

## Solar Oven Design Brief

### **Problem Statement:**

*Beep...Beep...Beep... The beeping of Shree's heart monitor was both my personal blessing and curse. It was my constant, steady reminder that my sister was alive, but battling to survive and in critical condition. As I lay on my cot in the infernal heat, the dust never settling in the makeshift medical hut, I listen to the doctors' conversations and bustle of the American Red Cross volunteers, working to save survivors of the quake...*

\*\*\*

Shree and I were brought in to the medical hut only yesterday; we were pulled from the rubble of our once beautiful home. Mother and father were away at the market when the house began to shake. It shook so hard the wall with the big window overlooking the front yard crumbled to the ground before my eyes. The earth turned to liquid, and it kept moving back and forth. It felt like we were in a boat being tossed around. The last thing I remember is lying on top of Shree trying to protect her as our whole world came crashing down loudly around me.

The doctors have not paid me much attention. Aside from my broken leg, crushed collarbone, and badly bruised neck, I am relatively okay. Shree is not. She has not woken up since the Red Cross saved us from our destroyed home and I overheard the doctors say she needs surgery to stop her internal bleeding. "Surgery is scheduled for tomorrow," I heard the lead-doctor say. All I can do is lay here -listening to the beep... beep... beep- and pray that she wakes up. I am thankful for that cursed beeping; at least I know she is alive.

As I stare at the monitor producing the bittersweet beep, my eyes catch a shiny glimmer. The metal instrument on the tray table next to Shree's bed began to rattle. My breath is trapped in my throat. I stare intently as the rattling medical tray begins to shake and rattle and eventually fall over with a loud clang. Here comes another tremor. With eyes fixed, breath held, and muscles clenched, I listen carefully for Shree's only evidence of life. All sounds of sanity are swallowed by the vicious earth- relentless and refusing to be still. Then, after what felt like forever, the tremor stilled and the dust began to settle. The benevolent beep... beep... beep returned and I exhaled a stream of sheer relief. As if surviving the biggest earthquake Nepal has ever seen wasn't enough, now we suffer through tremors as often as four times a day.

Three doctors and a nurse circle Shree's bed.

"Without an ultrasound machine there is no way to tell how much damage there is," said the lead doctor.

The youngest-looking white coat asked, "So, is the surgery then considered exploratory?"

"Well, technically, yes. Although with the right medical equipment, this has the potential to be a relatively easy save."

"I just wish we knew where the source of the bleeding was," said the third.

With sage wisdom the lead doctor replied, "I am thankful for what we have. Sure, the circumstances are not ideal, but we have enough technology and resources to save this young lady's life. It may take longer than we would like, so we should all be prepared for a long

surgery in the morning. Nurse, please prep the patient, sterilize the equipment, and be prepared to help us in the morning. It's going to be a tedious procedure and we'll need all hands on deck."

The three doctors continued on their rounds and I watched the nurse make various notes in Shree's folder. Beep... beep... beep flooded my ears. Tears began to flow down my face and I turned to look through a rip in the plastic wall. The sun was setting as I watched another van pull up with survivors. I took a deep breath and hoped sleep would come quickly.

The hustle and bustle of the medical hut died down slowly. Sleep did not come quickly and soon I was listening to the rhythmic sound of Shree's heart monitor and the crickets. The night's song was a steady, "chirp, chirp... beep... chirp, chirp... beep... chirp, chirp... beep..." I strained my neck to gaze at the stars through the rip in the plastic wall. I wondered what tomorrow's surgery would bring. Would Shree finally come back to me? Would they operate on her right next to my bed? Would I have to watch and listen to the whole procedure? Would they be able to stop the bleed that is coming from who knows where? I cleared my mind to listen, "chirp, chirp... beep... chirp, chirp... beep... chirp, chirp... beep..." I hope the doctors knew what they were doing. I had watched the nurse sanitize medical equipment and prepare for surgery before. I watched as she plugged in the machine that looked like a cross between washing machine and a dishwasher. She'd lay various scalpels, tweezers, scissors, and other instruments whose names I did not know on wire shelves, set the timer for twenty minutes and wait for the machine to signal it had done its job. She had meticulously busied herself with this task at least a dozen times since we arrived. As I tried to imagine the nurse sterilizing the equipment for Shree's procedure tomorrow, my ears tuned in to the night's song, and I drifted off to sleep.

