TIME AND MOTION STUDIES IN SALAD PREPARATION

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TIME AND MOTION STUDIES IN LAUNDRY PREPARATION

by

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To Mrs. Mabelle B. Ehlers I wish to express my thanks for her help and suggestions. I also want to extend my thanks and appreciation to Mrs. Ada Kitchen, the operator studied, for her patience and cooperation. I am also grateful to Mr. Lorin G. Miller for his guidance in the technique of motion mate study.

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I. INTRODUCTION

A. Definition of time study

Time study, according to Ralph M. Barnes (5), is an analysis of the methods, materials, tools and equipment used or to be used in the performance of a piece of work. Frederick W. Taylor and his co-worker, S. E. Thompson, define time study as "The process of analyzing an operation into its elementary operations and observing the time required to perform them" (1). They say it makes possible the "Transfer of skill from management to men," and that it consists of two divisions, the analytical work and the construction work.

B. Definition of motion study

Motion study is part of the analytical work mentioned above. This has to do with the selection, invention and substitution of the motions and variables that are to be measured (1). Barnes defines motion study as a critical examination of the elementary motions of an operation to determine whether all the motions are necessary in full or in part.

C. A brief history of time and motion study

1. Fredrick W. Taylor

The origin of time and motion study may be credited to Taylor, who began its development in the Midvale Steel Company in 1881. He placed his emphasis on materials, tools, and equipment. The principles of management which he thought most fundamental were the making of each man's work into a science with consequent elimination of the old rule-of-thumb method

of doing the job, the proper selection and training of the workers; followed by the securing of cooperation between men and management. He applied the scientific method to the determination of a fair day's work. Among those who came under Taylor's influence were Frank and Lillian Gilbreth, pioneers in the field of motion study.

2. The Gilbreths

Frank Gilbreth was known for taking the hard jobs that others did not want and making them easy. Together, the Gilbreths originated micromotion, a process of taking motion pictures of the job. This process has two purposes: To assist in finding the most efficient way to do the job, and to assist in teaching others to understand the meaning of waste motion.

Frank Gilbreth was one of the most notable consulting engineers of his time. He perfected many devices for determining the "one best way" of doing the job and preached the "conservation of motion for the sake of man" (14). Mrs. Gilbreth has carried on since her husband's death and is, at present, a professor of management at Purdue University.

3. Some more recent workers

Dr. Ralph M. Barnes, a professor of engineering at the University of Iowa, is another man who has contributed to the field of scientific management. He has done much on the floor in the factory and has written several books on time and motion study. The studies of Marvin E. Mundel, a professor of engineering at Purdue University, have had to do largely with industrial production, but he has also done several

problems in farm work and in work simplification in the home. He has guided several graduate students in time and motion studies. One of these was Mary Jane George who completed a problem entitled "A Study of the Facilitation of Cafeteria Service." This is an excellent application of time and motion study to food service. Orpha Mae Huffman and Jean Hughes Dunnigan have also done some work in the time and motion study field in institution kitchens though, except for these two women, not many time and motion studies have been made on food preparation on a quantity basis. Miss Huffman did a micro-motion study of the procedures used in making blueberry muffins in the bake shop of the Institution Administration Department at Purdue University in 1941. Her report of this study appears in her Doctor's dissertation, as yet unpublished. Mrs. Dunnigan did a series of time and motion studies on salad and sandwich making at the McKenzie High School cafeteria in Detroit (14). The sandwich procedure found to give the greatest volume of production she demonstrated at the American Dietetic Association Meeting in Detroit in October 1942. This was reported and illustrated in February 1943 in Forecast magazine and was also reported in the American Dietetic Association Journal in the same month.

D. The chief purpose of the problem presented

The purpose of the problem presented here is as follows:

1. To show the time required by the average worker to prepare, under given working conditions, specific salad vegetables for particular uses.
2. To show the time required to assemble the prepared vegetables into salad ready to use.

3. To show how to fit the time required for preparation and for the complete process into the working time available.
4. To thus prevent the appearance on the menu of too many time-consuming salads in one day.

II. A REVIEW OF LITERATURE

Most of the literature on time and motion study is written by engineers and leading workers in the field. It relates specifically to factory procedures, but can be adapted for quantity food production as well. The writers discuss the objects of time and motion study, the basic investigations that have to be made before the timing begins, the characteristics of the time study analyst, how the operator to be studied should be selected and the number of studies to be taken on a particular operation.

A. The object of time study

The objects of time and motion study, according to Barnes (5) are:

1. To find the most economical way of doing work.
2. To standardize methods, tools, materials, and equipment.
3. To determine accurately the time required by the average worker to do the job.
4. To train the worker in new methods.

Dwight Merrick (9), a follower of Taylor, states that the object of this work is the determination of all possible improvements of the equipment and surroundings in the actual performance of the work and of the unit time under satisfactory conditions (9). Specifically the objects of motion study, as stated by Ralph Davis (4), are the elimination of waste motions and the development of more efficient motions (4). In a broader statement Davis gives as his objectives for time and motion study the following:

1. Increased per capita production.
2. Decreased production costs.
3. Higher turnover of work in process.
4. Fair basis for wage incentives.
5. Greater employee earnings.
6. Improved employee morale.
7. More accurate cost accounting.
8. More accurate production control.

He believes that increased production will come through improved working conditions and methods of work; definite service objectives and an opportunity for employees to improve their earnings; training and greater interest in, and application to the job.

B. Basic investigations

Before collection of data even begins, there are certain basic investigations that have to be made. The work and all surrounding conditions must be carefully surveyed. The work must be analytically divided into its basic elements. The time must be observed and recorded for each element of the operation and an analytical study made of that recorded unit time.

C. Characteristics of the time study analyst

The time study analyst, or person making the investigation, must have certain characteristics. He has to talk with the workers in their own language and be frank with them about the work he is doing. He has to listen to their complaints and investigate them. He has to be diplomatic, sincere, honest, understanding of human nature, tactful and patient, and able, as far as possible, to explain "why" to the worker. He has to have the ability to get things done, a constructive imag-

inition, inventiveness, and the ability to inspire and sustain the interest of others. Above all, he has to win the cooperation of the worker.

D. Selecting the operator to be studied

There seems to be some controversy over the selection of the employee on whom the study is to be made. W. O. Litchner (4) believes that the skilled employee should be studied because his motions are more uniform and he works more steadily. The skilled worker will probably use the best methods and adapt himself to the new methods more rapidly (9). The results obtained with skilled workers are more dependable and the effect of the personal equation is less. Lowry, Maynard and Stegemerten (8) suggest the selection of the operator or worker from whom the best results can be obtained. They feel that the more intelligent an operator is the more easily he can be reasoned with and the more likely he is to be cooperative; that he is more desirable because he is more consistent and systematic. Factors influencing the choice of an operator to be studied, in their estimation, are the following: (8)

1. Attitude: Feeling for the work, fellow workers, and company.
2. Conduct: Attentive to work.
3. Dependability: Attendance, punctuality, and reliability.
4. Intelligence: Judgment, resourcefulness, and ease of learning.
5. Performance: Quality and quantity of work, waste and broken tools.
6. Physical qualities: Physique, health, and strength.

Barnes (5), on the other hand, believes the study should be made on the average operator, because if the standard is set

on the most efficient worker, other employees observing the study will feel that the standard is not a fair one and that they are being exploited (5).

E. Number of studies to be taken on a particular operation

The number of studies done depends on the judgment of the observer and the kind of job being timed. The number of times the series of elements that make up the job is studied depends on several factors, but should be sufficient to give a true sample. The factors on which it depends are the length of the cycle, the number of elements in the cycle, and the consistency and skill of the operator.

III. [illegible]

A. Selection of the methods

[illegible] determine the combination to be used are the extent [illegible] and anticipated life of the job; the labor conditions of the job, such as the basic wage rate, the ratio of handling time to machine time, and the special qualifications of the employee required for the job. An electric time-recording machine is used where the elements to be timed are too small to be accurately timed with a watch, where the extensiveness and anticipated life of the job warrant it, and where the electricity is of the correct voltage. Another and more common way of taking a time study is with a stop watch. This was the method of timing selected for these studies. The methods of preparation studied here, in general, washing and removing of any decayed leaves or spots, cutting, chopping*, and slicing by hand with a knife as shown in Plate 7, or slicing by machine, either hand or power operated**.

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*The chopper is a Buffalo, Number 299, manufactured by the John E. Smith Sons Company at Buffalo, New York. See Plate 1.

**The hand operated machine is the Slicechief Senior made by the Slicechief Manufacturing Company at Litchfield, Michigan. The power machine is a slicer attachment on a Hobart mixer, Model G-660, manufactured by the Hobart Manufacturing Company at Troy, Ohio. See Plates 2 and 3.

PLATE 1
The Ludlow Chopper

PLATE 2
Hand Operated Machine
(The Slicechief)

PLATE 3
Power Operated Machine
(Hobard Mixer Attachment)

PLATE 4
Cutting by Hand With a Knife

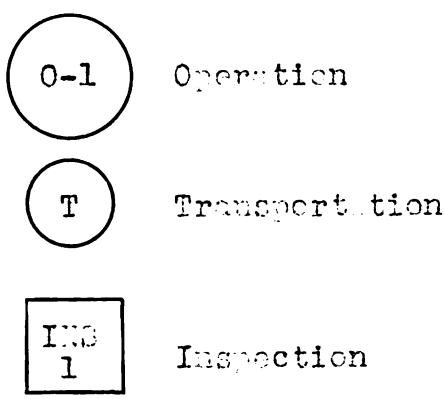
B. Description of terms

1. Operation analysis

After basic investigations, the operation analysis has to be made. In making this analysis the materials, tools, handling of the equipment, working conditions and all of the other factors affecting the job must be considered, but the most important thing to consider is an analysis of the operation. In the studies presented here the number of times a process was repeated, the quality of the vegetable, the number of times it had to be moved from one operation unit to another, how long it stood in temporary storage between operations, where it was prepared and how long before serving, had to be considered in analyzing the operation. From this analysis a process chart is made.

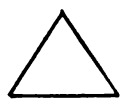
2. Process chart

A process chart is a device for recording a process in a compact manner, as a means of improving that process or operation. It shows why the work should be done, what is done, how, who does it, where and when. Some are more elaborate than others, but all use symbols. Some of the most common ones are:



Temporary storage

Permanent storage



Storage outside the control of the investigator

These symbols are used in describing the processes observed in this study and shown in Figures 21, 24, and 22. The process chart is used to suggest improvements, to show changes in one process as it affects another, to show the operations in process that should be more thoroughly analyzed, and to aid in plant layout. With this information the stop watch is applied to the operation.

3. The stop watch

There are two kinds of stop watches: The decimal hour watch and the decimal minute watch. The latter, which was used for these studies, is preferred by most time study analysts, because short elements can be recorded more easily and it is simple to calculate.

4. Time study board

The board is large enough to hold the time study sheet, or observation sheet, on which the record is being taken, but not so large that it is unwieldy to hold. The

PLATE 5
Time Study Board and
Decimal Minute Stop Watch

watch is fastened in position as shown in Plate 5 so that it is easily handled with the left hand and falls in the direct line of vision of the time study analyst. In this way it takes only a glance to read the watch, make the recording, and observe the next movement of the operator.

5. "Therbligs"

The movement, or motion, usually timed is the "Therblig." The term "Therblig" refers to any one of eighteen, elementary, subdivisions of a cycle of motion. They are:

1. Search
2. Find
3. Select
4. Grasp
5. Transport Load
6. Position
7. Assemble
8. Use
9. Disassemble
10. Inspect
11. Pre-position
12. Release Load
13. Transport Empty
14. Rest for Overcoming Fatigue
15. Unavoidable Delay
16. Avoidable Delay
17. Plan
18. Hold

Each is represented by a symbol, a color, and a Dixon pencil number. They are further classified as (a) "get ready" including all the elements before "use," (b) "do it or make it," or the element "use," and (c) "clean up" which includes all of the elements coming after "use" (11). Timing the "Therblig" is the most accurate type of stop watch study, but is not always used when total time is the result sought. The second classification, or "do it," as suggested in Frank and Lillian Gilbreths' article in Management and Administration, was the unit timed for the studies presented here.

6. Rating factor

After the record has been made, the standard time or time required by the average worker is determined. This is done by a leveling process as developed by Westinghouse (5). Since skill and effort differ from worker to worker and from day to day, if the standard is set on a very skillful worker, the average or less skilled worker would not be able to meet it. On the other hand, if the standard is set without taking skill and effort into account, using a less skilled operator, the skilled operator will just meet this time or will exceed it to an extent to which he is not entitled. The factors for rating the worker are skill, effort, working conditions, and consistency. These are the factors on which 175 men took comparative studies over a period of about one year, of workers doing the same job, using identical motions and yet producing different volumes of work (5). The result of their work is the performance rating chart. The employee

who was observed in this study was a little above average and was rated accordingly for all four factors.

7. Leveling factor

The figures that appear on this chart are used to give the leveling factor which is that factor "by which the average time is multiplied in order to adjust for difference in performance above or below average" (8). The level is determined by adding algebraically the numerical values for skill, effort, working conditions, and consistency as chosen from the performance-rating chart.

RATING CHART

SKILL			EFFORT		
Super	+.15 .13	A-1 2	Kill	+.13 .12	A-1 2
Excellent	.11 .08	B-1 2	Excellent	.10 .08	B-1 2
Good	.06 .03	C-1 2	Good	.05 .02	C-1 2
Average	0	D	Average	0	D
Fair	-.05 .10	E-1 2	Fair	-.04 .08	E-1 2
Poor	.16 .22	F-1 2	Poor	.12 .17	F-1 2
WORKING CONDITIONS			CONSISTENCY		
Ideal	-.06	A	Perfect	-.04	A
Excellent	.04	B	Excellent	.03	B
Good	.02	C	Good	.01	C
Average	0	D	Average	0	D
Fair	-.03	E	Fair	-.02	E
Poor	.07	F	Poor	.04	F

CHART 1

C. Procedure

1. The technique of a stop watch study

The technique for taking stop watch studies varies according to the purpose of the study. Some are much more exact and detailed than others, but in general there are several steps that need to be followed. All the information asked for in the heading of the observation sheet must be carefully recorded. This usually includes the name or number of the operator and the date and department in which the job is done. The job must then be divided into the elements to be timed, since the "Therblig" is too short in duration. Handling time should be separated from machine time and the constant elements should be separated from the variable elements (5). Each element should be clearly and concisely stated and recorded on the observation sheet.

Timing begins when this information is ready. There are four rather common ways to read the stop watch. It may be read continuously, e. g., the watch is permitted to run continuously over the period of study. The observer then notes the time at the end of each element and records it after its name or symbol on the observation sheet. This is usually considered the best method and was the one used for these studies. The watch may be snapped back at the end of each element, known as the repetitive method of timing. This gives the direct time without subtraction, but is not as accurate as the continuous method. Continuous and repetitive timing are the methods most commonly used, but for special cases

there are accumulative and cycle timing. The accumulative method is used where there are two elements to be timed separately. Two watches are mounted close together on the stop watch board and when one is stopped the other automatically starts. In this way each element may be more accurately timed, because the watch is stopped when it is read. Where there is a series of very short elements that cannot be accurately timed with a watch the cycle method is used. The series of elements is timed as many times as there are elements. Each time one element is left out. By means of a simple calculation it is possible to find the time for each element of the cycle. The inexperienced find it difficult to do so many things at once, viz., observe the operator, read the watch, and record the data, but after a little practice it becomes quite easy. A distinctive sound usually accompanies the beginning and end of each element, and the time study analyst learns to listen for this sound while his eye is on the watch.

2. Determining the rating and leveling factor

The next step is rating the skill and effort of the operator and leveling them to give the standard time. These factors depend on the judgment of the time study analyst. The analyst determines the skill, effort, working conditions, and consistency of the operator in comparison to what he considers average. From the performance-rating chart he then gives the worker a rating. If he considers the operator very skillful, he might rate skill "excellent" or "super."

This is recorded as B-1 or B-2 or A-1 or A-2. In figures it might be anywhere from .18 to .15. Skill may bear no relation to effort and though the operator is very skillful he may be putting forth very little or no effort. Effort would be rated accordingly "average," "fair," or "poor." D is average with zero the numerical value. Fair is F-1 or F-2 with the numerical value a minus .04 to minus .08 and poor is F-1 or F-2 with minus .12 to minus .17 the numerical value. The same process is used to determine the working conditions and consistency. The operator studied, slightly above average, was rated as follows:

Skill	C-1	.06
Effort	C-1	.05
Working Conditions	C	.02
Consistency	C	.01

These figures are added algebraically to give the leveling factor. In this case the leveling factor is 1.14.

3. Setting the standard time

The standard time is then set by multiplying the average time by the leveling factor.

4. Making allowances

To the standard time is added an "allowance." Allowance is made for personal time, fatigue, unavoidable delay, and for special reasons on certain jobs. The basis for allowance, according to Dickson (15), is the number of minutes worked and the standard amount of work done in that time, usually a working day. He feels that thirty minutes, or five and one half percent, or a nine hour day is a fair

constant personal allowance. On an operation that does not require much skill or energy ten percent is ample allowance, but where the operation requires accuracy and the quality of the work must be considered, fifteen to twenty percent is often allowed (15). Barnes says two to four percent or about twenty-one minutes is ample rest time for light work. More should be allowed for heavy work and in hot or disagreeable working conditions. The allowance for fatigue depends on the kind of work, but usually there is no allowance. Hours are shortened and labor-saving machines, tools, and fixtures are used. Unavoidable delay is that delay caused by the machine or operator or some outside force not to be accounted for by the operator. On some jobs allowance has to be made for special delay, such as waiting for help to lift, or having to work quickly while the material is of the right consistency. Since no special allowances were necessary for the operator studied for this report, her work being light as compared to other jobs in the kitchen and her working day being eight hours with a one-hour rest period at the end of five hours, an allowance of two percent was made. This is .0003 minutes for each operation. The allowance after it is determined is added to the standard time to yield the time allowed for the job.

