THE OHIO STATE UNIVERSITY

COLLEGE OF ENGINEERING

Problem Solving

Technical Communication

Today's Learning Objectives

After today's class, students will be able to:

- Identify the five steps in problem solving
- Understand strategies for problem solving
- Apply the five steps of problem solving to a new problem

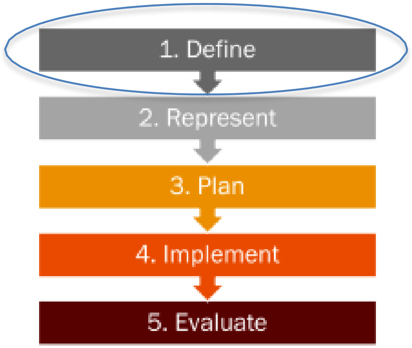
Problem Solving Method

1. Define
2. Represent
3. Plan
4. Implement
5. Evaluate

- Problem solving is an iterative process. At any point you may need to go back to a previous step (even the beginning!) and re-work the problem.
- Reworking the problem will provide a better solution than rushing through the steps. Your first solution may not be your best solution!

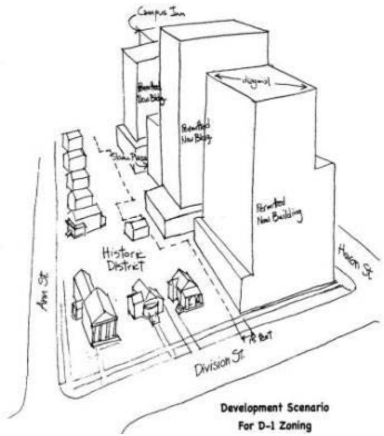
1. Define

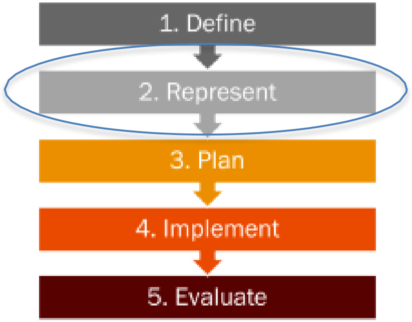
- What is the problem? What are the constraints?
  - Restate the problem so the goal is clearly identified
  - Document what is known and unknown
  - Identify and document constraints/limitations (e.g., time, materials, budget, technology, etc.)
  - Document initial assumptions or estimates for values of parameters needed



