Marquette Engineering Outreach
Marquette University College of Engineering
Haggerty Engineering, 210 PO Box 1881
Milwaukee, WI 53201 414.288.6720

FLUID POWER WORKSHOP for TEACHERS

A Summary Report for the
NFPA Education Committee and Foundation Board

By

Jack Samuelson

On August 3, 2010, 21 middle and high school science teachers participated in the 'Fluid Power Workshop for Teachers' held at the College of Engineering on the campus of Marquette University. Funding for the workshop was provided by the National Fluid Power Association (NFPA) Education and Technology Foundation. This event was hosted by Marquette Engineering Outreach; Jack Samuelson, Engineering Outreach Consultant, was the instructor. Teachers came from public and private schools in the Milwaukee area, the Fox Valley, and Western Wisconsin.

The goals of the workshop were to enhance the teacher's knowledge of fluid properties and fluid dynamics, and the applications of fluid power in modern society, as well as provide them with the skills and materials to conduct experiments involving fluids in their classrooms. During the 5-hour event, the participants engaged in activities that could be replicated in their classrooms, using principles of pneumatics and hydraulics. The hands-on activities included constructing pneumatic rockets, cartesian divers and hydraulic machine models. Online resources of the NFPA and other organizations were demonstrated. At the conclusion of the workshop, discussions were held regarding implementation of the workshop activities in the teacher's classrooms. The teachers were also provided with about $250 of materials, enough to conduct experiments with all of their students.

The workshop was well received by the teachers, as summarized on the following pages. In addition, the workshop had a positive impact on the outreach program.The activities involving cartesian divers and hydraulic machines will be integrated into some of the programs offered through Marquette Engineering Outreach for K-12 students. A new course for students age 10-16 was developed : 'Fun with Fluid Power : Hydraulic Robotic Arms to Pneumatic Rockets.' A list of resources in fluid power and fluid dynamics was compiled for teachers and students, as well as a handout on 'Fluid Facts.'

Marquette Engineering Outreach is grateful for the financial support of the Foundation to provide teachers with the skills and materials necessary to implement fluid dynamics and fluid power activities in their classrooms. We are also pleased to have received another grant from the foundation this year to host 'Teaching Fluid Dynamics Utilizing Fluid Power Applications: A Workshop for Secondary Science Teachers.' This workshop will be held at Marquette on April 2. Last, and certainly not least, we appreciate the support of these fine staff members at NFPA: Sue, