FRAME

Guiding Question

What are the wants and needs of stakeholders?

Most projects are brought to engineers by customers looking for a technical solution to a problem. What these stakeholders want is driven by a perception that the solution will improve their environment, simplify tasks, reduce costs, or address other needs.

The first phase of the engineering design process is to gather available information to frame the problem. This framing includes determining the wants and needs of the client as it relates to the project. Additionally, the requirements that the solution must address are established. The engineer is challenged with developing a *best-fit* solution for the problem based on this information.

What does the customer want? List them in the order from most important to the customer to least important.

Customer Wants & Needs	Customer Justification

You may not be able to address all the customer wants. In the next table, rank the wants in order from most important to least important--*as you see the importance*. Include a justification for your decisions.

Customer Wants & Needs(ranking)	Customer Justification

Requirements

Establishing the requirements of the project is a very important part of this first phase. Every activity in the rest of the project will be measured by whether it meets the specified requirements. The project must address these requirements to provide a solution. To establish the requirements consider the following questions:

- What are needs of the customer, the engineer, and the stakeholders?
- What additional factors are required for a solution?

Identify requirements below:
• **Project Specific Requirements:** **(cost, time limits, location, etc.)**

- **Technical Requirements:**
  (safety and codes, skills, conservation of resources, etc)

- **Human/Social Requirements:**
  (aesthetics, trends, history, values, ethics. etc.

How well do these requirements match with the customer wants? For those that do not match, make an argument for why they should remain a requirement.

The wants and requirements must be negotiated to develop a final requirement specification list. The negotiation must take place between all stakeholders, including the customer and the engineers. To move to the next phase, it is necessary for everyone to agree on the final list of requirements. Use your lists of wants and requirements to decide which of these your project will address. It may be necessary to communicated again with stakeholders to come to a consensus about the final requirement specifications.

Once you have come to a consensus, list the negotiated requirements that the design must address to provide a solution to the problem. List them here in order from most important to least important. Communicate this list with the rest of the stakeholders.

Negotiated Requirements

Now that you have decided on the requirements for your work, restate the problem. Include the clarified requirements to better frame the overall problem.

Problem
Requirements

You should constantly refer back to your framed problem in each phase of engineering design. Record the requirements in the box provided at the beginning of each phase.

RESEARCH

Requirements

Guiding Questions

What do I know and what do I need to know?
What are the best possibilities?

In this phase of the design process, you examine what you already know that may help you solve the problem. In the space below, list things you know that relate to solving the problem. This may include science concepts you know, people you might know that can help you and sources of information.

What I know that can help solve the problem:

Next, think about what you need to find out to solve the problem. You may need to learn about the science or math related to solving the problem. List what you need to find out below.

What I need to know to help solve the problem:

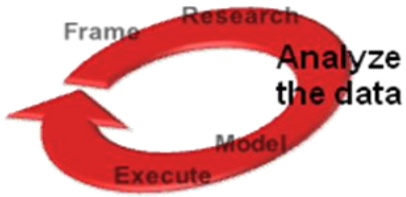
You will use many different ways to learn what you need to know. These may include investigations, reading journals or articles, interviews with experts, field trips, and internet searches. Record all your work in your journal. Your journal is a valuable tool and resource that can only help you if you keep a careful record of all that you learn and do.

Your journal should include all:

- procedures
- graphs
- charts
- drawings
- data
- questions
- ideas
- reflection

Once you have completed the research phase, it is time to consider all of the possibilities that you have for the solution to your problem. Do not forget to consider all required specifications. List all of the possible solutions to the problem.

All possible solutions to the problem:



ANALYZE

Requirements:

Guiding Question

How does the research data determine design decisions?

How do you find the best solution or solutions? You have a list of possible solutions to the problem from the research phase. Now you will analyze the data you have collected to come to a decision about the best solution. List your best options for the design. More than one acceptable option is a possibility, but in this phase you must justify your choices for the best options and eliminate others. Consider the requirements for the project and make a decision about your design.

Best options	Justification		Design decisions
		Which of the best options will you choose?	

