High School

Time Frame: Three 45-60 minute sessions (times can be easily modified)

AIM: How can we design (and build) a sustainable dam for the people of Balang Commune?

NEEDED PRIOR KNOWLEDGE: Background on Cambodia (available materials, poverty, culture). Visuals of dams familiar to students,

LEARNING OBJECTIVES: *Aligned with Massachusetts standards for technology/engineering HighSc*

- Explain problem and develop possible solutions that consider human values/culture, economics, health and environment
- Perform individual engineering functions in order to share research/ideas in team collaboration
- Choose optimal solution, clearly documenting ideas against design criteria and constraints
- Create pictorial and multi-view drawings that include scaling and dimensioning
- Create engineering design presentation using multimedia, oral, and written communication
- Optional extension—Construct a truss and analyze to determine whether the members are in tension, compression, shear and/or torsion

GUIDING QUESTIONS (GQ):

1. What challenge(s) do the Cambodian people face?
2. How can our group work together to find and present a solution for the community?
3. Which solution is optimal and how did you choose?
4. How can we share our solution with the community?
5. Why was your idea good for the community now and in the future?

LESSON PLAN / ACTIVITIES:

Materials: Poster Paper, Information on Cambodia—including articles, visuals, maps, ect., engineering drafting paper or internet, one empty plastic cup, 10-15 popsicle sticks, one plastic cup full of grave (optional), one plastic cup full of soil (optional), one Styrofoam tray, one square of card board at least 6" square, one block of modeling clay, scissors, masking tape, metal paper clips, string, and engineering or graph paper, water, presentation equipment (if available),
Worksheets: Engineering Design Process, Environmental Impact Statement (EIS), Example EIS: http://www.southlawrencetrafficway.com/downloads/Summary.pdf, Community Outreach, Final Proposal/Budget

Day One:

Task One: 5-10 minutes

Present Cambodia Situation to students—read situation and have students respond to the following question in the step one box of their engineering design process worksheet (Engineering Process)

1. What challenge(s) do the Cambodian people face?

Turn and talk share with partner. Students should add his/her partner's different responses to sheet. Project manager should record all responses on Group Engineering Process Sheet (which could be a poster that would later be used for presentation.

Task Two: 30 minutes Students should be divided into teams of four. Teams should research the situation in Cambodia—people, environment, housing, needs, resources, ect—by dividing research to individuals based on each role. Students should research in the library or online. If internet is not available, teacher should provide information including the following: maps, photos of community, natural environment, housing, river, dams (others in Cambodia and familiar local dams). Students should record information that they find that would be useful for planning a solution.

Suggested Websites:

- EWB Cambodia Link (location, photos,current design): http://ewbnycambodia.blogspot.com/
- Human Translations (Villagers): http://www.humantranslation.org/Gal_Balang/index.html
- New Orleans Levee break: http://soundwaves.usgs.gov/2006/01/
- Dam Vocabulary: http://water.nv.gov/Engineering/Dams/Glossary.cfm
- Dam Basics: http://www.pbs.org/wgbh/buildingbig/dam/basics.html

Engineering Team Structure: Students should be divided into teams of at least four. Each group should be assigned a function: Geotechnical engineer (materials/forces), Anthropologist (historic and cultural considerations), Environmental engineer (Sustainability and EIS), Project Manager (Public, manager, timeline, communication), see below. ***Research tasks in bold.***

Environmental engineer	**Environmental engineer may research and advocate for environmental concerns of community (this includes finding out local available resources, local health and environmental concerns, global impact of project—CO_2 emissions, energy consumption, ect., dams in neighboring villages).** It will also be the job of the environmental engineer to be the primary person involved in the write up of an environmental impact statement.
Anthropologist	**Anthropologist would research the history and cultural needs of the community—looking at South Asia, Cambodia as a country, and any information that is known about the village.** The anthropologist should advocate for the human needs of the community and should brainstorm ways to empower its citizens to take ownership of the project. What sort of community education initiatives could our team develop? How will this project move the community forward? What have we learned from the past and how can that be applied to this project and the future?
Geotechnical Engineer	**Geotechnical Engineer would research dam structures used in similar situations domestic and international—pictures would be a useful way to record research. This person would also indicate the materials needed for each type of dam and what resources are readily available at the site.** The geotechnical engineer will be the guiding force behind the dam design. This does not mean that the geotechnical engineer must choose the design or draft all of the plans, rather in means that this person will facilitate the discussion and will review the final plans to make sure that they are accurate and aesthetic. The geotechnical engineer may decide how the team will represent its solution—multi-view hand drafted plans, AutoCAD, sketches that include natural environment/community, or a combination.
Project manager	**Project manager should research the specific situation, by taking notes from problem statement and discussing problem with teacher and EWB chapter (if available). PM should also organize and compile the group's research.** The PM must be in communication with all of the team members, the local community leaders (the teacher or EWB chapter should act as this voice). S/he may also outreach to other teams to share ideas or team up. The project manager is also in charge of considering the budget—

	and all economic concerns. How will we collaborate with the community to obtain funding for this project?

Task Three: 5-10 minutes In teams answer the following together and record on Engineering design process worksheet.

- Based on your research, what does the community need and what resources do they have to offer?

Recap: 5-10 minutes *In engineering journals, answer the following questions:*

2. a. How did our group work together to thoroughly understand the situation in Cambodia?
   b. How will our group work together to find and present a solution for the community?

Homework*—Use class notes from individual and group research to answer the following:*

- *What are some viable solutions for the community? (at least three)*
- *Which solution is optimal and how did you choose?*
- *Why was your idea good for the community now and in the future?*

DAY TWO: Design!

Task One: 5-10 minutes In groups, share responses from homework. Groups should discuss and chose the optimal solution. Project manager can record group response on the group Engineering Process Sheet.

Task Two: 25-30 minutes Each team member works on their individual design task—group can collaborate to resolve challenges that arise and answer teammate's questions. **Design tasks in bold.**

Environmental engineer	**Design task: Collaborate with anthropologist and teammates to write up the environmental impact statement.** Consider future environmental impacts as well as initial impacts. Environmental/Human Impact Statement worksheet
Anthropologist	**Design task: Design initiative that will educate and empower community to own and maintain the project. Choose one part of the project—example: the materials used—and create a workshop for grade school students that discusses the purpose of that part of the project—example: Why were the material used and what other materials could have been used instead?** The anthropologist should advocate for the human needs of the community and should brainstorm ways to empower its citizens to take ownership of the project. How will this project move the community forward? What have we learned from the past and how can that be applied to this project and the future? Community outreach worksheet
Geotechnical Engineer	**Design Task: The geotechnical engineer will be the guiding force behind the dam design—structure and materials. This person will facilitate the discussion and will review the final plans to make sure that they are accurate and aesthetic. The geotechnical engineer may decide how the team will represent its solution—multi-view hand drafted plans, AutoCAD, sketches that include natural environment/community, or a combination.** *Available drafting paper and tools*
Project manager	**Design Task: The PM will work very closely with the geotechnical engineer to draft the plans. Also, the PM (and others) should be in communication with all of the team members, EWB-chapter, teacher, the local community leaders. S/he may also outreach to other teams to**

	share ideas or team up. The project manager is also in charge of considering the budget—and all economic concerns. How will we collaborate with the community to obtain funding for this project? *Final proposal and budget worksheet*

Task Three: 5-10 minutes Teams bring together what each member has completed. Each teammate presents work and hears feedback. When every member has gone, team members use feedback to make revisions.

Recap: 10 minutes Class divides into four corners, each corner is a different job (Environmental, Project manager, ect) Individuals present their work to the people with their same jobs and record feedback. When every person has gone, individuals take feedback to team and discuss possible revisions.

Day Three: Build, Test, and Present Prototype!

Set up: Set up tub stations with wet sand sloped to one side. Don't wet the sand too early or it may dry out. Students should sit with teams. Each team receives a tool set—including at least one empty plastic cup, 10-15 popsicle sticks, one plastic cup full of grave (optional), one plastic cup full of soil (optional), one Styrofoam tray, one square of card board at least 6" square, one block of modeling clay, scissors, masking tape, metal paper clips, string, and engineering or graph paper. Provide water when the dam is ready for testing.

Task One: 15-20 minutes Teams will first mold a stream/river in the wet sand. Then, teams will build a small model of a dam that they have designed using the allowed materials that spans the river. Students should choose and label materials to represent real-world materials in Cambodia.

Task Two: 25-30 minutes Final presentations. Groups will present final project to class in format of their choice. Groups may want to use their Engineering Process Worksheet (or poster) as a framework for the presentation. Teams must use more than one method for presentation—verbal, visual, computer, ect. Presentations must include the following:

- Testing of the prototype
- Description of design process and design rationale
- Environmental impact of project
- Project Budget

3. How the solution will be shared with the community

Final Thought: **5-10 minutes** In engineering journals respond to the following question:

4. Why was your idea good for the community now and in the future?

Forms of Assessment:
Research Notes—distinguishing important information
Oral answers to guiding questions
Peer Turn and Talk responses to in class questions and homework
Worksheet—Engineering Design Process
Team share
Drafted dam designs/Environmental and Human impact statement
Final presentations (written, poster and oral)
Communication with teacher and EWB representatives (if available)