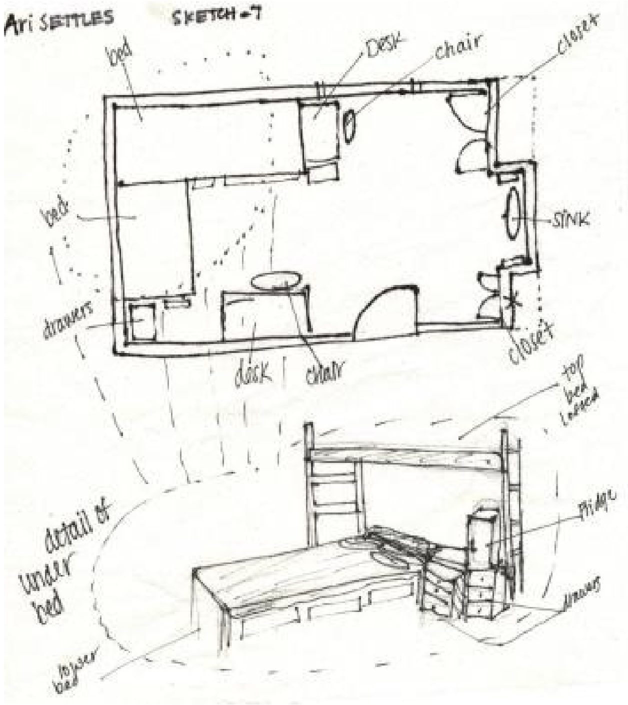
2. Represent

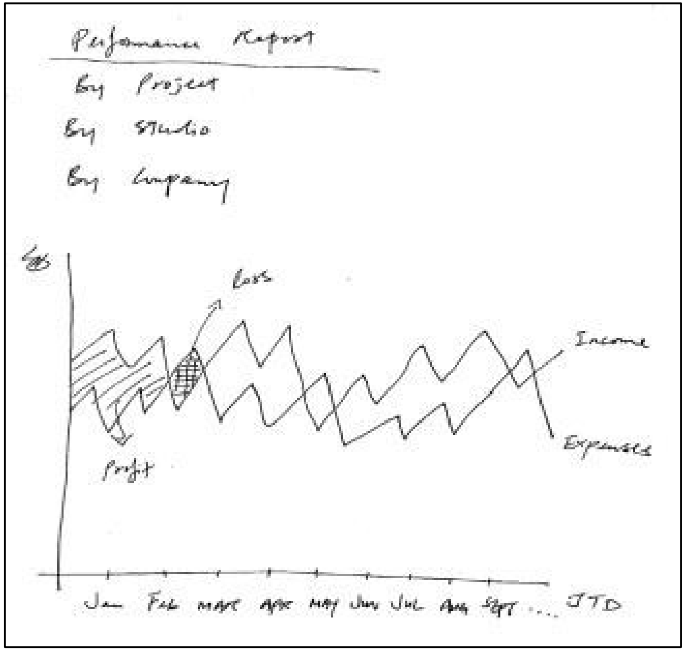
- Display the problem in a visual form so it is easier to understand:
  - Sketch or Diagram
  - Graph
  - Flowchart
  - Orthographic Drawing





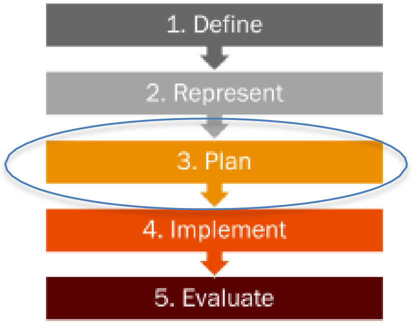
2. Represent


Ari SETTLES
SKETCH #7
bed
Desk
chair
closet
bed
SINK
drawers
closet
desk
chair
top bed lofted
detail of under bed
fridge
drawers
lower bed


Performance Report
By Project
By Studio
By Company
Loss
Income
Expenses
Profit
Jan Feb MAR APR MAY Jun Jul Aug SEPT ... YTD

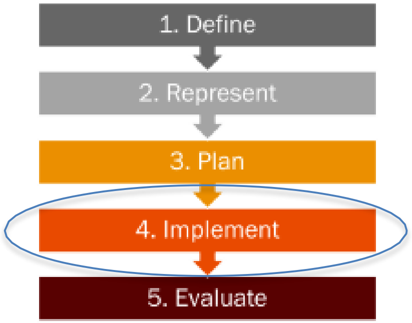
3. Plan

- Identify underlying principles to help solve the problem (math rules, laws of physics, etc.)
- Look for similarities and differences with previously encountered problems
- Identify potential tools to be used
- If required, make additional assumptions or estimates
- Confirm that assumptions are valid (use references!)



4. Implement

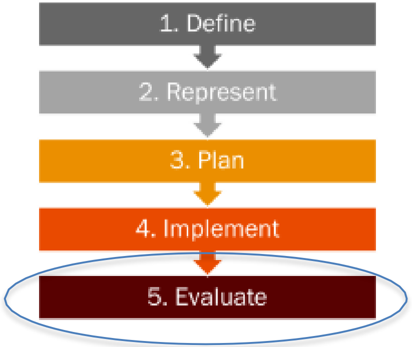
- Implement the plan!
  - Perform a dimensional analysis: crunch the numbers & keep track of your units!
  - Keep work organized and well-documented
  - Display results appropriately in a well-labeled table or graph
  - Track progress if task is extensive



5. Evaluate

- Always evaluate your work!
  - Does the solution make sense and answer the original question?
  - Is the magnitude of the answer reasonable?
  - Are the units correct and reasonable?

- How can we verify our answer?
  - Use another approach with the same variables
  - Research your answer, compare to existing solutions



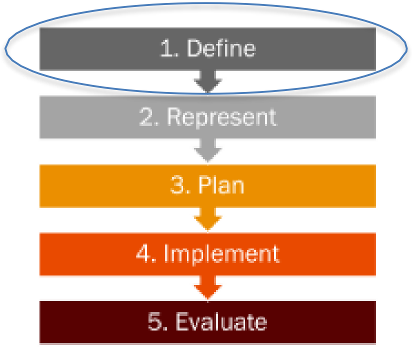
Problem Solving Activity

Sample Problem

- Let's work through a sample problem together.
- **Problem:** Determine how much paint is needed to paint a room that is 16'x 20' with a 10 foot ceiling.
- **Given Info:** There are two windows and two doors, and the room needs two coats of paint.