In the tables presented the data from all studies of each vegetable are shown, but those farthest from the obvious mean were struck out and not included in the totals. The abbreviations used in the tabulations of the data are as

follows:

1. No. Observ. means number of observations
2. Avg. Time means average time
3. Min. Time means minimum time
4. Max. Time means maximum time
5. Level. Fct. means leveling factor
6. Std. Time means standard time
7. Allow. Time means allowed time

In the figures presented all baskets, mixing bowls, and trays not actually on the table are placed on stools or frames so that they are thirty inches from the floor. The table is thirty-four inches high which is standard table height.

THE WORK AREA USED

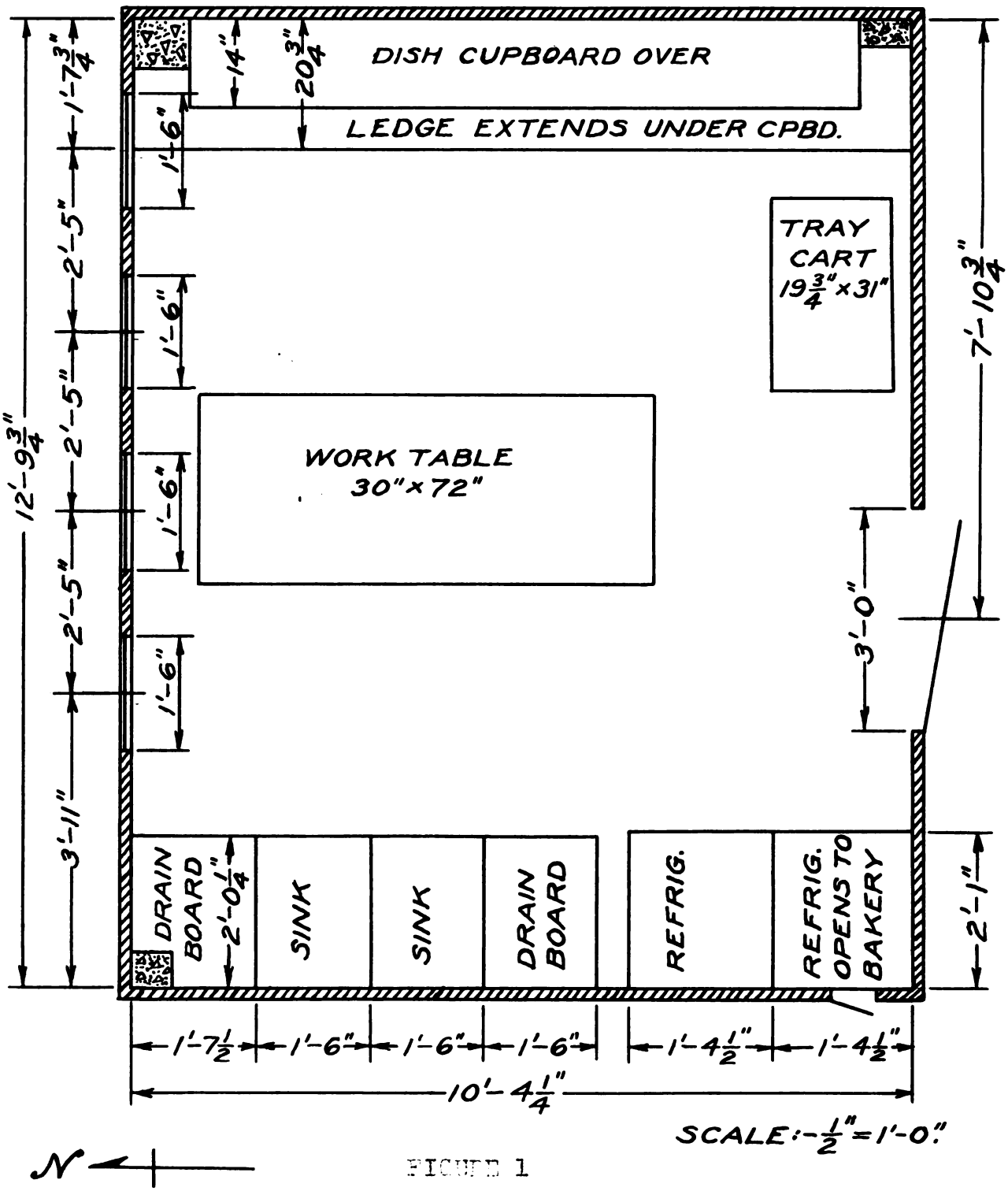
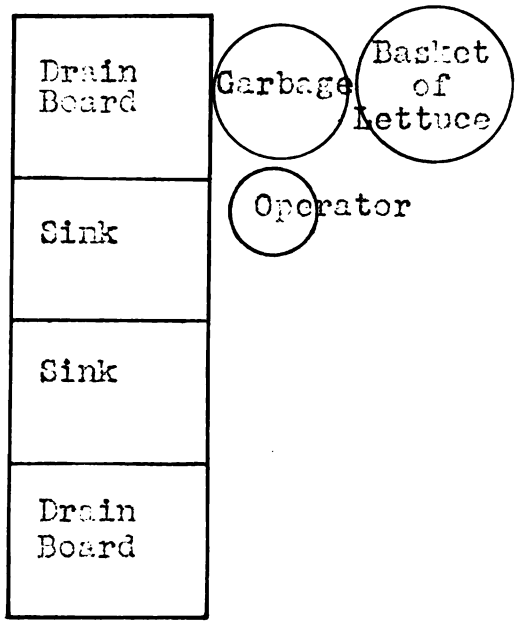


FIGURE 1

WASHING AND REMOVING OUTSIDE LEAVES OF HEAD LETTUCE

METHOD I



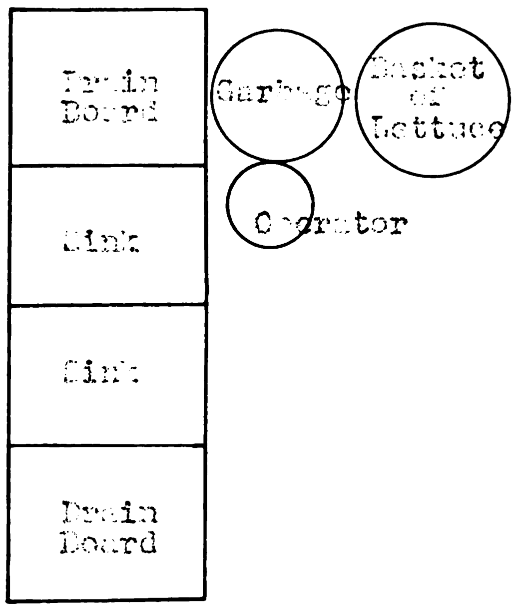
LEFT	RIGHT
Pick up head of lettuce with both hands holding the knife in right hand	
1. Hold head turning it as necessary	1. Cut off core end, bad spots and outside leaves
2. Hold head under running water and wash	2. Turn on water at sink and help wash lettuce
3. Put head of lettuce on drain board	3. Begin to reach for next head

Repeat this operation until bushel is done

FIGURE 2

WASHING AND REMOVING OUTSIDE LEAVES OF HEAD LETTUCE

METHOD II



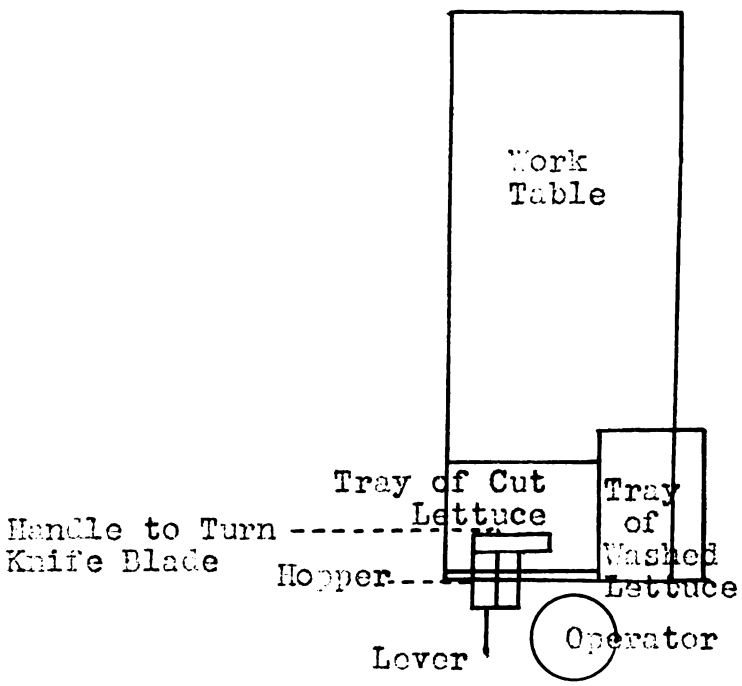
LEFT	RIGHT
Pick up head of lettuce with both hands holding the knife in right hand	
1. Hold head turning it as necessary	1. Cut off outside leaves and bad spots
2. Put head in sink of water	2. Begin to reach for next head

Do out until bushel is done

Use both hands to lift the heads of lettuce out of the sink of water and put them on the ledge to drain

FIGURE 3

CUTTING HEAD LETTUCE ON HAND MACHINE

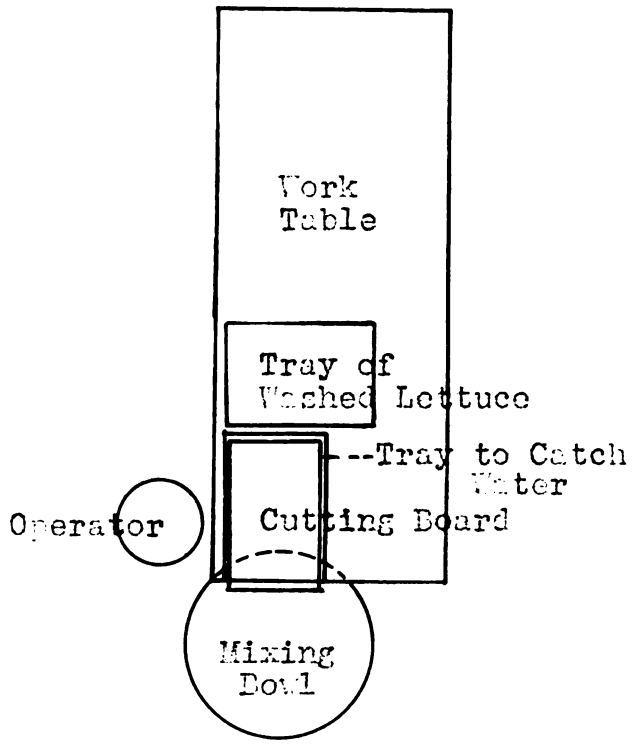


LEFT	RIGHT
1. Pick up head	1. Cut in half and put knife on tray
2. Put ½ head in hopper	2. Help left hand
3. Push lever	3. Turn knife blade

Repeat this operation until bushel is done

FIGURE 4

HAND CUTTING HEAD LETTUCE

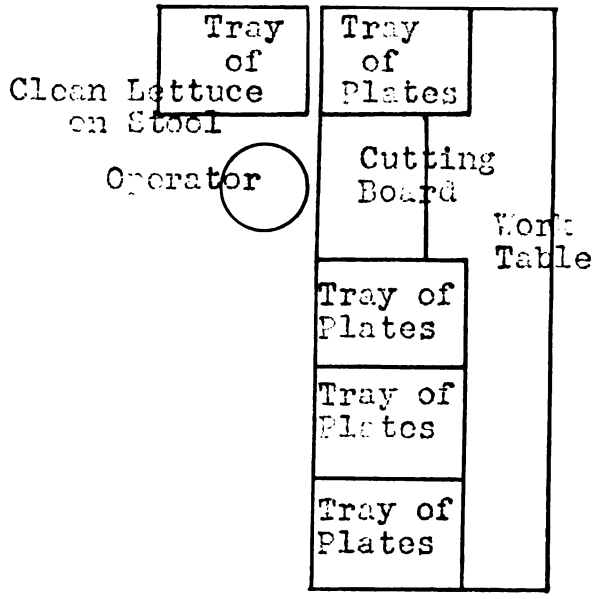


LEFT	RIGHT
1. Hold head firmly on cutting board	1. Cut head in half
2. Hold ½ head firmly on board, cut side down	2. Cut ½ head lengthwise and crosswise of head
3. Place other half head to be cut	3. Cut ½ head lengthwise and crosswise of head
4. Reach for next head	4. Using blade of knife, slide cut lettuce into mixing bowl

Repeat the operation until bushel is done

FIGURE 5

CUTTING HEAD LETTUCE WEDGES, PUTTING WEDGES ON PLATES



LEFT	RIGHT
1. Pick up head of lettuce and hold firmly on board	1. Cut lettuce
2. Assist right hand in putting on plates	2. Put on garnished plates

The number of wedges cut before the knife is laid down and the wedges put on the plate varies with the quality of the lettuce.

FIGURE 6

HEAD LETTUCE

QUANTITY STUDIED 1 BUSHEL or 20 to 22 HEADS	OPERATION TIME IN MINUTES						
	Washing and Removing Outside Leaves		Cutting on Hand Operated Machine	Hand Cutting	Cutting Wedges, Putting on Plates	Cutting Wedges, Putting on 8 Plates	Hand Cutting One Head
	Method I	Method II					
	~~12.00~~	9.85	8.63	15.00	36.24	1.90	.92
	11.00	9.84	~~13.10~~	20.00	~~41.44~~	1.98	.78
	8.25	8.35	12.20	24.00	31.14	2.32	.35
	9.57	~~10.48~~	11.63	18.00	~~41.75~~	2.87	1.00
	7.00	8.00	~~6.88~~	24.82	38.42	2.00	1.20
	11.30	9.37	12.86	15.05	30.15	1.42	1.10
	9.10	~~5.82~~	8.80	~~13.33~~	~~25.10~~	2.23	.85
	7.89	8.50	10.93	14.18	39.79	1.41	.80
	7.30	7.35	9.00	18.92	30.00	1.76	.70
	9.00	7.85	10.40	20.35	40.00	1.40	.60
	8.00	6.00	8.80	14.00	~~29.41~~	1.80	.70
	12.53	8.85	8.84	25.00	30.00	1.54	1.25
	~~6.22~~	7.70	9.00	~~26.98~~	~~27.93~~	1.73	.80
	13.39	8.68	8.65	21.41	~~44.88~~	1.67	.55
	10.20	7.38		14.77	35.33		.70
	9.60	~~5.75~~			35.66		1.20
					~~41.88~~		.90
					31.27		1.00
					35.91		.75
					~~27.78~~		.50
Total	133.03	107.02	118.94	245.51	409.96	26.03	16.75
No. Observ.	14	13	12	13	12	14	20
Avg. Time	9.50	8.23	9.91	18.87	34.17	1.83	.84
Min. Time	7.00	6.00	8.63	14.00	30.00	1.41	.35
Max. Time	13.53	9.37	12.80	25.00	40.00	2.87	1.25
Rating	C1-C1-C-C						
Level. Fct.	1.14	1.14	1.14	1.14	1.14	1.14	1.14
Std. Time	10.8300	9.3888	11.1974	21.5118	38.9523	2.0868	.9804
Allowance	.0803	.0803	.0803	.0803	.0803	.0803	.0803
Allow. Time	10.9508	9.4030	11.2182	21.5336	38.9746	2.1070	1.0012

TABLE 1

IV. RESULTS

A. The time required to prepare certain vegetables under definite working conditions

1. Head lettuce

Iceberg head lettuce, the most common salad green, was washed and cored by two methods, I and II as shown in Figures 2 and 3. It was cut or diced by hand and cut or sliced on a hand operated cutter as shown in Figure 4. It was also cut and put on plates in wedges for a plain head lettuce salad. The heads were cut on the power driven machine several times, but the data is not presented as this method of preparation bruised the leaves too badly to consider such a method no matter how much time was saved.

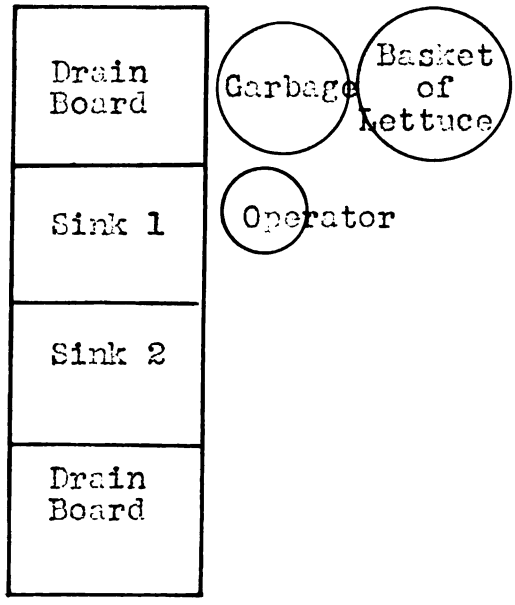
WASHING AND REMOVING OUTSIDE LEAVES--In washing head lettuce the amount of time required by using Method II is almost consistently less than that required by Method I and the range from minimum to maximum only 3.37 minutes. In Method I the range is 5.53 minutes and five of the figures run to two digits; whereas there are no two digit numbers in Method II. Method I requires .49 minutes per head and Method II only .36 minutes. The allowed time for Method II is 9.4030 minutes and for Method I is 10.8500 minutes. This would seem to indicate that Method II was the best, but this is not necessarily true. In Method II the heads are dropped into a sink of water and then all lifted out at one time. In Method I each head is held under running water and

placed on the drain board immediately to drain. Thus the 1.4478 minutes saved by using Method II might be lost in waiting for the water to drain out of the lettuce or in shaking the water out of the heads as they were used.