I awoke to the sound of plastic and paper being crumpled and smoothed, metal clanging on metal, and the buzz of adult conversation. Once again my ears sought the familiar signal that my sister was still alive. She had made it through the night and was being prepped for surgery. I watched as the nurse checked Shree's vitals and recorded them in her chart, then as she carefully wrapped Shree's hair in a paper cap, and finally draped paper and plastic sheets methodically around her body. Just as she was finishing, the lead doctor joined her, "Are we about ready to begin?" he asked. "Almost, doctor," she replied, "I just need to sanitize the medical instruments and we will be ready. I've prepared her chart for you." As he took Shree's chart from her hands, he said, "Great, we are on schedule. Twenty minutes is about how long I'll need to read over the patient's information one final time, scrub for surgery, and plan our approach for finding this bleed. Once you've started the autoclave, please call the anesthesiologist." The doctor sharply turned and walked away. The nurse began to gather the medical instruments from the tray and place them in the machine that sterilizes them, just as I had seen her do so many times before. Once the machine was loaded, she set the timer and walked away.

As I lay in my cot watching the timer begin to count down on the machine, I listened to its hum and Shree's heart monitor. In twenty minutes the doctors would begin surgery, my heart started to race and my mind began to wander until the nurse delivering my breakfast tray pulled me back to reality. I hadn't realized how hungry I was. I began to unwrap the plastic from my bowl of dhido when I noticed the plastic cup of water begin to ripple. Slowly the ripples turned to splashes and then the earth started to tremble again. The hanging lamps jumped from side to side and my water tipped over and spilled all over my bed. The sounds of rattling instruments and scared patients waking up to the quivering earth were quickly engulfed by the furious

tremor. The tear in the plastic wall violently ripped open, the side of the tent collapsed and clouds of dust and dirt filled my lungs. The tremor went on for an eternity.

Then silence and stillness filled the medical hut. I listened to the pounding of my heart amplified in my ears and held my breath again. Where was the blessed, cursed beep...beep...beep? The silence was palpable- no beep, no hum, no clock counting down on the machine. Panic set in. Was Shree still breathing? I tried to scream for help, for someone to come and check on my sister, but there was no voice to be found. Tears of helplessness and terror overcame me.

The nurse ran quickly to check on Shree and then to the sterilization machine. The lead doctor was at Shree's bed at once. He listened to her heart and checked her vitals prudently. Tears of joy and relief flowed when he announced Shree's heart was still beating. "Luckily, she survived the tremor, but I fear she is running out of time. It's time to begin the surgery," the doctor said. With fear in her voice, the nurse responded, "But, doctor, the autoclave didn't finish the sterilization cycle and the power is out. Without sterile equipment, there is no way to safely operate. How can we possibly sterilize the instruments without the autoclave?"

"The sooner we figure out the answer to that question, the sooner we save Shree's life," answered the doctor.

### **Design Statement:**

Design and build a solar oven, using available recycled materials, to boil water and/or sterilize medical equipment.

### **Design Criteria/Constraints:**

1. The oven cooking chamber's length (L) and height (h) and depth (d) need to be at a **minimum** of 11.5" x 6" x 11.5" (l x h x d) and a **maximum** of 24" x 24" x 24".
2. The oven must be equipped with convenient access to the cooking chamber so that a container with water can be cooked.
3. The oven must accept a digital thermometer that will stick through an oven wall to measure the temperature inside the cooking chamber.
4. The winning design will be based upon the rate of temperature increase over time.
5. Designs with reflectors are permitted and may be necessary to achieve optimal temperatures in a short amount of time.

### **Materials:**

Teams will be provided recycled materials such as cardboard and shredded paper. Design materials that are also available for use include duct tape, black paint, and aluminum foil. Teams will also be provided one piece of clear plexi-glass that is approximately 12" x 12". Other RECYCLED materials may be used with instructor approval. However, the RECYCLED materials will be limited to paper/wood products, styrofoam, and aluminum. The only material that is allowed to be used for reflective capabilities will be aluminum foil.

## **Deliverables:**

1. Team Norms located in Engineering Notebook.
2. Gantt Chart/Timeline located in Engineering Notebook.
3. Documented research in Engineering Notebook (include references)
4. Hand Sketches of possible solar oven designs in Engineering Notebook (each team member responsible for one sketch).
5. Design Selection Matrix indicating winning design solution.
6. Engineering Notebook documentation/notations of the process of constructing and testing the solar oven.
7. Data Analysis and graphical representation of initial performance testing (including initial temperature and the rate of increase in temperature over time (logistic regression)).
8. Explanation of the use of insulation if materials, if used.
9. Evaluation of performance of initial design and method used to improve design for second performance test (documentation).
10. Data Analysis and graphical representation of second performance test (including initial temperature and the rate of increase in temperature over time (logistic regression)).
11. Persuasive summary of why your design is optimal (marketing).
12. Correct usage of English spelling and grammar.
13. A description of each team member's contribution on this project.

## **Grading Criteria:**

- Technical report (to be completed in your English course)
- PowerPoint presentation to include evidence of the deliverables listed above.  
Presentation must be 3-5 minutes and ready to be delivered by \_\_\_\_\_
- Group Member Assessment (Weekly Self Evaluation and Teammate Evaluation).

Teamwork is 20% of the overall grade  
Engineering Notebook is 30% of the overall grade  
Presentation is 50% of the overall grade