Labor Utilization in Picking Pears

R. D. Langmo

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Agricultural Experiment Station, Oregon State University, Corvallis

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Introduction

Harvesting is the most costly annual operation in the production of pears. It has remained unchanged for a number of years while other orchard activities have changed materially through substitution of equipment and new technologies for labor. Advancing efficiency in other operations undoubtedly has stimulated interest to improve picking practices. This is substantiated by recent experiments with new cultural practices and picking aids ultimately intended to make harvesting less costly.

To effectively evaluate new developments in harvesting, better knowledge of present practices and costs is needed. To accomplish this, the following information is provided in this report.

1. The distribution of work activities and their required time per field box of fruit while the picker is working within assigned sets of trees.

2. The distribution of the primary picking duties of reaching for fruit, removing it from the stem and carrying it to the bucket.

3. The proportion of time devoted by the picker to nonproductive work, delays, and rest.

In addition to the above objectives, some factors are presented that may be considered in the selection of new methods and mechanical aids for picking.

Information contributing to these objectives was determined by means of time studies and observations of conventional picking operations in several orchards. The job of picking has been divided into several identifiable parts. This facilitates analysis of the work and also makes it possible to estimate more accurately the influence of possible changes that may involve only certain phases of the total picking activity. Details of the study methods and conditions and definitions of the work components appear in Appendix A.

Results

Time Study of Picking Activities

Summarization of work sampling time studies reveals that a pear picker's activities while working within a set of trees, are distributed as shown in Table 1. Weighted averages for both percent of time and man-minutes per box are derived from observations of work with Bartlett and Bosc varieties. Minor variations in results within elements for the two varieties are included in a table appearing in Appendix B. In both cases the total cycle time per box is the same.

Combined picking activity from on the ground and ladder, elements 1 and 2, takes about 69% of the working time, or 3.5 man-minutes for each box of

Table 1. Distribution of Pear Picking Activities in Percent and Man-Minutes Per Field Box. /1

	Operation Elements	Percent of Time	Man-Minutes Per Box
1.	Pick while on ground	23.9	1.22
2.	Pick while on ladder	44.9	2.32
3.	Move to new position on ground	2.6	0.13
4.	Move to new position on ladder	7.9	0.38
5.	Reset ladder	7.2	0.35
6.	Move to stack of boxes to empty bucket	2.9	0.15
7.	Move to tree to resume picking	2.4	0.12
8.	Empty pears from bucket into boxes	3.0	0.16
9.	Level or redistribute pears in boxes	3.6	0.16
10.	Handling empty or full boxes	1.6	0.07
	TOTAL CYCLE	100.0 %	5.06 Minutes

/1 Some of the operations are illustrated in Figures 1 through 5.

40 to 45 pounds of fruit. The remaining 31% of the time, a little over 1.5 minutes per box, is used by the picker to move himself, pears, and picking equipment about the work area. About 16% of the working time and eight-tenths of a minute per box is devoted to elements 3, 4, 6, and 7 as the picker moves on the ladder about the tree and to and from the box stacking area. Emptying and leveling fruit and handling boxes, elements 8, 9, and 10, total to nearly 8% of the time and four-tenths of a minute per box.

Fruit Picking Hand Movement Analysis

Film study results in Table 2 show that the picker's hands are reaching for fruit during 30% of the "pick" time, removing fruit from the stem 43% of the time, and carrying it to the bag for release 27% of the time. These percentages for hand activities, however, do include brief periods when the

Table 2. Distribution of Hand Movements while Picking Pears /1

Hand Movement	Percent of Pick Time (3.5 Min./Box) Range	Weighted Average
Reach from bucket to pear	16 to 41	30
Grasp and remove pear(s) from stem	19 to 66	43
Carry pear(s) to bucket and release	19 to 49	27
		100%

/1 Film for this analysis depicted two qualified workers picking Bartlett, D'Anjou and Bosc pear varieties.

hands were holding onto a branch or the ladder or were just idle. Random observations of the films disclosed nonproductiveness to be about equal for

Figure 1. Picking from a 12 foot ladder takes 45% of the picker's working time.

Figure 2. Moving the ladder takes over 7% of the picker's working time.

Figure 3. Pears are emptied from the bucket into field boxes.