CUTTING BY HAND AND ON HAND OPERATED MACHINE--When the bushel of cleaned heads was cut by hand as shown in Figure 5 the time ranged from 14.00 minutes to 25.00 minutes. This rather wide range of 11.00 minutes is due to the natural variance in the quality of the lettuce. Firm, solid heads can be cut much more rapidly than loose ones. The allowed time for hand cutting is 21.5326 minutes and for cutting on the hand operated machine is 11.2182 minutes, or 10.3144 minutes less. However, it takes a total of 2.19 minutes, Table 10, to assemble and disassemble the hand cutter. This must be added to the total time for this method of cutting, making it 13.4082 minutes. Though 8.1344 minutes is saved by cutting on the machine, this method is not necessarily better than cutting by hand. Hand cut lettuce retains its crisp, fresh appearance more than machine cut and does not look so "chewed."

When cut by hand 13 heads can be cut in 13 minutes as shown in Table 11. The allowed hand cutting time per head is 1.0012 minutes or 2.19 heads in 2.19 minutes, the time required to put up and remove the cutter. Therefore, cutting by hand would be preferred for three or less heads as this many heads could be cut in the time required to handle the machine.

WASHING CARTON LEAF LETTUCE

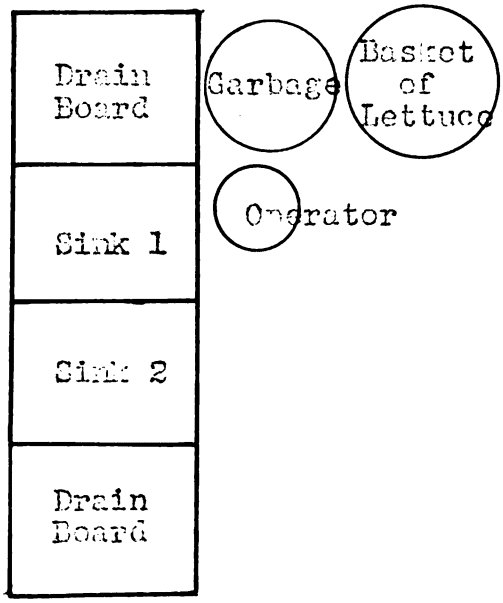


LEFT	RIGHT
1. Same as right but hold bunch	1. Pick up bunch of lettuce and put on drain board, knife in hand
2. Hold	2. Cut root end off
3. Put in sink 1 of water and pick up bunch on drain board	3. Cut root end off
4. Put in sink 1 of water	4. Pick up another bunch

Repeat steps 1 to 4 until all are done
Put knife down
Wash with both hands and put in sink 2
Wash with both hands and put in sink 1
Let stand until ready to use--lift to drain board

FIGURE 7

WASHING HOT HOUSE LEAF LETTUCE



LEFT	RIGHT
1. Twist off leaves by grasping them in the hand lightly	1. Pick up bunch by root end
2. Put in sink 1 of water	2. Throw root end into garbage

Let soak until ready to use

Using both hands, lift out of water and lay on ledge to drain

FIGURE 8

LEAF LETTUCE

QUANTITY STUDIED 1 BASKET HOT HOUSE or ½ BUSHEL CARTON	OPERATION TIME IN MINUTES: Washing Garden Lettuce	Tearing Off Root End, Putting In Water	Washing and Putting on Board to Drain
	7.61	3.10	3.00
	8.31	3.00	3.33
	10.39	3.03	2.31
	9.53	3.06	2.30
		3.75	2.65
		4.45	1.50
		2.00	2.33
		1.60	1.50
		2.00	1.50
		2.03	1.60
		2.50	1.35
		2.33	1.10
		2.00	2.00
		2.50	2.10
Total Time		37.89	28.38
No. Observations		14	14
Average Time		2.70	2.02
Minimum Time		1.60	1.10
Maximum Time		4.45	3.33
Rating	C1-C1-C-C		
Leveling Factor		1.14	1.14
Standard Time		3.3060	2.3038
Allowance		.0208	.0208
Allowed Time		3.3268	2.3246

TABLE 2

CUTTING IN WEDGES--In cutting wedges of head lettuce for a plain salad and placing these wedges on the garnished plates, as shown in Figure 6, the time required varies 10.00 minutes from minimum to maximum. Close examination of the figures in Table 1 will show that the actual range is 17.10 minutes. These extreme figures were not included in the total, which yielded an allowed time for this operation of 38.9746 minutes. The allowed time per tray of eight plates taken from averages of 18, 21, and 32 trays is 3.1070 minutes. This method of preparing lettuce takes a longer time, but is the most common method used at present in the preparation and serving of plain head lettuce salad.

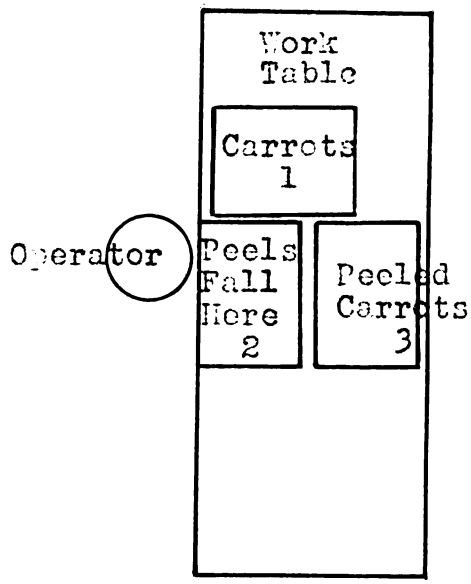
2. Leaf Lettuce

Another common salad green is leaf lettuce. This is used largely as a salad garnish and the time required to wash it was the only time studied. Using the method shown in Figure 8, only 5.6504 minutes are required to wash a 10-pound basket of hot-house lettuce. The washed leaves are then torn to the desired size as they are put on the plate. If the lettuce is slightly wilted, it can be left in the sink of cold water ten to thirty minutes and then be lifted out to drain. It takes only 3.3336 minutes to wash it and lift it out. The figures in Table 3 for garden lettuce are for one-half bushel, washed as shown in Figure 7, but they are not numerous enough to be significant.

3. Carrots

Carrots are used in fewer salads than lettuce, but can

PEELING CARROTS BY HAND

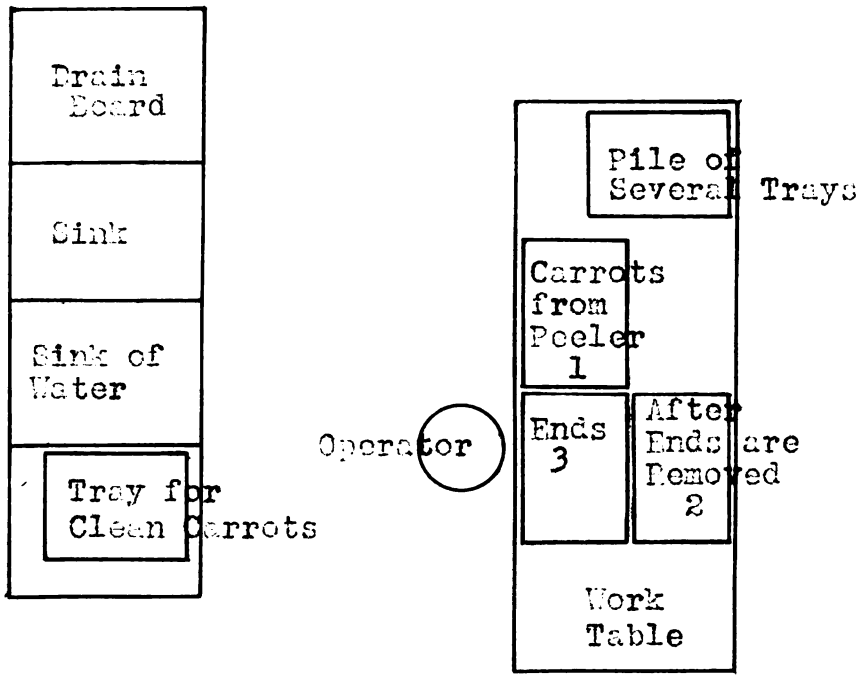


LEFT	RIGHT
1. Pick up carrot	1. Knife in hand
2. Hold and turn carrot as necessary	2. Peel
3. Put on tray 3	3. Wait

Repeat this process until all the carrot are done

FIGURE 9

REMOVING ENDS AND TASTING CARROTS



LEFT

1. Pick up carrot and hold

RIGHT

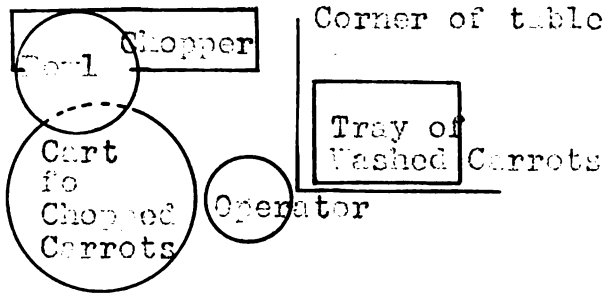
1. Cut off ends and spots and toss on tray 2

Repeat this operation until all carrots are done

With both hands
1. Pick up tray of carrots
2. Dump them into sink of water
3. Take tray from pile on table and place on drain board
4. Wash carrots and put them on the clean tray

FIGURE 10

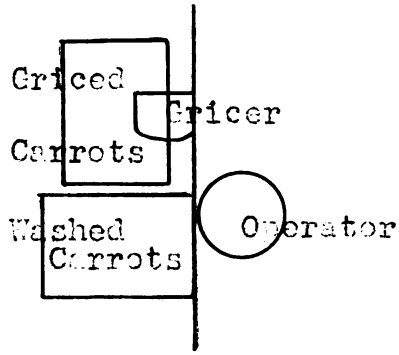
CHOPPING CARROTS



Both hands are used in filling the bowl and in emptying it. The bowl rotates and the knife blade turns continuously.

FIGURE 11

GRICING CARROTS



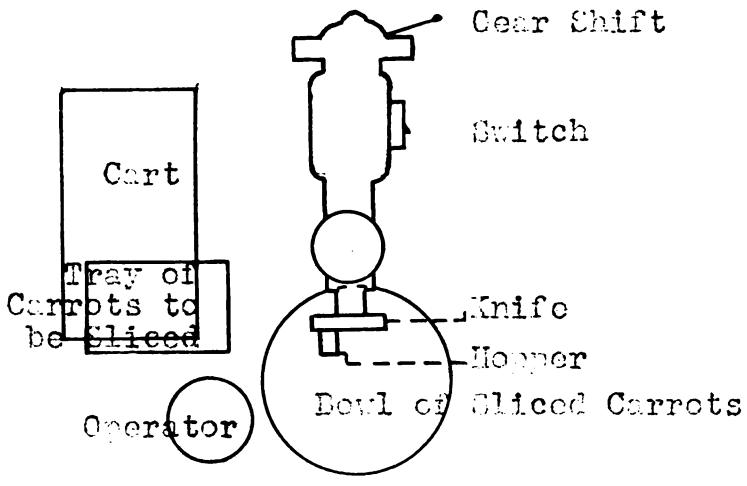
The Gricer is attached to the ledge about 3 feet from the south wall.

LEFT	RIGHT
1. Pick up carrot and put in gricer	1. Turn the handle of the gricer

The carrots fall on the tray
Repeat until all carrots are griced

FIGURE 12

SLICING CARROTS ON POWER MACHINE



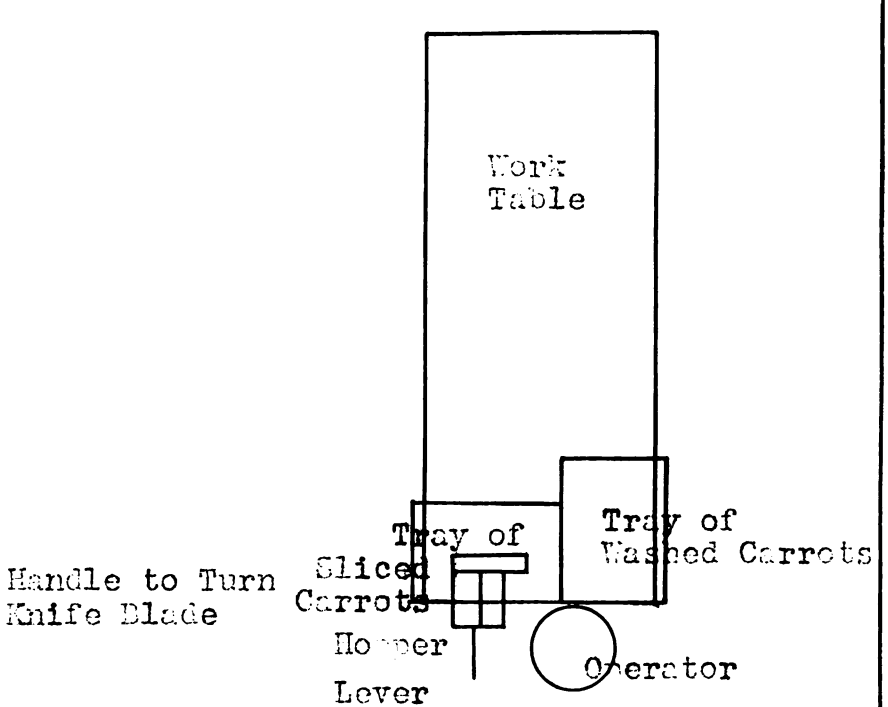
LEFT RIGHT

Both hands fill the hopper with carrots. In this case they go in the end of the hopper and must all be placed so that the end of the carrot hits the knife.

Push the carrots in with a wooden mallet held in the right hand.

FIGURE 13

SLICING CARROTS ON HAND OPERATED MACHINE

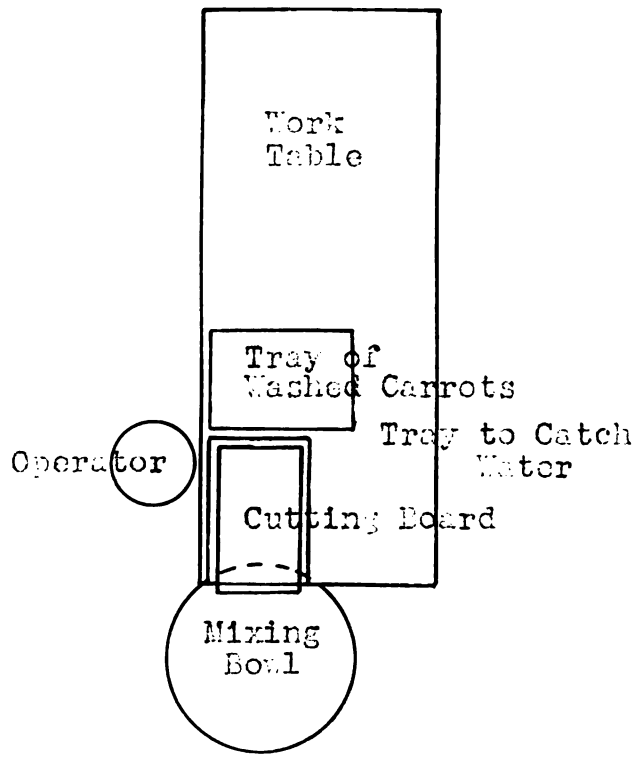


LEFT	RIGHT
1. Pick up carrots and fill hopper	1. Pick up carrots and fill hopper
2. Push lever	2. Turn knife blade

Carrots are sliced so that ends of them hit the knife.

FIGURE 14

SLICING CARROTS BY HAND



LEFT	RIGHT
1. Pick up carrot and hold firmly on board	1. Slice with a downward stroke of the knife
2. Pick up next carrot	2. Using blade of knife, slide slices into mixing bowl

Repeat until all the carrots are done. This method does not yield as thin slices as either of the other slicing methods.

FIGURE 15

CARROTS

QUANTITY STUDIED 5 POUNDS	OPERATION TIME IN MINUTES						
	Peeling by Hand	Machine Peeling	Washing and Cutting Off Ends	Chopping	Grating	Slicing on Power Machine	Slicing on Hand Operated Machine
	~~13.75~~	3.33	4.00	1.50	~~6.00~~	~~3.10~~	2.50
	10.00	3.33	3.50	1.30	5.50	1.80	2.00
	10.00	3.43	3.80	1.10	3.56	2.20	2.77
	9.47	3.43	4.00	1.20	~~6.75~~	1.50	1.80
	~~2.10~~	3.70	2.80	1.55	3.55	~~2.10~~	~~2.35~~
	8.81	3.43	4.00	1.30	5.83	2.15	2.65
	10.00	3.45	5.20	1.58	4.80	1.70	2.00
	8.20	2.13	3.00	1.35	4.00	1.85	2.22
	10.20	3.30	4.40	1.25	4.65	1.90	2.05
	8.20	3.86	3.20	1.00	4.95	2.30	1.90
	~~3.50~~		4.44	1.20	4.20	1.90	~~3.50~~
	8.20		3.54	1.55	3.60	2.20	2.90
	10.00		3.65	1.30	4.80	2.56	2.30
			3.40	1.50	4.52	2.70	2.65
			~~3.67~~			2.00	~~2.49~~
			~~2.30~~				
			2.30				
			3.00				
			5.30				
			~~2.70~~				
Total Time	111.28	35.39	78.80	18.28	54.78	28.26	35.58
No. Observ.	12	10	20	14	12	14	15
Avg. Time	9.27	3.53	3.64	1.30	4.56	2.01	2.37
Min. Time	8.20	2.13	2.30	1.00	3.56	1.20	1.80
Max. Time	10.20	3.86	5.20	1.58	5.62	2.70	2.90
Rating	C1-C1-C-C						
Level Fct.	1.14	1.12	1.12	1.14	1.14	1.14	1.14
Std. Time	10.5678	3.9496	4.1396	1.4820	5.1984	2.2914	2.7018
Allowance	.0208	.0208	.0208	.0208	.0208	.0208	.0208
Allow. Time	10.5886	3.9704	4.1604	1.5028	5.2208	2.3133	2.7226

TABLE 3

be prepared in more ways. They were studied under all the methods of preparation mentioned on Page 9, adding the use of the gricing machine shown in Plate 6. A gricer is a hand operated machine into which vegetables are fed with the left hand while the right hand operates the machine. Gricing cuts the carrot into curved pieces about one inch long and a quarter of an inch wide.

	3.00		
	3.30	Total Time	36.97
	3.09	No. Observations	10
MACHINE	4.39	Average Time	3.69
PEELING	4.00	Minimum Time	3.00
ONE	3.70	Maximum Time	4.39
HALF	3.00	Rating	C1-C1-C-C
BUSHEL	3.09	Leveling Factor	1.13
	3.10	Standard Time	4.0383
	3.30	Allowance	.0307
		Allowed Time	4.0536

TABLE 4

PEELING--The carrots were peeled in one-half bushel and 5½-pound lots in a mechanical peeler. The peeling was done in 5½-pound lots because a half a pound is lost in peeling and five pounds was the amount wanted after they were peeled. One-half bushel is the unit usually used for this operation because it is waste effort and lost power to peel less. Carrots are seldom peeled mechanically in as small quantities as 5½-pound lots, since it requires 3.9704 minutes to peel 5½ pounds and 4.0536 minutes, Table 4, or only .1832 minutes more, to peel one-half bushel or twenty-five pounds. The time required to peel 5½ pounds by hand varies, as shown in Figure 9, from 8.30 minutes to 10.30 min-

utes, but the time allowed is 10.5836 minutes. This is 6.6100 minutes more than mechanical peeling and much more effort and motion. After peeling, the ends of the carrots have to be cut off, any bad spots cut out, and the carrots washed. This is done as shown in Figure 10. The time allowed is 4.1604 minutes, but it may vary from 3.83 minutes to 4.33 minutes. The loss in cutting off the ends is four to eight ounces, Table 14, leaving only four pounds eight ounces to four pounds twelve ounces to prepare for salad.

CHOPPING--For chopping carrots, see Figure 11, the time varies from 1.00 minutes to 1.58 minutes. However, 1.5033 minutes are allowed for this operation plus the 1.33 minutes required to assemble and disassemble the chopper. See Table 10. This makes a total allowed time of 2.8333 minutes. Chopped carrots are not usually used in a tossed vegetable salad. Therefore this method of preparation cannot be compared with gricing or slicing.

GRICING--The allowed time for gricing, as shown in Figure 12, is 5.8302 minutes or 2.9609 minutes more than slicing on the power driven machine and 3.4976 minutes more than slicing on the hand operated machine. The time allowed for gricing is actually increased .5% minutes, Table 10, or the time required to assemble and disassemble the gricer. This makes a total allowed time of 5.7408 minutes. Gricing, however, gives a very different looking product than slicing and is preferred for some purposes. The time required for slicing on the power driven machine as shown in Figure 13

varies from 1.20 minutes to 2.70 minutes or over a range of 1.10 minutes. The difference is due to the variable sizes of carrots. Large ones slice more easily than small ones.

PLATE 6
The Gricer

Slicing on the hand operated machine as shown in Figure 14 varies from 1.80 minutes to 2.90 minutes, or over a range of 1.10 minutes. This is also due to the varying size of the carrots. The use of the hand slicer requires 2.7876 minutes or .4104 minutes more than the 2.3133 minutes required when the power driven machine is used.

HAND SLICING--Both the machine methods give a much thinner piece than when the carrots are sliced by hand. See Figure 15. When sliced by hand from two pounds to two pounds eight ounces are sliced in two minutes, Table 11, whereas four pounds eight ounces to four pounds twelve ounces, Table

18, are sliced in only 3.3133 minutes on the power driven machine and in 2.7136 minutes on the hand operated slicer. However, it requires 1.36 minutes to assemble and disassemble the power slicer and 2.19 minutes to assemble and disassemble the hand operated machine. See Table 18. This time must be added to the cutting time for these machines, making the total time for slicing four pounds eight ounces to four pounds twelve ounces on the power machine 4.6733 minutes and on the hand operated machine 4.9136 minutes. Therefore, since slightly more than two pounds can be cut by hand in two minutes and only slightly more than four pounds in 4.6733 minutes on the power machine and in 4.9136 minutes on the hand operated machine, there is scarcely any time saved by the use of either machine. On as small a quantity as this, time and motion would apparently be saved only if the machine were already assembled for another purpose or if more than four pounds of carrots were to be sliced.

4. Celery

Celery is one of the more common salad vegetables and is prepared in a variety of ways. Since this report deals largely with the time required to prepare vegetables that may be used in a tossed vegetable salad, only the time required to clean celery and dice it was studied. We shall refer to a stalk of celery as that one piece which is stripped from the bunch; a bunch of celery is several stalks as they grow together. A bundle of celery is several, usually twelve, bunches tied together. The unit studied was ten to

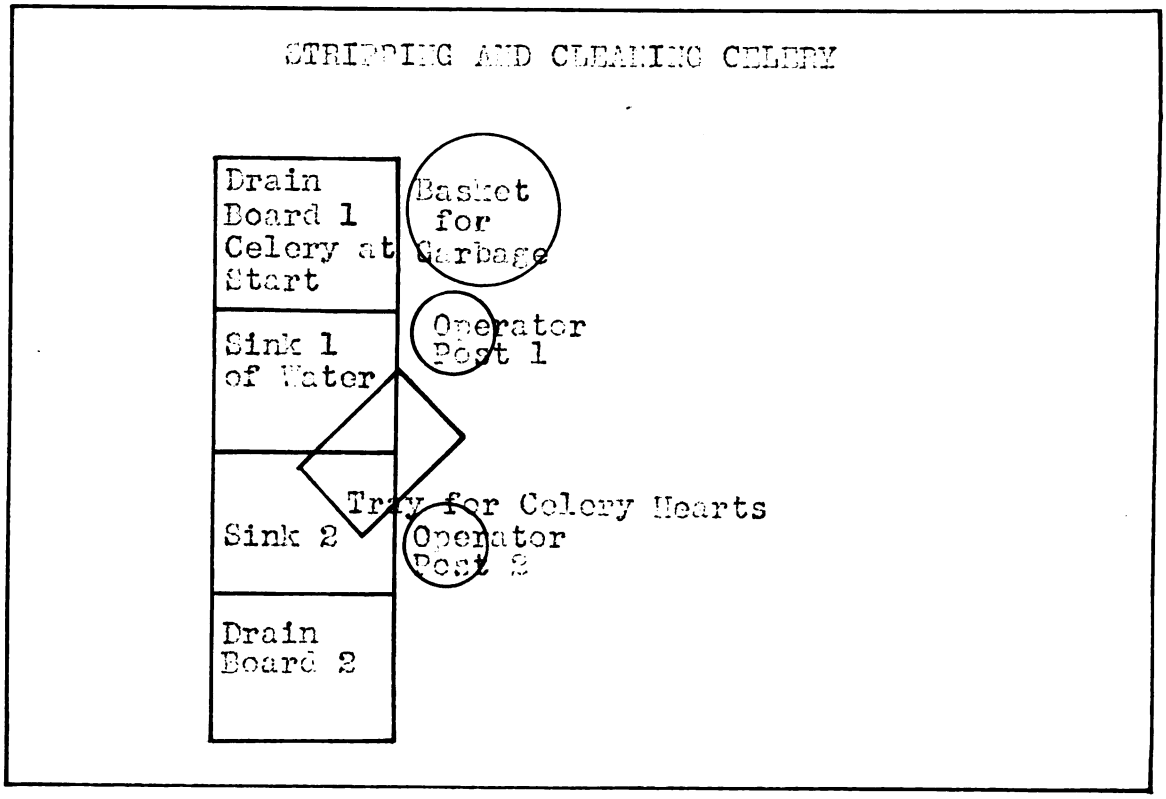


FIGURE 16

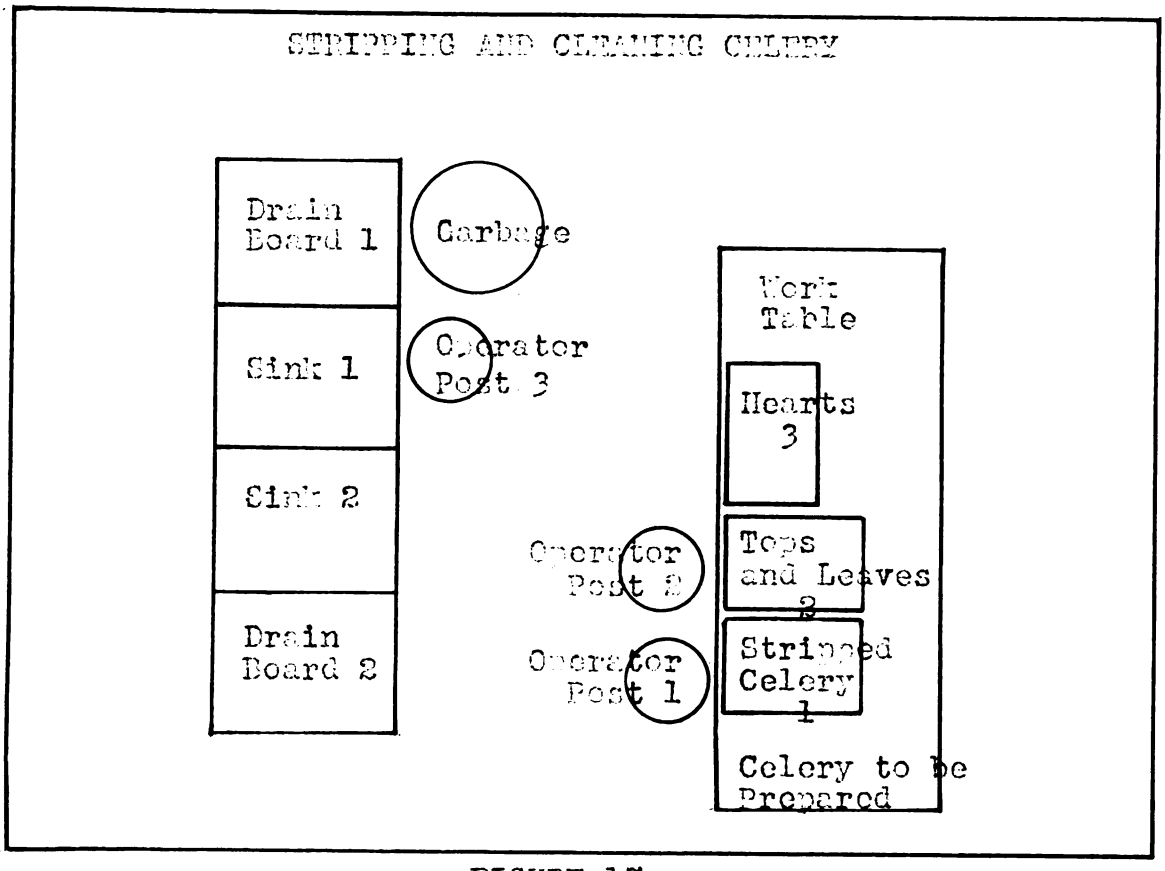


FIGURE 17

STRIPPING AND CLEANING CELERY

Operator STRIPPING at post 1

LEFT	RIGHT
1. Strip down to heart	1. With knife in hand, pick up and hold bunch of celery
2. Put heart on tray	2. Transfer heart to left hand
3. Hold stalk	3. Cut off leaves and end and let them drop into basket of garbage
4. Put piece in sink 1 of water	4. Reach for next bunch of celery

Repeat this operation until all the celery is topped and in the sink.

Operator WASHING at both posts

1. Hold stalk	1. Hold vegetable brush
2. Hold and turn stalk	2. Scrub

When all the celery is in sink 2 douse it up and down with both hands and put on drain board 2.

Operator CLEANING at post 2

1. Pick up stalks of celery 1 or 2 at a time	1. Cut off brown spots and scrape if necessary
2. Put on tray	2. Rest

The garbage drops into the sink.

FIGURE 16a

STRIPPING AND CLEANING CELERY

Operator STRIPPING at post 1

LEFT	RIGHT
1. Grasps bunch of celery	1. Pick up bunch of celery and transfer to left hand
2. Hold	2. Strip all that is to be stripped from that bunch
3. Hold	3. Cut off tops about 4 or 5 inches from root, letting tops fall on tray 1

Repeat until all celery is stripped.

Operator CUTTING OFF TOPS at post 2

1. Hold	1. With knife in hand, pick up 2 or 3 stalks and transfer to left hand
2. Hold	2. Cut off ends and leaves, allowing them to drop on tray 2
3. Throw into sink 1 of water	3. Wait

Gather up tops and leaves and put in garbage.

Operator WASHING at post 3

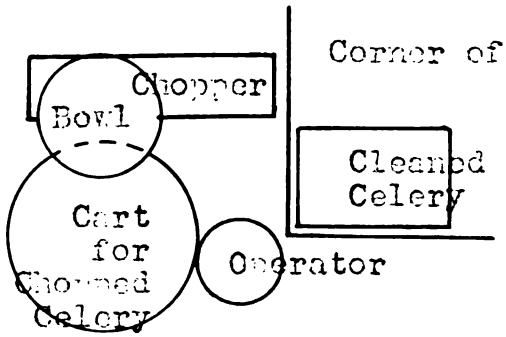
1. Pick up stalks	1. Brush in hand
2. Hold	2. Brush
3. Put on drain board 1	3. Wait

Operator CLEANING at post 3

1. Pick up stalk and hold	1. Scrape and cut out bad spots
2. Put on drain board again but to one side	2. Wait

FIGURE 17a

CHOPPED CELERY

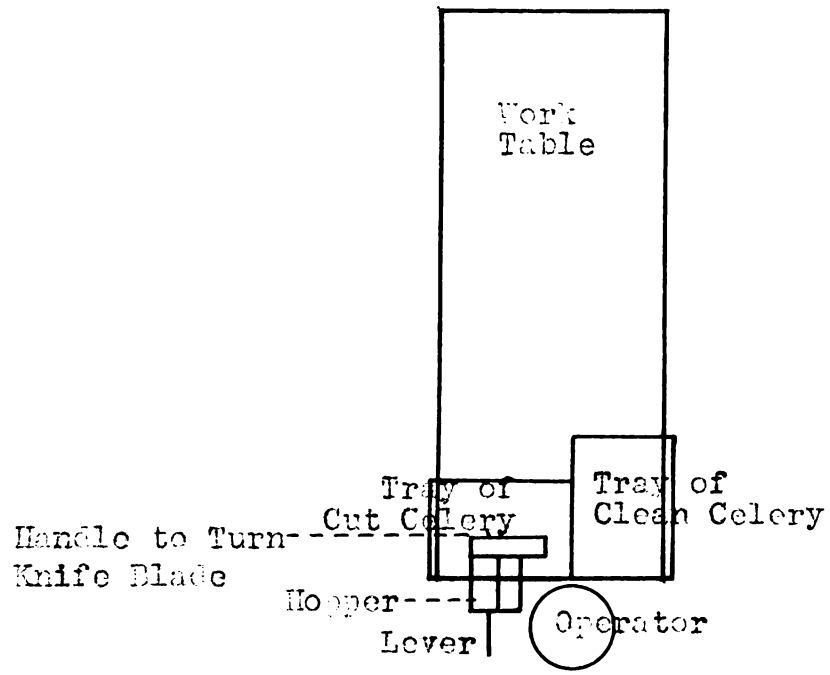


LEFT	RIGHT
1. Wait	1. Turn machine on and fill bowl
2. Fill chopping bowl	2. Fill chopping bowl
3. Empty chopping bowl	3. Empty chopping bowl

Repeat until all celery is chopped

FIGURE 13

CUTTING CELERY ON HAND MACHINE

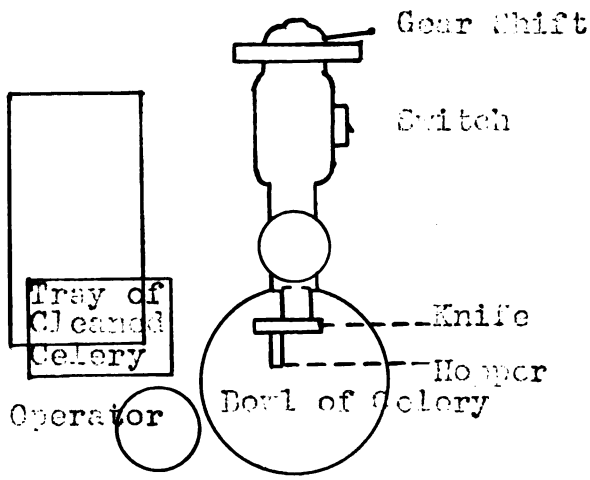


LEFT	RIGHT
1. Pick up a handful of stalks	1. Knife in hand
2. Hold	2. Cut in proper lengths for machine, let fall on tray
3. Put in hopper of machine with all pieces going the same way	3. Assist left hand
4. Close top of hopper and push lever	4. Turn handle that rotates the cutting knife

Repeat until all the celery is done

FIGURE 19

CUTTING CELERY ON POWER MACHINE



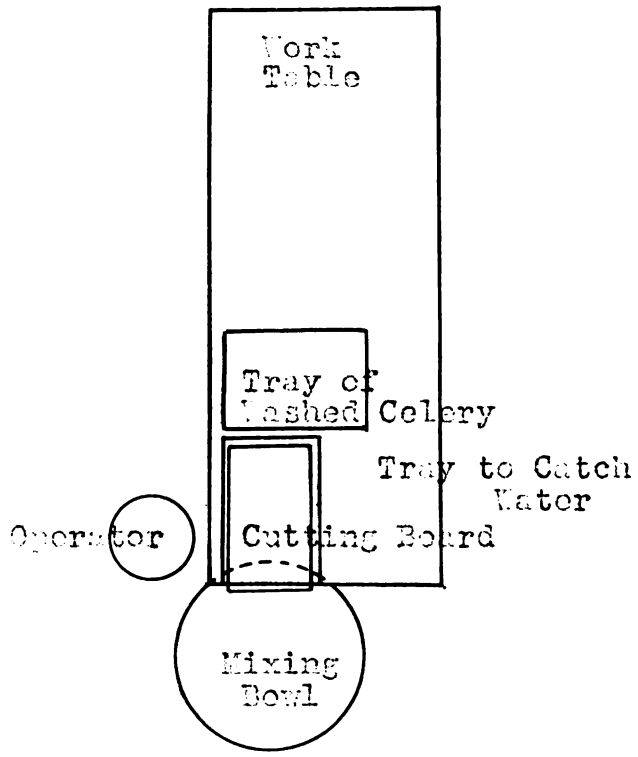
LEFT RIGHT

Both hands fill the hopper with clean celery. It is placed so that the ends of the stalks touch the knife blade.

