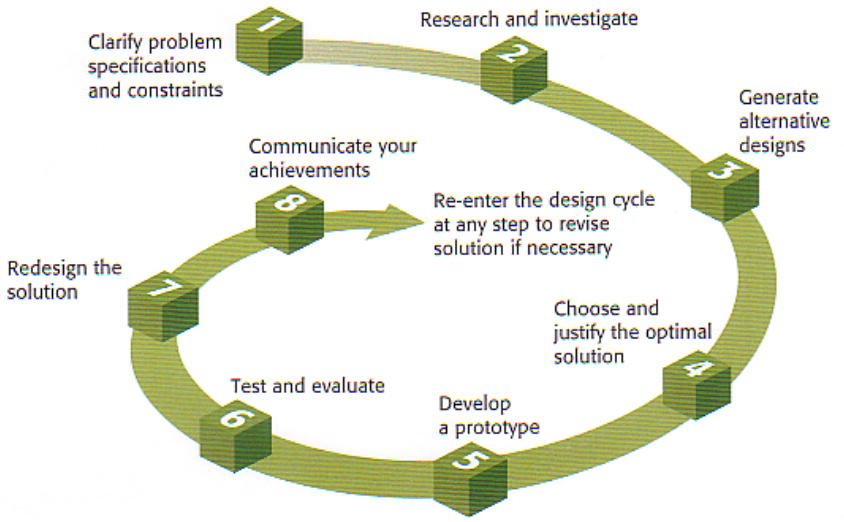
DESIGN JOURNAL

Operation: Safe Water for Bangladesh



Most engineers use a design journal to record their work. A design journal serves several purposes. It helps to ensure that you follow the informed design process so you can develop the best solution possible. In case you come up with a patentable invention it shows how and when you developed the idea. Please use it to keep track of everything you do to solve this problem, and be sure to date and initial every entry.

Name _____

Period _____

School _____

Date _____

Design Team Members: _____

_____

_____

DATE_____ **Initials** _____

The Grand Design Challenge

Operation: Safe Water for Bangladesh

Congratulations! Your training with Engineers across Borders has come to an end and now you are ready to take on your first challenge as a junior engineer. Your task, along with your teammates is to design and build a multi-system water filtering device that can produce safe drinking water for a family of five living in Bangladesh.

As with every engineering design challenge, there are design specifications and constraints that must be considered as you develop your solution; they are listed below:

Design Specifications:

1. Must be a multi-system filtering device (more than one filtration component, not just different media)
1. Must effectively remove contaminants from the water
2. Must have a turbidity measurement of <5 NTU's
3. Must be easy for the locals to use and take apart to clean
4. Must be capable of producing 20 liters per day of safe drinking water to serve five people

Design Constraints:

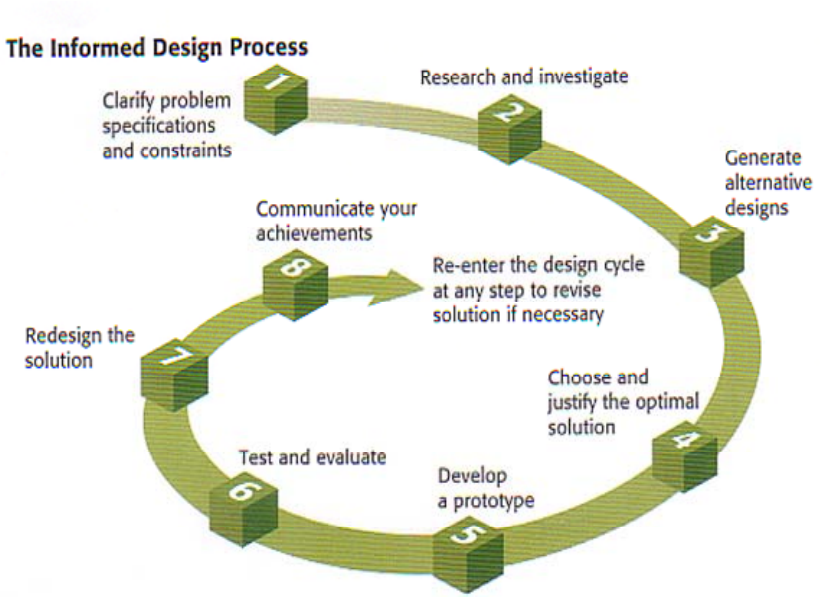
1. Must be made of materials native to Bangladesh
2. Must be completed in teacher-specified number of days
3. Must be of little or no cost

There are three lists below; think of these as possible construction materials and filter media. You may use other materials beyond the list; your teacher will decide if there will be a cost.