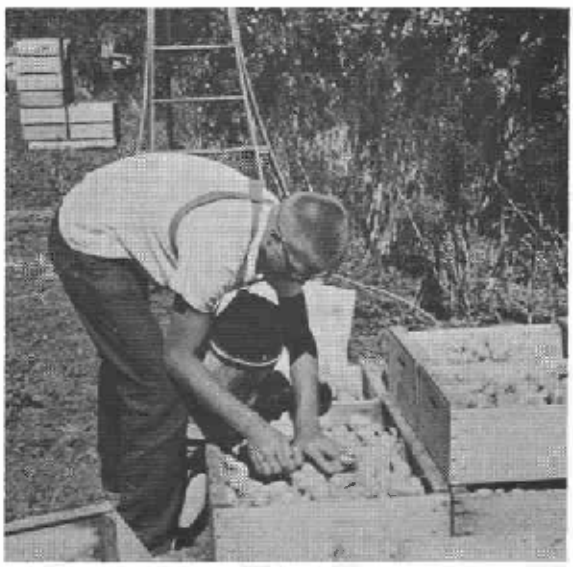

Figure 4. Leveling prevents injury to fruit when the boxes are stacked.

Figure 5. Handling field boxes is a part of the picker's job.

the right and left hands. This "hold and idle" use of the hands takes about 6% of the "reach," "grasp," and "carry" of 3.5 minutes per box. It is equivalent to 4% of the total cycle time of 5.1 minutes. The preceeding estimate is conservative for the film revealed only limited difficult situations in which the picker needed one hand for holding.

The summarization in Figure 6 relates the specific hand activities of picking fruit to the total duties of a picker in harvesting a field box of pears. Calculations dependent upon data from the film analysis are demonstrated in Appendix C.

Allowance for Nonproductive Work and Delays

As derived from record data, about 25% of the on-the-job time available to pickers is used for nonproductive duties in the orchard and various delays. Derivation of this figure is described in Appendix D.

Discussion

Information for Cost Comparisons

Results of the foregoing time studies provide a useful point of departure to assist in evaluating mechanical aids and modified methods for picking pears. The production time provided makes it possible to predict the influence of methods changes that would eliminate or alter only certain work elements within the total pick cycle.

Pear pickers usually are paid at a piece rate of a certain amount of money for each box harvested. If direct labor were the only cost involved, efforts to improve picking efficiency might seem unwarranted. This, however, is not the case, for it is possible that pay rates, and even the method of payment might change to be commensurate with new job requirements and productivity. In addition, numerous indirect costs would decrease with improved picking efficiency. Though not ordinarily isolated in accounting records, these indirect costs would result from administrative functions for picking labor such as (1) procurement, (2) maintenance of records, (3) payroll handling, (4) insurance, (5) supervision, and (6) termination.

High incidence of labor turnover will magnify the above costs. Methods improvements would reduce indirect costs by increasing production per picker and hence lowering the required size of the picking force. With local workers making up a larger proportion of seasonal labor there likely would be less of a turnover problem. Also, when migrant workers are in short supply, efficient picking could reduce losses from fruit that may go unpicked or be picked after passing optimum maturity.

Information is needed about the following items for both present and proposed conditions for comprehensive evaluation of alternate picking methods:

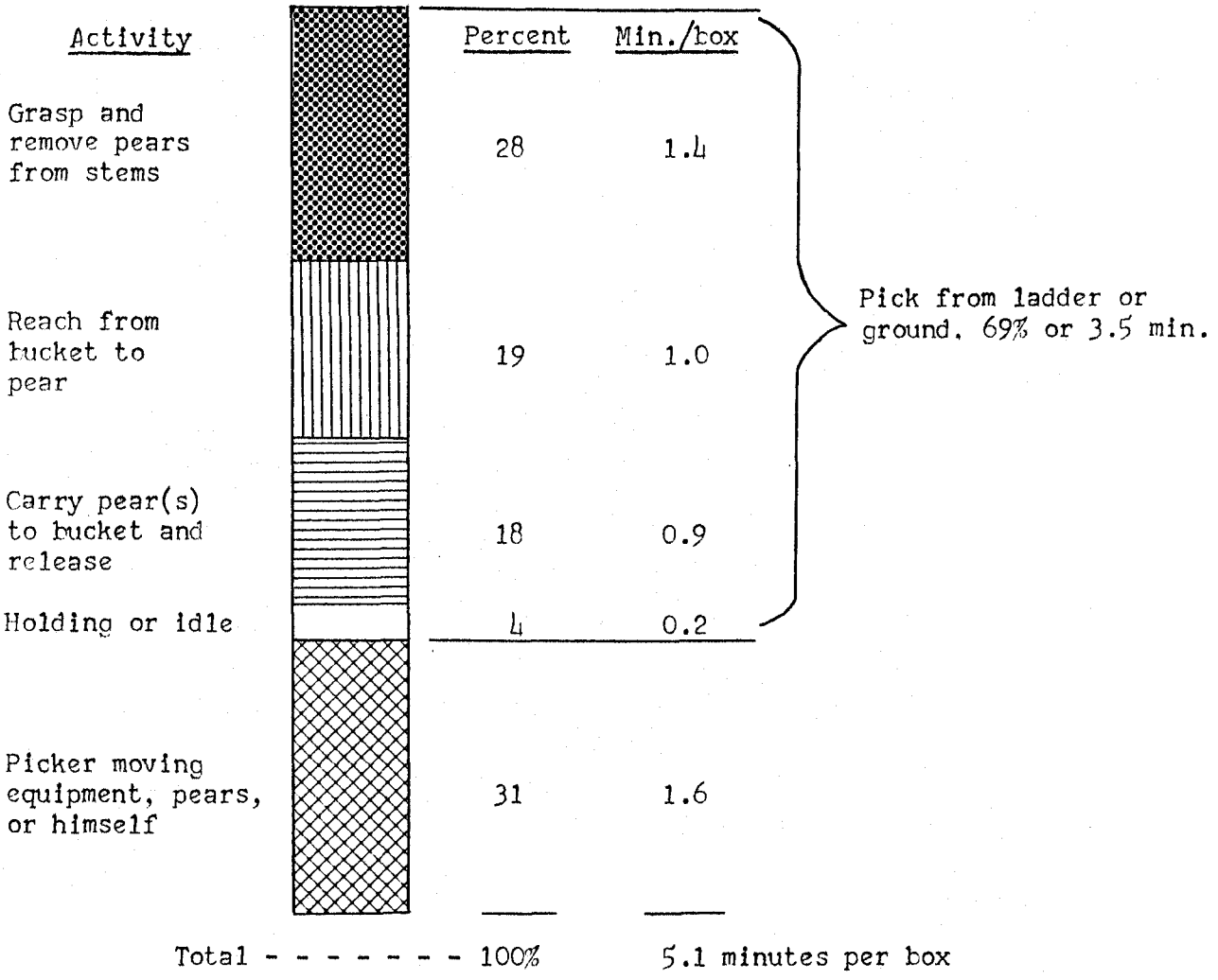

Figure 6. Relation of hand work to total picking time.

1. Units of production required
2. Production time per unit
3. Direct labor and material* costs per unit
4. Administrative costs per unit
5. Equipment depreciation, installation, maintenance, operating and interest costs per unit
6. Labor training costs
7. Cost savings allocated to taxes

Preplanning should be directed at estimating any adjustment mechanical picking implements might impose on orchard layout, cultivation, irrigation, and control of tree shape. Though difficult to predict with precision, these factors could conceivably change fruit quality, size and production per acre and also govern the maneuverability and ease of use of mechanical orchard equipment. Also, workers and growers may react favorably or unfavorably to changes in practices.

Approaches to Improvements

The ultimate objective of a change in practice, to be justified, must in some way improve the product, reduce its cost, or eliminate hazardous or undesirable working conditions.

Two general approaches can be considered to improve pear picking functions. One approach would seek a low cost of change through improved work methods and management. The other would lower costs by substituting equipment for labor.