1. Define Sample Problem

- Identify the Goal:
  - Determine the number of cans of paint needed to paint the room.
- Identify Constraints:
  - Two coats of paint



1. Define Sample Problem

- Document known and unknown information:

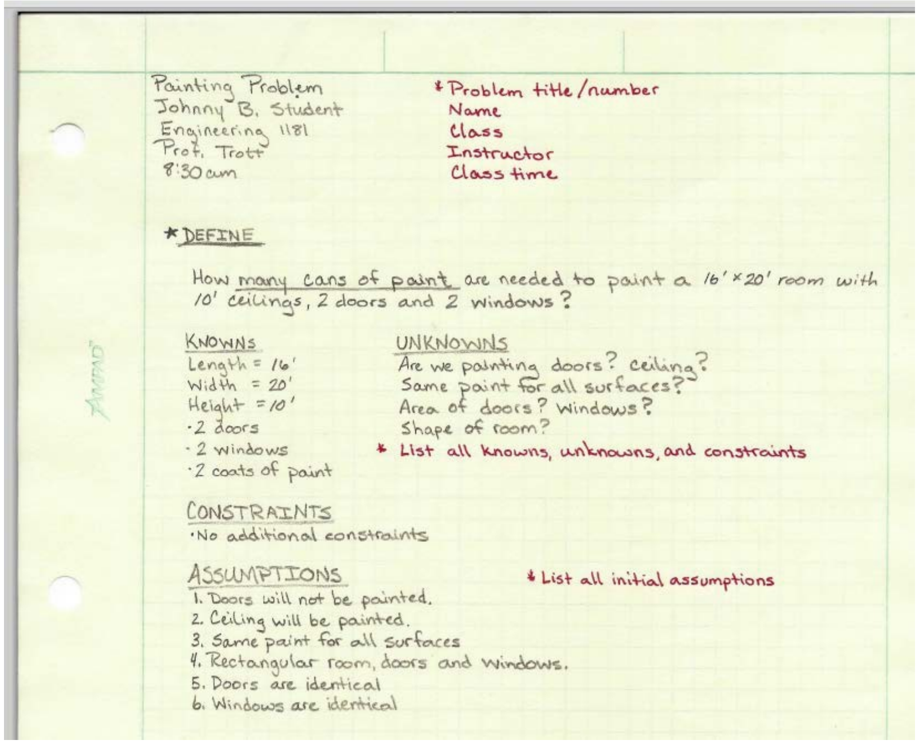
- Known:
  - Length: 16 ft
  - Width: 20 ft
  - Height: 10 ft
  - Two doors
  - Two windows

- Unknown:
  - Are doors painted?
  - Are windows painted?
  - Use the same paint as wall?
  - Dimensions of doors?
  - Dimensions of windows?

1. Define Sample Problem

- Document assumptions, estimates, and research:
  - The ceiling of the room will also be painted
  - The same paint will be used for walls and ceiling
  - Doors are not painted
  - Windows are not painted
  - Size of doors and windows
  - Coverage of paint (thick or thin)

1. Define Sample Problem



Painting Problem
Johnny B. Student
Engineering 1181
Prof. Trott
8:30 am

* Problem title/number
Name
Class
Instructor
Class time

*DEFINE

How many cans of paint are needed to paint a 16'×20' room with 10' ceilings, 2 doors and 2 windows?

KNOWNS
Length = 16'
Width = 20'
Height = 10'
· 2 doors
· 2 windows
· 2 coats of paint

UNKNOWNS
Are we painting doors? ceiling?
Same paint for all surfaces?
Area of doors? windows?
Shape of room?

