Meal Picking - Middle School
Student Worksheet

Name: ___________________________    Date: ___________________

Part I: Introduction

1. What is a distribution center? ____________________________________________
   ______________________________________________________________________
   ______________________________________________________________________

2. Give an example of a distribution center. __________________________________
   ______________________________________________________________________

3. Give two examples of where distribution centers for meal picking might be used?
   ______________________________________________________________________
   ______________________________________________________________________

4. What is the benefit of having a distribution center for meal picking?
   ______________________________________________________________________
   ______________________________________________________________________
   ______________________________________________________________________

Part II: Simulation-“Tables”

1. What is a systems design? _________________________________________________
   ______________________________________________________________________
   ______________________________________________________________________

2. Why do engineers use simulations to study systems designs?
   ______________________________________________________________________

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Page 1 of 6
Meal Picking - Middle School
Student Worksheet

The information in the table below represents the data collected in the “Tables” simulation.

Scenario 1: Tables

<table>
<thead>
<tr>
<th>Meal Order #</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>Overall Time (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Picking Time (sec)</td>
<td>26.0</td>
<td>25.2</td>
<td>24.4</td>
<td>20.4</td>
<td>21.1</td>
<td>18.7</td>
<td>18.0</td>
<td>26.6</td>
<td>22.3</td>
<td>18.9</td>
<td>24.1</td>
<td>22.4</td>
<td>268.1</td>
</tr>
<tr>
<td>Walking Time (sec)</td>
<td>60.2</td>
<td>60.3</td>
<td>55.3</td>
<td>45.9</td>
<td>53.8</td>
<td>56.9</td>
<td>51.0</td>
<td>67.3</td>
<td>48.2</td>
<td>61.2</td>
<td>58.7</td>
<td>53.2</td>
<td>672.0</td>
</tr>
<tr>
<td>Total Time (sec)</td>
<td>86.2</td>
<td>85.5</td>
<td>79.7</td>
<td>66.3</td>
<td>74.9</td>
<td>75.6</td>
<td>69.0</td>
<td>93.9</td>
<td>70.5</td>
<td>80.1</td>
<td>82.8</td>
<td>75.6</td>
<td>940.1</td>
</tr>
</tbody>
</table>

3. What is the range of the Picking Times?_________What does this number tell you about the Picking Times?_________________________________________________________

4. Calculate the Average Total Time needed to pick a Meal Order? Round to the nearest hundredth of a second.________

\[ \text{Average} = \frac{\text{OverallTotalTime}}{\text{NumberOfMealOrders}} \]

5. What is the dependent variable?_______________Independent variable?____________________

6. Is it better to have a faster or slower Average Total Time?_______Why?__________________

______________________________________________________________

7. What are possible changes that can be made to this meal picking design to decrease the time it takes to pick meals?____________________________________________________

______________________________________________________________
Part III: Simulation-“Random Pick-to-Light”

1. What changes in the systems design are shown in this simulation?______________________________________________

The information in the table below represents the data collected in the “Random Pick-to-Light” simulation.

Scenario 2: Random Pick-to-Light

<table>
<thead>
<tr>
<th>Meal Order #</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>Overall Time (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Picking Time (sec)</td>
<td>26.0</td>
<td>25.2</td>
<td>24.4</td>
<td>20.4</td>
<td>21.1</td>
<td>18.7</td>
<td>18.0</td>
<td>26.6</td>
<td>22.3</td>
<td>18.9</td>
<td>24.1</td>
<td>22.4</td>
<td>268.1</td>
</tr>
<tr>
<td>Walking Time (sec)</td>
<td>30.8</td>
<td>27.8</td>
<td>33.0</td>
<td>29.6</td>
<td>34.9</td>
<td>23.1</td>
<td>33.4</td>
<td>32.3</td>
<td>37.4</td>
<td>38.2</td>
<td>40.9</td>
<td>30.3</td>
<td>391.7</td>
</tr>
<tr>
<td>Total Time (sec)</td>
<td>56.8</td>
<td>53.0</td>
<td>57.4</td>
<td>50.0</td>
<td>56.0</td>
<td>41.8</td>
<td>51.4</td>
<td>58.9</td>
<td>59.7</td>
<td>57.1</td>
<td>65.0</td>
<td>52.7</td>
<td>659.8</td>
</tr>
</tbody>
</table>

2. Which Time (Picking or Walking) shows the bigger change compared to the first simulation? Why?________________________________________

3. Calculate the Average Total Time needed to pick a Meal Order using this systems design. Round to the nearest hundredth of a second.___________

\[
Average = \frac{\text{Overall Total Time}}{\text{NumberOfOrders}}
\]

4. How does this Average Total Time compare to the Average Total Time from the “Tables” Simulation in Part II?________________________________________

5. Brainstorm methods to improve this simulation’s design in order to produce an even faster Average Total Time.________________________________________
Part IV: Conclusions

1. Watch the “Ordered Pick-to-Light” Simulation. What makes this design the better system of the two which use the Pick-to-Light System?

2. The Average Total Time using this simulation is 35.84 seconds. How much faster is it compared to the “Tables” simulation? (Note: This improved time is for picking only 12 Meal Orders. Although the difference may seem trivial it is significant throughout the course of a day, month, etc.)

3. List factors other than the systems design that can affect the Average Total Time.

4. When would a faster Average Total Time not be better?

Fun Fact

Emirates Flight Catering, which provides in-flight meals for over 100 airlines, produces and packages up to 175,000 meals per day!
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Student Worksheet

Part V: Cost Analysis

1. What are some costs of running a cafeteria distribution center?__________________________
                                                                                           ______________________
                                                                                           ______________________
                                                                                           ______________________

2. An Airline Catering Company pays each picker (an employee who picks the meals) $8 per hour and each picker works 40 hours per week.

   a. How many hours per month does a picker work? (Use 1 month = 4 weeks) ___________

   b. How much is the labor cost per month for each picker? ________________

The company is researching a new systems design for their meal picking to reduce labor costs. Use the information in the table below to answer the following questions.

<table>
<thead>
<tr>
<th>Systems Design</th>
<th>Total Time to pick 12 Meal Orders (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tables</td>
<td>940.1</td>
</tr>
<tr>
<td>Random Pick-to-Light</td>
<td>659.8</td>
</tr>
<tr>
<td>Ordered Pick-to-Light</td>
<td>430.1</td>
</tr>
</tbody>
</table>

   c. Calculate the time difference between each of the 3 systems designs.

<table>
<thead>
<tr>
<th>Systems Design</th>
<th>Time Difference (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tables vs Random Pick-to-Light</td>
<td></td>
</tr>
<tr>
<td>Random vs Ordered Pick-to-Light</td>
<td></td>
</tr>
<tr>
<td>Tables vs Ordered Pick-to-Light</td>
<td></td>
</tr>
</tbody>
</table>
Meal Picking - Middle School
Student Worksheet

d. The average picker fills 324 Meal Orders per day. Using the data from the table in part c for 12 Meal Orders, calculate the time difference (in seconds) of the three systems designs per day (324 Meal Orders). Then convert your answers to the nearest hundredth of an hour.

<table>
<thead>
<tr>
<th>Systems Design</th>
<th>Time Difference per day (sec)</th>
<th>Time Difference per day (nearest 100th of an hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tables vs Random Pick-to-Light</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Random vs Ordered Pick-to-Light</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tables vs Ordered Pick-to-Light</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

e. Determine the amount of money saved on labor by the airline catering company who changed from the Tables systems design to Ordered Pick-to-Light. (Use 1 month = 30 days)

<table>
<thead>
<tr>
<th>Tables vs Ordered Pick-to-Light</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Difference per day, per picker (nearest 100th of an hour)</td>
</tr>
<tr>
<td>---------------------------------</td>
</tr>
</tbody>
</table>

f. If that company employs 50 pickers, how much is saved on labor costs per month from using the better systems design? __________

g. How much does the new systems design save the company on labor cost per year? __________
(Use 1 year = 12 months)

**Conclusion:** Engineers have an important job in designing systems that maximize production in order to increase profits for companies.