Both methods have been successfully demonstrated. For example, through better labor utilization, Israel reduced picking labor for its citrus crop by 22% and at the same time increased the volume of export quality fruit through reduced damage. (1)**

The substitution of equipment for harvest labor is well established in several fruit and vegetable crops. Some experimental work is being done with mechanical equipment to aid in picking apples and pears. A self-propelled picking machine that is controlled by the picker from an elevated platform is being developed at the Wenatchee Tree Fruit Experiment Station (2). Trial picking with this unit has shown that substantial savings in direct labor are possible. However, savings apparently are not yet sufficient to cover equipment costs. Time studies and cost analysis of apple picking have also been made in Michigan (3). Results of the work indicate that under ideal conditions not more than $1,000 could be justified for equipment that permitted the picker to achieve a 50% increase in production. These experiences do not mean that mechanization is impractical. They simply indicate, as is typical of early stages of development, that further refinements are needed to make a more effective man-machine relationship. It must be recognized that continued analysis will disclose further improvements, possible reduction in indirect costs, and potential savings through improved fruit yield and quality. Also mechanization may ultimately influence orchard layout, spraying practices,

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* There probably would be no change in material cost for pears except as different picking methods might influence fruit knocked down or damaged by harvesting.

** Numbers in parenthesis refer to literature citations on page 17.

cultivation, and irrigation techniques to accommodate quick maneuvering and permit ready access to the fruit.

These conditions are pointed out to emphasize the need to consider all factors that may contribute to the selection of the most desirable method from among several alternatives.

Current Results Suggest

The estimated 25% allowance time devoted to nonproductive activities could be reduced appreciably without any hardship to the pickers. However, closer field supervision would be necessary to shorten the delays connected with checking production, changing tree sets, moving to new orchards, and waiting for empty boxes or other equipment.

Development of mechanization to assist pickers should aim at making available for picking a large part of the 31% of time shown in Figure 6 that workers now spend moving fruit, equipment and themselves about the harvest area. Controls and the work place environment on the machine should permit maximum opportunity for the operator to remove fruit from the tree for that is the one activity that human hands do better than any device thus far conceived. Transferring much of the physical work to a machine would reduce time lost for fatigue recovery. Properly designed, a machine could be a safer place to work than on a ladder. Fewer accidents could result in substantial savings through lower insurance costs. Oregon State Industrial Accident Commission rates for 1960 show that ladder work insurance premiums were in the vicinity of $9 per $100 of payroll or 50% higher than the average farm work rate of $6.40.

Growers, field foremen, and skilled pickers recognize in current picking methods that well-planned practices make the work easier and more productive. Experience has shown that unnecessary steps, ladder moves, and box handlings can be saved if equipment is properly arranged and the best starting point selected in the assigned set of trees before picking starts. Training pickers to use effective work methods requires demonstration,* constructive supervision, and a receptive attitude.

Management of current picking methods or planning for machine assistance should consider means of getting as much marketable fruit to the packing house with as little picking and handling damage as possible. One source of loss was demonstrated by two small surveys made during the 1961 season which gave evidence of the value of fruit knocked down by picking. Pears lost in this fashion are illustrated in Figure 7. Counts were made, before and after picking, of ground fruit under nine randomly selected trees in a D'Anjou

* Some good picking practices are demonstrated in two motion pictures, "Picking Oregon Pears and Apples" (16 mm, color, sound, 20 minutes running time) and "Picking Rogue River Pears" (16 mm, color, sound, 8 minutes running time). Both films are available from office of Audio-Visual Instruction, General Extension Division, Corvallis, Oregon.

Figure 7. Fruit under this tree cost money to produce but will contribute no return.

orchard. The set of fruit on trees in this section was relatively light. Picking caused an average of about 19 knocked-down pears per tree. A similar study of 26 trees in a Bosc orchard with a good set of fruit indicated an average of 33 pears per tree knocked down by harvest activities. Fruit in this area was of a size that averaged 119 per field box, hence about 3/10 of a box of fruit was lost under each tree. The loss, with a packing house door value of $1.50 per box, amounts to 45 cents per tree in this case. A substantial reduction in the loss attributed to knocked-down fruit would help cover methods improvement costs.

If present trends are followed, machine assisted picking will incorporate the use of bulk containers. Conversion to bulk handling, if not already accomplished, can be readily adapted to most current harvesting methods. Economies of bin use reflected in field container costs, costs of movement of fruit from orchard to packing plant, and storage space charges have been well established. (4, 5, 6, 7, and 8). Utilization of bins also makes more picking time available to the pickers since box handling and fruit leveling activities are eliminated. A previous study (9) comparing picking into field boxes and bins indicated that the savings in time, if used for production, could equal the work of one man out of every 12 or 13 pickers. As pointed out earlier, if fewer pickers can maintain the required rate of fruit output, various administrative costs would be reduced.