* List all knowns, unknowns, and constraints

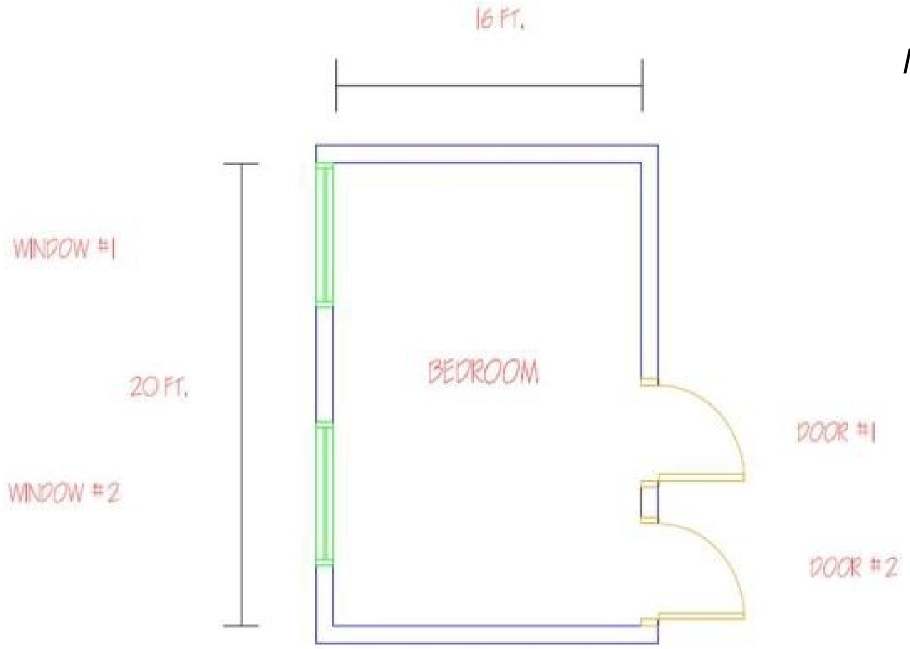
CONSTRAINTS
· No additional constraints

ASSUMPTIONS

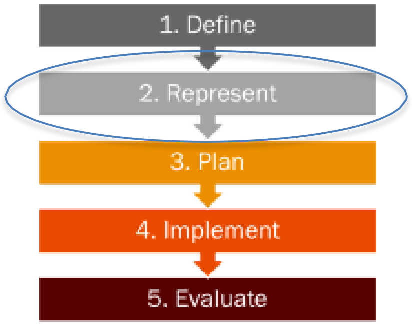
* List all initial assumptions

1. Doors will not be painted.
2. Ceiling will be painted.
3. Same paint for all surfaces
4. Rectangular room, doors and windows.
5. Doors are identical
6. Windows are identical

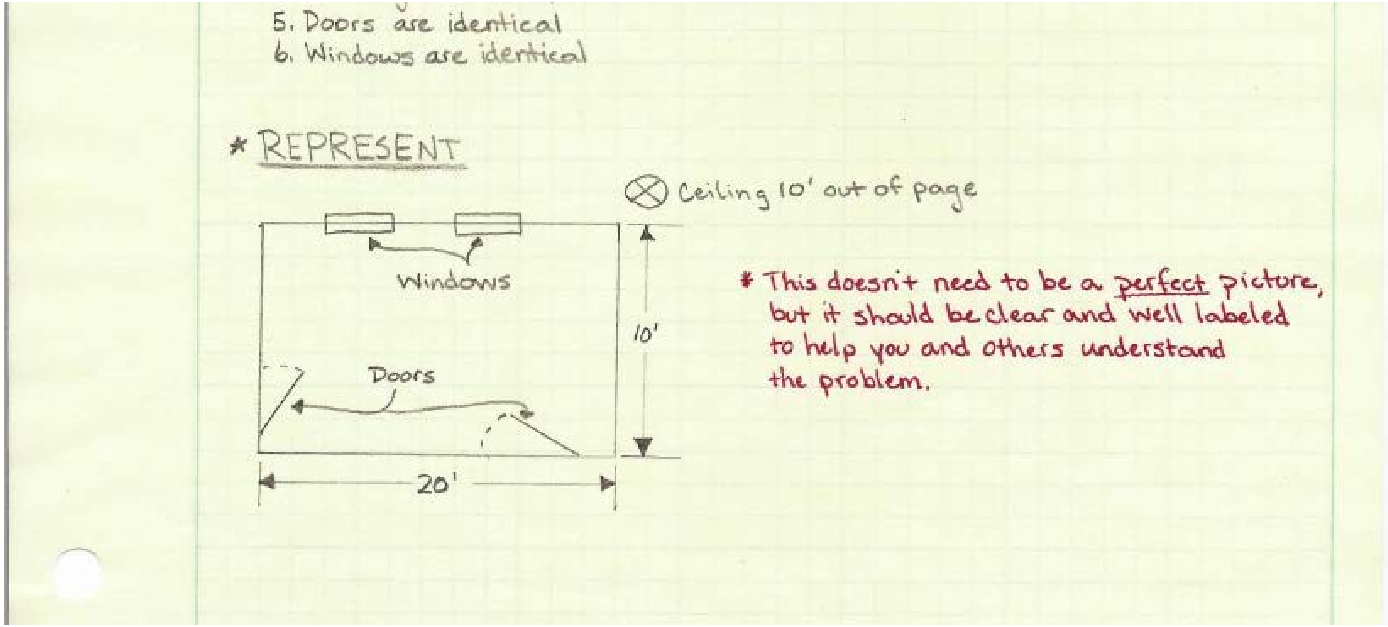
2. Represent Sample Problem



Note: Ceiling height is 10 ft.

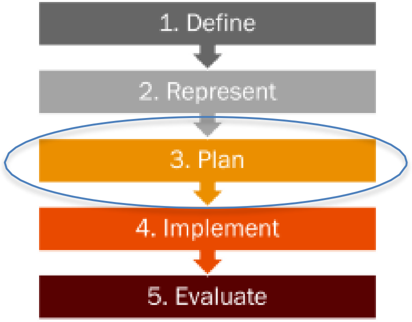


2. Represent Sample Problem



3. Plan Sample Problem

- Identify the underlying principle(s):
  - Geometry Problem (area calculations)
  - Paint Coverage Problem (ft^2/gallon)



- Recognize similarities and differences of the problem:
  - Area calculations: find surface area

Area = length x width

$= Area_{walls} + Area_{ceiling} - Area_{windows} - Area_{doors}$

3. Plan Sample Problem

- Paint Coverage: calculate needed cans of paint
  - 1 can of paint = 1 gallon of paint
  - Coverage (ft^2/gal)

Gallons = # Coats x $Area_{tot}$/Coverage

3. Plan Sample Problem

- Identify tools to be used:
  - Calculator, spreadsheet, iPhone app, pencil, etc.

- Make assumptions or estimates:
  - Area of door: 7 ft x 3 ft = 21 ft^2 per door
  - Area of window: 3 ft x 5 ft = 15 ft^2 per window
  - Paint coverage: 320 ft^2 per gallon

3. Plan Sample Problem

* PLAN

NEW ASSUMPTIONS

7. Doors have an area of 20 [ft^2]
8. Windows have an area of 15 [ft^2]
9. Paint covers 320 [ft^2/gallon]
10. Paint comes in 1 gallon cans.

TOOLS

- Calculator
- Internet

* Document all new assumptions needed to solve the problem

EQUATIONS

$A_{tot} = A_{room} + A_{ceiling} - A_{doors} - A_{windows}$

$A = L \times W$ and $G = \frac{A_{tot}}{c} \times n$

* Equations should "describe" the problem

where
G = gallons of paint
A_{tot} = total area to paint
C = coverage
n = number of coats

* Label variables

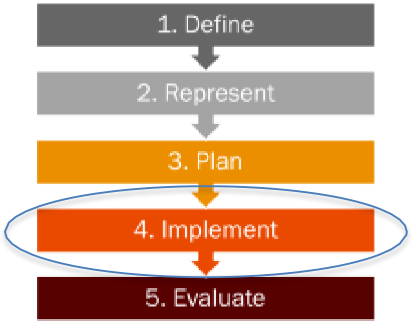
* IMPLEMENT

4. Implement Sample Problem

- Execute the Plan!

$$\text{Painted Area} = \text{Area}_{\text{walls}} + \text{Area}_{\text{ceiling}} - \text{Area}_{\text{windows}} - \text{Area}_{\text{doors}}$$

$$\text{Painted Area} = 968\ \text{ft}^2$$



4. Implement Sample Problem

- Execute the Plan! (continued)

- Gallons = # Coats x $Area_{tot}$/Coverage
  - Gallons of Paint = 6.1 Gallons
  - Since 1 gallon = 1 can,
    Paint needed = **6.1 cans**

4. Implement Sample Problem

n = number of coats

*IMPLEMENT

$$A_{tot} = \underbrace{2(16[ft] \times 10[ft]) + 2(20[ft] \times 10[ft])}_{\text{2 of each size wall}} + \underbrace{(16[ft] \times 20[ft])}_{\text{Ceiling}} - \underbrace{2(20[ft^2])}_{\text{doors}} - \underbrace{2(15[ft^2])}_{\text{windows}}$$