MODEL

Requirements:

Guiding Questions

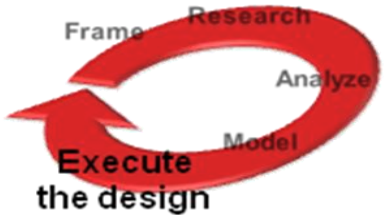
How do we model and justify our design?
How will the design perform?
Do stakeholders have suggested revisions?

In this phase, you will synthesize all of your design components into a system. This is not the actual implementation of your design but is a model. This model may be a detailed scaled drawing, a scaled replica of the final design or a detailed description. Once you have made your model, you must justify your decisions and predict the performance of your design. You will communicate your model in a formal presentation. A rubric is included to guide expectations for the presentation.

At the completion of this phase, you will need:

- your model,
- justifications for your decisions, and
- predictions for the performance of your design.

Presentation Rubric			
Evaluation Criteria	**Best** (can continue)	**Acceptable** (can continue with modifications)	**Needs Improvement** (can continue without major modifications and new presentation)
Design Specifications Recognizes major requirements that must be addressed with the project	Exceeds specifications given by addressing all needs with additional benefits or wants evident (if applicable) and noted	Meets specifications given for project by addressing needs	Does not meet the specifications provided; investigation should continue before moving to the next phase
Model Scaled model labeled with required information and measurements	Schematic or other representation is to scale and labeled with all required information and measurements; it clearly communicates information	Schematic is to scale and labeled with measurements and information to clarify	Schematic is not complete and needs information to move to the next phase
Justifications Addresses wants and needs that are considered essential to solution	Justifications for the solution are given by addressing requirements; includes elaboration with drawings, data and measurements	Justifications for the design communicate all aspects required to explain the solution	Justifications do not provide evidence needed to proceed; more information is needed to move to the next phase
Predictions Communicates anticipated performance of solution	Clearly communicates predictions on performance that meets requirements and provides evidence for predictions	Communicates predictions on performance that meets all wants/needs	Predictions are not complete or fail to align with design information provided; must adjust to move to the next phase



EXECUTE

Requirements:

Guiding Questions

What is our plan to execute the design?
How will we manage resources?

In this phase, you will produce the design as modeled and according to plan. As you complete this phase, you should develop and implement your plan to make and test your product. This will include:

- defining a timeline with personnel requirements and responsibilities,
- establishing inspection / feedback procedures,
- following all safety procedures, and
- adhering to relevant policies, codes, or laws.

When you complete this phase, your finished product should conform to your design specifications and meet all the requirements and expectations. Several templates are included to help you organize your work and feedback. The **Planning Template** is designed to help you plan and execute the design. Additionally, you will receive feedback from your peers and your teacher. Peer and teacher review templates are included to help you organize your feedback.

Design Implementation Team Roles and Responsibilities					
Name &Team Role	Responsibilities	Deliverables & Due Dates	Resource Requirements	Progress Assessment Criteria	Completion Evaluation Criteria

Execute Planning Template				
Design responsibilities	**Team member**	**Required materials**	**Due date**	**Requirement check off**
				☐ meets safety requirements ☐ follows codes/laws/policies ☐ follows model ☐ meets requirements
				☐ meets safety requirements ☐ follows codes/laws/policies ☐ follows model ☐ meets requirements
				☐ meets safety requirements ☐ follows codes/laws/policies ☐ follows model ☐ meets requirements
				☐ meets safety requirements ☐ follows codes/laws/policies ☐ follows model ☐ meets requirements
				☐ meets safety requirements ☐ follows codes/laws/policies ☐ follows model ☐ meets requirements

Review & Assessment						
Required Specifications	**Exceed (Evidence)**		**Meet (Evidence)**		**Adjust (Evidence)**	
	Peer	**Teacher**	**Peer**	**Teacher**	**Peer**	**Teacher**
Time specification for completion						
Meets budget requirements						
Presentation						
Justifies design based on Requirements						
Communicates STEM content required						
Demonstrates team cooperation						
Design performs as predicted						

Bill of Materials			
Part	**Quantity**	**Price/Unit**	**Total Price**
		TOTAL	