2002 Introduction to Engineering Team Project

Team Members:

Sergio Benavides
Alvaro Deleon
Melinda Delgado
Chris Navarette
Rose Rainoldi

Conducted by:

Dr. A. Fuentes

April 29, 2002

Table of Contents

Problem Statement

A surface mining company is looking for an innovative and economical way to transport iron ore up from the bottom of their open pit mine. The company would like to take the fullest advantage of the potential gravitational energy that exists in nearby streams. They have proposed a contest to the university's engineering students to design a prototype system. Each team is required to submit design, economic and safety reports. The team that is able to transport the heaviest amount of iron ore up from the bottom wins.

Summary of Design Contest Parameters

(as set forth by Dr. A. Fuentes)

1. The simulated center of mass ore must be carried up on a ramp with a 60 percent grade. The required distance traveled on the ramp will be 100 cm. Dimensions of the ramp are as follows: length = 120 cm., width = 7 cm., thickness = 3.8 cm.
2. Two successive runs must be made, each starting with two liters of water and a team-selected quantity of simulated ore. Each team may choose the amount of simulated ore to be placed in their ore bucket for each run.
3. Teams will be assigned their order in the competition by a random process. Teams will have three minutes to set up their devices. Clamps, tape and other devices may be used to fasten the device to the simulated mine, but nothing may be used which will damage or modify the surface for other contestants. If assembly continues beyond the three-minute limit, a penalty of 25 points per second will be assessed. Failure to ready the system within 5 minutes from the starting time will result in disqualification and the team will be asked to remove its system from the simulate mine.
4. All energy input to this system must come from the potential energy of the water in the reservoir. No energy storage components are allowed, including batteries, capacitors, springs, flywheels, or other falling weights.
5. Two liters of water will be supplied in a reservoir whose drain outlet is located 1.0 m. above the base on which the ramp sits.
6. Once the run commences, the team may not touch or assist the device.
7. The water leaving the team's device must be discharged at least 10 cm above the plane of the base on which the ramp sits. The device must not spray or spill water so that it falls outside the catch pan.
8. Each team's score will be computed by the sum of the score from two runs.

Design

Initial Design

Our team first decided to make and utilize a 4-pulley system in the hope of being able to lift a greater amount of weight than the water. We gathered enough information to design our pulley system. Since the winner of the competition is determined by adding up the sums of the amount of weight lifted in the two runs, in theory the use of 4 pulleys would allow the 2 liters of water to pull 4 times its weight up the ramp. In order for this system to work there would have to be two free flying pulleys attached to each other. There was one major problem we encountered with this design. To make up for the force that is lost; we would have needed to increase the distance that the water travels. Since the contest parameters specifically state that the water cannot move down more than 90 cm. (while the truckload moves 100 cm.), we decided to abandon this design.

Final Design

Our team's final design is much simpler. It consists of a single pulley and two spools of sewing thread. The two spools are different sizes and are nailed firmly to each other (similar in design to a wheel and axle). Each spool has a string tied to it. The truck is tied to the larger spool, while the water container with the help of one pulley is tied to the smaller spool. The purpose of the two spool apparatus is to convert the 90 cm. of allowable water drop distance to 100 cm. that the truck is required to travel up the ramp. As the water fills the catch container, it will pull on the spool apparatus and start it rotating. At the same time the spool with the larger diameter will be turning in unison and pulling the truck up the ramp at a greater distance. The spool apparatus is constructed of two eye hooks screwed into a piece of wood which is clamped down onto the end of the ramp. A 7" screw is hung between the two eye hooks and inserted through the spools. Various nuts and washers are used to stabilize the movement of the screw.

The truck we used is a plastic toy dump truck, which is lightweight and has 2-inch diameter tires. We added height to the walls up the dumping apparatus to prevent the nuts and bolts (simulated iron ore) from falling out. The wall extensions were made of cardboard, so they would not add much extra weight to the truck. The pulley we used is screwed on to a wooded board that is 130-cm. high. We constructed the stand with 7 varying sized pieces of 2 X 4's screwed tightly to each other for sturdiness. Our water container is also made from plastic in order to not add a lot of extra weight to the water as it is pulled down by gravity. As the water is released, it is carried to our container by the use of a hose. We made a hole in the side of our container to allow the hose to empty the water inside without spilling. We did several trial runs on our project and we were able to move about 0.75 kg. of weight up the ramp 100 cm..

Design Materials

(5) 2" x 4" wood boards

(12) 2-1/2" wood screws

(3) 1/4" nuts

(1) Toy dump truck

(1) 1 meter garden hose

(3) C-clamps

clear plastic tubing (4 in.)

(2) spools of thread

Metal edging (3 ft.)