Maintain conventions to keep your work organized

$$A_{tot} = 2 \times 160[ft^2] + 2 \times 200[ft^2] + 320[ft^2] - 40[ft^2] - 30[ft^2]$$

$$A_{tot} = 970[ft^2]$$ *Follow units all the way through!

$$G = \frac{970[ft^2]}{320\left[\frac{ft^2}{gal}\right]} \times 2 = 6.1 \text{ gallons},$$ Therefore, I need 7 1 gallon cans of paint.

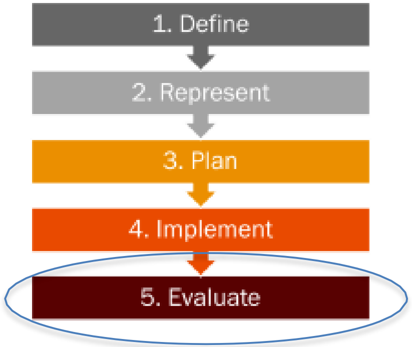
*Note significant figures.

*EVALUATE

·The amount of paint seems reasonable

5. Evaluate Sample Problem

- Does 6.1 cans of paint make sense?
  - Does it answer the original question?
  - Are the units appropriate?
  - Is 6.1 cans an appropriate scale?
  - What about lost/wasted paint?
  - Is the paint coverage rate reasonable? What did this include? (i.e., type of surface)



5. Evaluate Sample Problem

- To verify our calculations, can we use other approaches involving the same variables?
- Yes! One possible way is:
  1. Calculate a total length for the walls and multiply by the height to find total area.
  2. Calculate gallons of paint for each all walls and the ceiling.
  3. Add up total paint needed.

5. Evaluate Sample Problem

- Now that we have an acceptable answer, we need to present it clearly in the appropriate format.
- Sometimes this includes a graph or chart
- With this example, we can simply state the answer in a complete, descriptive sentence:

- **“7 cans of paint are required to paint the walls and ceiling of the room, given the assumptions above.”**

5. Evaluate Sample Problem

* Note significant figures.

*EVALUATE

- The amount of paint seems reasonable.
- From outside source, Olympic.com Paint Calculator, a similar value is obtained.

PRESENT THE SOLUTION

7 cans of paint are needed to apply two coats to a 16' × 20' room with the aforementioned assumptions.

"So… what am I learning and why?"

- When facing complex problems, engineers need a method to improve the odds of success.
- This method provides a valuable strategy for solving complex problems, as engineers do.
- You will be assigned problems to help you practice this strategy throughout the semester.

Technical Communication

Technical Communications in the Real World

- Communication, both oral and written, is extremely important in the business world. The best communicators are often the most successful people. Steve Jobs was an excellent communicator.

Why do engineers need to communicate?

- *Living in a "sound bite" world, engineers must learn to communicate effectively … If we place our trust solely in the primacy of logic and technical skills, we will lose the contest for the public's attention—and in the end, both the public and the engineer will be the loser.*

- - Norman Augustine, chair of the Human Space Flight Committee

What is Technical Communication?

- A method of sharing information about specialized subjects

- Examples include:
  - Laboratory reports and memos
  - Emails
  - Project contract or bid proposal
  - Assembly instructions for a toy
  - User guide for software
  - Drug prescription
  - Patents
  - Technical articles and publications

Technical Communication Style:

- Tense
- Roadmap (Introduction) – present
- Possible Future Work (Conclusion) – future/past
- Everything else – past
- Person
- Third Person – preferred
- Limit use of our, we, etc., but okay to use in some cases

Technical Communication Style:

- Voice
- Passive or active voice
- Just be consistent
- Other
- Avoid Emotional Statements
- Use Short Sentences
- Use Bulleted and Numbered Lists

Use the “How to” Guides and Templates posted on Blackboard

- The “How to” Guides and Templates aid students and contains:
  - An introduction to technical communication
  - An explanation of the different types of written assignments in the class
  - Templates for formatting

Technical Communication vs. High School Writing

High School Writing

- Expository
- Double spaced
- Essay format
- Descriptive
- Length requirement

Technical Communication

- Informative
- Often Single Spaced
- Professional format
- Concise and precise
- Short is preferred