Push celery in against knife with a wooden mallet.

FIGURE 20

C[illegible] BY HAND



LEFT	RIGHT
1. Pick up stalks of celery and lay parallel on cutting board	1. Knife in hand, split stalks lengthwise
2. Hold firmly together	2. Cut crosswise
3. Begin to pick up next stalks	3. Using knife blade, slide cut celery into mixing bowl

Repeat until all the celery is done

FIGURE 21

CELERY

QUANTITY STUDIED 10# 10 to 11 BUNCHING	OPERATION TIME IN MINUTES					
	Stripping and Cleaning		Chopping	Cutting on Hand Operated Machine	Cutting on Power Driven Machine	Hand Cutting
	Method I	Method II				
	14.40	18.35	1.45	5.13	2.60	9.00
	15.06	19.07	1.62	5.70	3.24	10.00
	15.32	17.25	1.61	5.00	3.20	9.30
	~~20.49~~	~~15.00~~	1.60	8.00	2.00	11.00
	17.44	17.00	1.53	8.07	1.90	9.42
	18.75	17.05	1.50	5.80	1.45	10.00
	18.00	17.90	1.15	9.00	2.25	10.00
	15.09	18.20	2.40	7.26	2.00	~~4.05~~
	16.20	20.25	1.10	~~9.46~~	~~3.60~~	9.29
	18.11	20.28	2.40	6.65	1.45	9.80
	~~13.82~~	19.82	2.60	9.07	~~3.90~~	13.80
	16.37	18.04	1.95	6.50	1.85	14.30
	18.00	17.85	1.92	9.00	2.18	14.00
	15.66	18.00				13.40
Total Time	198.40	239.06	22.83	85.18	32.06	239.06
No. Observ.	12	13	13	12	11	13
Avg. Time	16.53	18.38	1.75	7.09	2.00	10.97
Min. Time	14.40	17.00	1.10	5.00	1.75	9.00
Max. Time	18.75	20.28	2.60	9.07	2.60	14.30
Rating	C1-C1-C-C					
Level. Fet.	1.14	1.14	1.14	1.14	1.14	1.14
Std. Time	18.8442	20.9532	1.9950	8.0826	2.8300	12.5058
Allowance	.0208	.0208	.0208	.0208	.0208	.0208
Allow. Time	18.8650	20.9740	2.0158	8.1034	2.8508	12.5266

TABLE 5

STRIPPING AND CLEANING CELERY

	OPERATION TIME IN MINUTES							
	Stripping and Cutting off Tops, Putting in Sink		Garbage Disposal		Washing and Scrubbing		Scraping	
	Method I	Method II	Method I	Method II	Method I	Method II	Method I	Method II
	7.00	8.80	-----	.93	6.00	3.60	1.40	5.02
	8.22	9.00	-----	2.00	5.74	3.40	1.06	6.07
	7.13	7.00	-----	2.00	3.00	3.00	5.73	3.00
	7.84	8.50	-----	1.05	3.05	3.20	6.32	4.30
	7.70	9.90	-----	.20	4.80	3.22	5.95	4.75
	7.30	8.00	-----	1.00	5.20	4.30	7.39	5.00
	7.80	7.00	-----	.30	2.90	3.40	2.80	4.04
	7.90	8.00	-----	1.00	3.30	4.00	4.46	5.00
	7.80	8.10	-----	1.00	3.60	3.04	4.97	5.64
	8.80	7.64	-----	.51	3.45	3.27	5.75	8.30
	7.70	8.00	-----	.65	4.00	3.30	4.50	8.65
	9.90	8.30	-----	.50	2.50	3.80	5.50	6.00
	8.80	8.50	-----	1.00	2.50	3.70	6.14	5.00
	7.50	9.80	-----	.60	2.40	1.90	5.45	4.95
Total Time	111.47	115.52	-----	14.04	52.74	45.84	68.01	79.75
No. Observ.	14	14	--	14	14	14	14	14
Avg. Time	7.96	8.25	-----	1.00	3.83	3.27	4.85	5.65
Min. Time	7.00	7.00	-----	.50	2.50	1.90	1.06	3.00
Max. Time	9.90	9.80	-----	2.00	4.80	4.50	1.32	8.65

TABLE 6

eleven bunches. Out of this the heart was saved for other use and the leaves were not utilized; so that after the celery was washed and cleaned only five pounds twelve ounces to six pounds twelve ounces remained to be cut and used in the salad.

STRIPPING AND CUTTING--The celery was stripped and washed by two methods. When Method I, as shown in Figure 16, is used, the allowed time is 18.8690 minutes. For Method II, Figure 17, the allowed time is 30.9740 minutes or 8.1050 minutes longer. This would seem to indicate that Method I is the more efficient. The average figures in Table 6 bear this out to some extent by showing that the time consumed in disposing of the tops, leaves, etc., referred to as garbage, is eliminated when Method I is used. The time required to strip it, cut off the tops, and put the celery in the sink is 8.25 minutes in Method II and 7.96 minutes, or .29 minutes less in Method I. It takes 3.83 to wash and scrub the celery in Method I and .46 minutes less, or 3.37 minutes, in Method II. The extra washing time is saved in scraping since it requires 5.65 minutes to scrape using Method II and only 4.85 minutes, or .80 minutes less, using Method I, so that on the average Method I takes 1.54 minutes less. This, when leveled, is 8.1090 minutes. See Table 5.

CHOPPING--Celery is not usually chopped for use in salads, but this method of preparation was studied for purposes of comparison. It was chopped as shown in Figure 18, the allowed time being 2.0158 minutes plus 1.33 minutes to assemble and disassemble the chopper, or a total of 3.3458 minutes. See Table 10.

MACHINE CUTTING--Like carrots, celery is cut on the power driven machine, Figure 20, on the hand operated machine, Figure 19, and by hand, Figure 21. Hand cut celery is probably

the most satisfactory in appearance, but the time allowed for cutting by hand is 13.5866 minutes. This is 10.8358 minutes longer than when the power machine is used and 4.6832 minutes longer than when cut on the hand operated machine. The power driven machine requires 2.3008 minutes and the hand operated machine 5.8026 minutes longer, or 8.1034 minutes. It requires 2.19 minutes to assemble and disassemble the hand operated machine and 1.96 minutes for the power machine. See Table 10. This added to the cutting time means that the time to be allowed to cut five pounds twelve ounces to six pounds twelve ounces of celery is really 10.2934 minutes on the hand operated machine and 4.2608 minutes on the power driven machine. When celery is cut by hand, one pound to two pounds four ounces can be cut in two minutes, as shown in Table 12. This would seem to indicate that it would not pay to assemble either machine unless more than two pounds of celery are to be cut.

5. Cabbage

CLEANING AND CUTTING IN SECTIONS--One bushel or forty-five to fifty-one pounds of cabbage, Table 12, was cleaned, chopped, and shredded. It was cleaned and cut in sections by two methods. When Method I, as shown in Figures 22 and 22a, is used only 8.9356 minutes need to be allowed, but for Method II, Figures 23 and 23a, 10.7861 minutes, or 1.7905 minutes longer, are needed. The time varies in Method I from 5.55 minutes to 9.32 minutes or over a range of 3.87 minutes. For Method II the time varies from 8.31 minutes

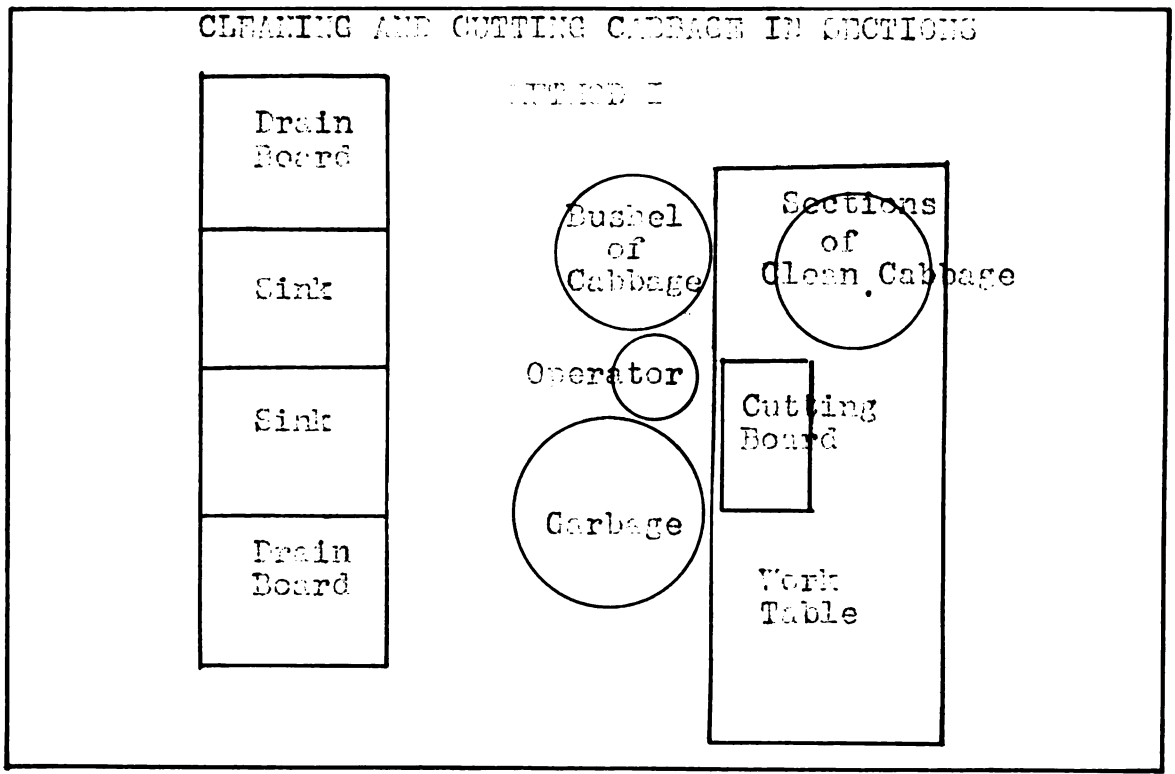


FIGURE 22

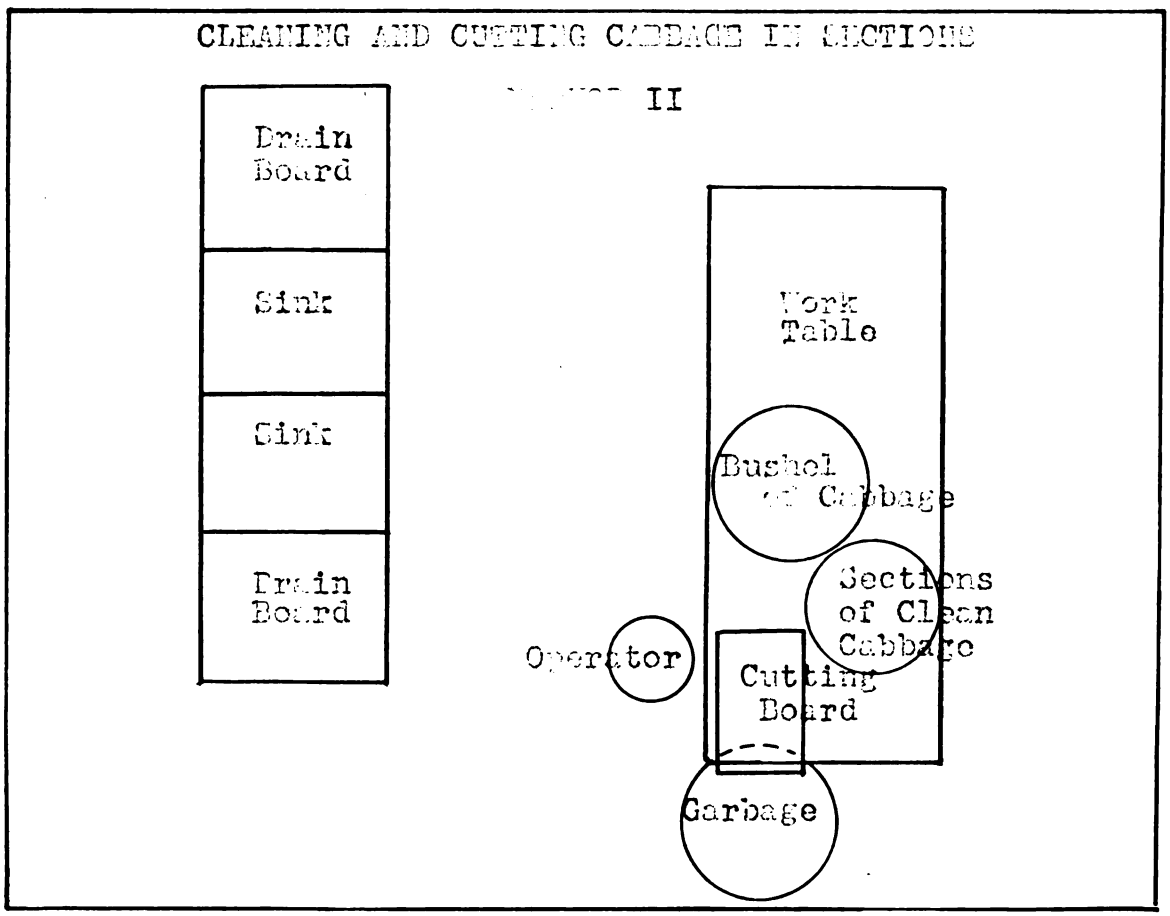


FIGURE 23

CLEANING AND CUTTING CABBAGE IN SECTIONS

LEFT	RIGHT
Pick up one head in each hand. Put the one from the right hand on the table and the one in the left hand on the cutting board.	
1. Steady head of cabbage on board	1. Cut off bottom
2. Steady head of cabbage on board	2. Tear off outside leaves
3. Steady head of cabbage on board	3. Cut head in half
4. Hold half head on board	4. Quarter, leaving core in section away from left hand
5. Put section in pan	5. Pick up section with core still in it
6. Hold quarter on board	6. Cut core from quarter
7. Put section in pan	7. Pick up second half of head
8. Hold second half of head on board	8. Quarter second half, leaving core in section away from left hand
9. Put section in pan	9. Pick up section with core still in it
10. Hold quarter on board	10. Cut core from quarter
11. Put section in pan	11. Pick up second head from the table
Repeat this operation on the second head	
Put knife down on table	
Use both hands to gather up outside leaves and cores and put in garbage. Repeat until the entire bushel is done.	

FIGURE 22a

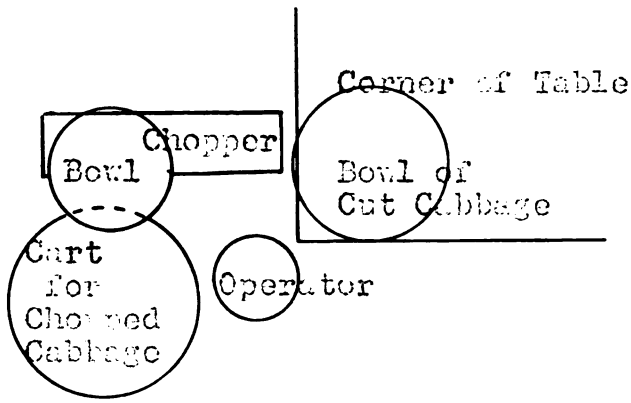
CLEANING AND CUTTING CABBAGE IN SECTIONS

LEFT	RIGHT
1. Take head from basket and hold on board	1. Cut off bottom and tear off outside leaves sliding refuse into garbage container
2. Still steadying head on cutting board	2. Cut cabbage head in half
3. Steady half	3. Quarter, leaving core in section away from left hand
4. Put section in pan	4. Wait, holding knife
5. Hold section with core on board	5. Cut core from quarter
6. Put section in pan	6. Wait, holding knife
7. Hold second half	7. Quarter, leaving core in section away from left hand
8. Put section in pan	8. Wait, holding knife
9. Hold fourth section	9. Cut core from fourth section
10. Put section in pan	10. Wait, holding knife

Repeat until bushel is done

FIGURE 23a

CHOPPING CABBAGE

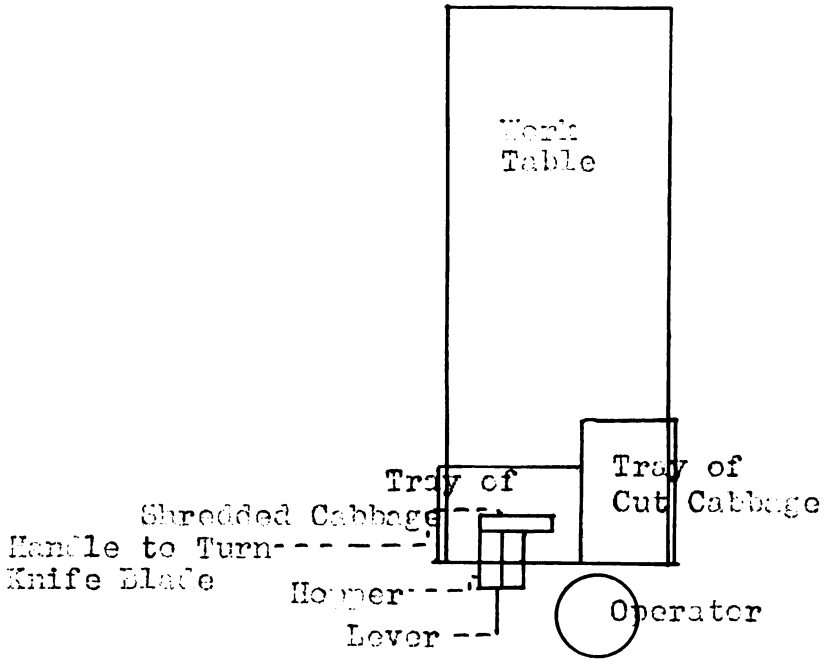


Both hands are used in filling the bowl and in emptying it. The machine is turned on and the bowl rotates continuously while it is being filled and emptied.

