Meal Picking - High 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?
   ________________________________________________________________
   ________________________________________________________________
Meal Picking - High 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>Overall Time (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>268.1</td>
</tr>
<tr>
<td>2</td>
<td>672.0</td>
</tr>
<tr>
<td>3</td>
<td>940.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Picking Time (sec)</th>
<th>26.0</th>
<th>25.2</th>
<th>24.4</th>
<th>20.4</th>
<th>21.1</th>
<th>18.7</th>
<th>18.0</th>
<th>26.6</th>
<th>22.3</th>
<th>18.9</th>
<th>24.1</th>
<th>22.4</th>
</tr>
</thead>
<tbody>
<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>
</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>
</tr>
</tbody>
</table>

3. What do you notice when comparing the Picking Times of each Meal Order?

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

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

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?

RIT Kate Gleason College of Engineering [http://www.rit.edu/rems](http://www.rit.edu/rems)
Page 2 of 7
Meal Picking - High School
Student Worksheet

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

1. What changes in the system's 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 system's design. Round
to the nearest hundredth of a second. __________

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

4. Find the Percent Change of this Average Total Time compared to the Average Total Time from
   the “Tables” Simulation in Part II? Round to the nearest percent. __________

   \[
   \text{PercentChange} = \left(\frac{\text{OriginalTime} - \text{NewTime}}{\text{OriginalTime}}\right) \times 100
   \]

5. Brainstorm methods to improve this simulation’s design in order to produce an even faster
   Average Total Time. ________________________________________________________

RIT Kate Gleason College of Engineering  http://www.rit.edu/rems
Page 3 of 7
Meal Picking - High School
Student Worksheet

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!
Part V: Cost Analysis

1. The monthly cost of a small hospital cafeteria distribution center can be demonstrated using the following equation: \( C = 8h + 33,000 \) where \( C \) represents the total cost and \( h \) is the number of hours paid for labor.

   a. What is the slope of this equation? \( \) What does it represent? \\

   b. What is the y-intercept? \( \) What does it represent? \\

   Give some examples of those costs. \\

   c. If the distribution center employs 4 pickers working 20 hours a week,

      How many hours of labor are worked for the month? (Use 1 month = 4 weeks) \( \)

      What is the total cost, \( C \), for the month? \( \)

      How much of the total cost is for labor? \( \)
2. An Airline Catering Company is researching a new systems design for their meal picking to reduce labor costs. Each picker gets paid $8 per hour and works 40 hours a week. Use this information and the data 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>

a. 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>

b. The average picker fills 324 Meal Orders per day. Using the data from the table in part a 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>
c. 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>Time Difference</th>
<th>Time Difference</th>
<th>Total Labor Cost Saved</th>
</tr>
</thead>
<tbody>
<tr>
<td>per day, per picker (nearest 100\textsuperscript{th} of an hour)</td>
<td>per month, per picker (nearest 100\textsuperscript{th} of an hour)</td>
<td>per month, per picker (nearest cent)</td>
</tr>
</tbody>
</table>


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

e. 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.