List 1: *Items that can be reused as possible building materials*	**List 2:** *Media easily found in Bangladesh*	**List 3***: Items available to purchase*	**Cost**
plastic cups	rocks	spigots	5.00
empty plastic bottles	pebbles	tubing	.50 p/in.
buckets	course sand	rubber bands	.10 ea.
clay	fine sand	tape	.50 p/ft.
scraps of material	charcoal	glue	1.00 p/stick
scraps of wood	grass	string	.50 p/ft.
cardboard	weeds		
	vines		
	paper		
	alum		

DATE_____ **Initials** _____

The Informed Design Process



1 CLARIFY THE PROBLEM SPECIFICATIONS AND CONSTRAINTS

***State the Design Problem in Your Own Words*.** The statement should not be long. Start with one clear sentence and add more sentences if there are important ideas that should be included. (Hint-refer to page 2.)

_____

_____

_____

_____

DESIGN SPECIFICATIONS: *Design specifications tell how a design solution must function to fulfill the challenge. These are the performance requirements that the solution must fulfill.*	**Describe the Specifications**	**GROUP ACTIVITY**
DESIGN CONSTRAINTS: *Constraints are the limits imposed upon the solution often related to the kinds of materials you can use, how much time is available, and in many cases, how much money the finished design can cost.*	**Describe the Constraints**	

DATE_____ **Initials** _____

2 RESEARCH AND INVESTIGATE

Engineering design involves gathering lots of ideas of many sources and making use of them to understand the challenge better and to get a sense of how others have addressed similar tasks. Working through the KSB's was a major part of this phase. But you may need to know more. Organize what you know and what you need to find out.

Summarize what you learned in the KSB's below in Column 1. Discuss with teammates what you think you may need to find out, then write those things in Column 2.

Column 1_**What I know**	Column 2_**What I need to find out**

INDIVIDUAL ACTIVITY

In this box, summarize the research you conducted as a result of Column 2.

DATE_____ **Initials** _____

3 GENERATE ALTERNATIVE DESIGNS

Engineering designers are famous for coming up with lots of ideas, from which they pick one to develop as a prototype. They brainstorm ideas without worrying about how good they are. They do these things so that they can develop something new and different, while still meeting the specifications and constraints of the project.

In this phase of the informed design process, you will first look around and see what others are doing.

That includes:

- Water Organizations
- Health Organizations
- Engineering Companies
- University Researchers
- Engineers without Borders
- Ordinary People

The links below might give you some ideas; check other sites as well.

Web sites:

- http://thewaterproject.org/biosand_water_filtration
- http://inhabitat.com/6-water-purifying-devices-for-clean-drinking-water-in-the-developing-world/
- http://www.cdc.gov/safewater/sand-filtration.html

Possible Solutions

1. Sketch two different possible ideas you feel might be possibilities for your final solution.
2. Write a short description below each sketch that explains your design and identifies your choice of materials and media.

INDIVIDUAL ACTIVITY

DATE_____ **Initials** _____

4 Choose and Justify the Optimal Solution

WEIGH OPTIONS / PICK an IDEA:

Use a Pugh chart to determine which idea is the best solution and to justify your choice as a prototype.

The design specifications are listed in the left column. Then look at each team member's sketches and number them to correspond to the chart. Rate each sketch on a scale of 1(low) to 5 (high).

PUGH CHART Who's design? *Ex. Amy 1, Amy 2, Seth 1, Seth 2* →	Design 1	Design 2	Design 3	Design 4	Design 5	Design 6	Design 7	Design 8
Device is multi-system; has more than two components								
Best capability to remove contaminates from the dirty water								
Easy for the locals to use and clean when needed								
Made of native materials								
No Cost								
Other								
Other								
Total Points								

GROUP ACTIVITY

Which design ranked highest and was chosen? _____

DATE_____ **Initials** _____

Detailed Drawing of the Chosen Filtering Device

- Each team member draws the chosen filtering device in the space below.
- The drawing must be very neat; include arrows and write notes to help clarify understanding of the construction, materials, media, and any other important details.

INDIVIDUAL ACTIVITY

DATE_____ **Initials** _____

5 Develop a Prototype

Make preparations to build your prototype.

Here's a reminder of your materials and media list. Circle which items you will use.

List 1: *Items that can be reused possible building materials*	**List 2:** *Media easily found in Bangladesh*	**List 3***: Items available to purchase*	
plastic cups	rocks	spigots	5.00 ea
empty plastic bottles	pebbles	tubing	.50 p/in.
buckets	course sand	rubber bands	.10 ea.
clay	fine sand	tape	.50 p/ft.
scraps of material	charcoal	glue	1.00 p/stick
scraps of wood	grass	string	.50 p/ft.
cardboard	weeds		
	vines		
	paper		
	alum		

What safety issues will you consider? _____

_____

Create a Plan of Action

There'll be lots of things to do. Use the chart below to list the tasks that need to be done in the order needed to complete them; who will do what, when, and mark done or not.

Task	Who	Due Date	Done
You are now ready to construct your water filtering device; get started! Take lots of pictures to use in your presentation.			