Enough cabbage for about 3 quarts, chopped, is put in the bowl. It runs about .25 minutes and is then emptied.

FIGURE 24

SHREDDING CABBAGE ON HAND MACHINE

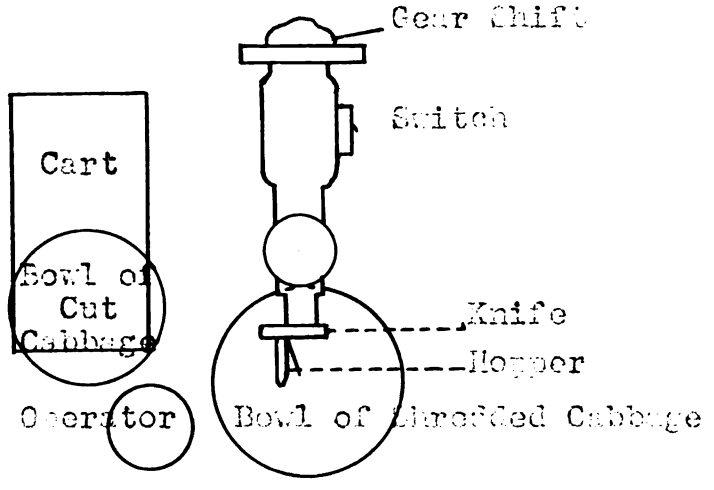


LEFT	RIGHT
1. Pick up section of cabbage	1. Pick up section of cabbage
2. Put section in hopper	2. Put section in hopper
3. Push lever	3. Turn knife blade

Repeat operation until bushel is done

FIGURE 25

SHREDDING CABBAGE ON POWER MACHINE



LEFT	RIGHT
1. Pick up sections of cabbage	1. Open hopper
2. Fill hopper	2. Fill hopper
3. Reach for next sections of cabbage	3. Close and push lever down forcing cabbage against the rotating knife

Repeat until all is done

FIGURE 26

CABBAGE

QUANTITY STUDIED 1 BUSHEL	OPERATION TIME IN MINUTES				
	Cleaning and Cutting in Sections		Chopping	Shredding on Power Operated Machine	Shredding on Hand Operated Machine
	Method I	Method II			
	8.34	9.35	9.82	11.80	13.30
	~~12.55~~	8.68	~~10.45~~	10.00	~~22.71~~
	8.25	~~12.30~~	9.40	10.40	15.00
	8.37	9.90	9.00	12.00	15.00
	9.05	11.95	9.50	13.90	13.70
	8.00	8.56	5.80	10.64	13.30
	~~13.35~~	10.00	6.20	12.54	13.15
	8.00	8.15	5.50	~~13.46~~	12.00
	5.55	9.20	5.38	8.53	10.90
	8.00	10.00	5.88	12.36	12.20
	5.90	~~7.86~~	5.00	11.06	10.65
	8.60	8.31	6.47	8.83	12.79
	7.08	8.48		~~8.76~~	
	9.32			9.40	
	7.30			8.84	
Total Time	101.76	102.40	77.35	126.40	141.99
No. Observ.	13	11	11	12	11
Avg. Time	7.82	9.30	7.03	10.53	12.90
Min. Time	5.55	8.31	5.00	8.53	10.65
Max. Time	9.32	11.95	9.82	12.54	15.00
Rating	C1-C1-C-C				
Level. Fct.	1.14	1.14	1.14	1.14	1.14
Std. Time	8.9148	10.7053	8.0142	12.1138	14.7060
Allowance	.0208	.0208	.0208	.0208	.0208
Allow. Time	8.9356	10.7261	8.0350	12.1340	14.7268

TABLE 7

to 11.95 minutes, or over a range of 3.64 minutes. Figures 22 and 23 would seem to indicate that Method II is the more efficient, but the data in Table 7 disproves this. Method II requires almost consistently more time than Method I. Three of the figures in column 2 of Table 7 have two digits, while there is no figure in column 1 greater than 9.32 minutes. This difference is probably due to the fact that in Method I two heads are taken from the basket at one time instead of one as in Method II and that in Method II there is a tendency to slide refuse into the garbage container two or three times while each head is being cleaned instead of only once every time two heads are cleaned. Thus, Method I probably uses less motion and therefore less time.

CHOPPING--Cabbage was chopped for plain cabbage salad so that this method of preparation might be compared with shredding. See Figure 24. It was found that the time for chopping one bushel of cabbage varied from 5.00 minutes to 9.82 minutes, the average time was 7.03 minutes and the allowed time 8.0850 minutes. This time is actually 9.6150 minutes when the 1.53 minutes required to assemble and disassemble the chopper are added. See Table 10. This is still much less than the time allowed for shredding cabbage.

SHREDDING BY MACHINE--The shredding was done on the power driven machine, Figure 26, the hand operated machine, Figure 25, and by hand. The time allowed for the power driven machine is 13.1340 minutes, or 2.5779 minutes less than the 14.7368 minutes allowed when the hand operated machine is

used. The time for the power driven machine varies from 8.53 minutes to 12.54 minutes, or over a range of 4.01 minutes, which is .34 minutes less than the range from 10.65 minutes to 15.00 minutes of the time required for the hand operated machine. This is due to the constant drive of a power machine as compared to the varied drive of the human hand.

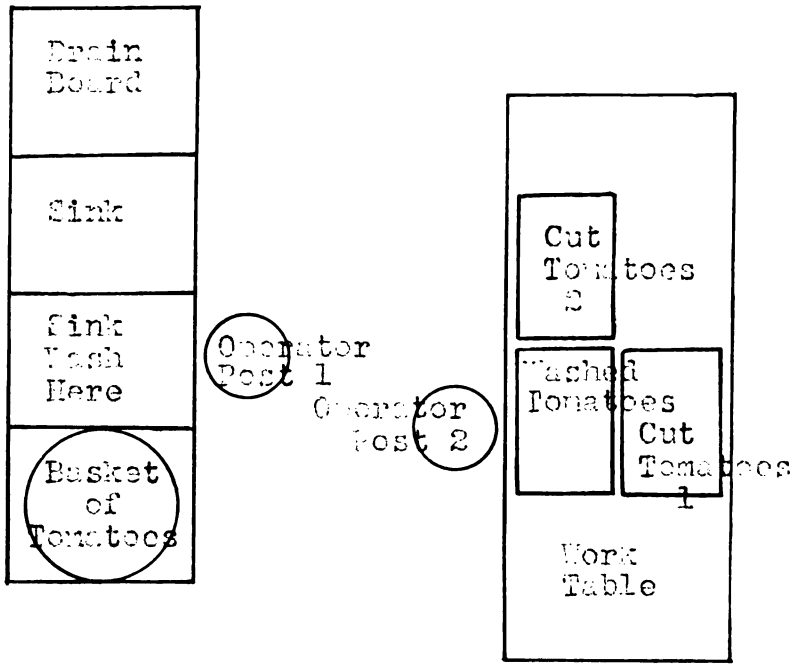
SHREDDING BY HAND--The average weight of a bushel of cabbage after it is cleaned and sectioned ready for shredding is thirty-nine pounds, Table 10. That is the average amount of cabbage shredded in the time allowed for one bushel. The time required to assemble and disassemble the power machine is 1.96 minutes, Table 10, and to assemble and disassemble the hand operated machine is 2.19 minutes, Table 10. These figures must be added to the allowed time for shredding, increasing it to 13.0940 minutes for the power driven machine and to 16.9168 minutes for the hand operated machine. When shredded by hand, eight pounds two ounces can be shredded in ten minutes. See Table 11. Therefore, if thirty-nine pounds can be shredded in 13.0940 minutes on the power driven machine and only eight pounds two ounces can be shredded by hand in ten minutes, or only 3.0940 minutes less, it would seem to pay to assemble the power driven machine for ten pounds of cabbage or more and the hand operated machine for twelve pounds or more.

6. Tomatoes

WASHING AND REMOVING BAD SPOTS--The studies made on

WASHING TOMATOES AND REMOVING BAD SPOTS

METHOD I



LEFT

Fill sink and dump in tomatoes. Put basket under sink and tray on drain board. Wash tomatoes and fill one tray. Lift to table.

1. Pick up tomato
2. Turn tomato over

RIGHT

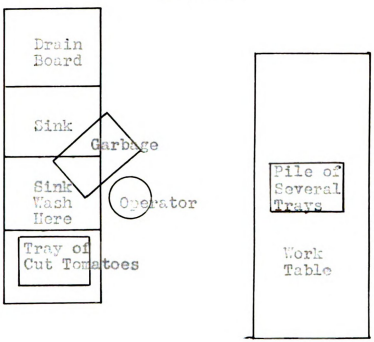
1. Cut off stem end
2. Cut off blossom end and put on tray of cut tomatoes 1 or 2

Wash another tray of tomatoes and repeat. Repeat twice more. About one peck is put on each tray.

FIGURE 27

WASHING TOMATOES AND REMOVING BAD SPOTS

METHOD II

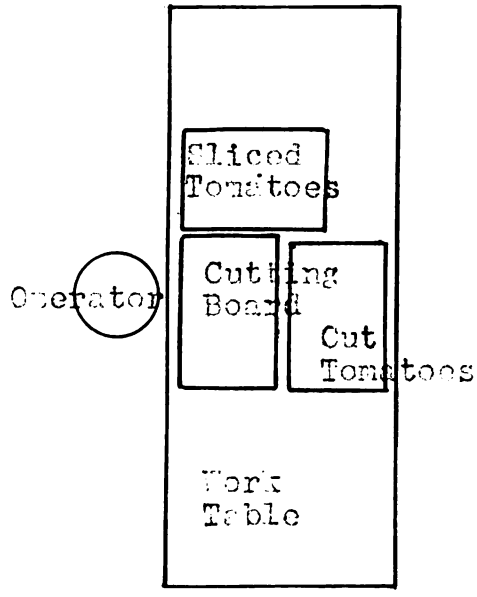


LEFT	RIGHT
1. Pick up tomato	1. Cut off stem and blossom ends
2. Put tomato on tray on drain board	2. Rest

When tray is full use both hands to transfer to table and get another tray from the pile on the table.

FIGURE 8B

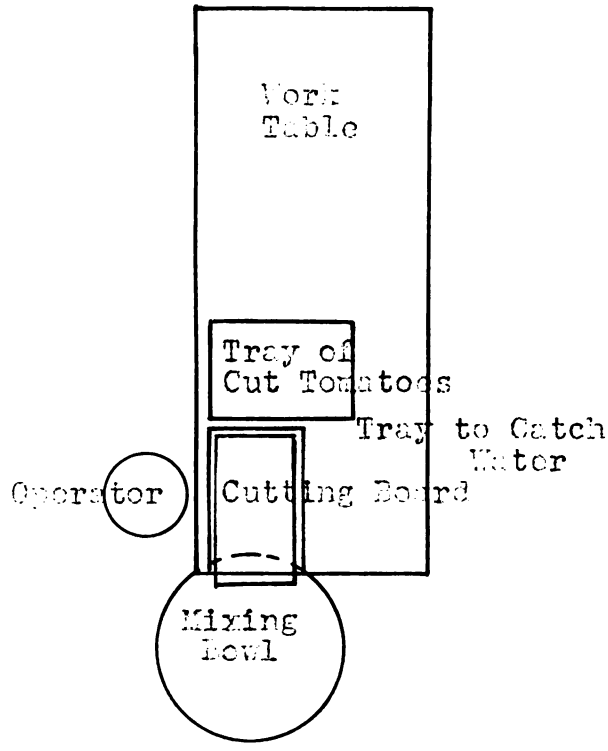
SLICING TOMATOES



LEFT	RIGHT
1. Pick up tomato and steady on board	1. Hold knife and slice tomato
2. Pile up slices	2. Slide knife blade under slices
3. Lift to tray	3. Lift to tray

FIGURE 29

DICING TOMATOES



HAND	KNIFE
1. Pick up tomato	1. Knife in hand
2. Hold firmly on cutting board	2. Cut lengthwise and crosswise 3 or 4 times
3. Begin to reach for tomato	3. Using blade of knife, slide tomato into mixing bowl

Repeat operation until all are done

FIGURE 30

QUANTITY STUDIED IS SHOWN IN EACH COLUMN	OPERATION TIME IN MINUTES						
	Washing and Cutting off Bad Spots on 1 Bushel		Slicing 1 Bushel	Setting Up Slices from ½ Bushel	Setting Up Slices on 256 Plates	Washing and Removing Bad Spots & Method II	Dicing &
	Method I	Method II					
	24.15	15.45	37.23	19.36	29.90	3.45	7.55
	24.00	17.33	36.64	18.40	31.01	3.62	9.30
	29.09	22.16	38.15	17.80	27.90	4.52	8.32
	26.63	18.86	34.40	18.70	29.10	4.36	7.98
	24.73		37.73	19.60	32.17	4.70	8.30
	25.96		39.15	18.60	25.46	3.60	9.22
	23.42		30.89	17.13	28.80	2.70	7.20
	24.10		41.50	14.50	30.42	3.00	6.75
	28.30		31.61			3.48	8.06
			38.00			3.58	7.31
			32.50				
			35.50				
			31.70				
Total Time	230.38		349.63	138.09	224.76	36.85	79.99
No. Observ.	9		10	8	8	10	10
Avg. Time	25.59		34.96	17.24	28.09	3.68	7.99
Min. Time	23.42		30.89	18.60	20.42	2.70	6.75
Max. Time	29.09		39.15	19.60	32.17	4.70	9.30
Rating	C1-C1-C-C						
Level Fct.	1.14		1.14	1.14	1.14	1.14	1.14
Std. Time	29.1726		39.8544	19.6536	32.0286	4.1958	9.1086
Allowance	.0208		.0208	.0208	.0208	.0208	.0208
Allow. Time	29.1934		39.8752	19.6744	32.0494	4.2160	9.1294

TABLE 8

tomatoes are not numerous enough to be significant, but they show some interesting facts. There are not enough data for Method II as shown in Figure 28 for washing and cutting off the bad spots to determine a time to be allowed, but the allowed time would probably be less than it is for Method I, as shown in Figure 27. The figures in column 1 of Table 8 range from 23.43 minutes to 29.09 minutes, while three of the four figures in column 2 are between 15.45 minutes and 18.26 minutes. The fourth one is only 33.16 minutes. This would indicate that such a conclusion might be drawn. Using Method I for only eight pounds of tomatoes, the time ranges from 2.70 minutes to 4.70 minutes, the allowed time being 4.2160 minutes.

	.93	Total Time	6.99
	.96	No. Observations	8
Arrange	.87	Average Time	.87
Tomato	.91	Minimum Time	.62
Slices on	1.00	Maximum Time	1.00
1 Tray of	.79	Rating	C1-C1-C-C
4 Plates	.90	Leveling Factor	1.14
	.63	Standard Time	.9918
		Allowance	.2198
		Allowed Time	1.0126

TABLE 9

DICING--When eight pounds of tomatoes are cut up for a tossed vegetable salad, as shown in Figure 30, the time to be allowed is 9.1894 minutes. The range from minimum to maximum is 2.55 minutes, or from 6.75 to 9.30 minutes.

SLICING--When one bushel of tomatoes is sliced, as

shown in Figure 29, the allowed time is 39.8752 minutes, but the range from minimum to maximum is 8.26 minutes. When slices from one-half bushel are arranged on the garnished plates, the allowed time is 19.6744 minutes. The range is from 18.60 minutes to 19.60 minutes. The entire 856 plates can be arranged with tomato slices in 38.0434 minutes, or 7.3054 minutes less than twice the time required for one-half bushel. Since 1.0186 minutes need to be allowed to arrange tomato slices on one tray of eight plates, as shown in Table 9, 7.93 trays or 63.44 plates of sliced tomatoes could be obtained from one bushel of tomatoes. This would indicate that 319 sliced tomato salads could be made from one bushel of tomatoes in 38.3468 minutes.