Conclusion

The prime objective, that of determining quantitatively how pear pickers used their working time, has been approached through the observations reported here. Subdividing the time of pickers' duties into work elements makes possible predictions of the influence of modifications in the picking job. Results obtained to date should aid in the evaluation and selection of future suggested changes in picking practices.

Within the limits of this investigation, some potential areas, but not specific means, of improvement in harvest activities have been pointed out. Knowledge obtained has shown that a significant amount of picking time is devoted to nonproductive activity. Availability of potential cost savings should be adequate justification for efforts to improve picking effectiveness through application of better work methods and mechanical assistance.

A real need has become evident for additional reliable information that will enable management to determine what alternative means may best improve picking efficiencies for specific conditions. Of immediate assistance would be research to determine the total allocation of pickers' time while they are in the orchard. This would make possible better planning of working, preparation, and nonworking time. Also needed is more exact knowledge of the indirect costs related to harvest labor to permit complete cost evaluation of potential harvest methods.

APPENDIX A

Study Technique

Method:

Data contributing to the objectives was obtained by observations in the Medford area during the 1961 harvest season. Conditions relative to the study were as follows:

1. Separate observations were made in the picking of Bartlett and Bosc pear varieties.

2. Studies were conducted in several areas of four different orchards.

3. Picking was done with the aid of twelve-foot ladders.

4. No Mexican Nationals were in the picking crews observed.

5. Performance data represents production in a variety of working conditions by about 20 workers with a wide range of physical ability and skill.

6. Time studies by work sampling over a relatively long period of time allowed many of the variables normally encountered in actual working conditions to be realistically included in final production time estimates.

Hand movement times needed for getting fruit from the tree to the picker's bucket were determined through detailed analysis of motion picture films. Approximations of nonproductive hand activities were also measured. Several picking positions and tree conditions were included in the film studied.

The foregoing time study conditions apply to activities of the picker working in the immediate area of his assigned set of trees. They do not account for other duties and delays related to the picking operation. Examples of nonproductive time include waiting for the checker to verify production, moving to a new set of trees, adjusting equipment, waiting for orders or orchard equipment, starting late, quitting early, time devoted to personal needs, rest for fatigue recovery, conversation, and horseplay.

An over-all allowance for nonproductive time was approximated with the help of current record data from the Oregon State Employment Service.

Job Definitions:

Changes intended to improve the efficiency of a job frequently do not influence the entire activity; hence, it is possible to better estimate the impact of changes if an activity, and the time it requires, is subdivided into components that are a normal and identifiable part of the job. These job components are commonly called elements.

Work element definitions employed in this study are as follows:

Pick from ground--all activity of reaching for fruit, removing it from the tree, and placing it in the picking bucket while the picker is working from the ground; movement around or under the tree so long as it does not interfere with simultaneous picking. Searching for fruit to pick, though isolated during the study, took so little time that it has been included in the time for pick.

Pick from ladder (see Figure No. 1)--the same activities stated in the previous element except that they are performed while on the ladder.

Move on ground--moving without the ladder around or under the tree to a picking position. No simultaneous picking occurs during the move.

Move on ladder--moving on the ladder to a picking position. No simultaneous picking occurs during the move. This element mainly involves time when the picker is going up the ladder with an empty bucket or down with a full one.

Reset ladder (see Figure No. 2)--all time the picker spends moving the ladder about his set of trees and positioning it at a tree for use.

To stack--time for moving from the picking area to the boxes where the bucket is emptied.

Empty (see Figure No. 3)--activity of emptying pears from the bucket into field boxes.

Level (see Figure No. 4)--distributing fruit within a box or to other boxes so it does not protrude above the top edge where it can be damaged when boxes are stacked.

Box handling (see Figure No. 5)--all handling of empty or full field boxes in the picking area, such as bringing empty boxes to the stack, moving full boxes and moving scattered empty boxes out of the way of picking activity.

Move to tree--walking from the box stack back to the ladder or picking area.