GROUP ACTIVITY

DATE_____ **Initials** _____

6 Test and Evaluate

GROUP ACTIVITY

Before you begin testing, determine the cost of your filtering device; make a list of the materials you used and show the total cost.	
	Cost
TOTAL COST	

It's time to see how well your device performs and meets the specifications and constraints of the challenge!

1. **Acquire your 16 oz of contaminated water from your teacher and a stop watch or timer.**
2. **Test your water sample to determine what contaminates are in it; use what you learned in KSB 4 and your turbidity tube. Write it in the space provided.**
3. **Start timing when you start to pour the water into your device.**
4. **This will be a ten minute test. If all your water has filtered out before ten minutes is up, stop the timer and note the minutes.**

DATA COLLECTION SHEET **Time it took to Filter Water _____ (sec's)**

	BEFORE FILTERING	**AFTER FILTERING**	**CONCLUSIONS**- Write a short summary of what happened
Water Amount			
Turbidity in NTU's			
Detect Bacteriological Contaminant? (Yes or No)			

DATE_____ **Initials** _____

Detect Chemical Contaminant? (Yes or No)			

Is your device capable of producing 20 liters of safe drinking water a day for a family of five?

_____ Amount of water that filtered in 10 minutes (in liters)

_____ Based on amt. and time above, how much water can your device filter in one hour?

_____ Based on amt. and time above, how much water can your device filter in 24 hours?

Show your work here:

Check *yes* or *no* if the specification or constraint was met.		
Yes	**No**	
		Is your device a multi-system filtering device? (more than one filtration component, not media)
		Did your device remove the contaminants from the water?
		Does your filtered water meet the required turbidity measurement of <5 NTU's?
		Is it made of materials native to Bangladesh?
		Is it easy for the locals to use and take apart to clean?
		Can it produce 20 liters per day of safe drinking water to serve a family of five?
		Did you complete the device and testing in the required amount of time?
		How much did your device cost?

DATE_____ **Initials** _____

What conclusions about your device did you reach as a result of the testing?

Please try to address each area of the specifications and constraints.

7 Redesign the Solution

GROUP ACTIVITY

Think about what you learned through the design and/or testing of your prototype and think about how you would make changes to the design if you were to do the activity again.
What did you learn through the design and/or testing of your model that would inform its redesign?

_____

_____

_____

What would the filtering device look like if you built it again? Sketch below and explain.

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If time allows, redesign your system and test and evaluate again.

Your teacher will provide you with the information you'll need to redesign.

Communicate Your Achievements

GROUP ACTIVITY

Plan and deliver a presentation about your design solution to the entire class. Use a variety of media (PowerPoint, WEB 2.0 Tools, etc.). Your teacher will supply WEB 2.0 information.

Dress professionally for your presentation.

In the presentation:

- Describe your design
- Demonstrate how you tested your design.
- Explain results of the testing.
- Describe how you met the specifications and constraints of the challenge, or not.
- Explain improvements you would make as a result of the testing.
- Thinking about the project as a whole, what were the most challenging steps?
- What was the most important thing you learned?
- Include pictures of your design and process as you and your team worked on this challenge.

Rubrics

STUDENT PRESENTATION RUBRIC	**Student**	**Score**
Overall Presentation Quality		
Introduction (interest and appeal)	**5**	
Clarity and sequence of presentation	**5**	
Student dressed professionally	**5**	
Clarity of speech, pacing, pitch	**5**	
STEM Learning		
Students explained what they learned	**5**	
Students explained tradeoffs they made in arriving at their group design solution	**5**	
Students proposed revisions upon what they learned	**5**	
Students played an active role in developing and making the presentation	**5**	
Use of Media		
Use of multiple types of media	**5**	
Quality of materials	**5**	
50 TOTAL POINTS		
Teacher Comments:		

DATE_____ **Initials** _____

STUDENT DESIGN JOURNAL RUBRIC		Score
1. Clarify design challenge, specifications and constraints		
Student accurately described the design challenge, its real-world context, and all the performance criteria and constraints.	**10**	
2. Research and Investigate		
Student described ideas relevant to the challenge that were gained from KSB tasks, and other research work needed.	**10**	
3. Generate alternative design solutions		
Student described two or more different ideas for possible design solutions using words and drawings.	**10**	
4. Choose & justify optimal solution		
Student analyzed the pros and cons of alternative designs, identified tradeoffs, and explained how the selected design may optimally meet criteria and constraints. Filled out the Pugh Chart	**10**	
5. Develop a prototype		
Student used appropriate tools and materials to make a physical or virtual design prototype that met the design criteria and constraints.	**10**	
6. Test and Evaluate		
Student developed, conducted, and documented appropriate tests and data to assess the prototypes' performance with respect to criteria and constraints	**10**	
7. Redesign the solution		
Student described two or more different ideas for possible design solutions using words and drawings.	**10**	
8. Communicate your achievements (See presentation evaluation criteria).		
Students contributed to a team presentation about their design and the design process.	**10**	
80 TOTAL POINTS		
Teacher Comments:		

DATE_____ **Initials** _____