C. Methods of assembling salads under certain conditions

Three methods of assembling the 856 salads normally prepared in the residence hall where the study was made are presented. These are listed as Method A, Method B, and Method C. The same type of garnish was used in all of the studies. The time required to tear the leaf lettuce to the proper size and put it on the plates varied from 18.00 minutes minimum to 33.45 minutes maximum, or over a range of 11.45 minutes. See Tables 13, 14, and 15. The time allowed for the complete operation is 33.5407 minutes. The cart on which the full trays of salad were placed, ready for storing in the refrigerator, was in the same position for all three methods. The average time required to lift one tray from the table to the cart is .1000 minutes. The figures in

ASSEMBLING AND DISASSEMBLING TIME FOR EQUIPMENT USED

	OPERATION TIME IN MINUTES											
	Hand Slicer			Power Slicer			Chopper			Gricer		
	Assemble	Disassemble	Total	Assemble	Disassemble	Total	Assemble	Disassemble, Empty	Total	Assemble	Disassemble	Total
	1.40	1.20	2.60	1.20	.60	1.80	.40	.69	1.09	.25	.21	.46
	.93	1.00	1.93	1.15	.63	1.78	1.10	1.10	2.20	.25	.25	.50
	1.22	.80	2.02	1.97	.45	2.42	.50	.80	1.30	.35	.25	.60
	1.00	1.40	2.40	1.50	.68	2.18	.90	.92	1.48	.49	.21	.70
	1.43	1.20	2.63	1.65	.70	2.35	.50	.98	1.82	.40	.13	.53
	1.10	1.40	2.50	1.15	.72	1.87	.45	.60	1.05	.44	.15	.59
	1.36	1.20	2.56	.85	.75	1.60	.40	.75	1.15	.27	.13	.40
	1.00	1.00	2.00	1.10	.64	1.74	.35	.75	1.10	.28	.24	.52
	.73	1.00	1.73	.80	.50	1.30	.40	.75	1.15	.39	.19	.58
	1.00	1.00	2.00	1.20	.60	1.80	.30	.75	1.05	.31	.18	.49
	.86	1.00	1.86	1.75	1.00	2.75	.40	.75	1.15	.29	.16	.45
Total Time	12.02	12.20	24.23	14.32	7.27	21.59	5.70	8.84	14.54	3.72	2.10	5.82
No. Observations	11	11	11	11	11	11	11	11	11	11	11	11
Average Time	1.09	1.10	2.19	1.30	.66	1.96	.51	.83	1.34	.33	.19	.52
Minimum Time	.73	.80	1.73	.85	.45	1.30	.40	.60	1.09	.25	.13	.40
Maximum Time	1.43	1.40	2.63	1.97	1.00	2.97	1.10	1.10	2.20	.49	.25	.70

TABLE 10

QUANTITY CUT BY HAND
IN EQUIVALENT MACHINE CUTTING TIME

	Shredding Cabbage 10 min.	Slicing Carrots 2 min.	Cutting Celery 2 min.	Dicing Head Lettuce 12 min.
	8# 7oz	2#	2# 2oz	13 Hds
	8# 4oz	2# 4oz	2# 4oz	13 Hds
	7# 15oz	2# 8oz	2#	13 Hds
	7# 4oz	2#	2# 4oz	13 Hds
	8# 2oz	2# 4oz	2#	13 Hds
	8#	2#	2#	13 Hds
	7# 8oz	2#	1#	13 Hds
	7#	1# 12oz	1# 4oz	13 Hds
	7#	2# 8oz	2#	13 Hds
		2# 8oz	1# 4oz	13 Hds
		2# 4oz	1#	
		2# 8oz	1# 12oz	
		2# 8oz	1# 4oz	
		2# 4oz	1# 8oz	
		2# 8oz		
Total Weight	69# 5oz	33# 12oz	24# 7oz	130 Hds
No. Observations	9	15	14	10
Average Weight	8# 2oz	2# 4oz	1# 8oz	13 Hds
Minimum Weight	7#	1# 12oz	1#	13 Hds
Maximum Weight	8# 7oz	2# 8oz	2# 4oz	13 Hds

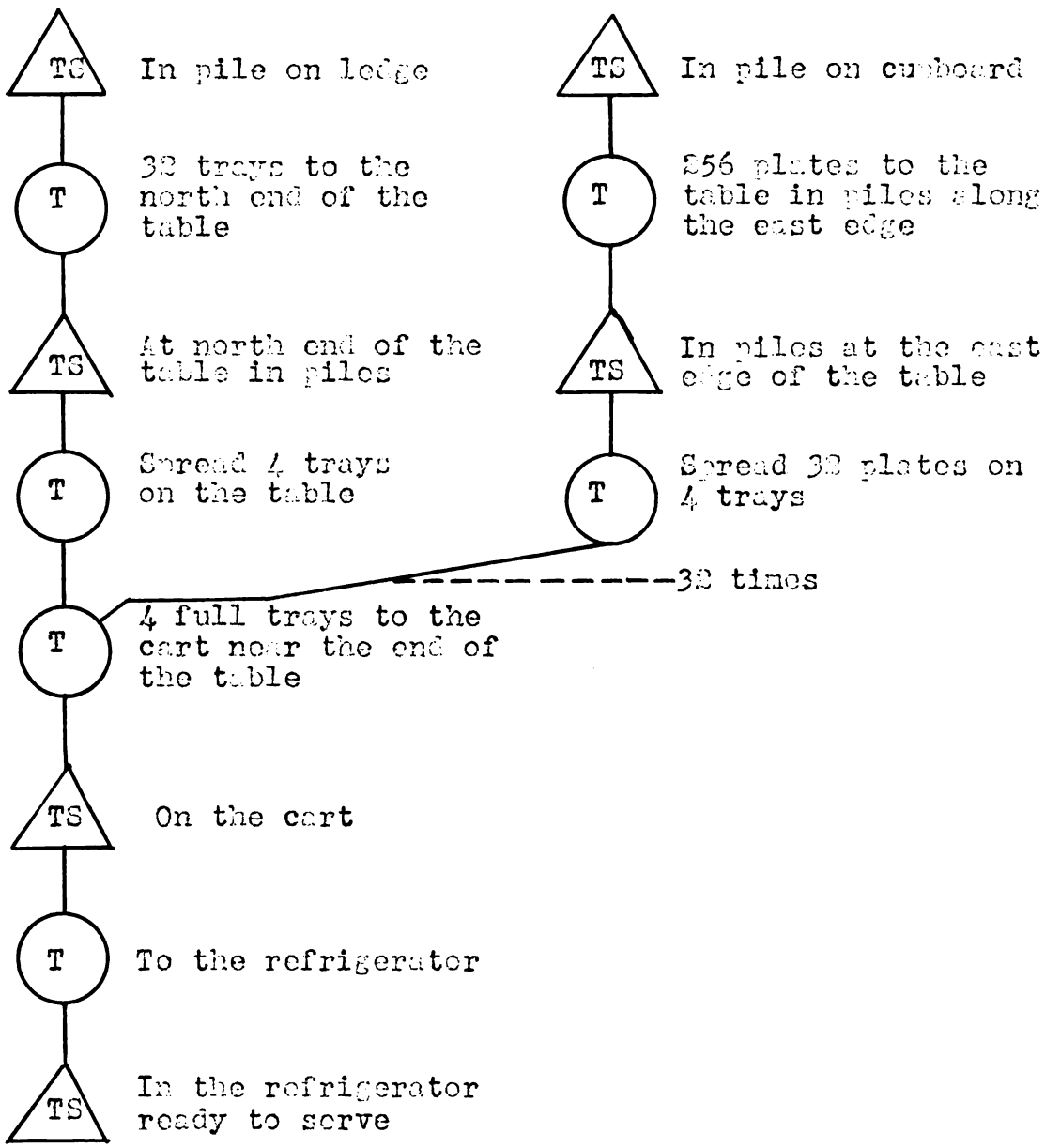
TABLE 11

PREPARATION LOSSES

	WEIGHTS IN POUNDS AND OUNCES					
	Cabbage		Carrots		Celery	
	Before Bushel is Cleaned	After Bushel is Cleaned	After Peeled, Before Ends Cut Off	After Ends Cut Off	Before Cleaned and Washed	After Cleaned and Washed
	45#	36#	5#	4# 8oz	10#	5# 12oz
	50#	40#	5#	4# 4oz	10#	5# 12oz
	54#	35#	5#	4# 12oz	10#	6#
	50#	40#	5#	4# 12oz	10#	6#
	51#	45#	5#	4# 12oz	10#	6# 4oz
	54#	42#	5#	4# 8oz	10#	6#
	50#	44#	5#	4# 12oz	10#	6# 4oz
	52#	45#	5#	4# 12oz	10#	6# 4oz
	54#	33#	5#	4# 12oz	10#	5# 12oz
	50#	40#	5#	4# 12oz	10#	6# 12oz
	53#	33#			10#	6#
					10#	6# 8oz
					10#	6# 12oz
Total Wt.	563#	433#	50#	45# 12oz	130#	80# 4oz
No. Observ.	11	11	10	10	13	13
Avg. Wt.	51#	39#	5#	4# 10oz	10#	6# 8oz
Min. Wt.	45#	33#	5#	4# 4oz	10#	5# 12oz
Max. Wt.	54#	45#	5#	4# 12oz	10#	6# 12oz
Avg. Loss	12#		6oz		3# 8oz	

TABLE 12

PROCESS CHART OF ASSEMBLY METHOD A



Note: Only 4 trays are taken to the refrigerator at one time. This operation is repeated 8 times to complete 256 salads.

FIGURE 31

ASSEMBLY METHOD A

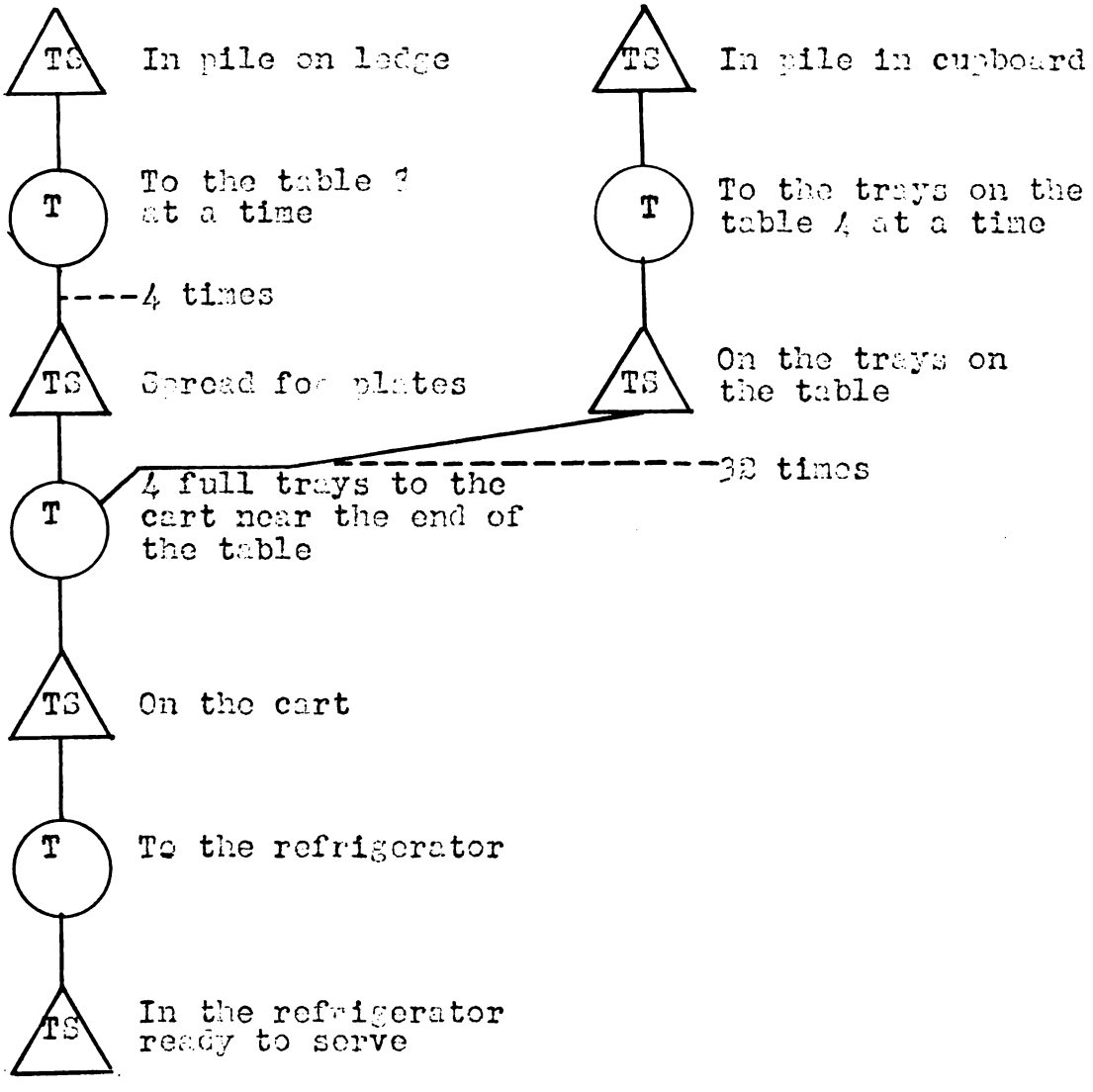
QUANTITY STUDIED 256 SALADS OR 32 TRAYS	OPERATION TIME IN MINUTES						
	Lifting Trays from Ledge to Table	Lifting Plates from Cupboard to Table	Spreading Trays and Plates	Total of First 3 Operations	Garnishing Plates Leaf Lettuce	Putting Trays on Cart	Taking Trays to Refrigerator and Storing
	.21	2.52	6.70	9.43	17.11	2.56	11.13
	.22	1.57	6.10	7.89	13.92	3.04	10.25
	.19	2.56	6.45	9.20	12.00	2.96	10.79
	.25	1.19	6.01	7.45	15.10	3.10	10.82
	.22	2.50	6.21	9.53	11.82	4.00	9.05
	.20	2.05	6.27	8.52	13.73	3.63	9.48
	.18	2.25	6.80	9.23	13.18	3.28	10.65
	.25	2.33	6.25	8.83	13.57	3.33	9.63
	.19	2.20	5.82	8.21	21.67	2.85	8.17
	.30	2.23	6.42	9.00	20.21	2.63	7.78
	.20	1.80	5.59	7.39	20.92	2.89	11.21
	.22	2.05	6.20	8.47	23.37	2.89	11.28
					19.25	3.40	9.10
					23.45	3.45	10.00
					18.80	4.07	
					20.21	2.50	
					24.46	3.32	
					20.81	4.05	
					22.84	4.00	
					19.25	3.07	
Total Time	2.63	25.30	75.42	103.15	324.71	66.04	132.26
No. Observ.	12	12	12	12	18	20	13
Avg. Time	.21	2.10	6.28	8.59	18.00	3.32	10.17
Min. Time	.12	1.19	5.59	7.39	12.00	2.56	9.05
Max. Time	.30	2.52	6.81	9.53	23.45	4.07	11.98
Rating	C1-C1-C-C						
Level. Fct.	1.14	1.14	1.14	1.14	1.14	1.14	1.14
Std. Time	.2394	2.3941	7.1592	9.7926	20.5800	3.7848	11.5938
Allowance	.0208	.0208	.0208	.0208	.0208	.0208	.0208
Allow. Time	.2602	2.4148	7.1800	9.8134	20.5408	3.8056	11.6148

TABLE 13

Tables 13, 14, and 15 vary from 3.56 minutes to 4.07 minutes. The allowed time for the complete operation or for thirty-two trays is 3.6056 minutes. See Tables 13, 14, and 15.

METHOD A--This has been shown to be the quickest method though not always, perhaps, the most efficient. The total allowed time is 45.7746 minutes. The plates are set up on the trays by a series of three operations. The total time allowed for the process is 9.6134 minutes, Table 13. It is easier to set up the trays and plates by this method because there is less chance for them to slide off the table and because only four trays are set up with plates at one time. This eliminates the element of fatigue in setting up 256 plates at one time. On the other hand, if a frozen salad is on the menu and has to be put up as rapidly as possible, it is not desirable to use this method. Either of the others would be better because if all the plates are set up at once, there is no waiting to set up plates after every thirty-two salads. Also if, for some reason, the operator has to wait for material to make her salads she could set her plates up according to Method B or C and thus use several minutes that might otherwise be wasted. Method A allows 11.6934 minutes to take the salads to the refrigerator and store them, or 1.0730 minutes less than Method C. It requires twice as many trips to the refrigerator as Method C, thus requiring more effort in walking, but actually taking less time.

PROCESS CHART OF ASSEMBLY METHOD 2



Note: Only 4 trays are taken to the refrigerator at one time. This operation is repeated 8 times to complete 256 salads.