(1) pulley

(1) 7" screw w/nut and washer

(2) 1/4" washers

scrap cardboard

tape

(2) eye hooks (3-3/4")

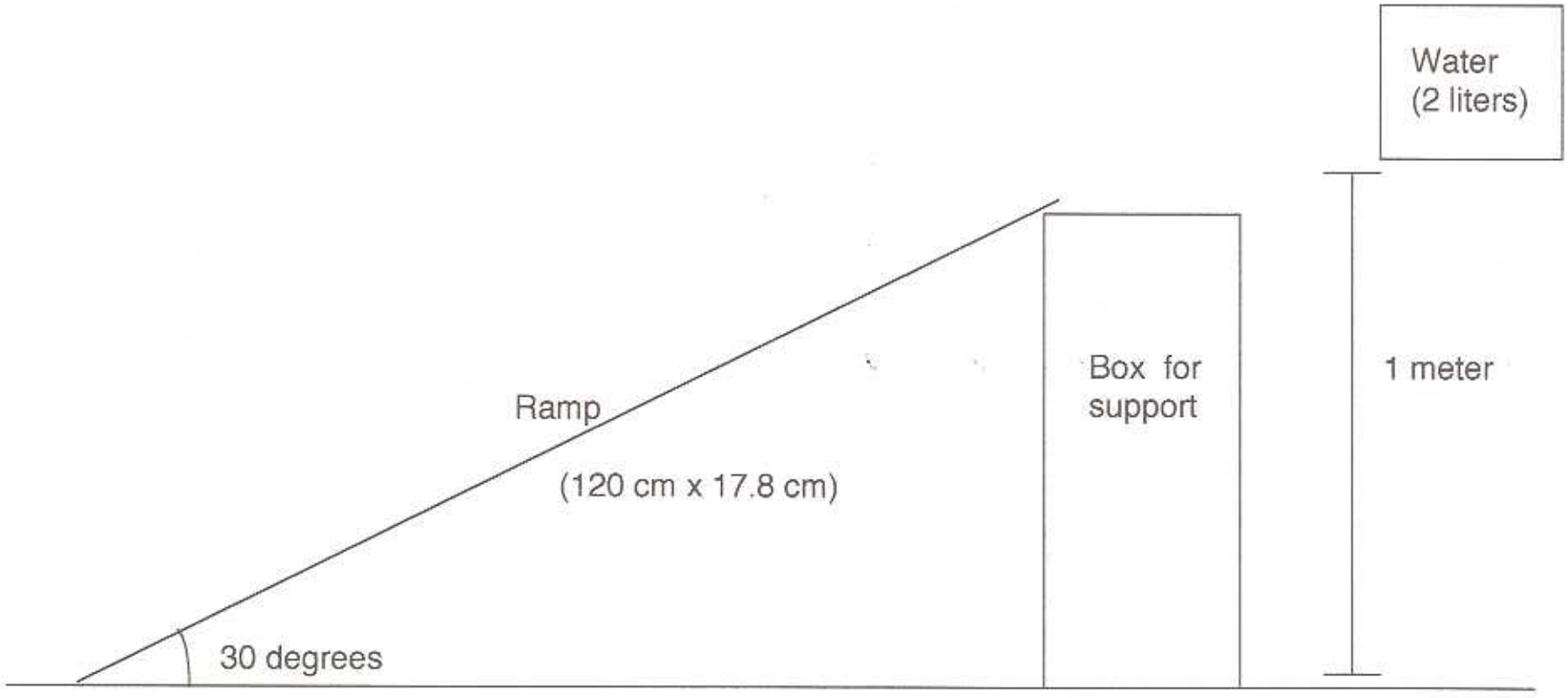
7/64" diameter string

(1) plastic water catchment container

Tools Needed

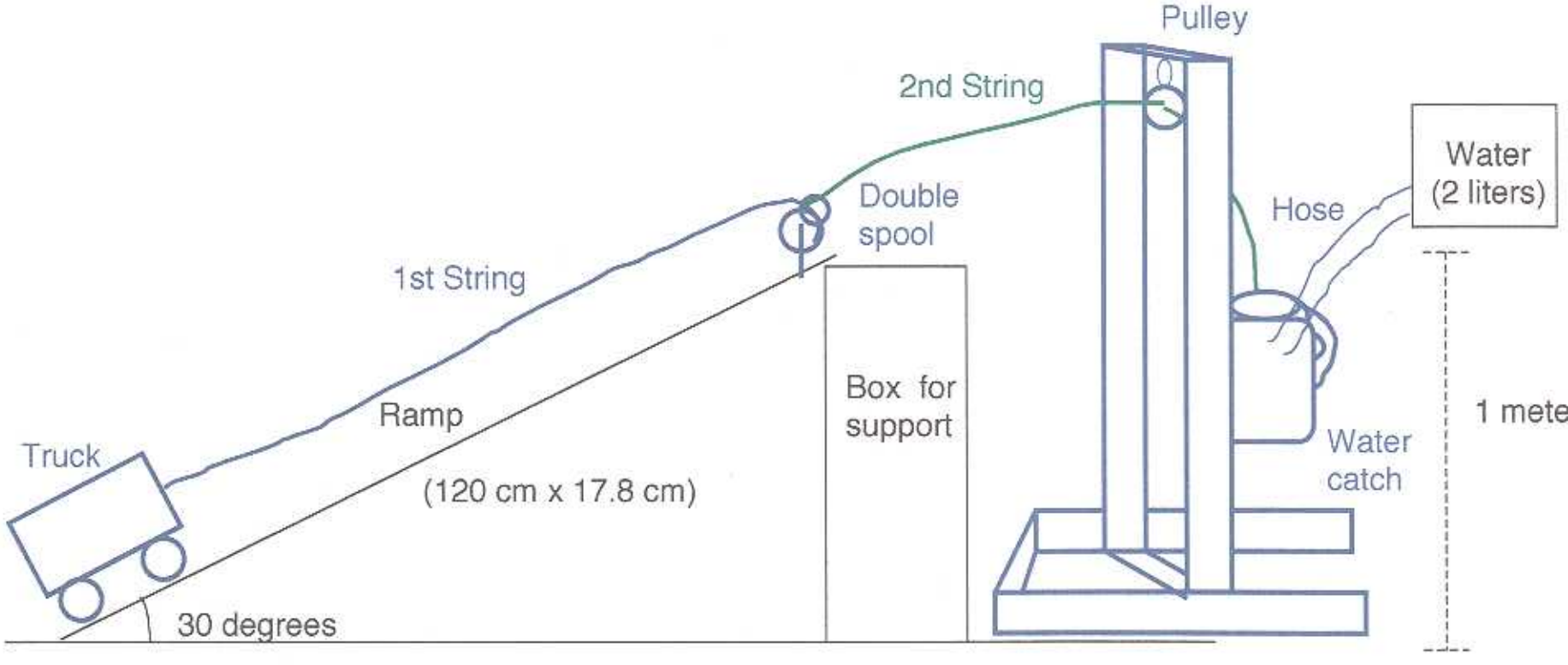
Power drill
Assorted screwdrivers
Scissors
Hand saw or circular saw
Cutting knife
Pencil
Measuring tape

