To: Engineering Communications
From: Patrick Austin (10-1)
Date: February 24, 2017
Subject: K-10 Project Proposal, Rough Draft

## Abstract

*By: Patrick Austin*

K-12 students in Nevada have compared poorly to students elsewhere in the country and abroad in STEM areas. Introducing students to engineering and science concepts early and reinforcing that introduction with hands-on experience, should result in students better prepared to apply that knowledge. Team 10-1 has designed a project which aims to give students a hands-on experience to support engineering concepts at an appropriate level of difficulty and complexity for their grade level.

## Design Concept

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As discussed in the Problem Statement, K-12 students in Nevada have ranked poorly in STEM areas when compared with students elsewhere in the country and abroad. Introducing students to engineering and science concepts early and reinforcing that introduction with hands-on experience, should result in students better prepared to apply that knowledge. Team 10-1 has designed a project which aims to give students a hands-on experience to support engineering concepts at an appropriate level of difficulty and complexity for their grade level.

### Audience

The Simply Machines project has been designed to target second grade students in Washoe County, and will satisfy appropriate Washoe County Core Curriculum standards for that grade level. The lesson plan and project materials will be designed to impart and then evaluate a basic, practical, age-appropriate understanding of how and why the three simple machines work.

### Lesson Goals

Students who participate in the project will be able to experiment with the simple machines to test how they work, internalizing engineering and physics principles in the process. Participation will satisfy Next Generation Standards K-2-ETS-1-1, “Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool” [Next Gen Science, website].

### Requirements and Restrictions

The students are presumed to have had prior education about and experiments with simple properties of matter, and we will develop on that knowledge. Beyond a basic awareness of properties of matter, no specific scientific knowledge will be required.

Simply Machines is a tactile project involving hands-on manipulation of the simple machines, so students with visual disabilities such as blindness or those who may have difficulty touching or

otherwise operating the machines may require special accommodation. These accommodations may include helping a blind student into physical contact with the machines, or visually demonstrating the machines to students who cannot touch them.

Students who encounter any other difficulties in exerting the coordination or strength required to successfully operate the machines can be accommodated by demonstrations from the instructor or the members of Team 10-1. The instructor and Team 10-1 will be prepared and available to provide this assistance if needed.

**Agenda**

The Simply Machines project will introduce students to a basic idea of engineering design and the concept of work, intuitively showing how simple machines can make it easier to do work. Fig. 1 shows six simple machines used to multiply force. Due to time limitations, and for the sake of simplicity in this introductory lesson, Simply Machines will focus on the pulley, the lever, and the wheel and axle.

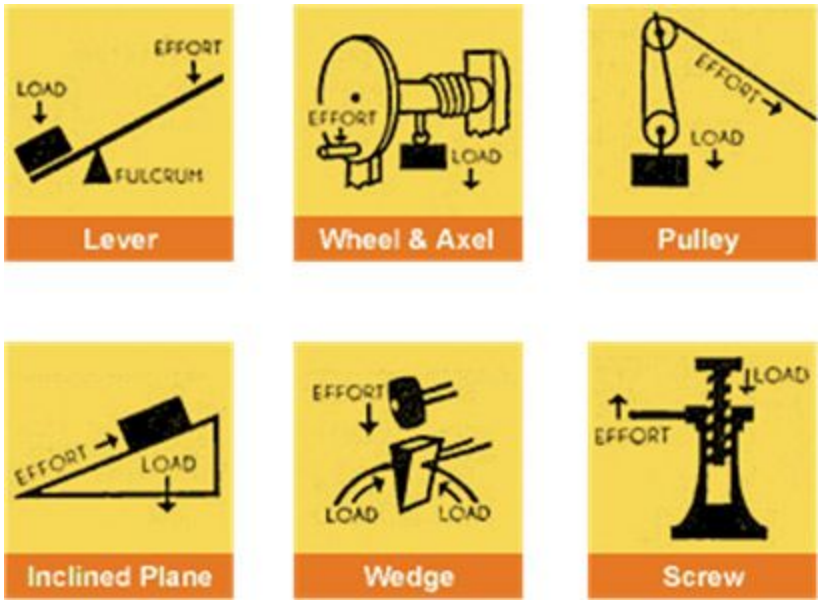


Fig. 1: Examples of six simple machines: the wedge, the wheel and axle, the lever, the inclined plane, the screw, and the pulley. The Simply Machines project will demonstrate the use of the pulley, the lever, and the wheel and axle. [Yale-New Haven Teacher's Institute, website]

