coffee breaks, all breaks in the
product flow and all periods of equipment downtime.

People are not capable of working 100 percent of the time. This
type of study measures actual "idle" time. If management believes it
is higher than it should be, further investigation is required to deter-
mine the cause. When the cause is determined, action can be taken to
reduce "idle" time.

This type of study helps provide a basis for effecting greater
efficiencies. Also, if carried a little further, it can provide other
information pertaining to standards of equipment and labor performance.

How to Determine Performance Standards
for Equipment and Labor

The sample form (Figure 1) provides a space at the top for record-
ing job production or output. Accurate production figures for several
such studies would provide an indication of actual average output per
hour for that job or operating line. Estimates of volume, in pounds

Figure 1. Sample Form for Work-Measurement Study

Job *Case forming*   Operators observed *5*

Date *7-10-58*   Production *500 Cases*

Study No. *1*   Start *11 a.m.*   Stop *11:30 a.m.*

Observer *H. M. H.*   Elapsed time *30 minutes*

Interval *30 seconds*

Worker	Observations	
	Work	Idle
Q, B, *C, D,* *E*	卌 卌 卌卌 卌 卌 卌卌 卌 卌卌卌 卌 卌 卌 卌 卌 卌卌卌 卌	卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌 卌
	200 marks	*100* marks

Idle time:

$$\text{Percent of idle time} = \frac{100\ (\text{"idle" marks})}{300\ (\text{total marks})} = 33\frac{1}{3}\%$$

per machine-hour, which equipment is capable of achieving over sustained periods of operation are available. These equipment standards can be compared to actual output per hour, and can indicate how near operation is to capacity and whether or not product flow is erratic. Operating at under-capacity or with an erratic product flow are common causes of inefficiencies.

Labor standards in terms of output per man-hour can also be developed from these work-measurement studies. To demonstrate calculations involved to find a labor standard, use the example (Figure 1) and calculate a standard from one study. Several such studies normally are required for developing an accurate labor standard. In development of labor standards, the 20-percent allowance for "idle" time is used. In the example only the work marks (200) and the production (500 cases formed) are necessary for development of a standard.

Calculation of a labor standard from the example (Figure 1) is made in the following steps:

1. Total man-minutes of work: 200 work marks ÷ 2 marks per man per minute = 100 man-minutes of work.

2. Man-minutes of work per unit of product: 100 man-minutes ÷ 500 cases formed = .20 man-minutes of work per case.

3. Add in allowance for 20-percent idle time: .20 man-minutes work per case ÷ .80 (proportion work time is of total time) = .25 total man-minutes per case.

4. Convert to cases per man-hour: 60 (minutes in hour) ÷ .25 total man-minutes per case = 240 cases per man-hour.

5. Convert to pounds of output per man-hour: 240 cases x 15 pounds per case = 3600 pounds of output per man-hour of time.

Thus, in this example, the standard for forming 24/10-ounce cases would be 3600 pounds per man-hour. In other words, one man-hour is required for each 3600 pounds of output per hour for an efficient case-forming operation, and the crew shown in the example above should have a total output of 5 x 3600, or 18,000 pounds per crew-hour.

Production based on these labor standards can be compared with actual production to determine the level of efficiency. Importance of both equipment and labor standards is demonstrated more fully in the following pages.

## Improving Efficiency through Selection of Techniques

Engineering cost studies can also provide information necessary for selecting between alternative methods or techniques for particular operations.

Here is an example of this type of study. Suppose management is interested in installing an automatic caser for 24/10-ounce casing operations. A decision must be made. Which is the least costly method of casing--hand or automatic?

Cost of the automatic caser is quite high compared to the equipment required for hand casing. How many hours per year must this caser be used for the labor savings to be greater than the additional annual cost of equipment?

Figure 2 shows the information needed to make a decision. Total season's cost of labor and equipment for the two methods of casing for different lengths of season are shown. The break-even point is about 500 hours. At this point season's costs for the two methods are equal. For any season longer than 500 hours, automatic casing is the least

Figure 2. Labor and Equipment Costs for Casing of 24 10-Ounce Packages of Frozen Peas as Related to Method of Casing and Length of Processing Season.
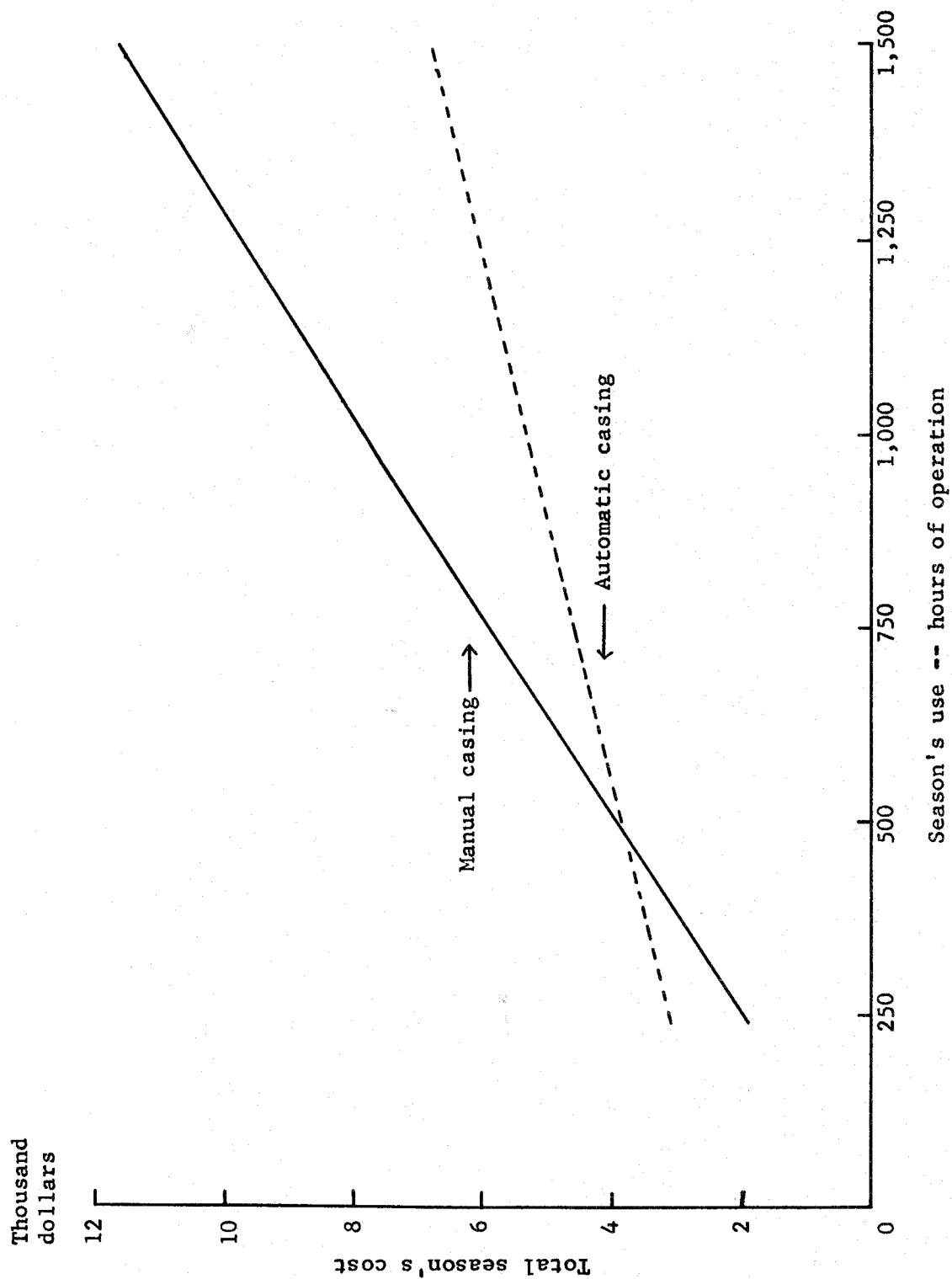
costly method of casing, and for any season shorter than 500 hours, the hand-casing method is the least costly.

To demonstrate how these costs were calculated, a season of a particular length can be selected, say 1000 hours, and costs developed for the two methods of casing for that length season.

Labor costs for the two methods can be calculated first. These are shown in Table 2. Labor requirements are first developed in the form of labor standards. These standards are expressed in terms of pounds of output per man-hour and are determined in the same manner as in the example given on page 5. The standard for "form case and feed automatic caser" is machine paced. Output of this worker is limited to capacity of the caser. In this example capacity of the caser is limited by the wrapping machine. The machine operator can work no faster than the machine he operates. Information on machine capacities can be obtained from performance data from your own and other plants, equipment manufacturers, or from research results.

Once standards are determined, output of the operation (which, for this example, is assumed to be 10,000 pounds per hour) is divided by the standard for each method to determine number of workers required. Table 2 shows that seven workers are required for hand casing, and two workers are required for automatic casing. (A fraction of a worker is raised to the next whole number.)

Season's labor costs are obtained by multiplying number of workers times a typical hourly wage rate ($1.10 is used in this example) times number of hours in the season (1000).

Equipment costs for the two methods of casing are shown in Table 3. Equipment requirements are determined by developing equipment standards. For both casing methods, equipment standards in this example are limited by capacity of wrapping machines. The number of pieces of each type of equipment is determined by dividing output of the operation (10,000 pounds per hour) by capacity of each type of equipment.

The season's equipment costs are developed by converting physical equipment requirements to annual costs. Fixed equipment costs include an allowance for depreciation, taxes, insurance, interest on investment, and fixed repairs and maintenance. Variable costs include an allowance for variable repairs, maintenance, and power. Calculations for fixed and variable costs for each piece of equipment are shown in Table 4.

The season's labor and equipment costs are combined in Table 5, which shows the total season's costs for the two methods of casing for the 1000-hour season. In a similar manner, costs are developed for seasons of 250, 500, 750, 1250 and 1500 hours to find the relationship shown in Figure 2.

With the rapid rate at which new technologies are being developed in food processing, plant managers are frequently faced with the problem of selecting between alternative methods or techniques. The type of study just explained provides information required by plant management for sound decision-making.

Table 2. Hand Casing Versus Automatic Casing - 10-Ounce Operation of
10,000-Pounds-per-Hour Capacity - 1000-Hour Season

Labor requirements	Hand casing	Automatic casing
Standards (lbs. per man-hour)		
Form and fill	1,594	--
Form and feed automatic caser	--	5,070
Number of persons required		
10,000 ÷ 1,594.	7	--
10,000 ÷ 5,070.	--	2
Season's labor costs		
1000 hours x 7 x $1.10	$7,700	--
1000 hours x 2 x $1.10	--	$2,200

Table 3. Hand Casing Versus Automatic Casing - 10-Ounce Operation of
10,000-Pounds-per-Hour Capacity - 1000-Hour Season

Equipment requirements	Hand casing	Automatic casing
Standards (lbs. per machine-hour)		
Equipment for hand casing	5,070	--
Equipment for auto casing	--	5,070
Number of pieces required		
Forming tables.	2	2
Supply chutes	2	--
Casing tables	2	--
Automatic casers.	--	2
Conveyor belts.	--	2
Season's equipment costs		
Fixed costs	$38.28	$2,333.10
Variable costs.	14.50	728.80
Total	$52.78	$3,061.90

Table 4. Season's Costs for Equipment Used in Hand and Automatic Casing of 24/10-Ounce Cases

Item	Used in		Replacement cost /1	Years use life	Annual fixed charge /2	Variable costs - 1000-hour season			Total seasonal costs
	Hand casing	Automatic casing				Repairs and maintenance /3	Electricity	Total Variable	
Forming tables	X	X	$ 50	15	$ 6.60	$ 2.50	$ --	$ 2.50	$ 9.10
Supply chute	X		45	15	5.94	2.25	--	2.25	8.19
Casing table	X		50	15	6.60	2.50	--	2.50	9.10
Automatic caser		X	6,750	10	1,113.75	337.50	2.10	339.60	1,453.35
Conveyor belt		X	350	15	46.20	17.50	4.80	22.30	68.50

/1 Includes FOB freezing plant, plus installation.

/2 Calculated as a percentage of replacement cost as follows:

   a. Depreciation based on years of use life
   b. Insurance - 1%
   c. Taxes - 1%
   d. Interest - 3%, which is about 5.5% of undepreciated balance
   e. Fixed repair - 1.5%

/3 Estimated on the basis of 0.5% of replacement cost per 100 hours of use.

Table 5. Hand Casing Versus Automatic Casing - 10-Ounce Operation of
10,000-Pounds-per-Hour Capacity - 1000-Hour Season

Total season's costs	Hand casing	Automatic casing
Labor	$7,700.00	$2,200.00
Equipment	52.78	3,061.90
Total season's costs	$7,752.78	$5,261.90
Cost per cwt. peas	$ .078	$ .053

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