



**CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY**

Name(s) Katherine M. Weitzel	Project Number J0336
Project Title Hydraulics: Effect of Mechanical Advantage and Range of Motion	
Abstract Objectives/Goals The purpose of this project is to test mechanical advantage and range of motion in a hydraulic arm. Hydraulic machines were used to clear large debris from roads and drainage ditches in the recent Montecito mudslides. This project examines the effectiveness of these machines, and the uses of mechanical advantage. A hydraulic arm was built using wood for the main body and syringes for the hydraulic cylinders and actuators. The displacement of fluid in different sized syringes, and the force required were then measured to determine the mechanical advantage and range of motion achieved. The results proved that mechanical advantage can be achieved through different sized syringes, but it limits the range of motion available. This causes a machine that is less effective, and on a larger, real world scale, force is not limited to human strength. Because of these factors, mechanical advantage can be achieved, but range of motion should be examined first. Methods/Materials hydraulic arm frame (templates from Professor Stephen Ressler, United States Military Academy at West Point), various sizes of syringes, mail scales. Measured displacement and force in various sizes of actuators and hydraulic rams. Results The 20ml syringe actuator and 35ml hydraulic ram has the largest movement of the large syringe in relation to the small syringe. The 35ml syringe moves 89% of the distance the 20ml syringe moves. The mechanical advantage, however, is only 8%. Based on the data collected the decision was made to use 35ml syringes for both the actuator and the hydraulic ram. The allows the arm to transfer power and still have enough range of motion. Conclusions/Discussion In conclusion, this project demonstrated that force can be transmitted through a fluid in a hydraulic system. In this example, no mechanical advantage was attained, however, the range of motion necessary to make the machine useful was achieved.	
Summary Statement I analyzed the relationship between range of motion and mechanical advantage in a hydraulic arm.	
Help Received Templates for the frame were designed by Professor Stephen Ressler of the United States Military Academy at West Point	