Cooperative Learning

*The instructional use of small groups so that students work together to maximize their own and others’ learning*

- Instructor is guide, coach, monitor, and facilitator
- Students build relationships with peers
- Interpersonal skills are integral to course content


Characteristics of Successful Cooperative Groups

- Positive Interdependence
- Face-to-Face Promotive Interaction
- Individual Accountability
- Teamwork skills
- Group processing

People Balance

- Collect data on the people entering and leaving your system
- Use this data to perform both differential and integral people balances

Writing a Balance

\[ \text{Input} + \text{Generation} - \text{Output} - \text{Consumption} = \text{Accumulation} \]

Define Team Member Roles

- Project Manager
- Project Definition Engineer
- Engineer in Charge of Data Collection
- Engineer in Charge of Data Analysis
- Engineer in Charge of Research Report
Select System
- System must have at least three entrances/exits
- Each entrance/exit must be monitored by a group member
- Traffic flow must inspire a testable, interesting hypothesis

Formulate Hypothesis
- Hypothesis should be one that can be easily tested using data on the flow rates of people into and out of the system.
- Possibilities include:
  - Composition (e.g., male versus female)
  - Time (e.g., early morning versus afternoon)
  - Preferences (e.g., Taco Bell versus Wendy’s)
  - Location (e.g., west door versus north door)
- Be creative!

Develop Data Collection Strategy
- Coordination of data collection
  - Locations
  - Times
  - Dates
- Placement of data collectors
- Differentiation of subjects
- Distribution of data sheets

Create Data Sheet

<table>
<thead>
<tr>
<th>Time</th>
<th>M Enter</th>
<th>M Exit</th>
<th>W Enter</th>
<th>W Exit</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 – 10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 – 15</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 – 20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 – 25</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 – 30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data Collection Location:
Data Collector:

Analyze Data
- Differential Balance
  - Indicate what is happening at an instant in time
  - Each term in the balance is a rate
- Integral Balance
  - Describe what happens between two instants of time
  - Each term in the balance is an amount

Differential Calculations

<table>
<thead>
<tr>
<th>Time</th>
<th>M Enter</th>
<th>M exit</th>
<th>W Enter</th>
<th>W Exit</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 5</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>5 – 10</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>5 – 15</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>10</td>
<td>8</td>
<td>25</td>
</tr>
</tbody>
</table>

The input flow rate of men during the first 5 minutes is:

\[
\left( \begin{array}{c}
\Delta n \\
\text{Interval}
\end{array} \right) = \frac{M}{\text{Interval}} = \frac{4M}{5\text{min}} = 0.8 \Delta n
\]
### Differential Flow Data

<table>
<thead>
<tr>
<th>Time</th>
<th>M enter</th>
<th>M exit</th>
<th>W enter</th>
<th>W exit</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 5</td>
<td>0.8</td>
<td>0.4</td>
<td>0.2</td>
<td>2.2</td>
</tr>
<tr>
<td>5 – 10</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.8</td>
</tr>
<tr>
<td>10 – 15</td>
<td>0.8</td>
<td>0.6</td>
<td>0.4</td>
<td>1.0</td>
</tr>
<tr>
<td>Total</td>
<td>0.9</td>
<td>0.7</td>
<td>0.5</td>
<td>1.7</td>
</tr>
</tbody>
</table>

The differential accumulation of men over the first 5 minutes is:

\[ \text{In} - \text{Out} = \text{Accumulation} \]

\[ 0.8 \text{men/min} - 0.4 \text{men/min} = 0.4 \text{men/min} \]

### Differential Accumulation

<table>
<thead>
<tr>
<th>Time</th>
<th>M (men/min)</th>
<th>W (women/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 5</td>
<td>0.4</td>
<td>-2.0</td>
</tr>
<tr>
<td>5 – 10</td>
<td>0</td>
<td>-0.8</td>
</tr>
<tr>
<td>10 – 15</td>
<td>0.2</td>
<td>-0.6</td>
</tr>
</tbody>
</table>

- What does a positive number mean?
- What does zero mean?
- What does a negative number mean?

### Integral Calculations

<table>
<thead>
<tr>
<th>Time</th>
<th>M enter</th>
<th>M exit</th>
<th>W enter</th>
<th>W exit</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 5</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>5 – 10</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>5 – 15</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>10</td>
<td>8</td>
<td>25</td>
</tr>
</tbody>
</table>

The input of men during the second 5 minutes is:

\[ (\text{In})_{\text{Interval}} = \frac{M}{10 \text{min}} - \frac{4M + 5M}{10 \text{min}} = \frac{9M}{10 \text{min}} \]

### Integral Flow Data

<table>
<thead>
<tr>
<th>Time</th>
<th>M enter</th>
<th>M exit</th>
<th>W enter</th>
<th>W exit</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 5</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>5 – 10</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>10 – 15</td>
<td>13</td>
<td>10</td>
<td>8</td>
<td>25</td>
</tr>
</tbody>
</table>

The integral accumulation of men over the second 5 minutes is:

\[ \text{In} - \text{Out} = \text{Accumulation} \]

\[ 9M - 7M = 2M \]

### Integral Accumulation

<table>
<thead>
<tr>
<th>Time</th>
<th>M (men)</th>
<th>W (women)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 5</td>
<td>2</td>
<td>-10</td>
</tr>
<tr>
<td>5 – 10</td>
<td>0</td>
<td>-14</td>
</tr>
<tr>
<td>10 – 15</td>
<td>3</td>
<td>-17</td>
</tr>
</tbody>
</table>

Calculations for the total input, output and accumulation are done similarly:

\[ \text{In} = (\text{In})_{M} + (\text{In})_{W} \]

\[ \text{Out} = (\text{Out})_{M} + (\text{Out})_{W} \]

\[ \text{Accumulation} = \text{In} - \text{Out} \]

### Total Flow for Different Doors
Develop Conclusions

- Test the hypothesis
  - Does your data support your hypothesis?
  - Why or why not?
- Lay out an action plan
  - What can be learned from this study?
  - What should be done with this knowledge?
- Put forth recommendations
  - What would you do differently?
  - How could you improve?

Write Report

- Summary
- Introduction
- Diagram/picture of system
- Data Analysis
- Discussion of results
- Appendix
  - Raw data
  - Sample calculations

Deliverables

- Progress report with data sheet
  - Email by 5 PM on September 22
- People Balance Report
  - Turn in during lab section on October 1
- Team assessments
  - Turn in during lab section on October 1