FIGURE 32

ASSEMBLY METHOD B

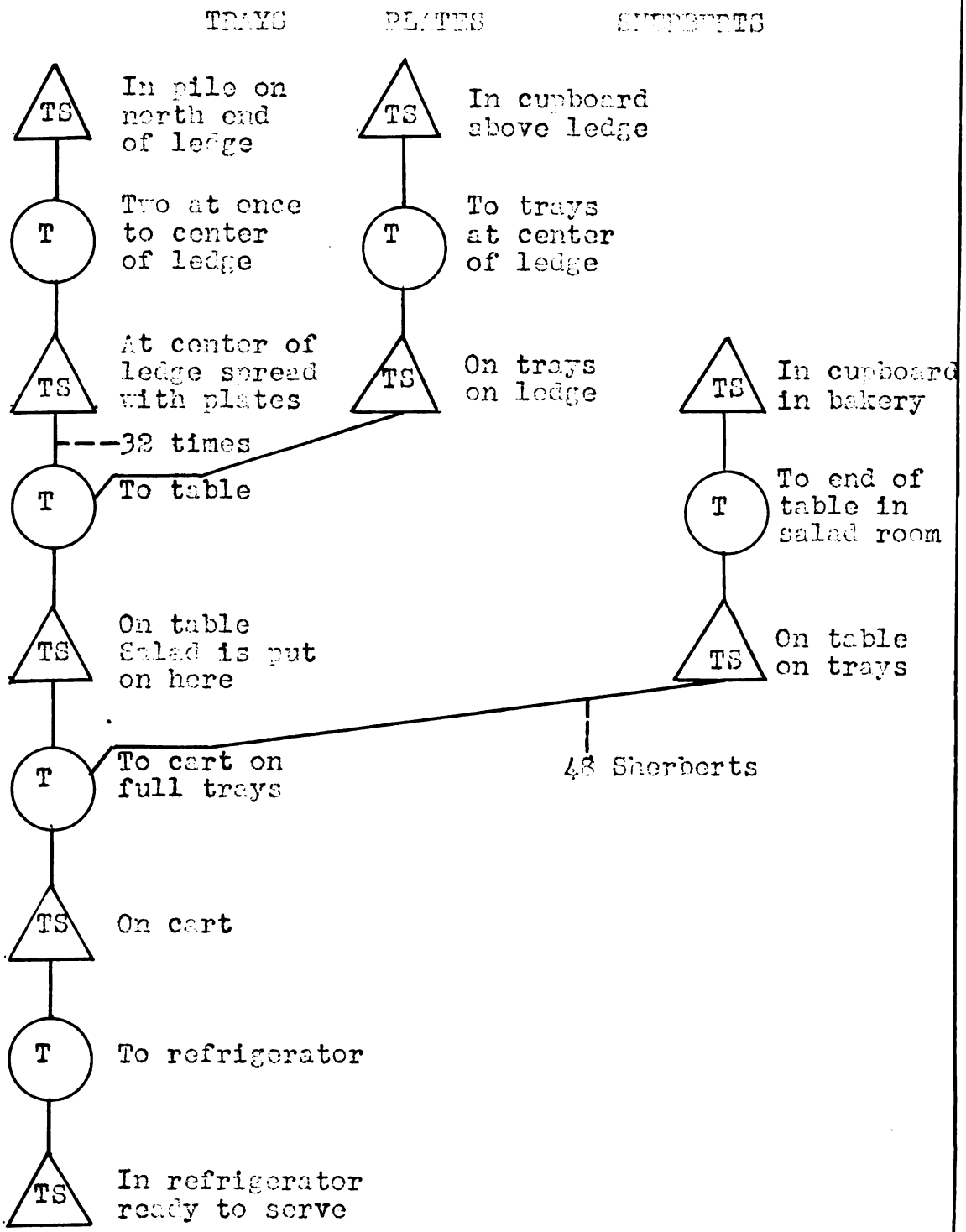
QUANTITY STUDIED 256 SALADS or 32 TRAYS	OPERATION TIME IN MINUTES			
	Setting Up plates and trays on Table	Garnishing Plates with Leaf Lettuce	Putting Trays on Cart	Taking Trays to Refrigerator and Storing
	9.82	14.11	2.56	11.13
	10.21	13.93	3.04	10.25
	11.01	12.00	3.93	10.79
	10.10	15.10	3.10	10.82
	7.84	11.83	4.00	9.05
	9.30	12.73	3.63	9.48
	8.00	13.12	3.08	10.65
	8.40	13.57	3.33	9.63
	7.63	21.67	2.85	8.17
	7.85	20.21	2.63	7.75
	8.60	20.93	2.89	11.21
	8.58	23.37	2.89	11.98
		19.82	3.40	9.10
		23.45	3.45	10.00
		18.80	4.07	
		20.21	3.50	
		24.40	3.32	
		20.21	4.05	
		22.84	4.00	
		19.85	3.07	
Total Time	106.68	324.71	66.04	132.36
No. Observations	12	16	20	13
Average Time	8.89	18.00	3.32	10.17
Minimum Time	7.63	12.00	2.56	9.05
Maximum Time	11.01	23.45	4.07	11.98
Rating	C1-C1-C-C			
Leveling Factor	1.14	1.14	1.14	1.14
Standard Time	10.1346	20.5200	3.7848	11.5928
Allowance	.0208	.0208	.0208	.0208
Allowed Time	10.1554	20.5408	3.8056	11.6146

TABLE 14

METHOD B--This, according to theory, should be the best method. Industrial engineers usually advocate the completion of one process before going on to the next as the most efficient method of doing a piece of work. In the assembling of salads this, so far, has not been proven true. The total allowed time for this method is 46.1166 minutes. It required 10.1554 minutes, Table 14, to set up the plates on the trays by this method, or .3480 minutes more than Method A and .2855 minutes more than Method C. This method is more difficult because the plates and trays slip around too easily, because the operator has to turn a great many more times, as she can take only eight plates from the cupboard at a time and because it is difficult for the average person to reach across the table when the trays are piled two or three high. When all the plates and trays are set up on the table there is no space left where the salad material may be placed in order that both hands may be used in putting it on the plates. Method B is the same as Method A in storing salads in the refrigerator.

METHOD C--This method has few particular advantages since the total allowed time is 46.9688 minutes. The plates can be put on the trays in spare minutes, setting some on the table and leaving some on the ledge. In this way the plates are all ready for salad ahead of time and there is still about 50% of the work space left on the table. It requires more handling of the trays than Method A or B, but does not take as long a time as Method B. Method C allows

PROCESS CHART OF ASSEMBLY METHOD C



Note: This method requires only 4 trips to the refrigerator.

FIGURE 33

ASSEMBLY METHOD C

QUANTITY STUFFED 256 SHANKS OR 32 TRAYS	OPERATION TIME IN MINUTES					
	Setting up Plates on Trays, Transferring to Table	Garnishing Plates with Leaf Lettuce	Putting Trays on Cart	Getting Chickens, Putting on Trays at [illegible]	Taking Trays to Refrigerator and Storing	Total for Chickens and Storing
	8.37	14.11	3.56	4.05	7.45	11.50
	8.76	13.93	3.04	6.00	9.05	15.04
	9.50	13.00	3.98	8.70	13.55	15.25
	9.40	15.10	3.10	2.50	9.00	11.50
	8.58	11.33	4.00	[illegible]	9.55	12.83
	9.50	13.73	3.63	2.10	8.50	10.60
	8.78	13.13	3.38	2.85	8.85	11.70
	7.75	13.55	3.33	2.50	7.40	10.90
	8.00	11.67	3.85	2.73	7.50	10.23
	8.35	20.21	2.63	2.63	7.54	10.17
	8.56	20.93	2.99	3.95	8.30	12.25
	8.35	13.37	2.99	2.35	7.20	9.53
		19.23	3.40	3.30	7.65	10.95
		23.45	3.45	3.38	7.38	11.20
		14.80	4.07			
		20.21	3.50			
		24.48	3.33			
		20.21	4.05			
		13.84	4.00			
		19.25	3.07			
Total Time	103.78	384.71	66.04	40.33	105.72	134.17
No. Observ.	12	18	20	13	13	12
Avg. Time	8.64	13.00	3.33	3.07	8.13	11.11
Min. Time	7.75	13.00	3.56	2.10	7.38	10.17
Max. Time	9.50	23.45	4.07	4.05	9.05	12.83
Rating	C1-C1-C-C					
Level Fct.	1.14	1.14	1.14	1.14	1.14	1.14
Std. Time	9.8496	30.5820	3.7848	3.4998	9.8682	12.7458
Allowance	.0984	.3058	.0378	.0350	.0986	.1274
Allow. Time	9.9480	30.8878	3.8226	3.5348	9.9668	12.8732

TABLE 15

9.8704 minutes, Table 15, for setting up the plates and trays. This is .2855 minutes less than Method B and .0565 minutes more than Method A. In storing the completed salads in the refrigerator sherbert glasses are used to separate the trays of salad on the cart so that eight trays are taken to the refrigerator at one time instead of four as in Method A and Method B. The stacking by use of sherbert glasses is done by placing three glasses on each tray between the plates. They are so placed that they provide three surfaces at one level on which to place a second tray. In this manner another tray of salads may be put on top of the first without disarranging the salads on the first tray. Taking eight trays to the refrigerator at one time in this manner requires only 1.2890 minutes, or 2.4040 minutes less than the time required for Methods A and B. But, the handling of the sherbert glasses requires 9.5206 minutes so that the total time for storing in Method C is 12.7660 minutes, or 1.0730 minutes more than Method A and Method B.

While each method has its own advantages and disadvantages, Method A is the quickest and Method B requires the least motion.

V. DISCUSSION

This report deals largely with the preparation of vegetables for a tossed vegetable salad. The vegetables studied are not the only ones ever used in such a salad but are the most commonly used ones in the residence hall where the studies were made. They were not purchased especially for study purposes, but were taken from the regular stock of vegetables as delivered twice a week. This was to insure getting stock for study purposes which was comparable to that used in daily salad preparation. The stop watch method of study was used and only the overall time was taken since the time necessary to do the complete job was the objective. For more detailed study other motion cycles could be substituted. The elements timed could be shortened or micromotion could be used.

Though the purpose of the studies presented was to show how long it takes to prepare these vegetables in several different ways within one working situation, how long it takes to assemble the prepared vegetables into salads ready to serve, and how to fit the time required into the time available for the job, the results show one way to be better than another, but still are not complete or comprehensive enough to arrive at "the one best way" for doing the job. In order to do this a great many more studied would have to be made and it would be desirable to use micromotion.

Hand preparation has been compared with machine preparation. In every case hand preparation required more time

and usually resulted in greater fatigue. It gave a much more pleasing salad in appearance than machine preparation, but not always a more palatable one. Lettuce when prepared by hand is not bruised and "chewed" in appearance. The strings in hand cut celery are not so noticeable. When cut by hand the knife used is sharper and more care is taken to cut all the celery strings and not to bruise the head lettuce. Since these two vegetables comprise the bulk of the salad they are the deciding factors in appearance. Tomatoes, because of their composition, are nearly always prepared by hand for salad purposes.

Machine preparation required less time for all vegetables studied, but did not always result in less fatigue for the operator. A power driven machine is less tiring than hand preparation or operating the hand machine. However, operation of the hand machine is more tiring than any other method. This is due to the fact that both hands have to move and each moves with a different kind of motion. The left hand pushes horizontally across the body while the right hand using a rotary motion to and from the body furnishes the power that turns the knife. Carrots and cabbage really have a better appearance when mechanically prepared. They are more sturdy vegetables and retain their crispness when griced, shredded or sliced. Mechanical preparation, however, is limited to rather large quantities. Three heads of lettuce can be cut by hand in the time required to assemble and disassemble the machine on which to do the cut-

ting: so if only three beets are to be cut no time would be saved by using the machine. Twenty-five pounds of carrots can be peeled in a mechanical peeler in only .1632 minutes more than the time required to peel 5½ pounds and in 6.5350 minutes less than 5½ pounds can be peeled by hand. Two pounds four ounces of carrots can be hand sliced in .19 minutes less than the time required to assemble and disassemble the hand slicer and in only .04 minutes more than the time required to assemble and disassemble the power slicer. This would seem to indicate that if less than two pounds are to be sliced, hand slicing would be preferred for speed. Celery can be cut by hand at the rate of one to two pounds in two minutes which is .19 minutes less than the time required to assemble and disassemble the hand operated machine and only .04 minutes more than the time required to assemble and disassemble the power machine. Therefore, unless more than two pounds of celery are to be prepared, hand cutting would be just as fast. Eight pounds two ounces of cabbage can be shredded by hand in ten minutes or one pound twelve ounces in the time required to assemble and disassemble the hand operated machine and one and one-half pounds in the time required to assemble and disassemble the power machine. If less than these amounts are to be shredded it would not pay to use the machine. These figures would seem to indicate that up to a very small quantity it would not pay, in time, to use the mechanical equipment provided for these purposes.

VI. CONCLUSION

The results of these studies show that under the working conditions existing in the residence hall where the studies were made the time which should be allowed for the preparation of certain salad materials varies with the method of preparation used and the amount to be prepared. This is the first report of time and motion studies carried out under this working situation and it is far from complete. However, it does show the amount of time the average worker would need to prepare the vegetables studied in several different ways and compares mechanical preparation with hand preparation.

A. Preparation of vegetables

Given a definite amount of time in which to prepare a tossed vegetable salad, the time for the preparation of each vegetable could be taken from the tables and added together to give the total time which would be needed for the salad. If these exceed the time available, methods requiring less time could be substituted or another salad could be used on the menu.

TOSSED SALAD--In other words, if an hour and three-quarters are available to prepare vegetables for 256 salads, they could be prepared according to Chart 2. This makes a very lovely fresh appearing salad. If, on the other hand, only an hour and a half is available, the method of preparation shown in Chart 3 could be used. Since machine cut

vegetables look more "chewed" than hand cut ones, this does not make as fresh or crisp a salad as when more time is

Wash and remove outside leaves of head lettuce using Method I	10.6508
Cut head lettuce by hand	11.8333
Peel carrots by hand	10.1316
Cut ends from peeled carrots	4.1604
Grice carrots	5.3333
Strip and clean celery using Method II	30,9740
Cut celery by hand	13.5666
Wash and clean tomatoes	4.3160
Dice tomatoes	2.1194
Total preparation time	92.1509

CHART 2

spent in preparation of the vegetables, but it is crisp and all the flavor and food value are there.

These are just two examples. Any combination of preparation methods and of materials might be used in order to fit the preparation time into the working time available.

Wash and remove outside leaves of head lettuce using Method II	9.4030
Cut head lettuce on hand operated machine	11.7133
Machine peel carrots	3.2704
Cut ends from peeled carrots	4.1604
Slice carrots on power machine	3.3133
Strip and clean celery using Method I	18.7490
Cut celery on power machine	4.3303
Wash and clean tomatoes	4.3160
Dice tomatoes	2.1194
Total preparation time	65.5771

CHART 3

Cabbage has not been included in the salad used as an example. It could be used in addition to the materials mentioned or could be substituted for head lettuce or celery and the time changed accordingly.

HEAD LETTUCE SALAD--There are several plain salads

that could be used if not enough time is available for a tossed salad or if all the material is not on hand. It only takes 9.4039 minutes to wash and remove the outside leaves of head lettuce and 38.9746 minutes to cut it in wedges and put the wedges on the plates. This makes a total of 48.3776 minutes to prepare lettuce for a plain head lettuce salad.

CABBAGE SALAD--For a chopped cabbage salad about two bushel of cabbage would be needed for the 256 portions normally prepared in the residence hall where the study was done. The time required to prepare this would be as follows:

Clean and section using Method I	8.9356 x 2 -	17.8712
Chop	8.0350 x 2 -	16.0700
Total		33.9412

Shredded cabbage in the form of cole slaw could be prepared in 42.1398 minutes as follows:

Clean and cut in sections using Method I	8.9356 x 2 -	17.8712
Shred on power machine	12.1343 x 2 -	24.2686
Total		42.1398

CARROT SALAD--One and a half bushel of carrots are needed for a plain chopped carrot salad. This could be prepared as follows:

Peel ½ bushel in mechanical peeler	4.0536 x 3 -	12.1608
Cut off ends and wash	4.1604 x 14-	58.2456
Chop	1.5033 x 14-	21.0462
Total		91.4446

SLICED TOMATO SALAD--For a sliced tomato salad a little less than a bushel of tomatoes are needed for this same number of salads. However, it would take 89.1934 minutes to

wash a bushel and cut off the bad spots and 39.8758 minutes to slice them; so that the total time to prepare tomatoes for a sliced tomato salad would be 69.0626 minutes*.

B. Assembly of salads

The time used to assemble the plates and trays, put the salad on the plates and store them in the refrigerator has to be added to the preparation time to show the amount of time needed for the complete process. That is, from the time the stock is brought from the store room until the salads are in the refrigerator ready to serve.

TOSSED VEGETABLE SALAD--For a tossed vegetable salad 99.1930 minutes are needed to prepare the vegetables, 21.5638** minutes to put the salad on the garnished plates and 45.7746 minutes for assembly. This makes a total of 166.5414 minutes, or about two hours and forty-five minutes, to get the salad ready for the table.

HEAD LETTUCE SALAD--A plain head lettuce salad can be ready to serve in 94.1522 minutes, or about an hour and a half, since 43.3776 minutes are needed to prepare the lettuce and 45.7746 minutes for assembly. A shredded cabbage salad requires 42.1398 minutes to prepare the cabbage, 21.5638** minutes to put it on the plates, and 45.7746 minutes for

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*These figures are not taken from a large enough sample to be significant. This time is for 319 salads.

**19.30
19.83
19.36
18.57
17.75
94.60

$\frac{94.60}{5}$ = 18.92 x 1.14 = 21.5638

assembly, or a total of 109.4826 minutes which is about an hour and fifty minutes.

CABBAGE SALAD--For a chopped cabbage salad only 38.9412 minutes need to be allowed for preparing the cabbage. This makes a total of 101.8346 minutes, or about ten minutes less than for shredded cabbage.

CARROT SALAD--A chopped carrot salad has to have 158.7690 minutes or two hours and forty minutes allowed for its preparation, 91.4456 minutes to prepare the carrots, 21.5688 minutes to put it on the plates and 45.7746 minutes for assembly.

SLICED TOMATO SALAD--Sliced tomato salad can be prepared allowing 69.0666 minutes to prepare tomatoes plus 45.7746 minutes to assemble, or a total of 114.8432 minutes which is one hour and fifty minutes.

C. Assembly methods

These totals have all been computed using Assembly Method A. In assembling the salads the method used will probably be Method A. since it requires the least time, but if fatigue is a more important element than time, Method C would be used. This method requires fewer trips to the refrigerator but takes 1.2082 minutes longer than Method A and .8662 minutes longer than Method B. Knowing the time needed for the complete operation can be of great help to the menu maker. Two salads requiring the greatest amount of time would probably not be used on one day's menu.

VII. SUMMARY

1. The work area provided seems to be satisfactory for the number of salads prepared.

2. Neatness is an important factor in salad preparation. A cluttered preparation area makes for much lost time and many lost motions.

3. The preparation time for any vegetable studied varies with the quality and cleanliness of the vegetable.

4. The preparation time can be changed by rearranging the equipment used in order to change the number of motions used.

5. The preparation time for one vegetable may be more or less than for an equal quantity of another.

6. Machine preparation is not always preferred to hand preparation and vice versa. The composition of the vegetable is one of the factors to consider in deciding which is to be used.

7. If the quantity to be prepared is small, it is sometimes just as fast to do the work by hand.

8. One activity through to completion, or as far as space allows, as advocated by most industrial engineers, has not proved to be true in putting the plates on the trays.

9. The time required for assembling the salads varies with the number and kind of motions used. The method using the least number of motions is not necessarily the quickest.

10. When a definite amount of time is available to pre-

pare vegetables for a tossed vegetable salad, the time for the preparation of each can be taken from the tables and be added together to fit the time available.

11. The amount of time needed for the complete preparation process for 396 salads is about two hours and forty-five minutes for a tossed vegetable salad, one hour and thirty minutes for head lettuce and shredded cabbage salad, one hour and twenty minutes for chopped cabbage, two hours and forty minutes for chopped carrot salad and about one hour and fifty minutes for sliced tomato salad.

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