Through the use of motion pictures, hand movements within the elements "pick from ground" and "pick from ladder" were subdivided as follows to permit more detailed analysis:

Reach--movement of the picker's hand from the time it starts to move away from the bucket until the fingers start to grasp a pear.

Remove fruit from stem--activity of the hand and arm needed to separate the fruit from the stem. When more than one pear is picked before the hand carries them to the bucket the transfer time from one pear to another is included.

Move to bucket--action of bringing the fruit to the bucket and releasing it.

Hold or idle--time when the hand is holding onto a branch or the ladder or being idle.

APPENDIX B

Table 1-a: Distribution of Pear Picking Activities in Percent and Man-Minutes per Field Box /1

	Percent of Time			Man-Minutes per Box /2		
	Bartlett	Bosc	Weighted /3 Average	Bartlett	Bosc	Weighted /3 Average
1. Pick from ground	24.5	23.7	23.9	1.24	1.20	1.22
2. Pick from ladder	47.6	43.9	44.9	2.41	2.22	2.32
3. Move on ground	2.4	2.6	2.6	0.12	0.13	0.13
4. Move on ladder	6.7	8.4	7.9	0.34	0.42	0.38
5. Reset ladder	6.2	7.5	7.2	0.31	0.38	0.35
6. Move to stack	3.1	2.8	2.9	0.16	0.14	0.15
7. Move to tree	2.7	2.3	2.4	0.14	0.12	0.12
8. Empty	3.6	2.8	3.0	0.18	0.14	0.16
9. Level	2.2	4.1	3.6	0.11	0.21	0.16
10. Box handling	1.0	1.9	1.6	0.05	0.10	0.07
TOTAL CYCLE	100.0	100.0	100.0	5.06	5.06	5.06

/1 Results are based on observations of about 20 pickers at intervals during two different weeks of work and in four orchards in the Medford, Oregon area.

/2 Man-minutes have been rounded off to hundredths (.01) of a minute rather than tenths (0.1) in order to retain some relationship between short elements. The times are not necessarily accurate at the second decimal.

/3 Average figures are weighted according to the number of observations for each variety.

APPENDIX C

Net Picking Time Calculation:

Picking from ground or ladder = 69% of total time per box or

3.5 minutes per box.

Time hands are doing productive work = 94%

Net picking time = 69% x 0.94 = 65% or

3.5 minutes x 0.94 = 3.3 minutes per box.

Calculation for Hand Movement "Grasp and Remove Pear":

Time to "grasp and remove pears from stem" = 43% of net picking time.

= 0.43 x 65%

= 28% of total time per box.

or in terms of minutes, 0.43 x 3.3 minutes = 1.4 minutes per box.

Times for the other hand movements were determined in the same manner.

APPENDIX D

Allowance Determination:

Following is a description of the method used to estimate the percent allowance in time to accommodate nonproductive work and delays associated with the activities of pear pickers.

Contributing information from the Oregon State Employment Service provided earnings on an hourly basis, rather than piece rate, for 350 pickers from Mexico for the 1960 season. The median hourly rate was $1.41 per hour. A less intense study by interview of domestic pickers indicated their income per hour was near this rate. Knowing the picking piece rate that occurs most frequently to be approximately 16 cents per box, a production rate for these conditions may be determined as:

$$\text{Average boxes per hour per picker} = \frac{\text{Median hourly income}}{\text{Piece rate per box}}$$

$$= \frac{\$1.41 \text{ per hour}}{\$0.16 \text{ per box}}$$

$$\text{Average boxes per hour per picker} = \underline{8.8}$$

Expressed as elapsed time per box:

$$\frac{60 \text{ minutes per hour}}{8.8 \text{ boxes per hour per picker}} = \underline{6.8 \text{ minutes per box}}$$

If 6.8 man-minutes per box is considered as the standard or total elapsed time expended for each box of pears picked it may be related as follows to the representative working time per box of 5.1 minutes to derive the allowance percent:

$$\text{Standard Time} = \text{Representative Time} \left[\frac{100}{100 - \text{Allowance \%}}\right]$$

$$\text{or Allowance \%} = 100 - \frac{100 \text{ (Representative Time)}}{\text{Standard Time}}$$

$$= 100 - \frac{100\ (5.1)}{6.8}$$

$$\text{Allowance} = \underline{25\%}$$

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