Initial Set-up



Not to scale

Final Set-up



Not to scale

Economic Statement

The following table lists the construction costs for all items necessary to build one mining unit.

Item Description	Quantity	Cost	Total
2" x 4" pine boards (scrap wood)	2	0.00	0.00
7" screw, washer & bolt	1	0.63	0.63
Cardboard, scrap (8" x 20")	1	0.00	0.00
Clamps (on loan – no charge)	4	0.00	0.00
Eye hooks (1/4" x 3-3/4")	2	0.69	1.38
Garden hose (30 inches)	1	0.00	0.00
Metal edging (3 ft.)	1	1.29	1.29
Nuts & washers (1/4")	3	0.51	0.51
Plastic tube, clear (4 inches)	1	0.34	0.34
Pulley (3/4" swivel ring)	1	1.99	1.99
Screws, wood (2 1/2" Philip head)	12	0.12	1.44
String, mason line (7/64 in. dia. – 10 ft.)	1	0.60	0.60
Thread spool (scrap)	2	0.00	0.00
Truck	1	1.88	1.88
Water catchment container (free)	1	0.00	0.00
TOTAL			**$ 10.06**

Safety Report

Safety was the number one concern on all our minds. Following proper safety precautions will reduce the risk of personal injury to our self and our teammates. Negligence of safety is negligence of proper engineering etiquette.

Construction

During the early construction stages of the frame, wood had to be cut and manipulated to meet certain needs. When we were cutting wood, we had on proper eye protection and we also made sure there weren't any foreign objects in the way of the blade.

Testing

When the frame had been constructed, the team began putting our system together and performing tests along the way. There were several concerns about our device that we kept in mind: water reservoir, moving string, pulleys (fixed and free moving), wheel and axle, and car.

Water Reservoir

The water reservoir catches the water through a hose. A string suspends the reservoir. As the reservoir fills with water it begins to sink, pulling on the hose. All hands and feet need to be clear of this area, as the reservoir has a tendency to jerk at times.

Moving String

It is important to keep fingers and hair clear of this, as they may get caught causing pain.

Pulleys

Pulleys change direction of force. It is important to keep fingers and hair clear of these.

Wheel and Axle

The wheel and axle device is a rotating device that is dispensing and collecting string all at once. It is important to keep fingers and hair away from this device. Failure to do so may result in pain and damage to the device.

Car

It was important that we did not leave the car lying around on the floor, as to where someone may trip and fall. Taking good care of this device ensures that it was able to hold its required wait and prevented injury to anybody else.

One of the most important safety aspects was communication. When we were testing, we made sure that everyone was watching and not touching.

Project Timeline

Task		April 1 – 7	April 8 – 14	April 15 – 21	April 22 - 28	April 29
Brainstorm ideas	Team					
Research design	Team					
Finalize design	Team					
Gather materials	Rose, Sergio, Melinda					
Develop prototype	Chris, Alvaro					
Construct prototype	Sergio, Chris, Alvaro					
Test prototype	Team					
Fine tune prototype	Rose, Melinda, Sergio					
Rough draft report	Rose, Melinda, Chris					
Final report	Team					
Report & prototype	Team					
Contest	Team					

Participation Report

Name	Design Conception	Project Construction	Final Report	Total Individual Participation
Sergio	20%	30%	0%	50%
Alvaro	20%	20%	30%	70%
Melinda	10%	0%	0%	10%
Chris	20%	20%	30%	70%
Rose	30%	30%	40%	100%
	100%	100%	100%	