The lesson plan for Simply Machines is shown in Fig. 2. Team 10-1 projects that the lesson will last approximately ninety minutes. After preparing the classroom to have three clear areas to host each machine, Team 10-1 will begin with a presentation to the class. Team 10-1 will introduce themselves and then conduct a brief lesson introducing the ideas of engineering and engineering design, defining a basic idea of work, and talking about how tools can help people to do work. Team 10-1 will briefly demonstrate and discuss each machine.

The students will then be divided into three small groups. Due to the projected classroom size of eighteen students, Team 10-1 anticipates and recommends groups of approximately six. These groups will rotate between the three areas every ten minutes, so that each student will visit each unit. Each unit will host one of the machines, as well as a member of Team 10-1 who will be available to provide assistance and answer questions about the machine located at that unit.

After the students have visited and experimented with each machine, there will be a brief cleanup period. The class will then reconvene as a single group once more. After a group discussion designed to reinforce the relationship between the initial lesson and the hands-on testing of the machines, there will be written and oral assessments of the success of the project.

To account for unforeseen factors that might change the timing of these elements, this agenda should be considered approximate. Team 10-1 is prepared to make adjustments dynamically if elements take more or less time than anticipated.

| Agenda Topic | Time Estimate |
|---|---|
| Classroom Preparation | 5 minutes |
| Introductions | 5 minutes |
| Engineering and Work Lesson | 10 minutes |
| Demonstration | 5 minutes |
| Team Organization | 5 minutes |
| Visit First Unit | 10 minutes |
| Visit Second Unit | 10 minutes |
| Visit Third Unit | 10 minutes |
| Classroom Cleanup | 5 minutes |
| Group Discussion | 10 minutes |
| Assessment and Quality Assurance | 15 minutes |

Fig. 2: An agenda for the Simply Machines project showing estimated times for each stage, adding up to 90 minutes total. These times are estimates, and Team 10-1 will make adjustments as needed.

### Materials

The materials shown in Fig. 3 will be used in the construction of the simple machines used in the Simply Machines project. These materials will be pre-assembled ahead of time to create the pulley, lever, and wheel and axle stations and brought to the classroom. An instructor who would like to modify the Simply Machines lesson plan may feel free to incorporate alternative building items, or add items to incorporate machines that Team 10-1 did not. The construction of these machines, including their dimensions and the particular materials and tools used, can vary widely without altering the overall lesson plan. For Team 10-1's implementation of this project, the cost of materials is not expected to exceed fifty dollars.

| **Materials Required** |
| --- |
| Lever: Board (specifications can vary), weights (e.g. books or blocks), fulcrum (e.g. books or blocks) |
| Pulley: rope or string, empty spool, weights (e.g. books or blocks) |
| Wheel and axle: rope or string, empty spools, weights (e.g. books or blocks) |

Fig. 3: Materials required to construct the three simple machines that will be demonstrated in the project. The materials can be modified for size, cost, or convenience as needed, and additional simple machines could be added or substituted for the ones specified here.

### Design Review

Team 10-1's initial idea was to demonstrate and let students use simple machines. The team synthesized this idea with the research found in the Literature Search, which suggested using the idea of work to introduce and explain how simple machines are used. The team's design concept was the result of combining this research with the original goal of giving hands-on experimentation. The goal of the exercise is introduce engineering design by linking it to a basic, useful concept in science and engineering, backed by a memorable, tactile, hands-on experience.

## Methods

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Simply Machines will employ hands-on activities to engage students with the physical principles that make simple machines work. Befitting the audience, Team 10-1 will target learning objectives in line with Washoe County Core Curriculum standards for second graders. Team 10-1 will compile a lesson package including materials for presenters and instructors, and a quiz or worksheet together with class discussion in order to quantitatively and qualitatively evaluate the success of the project.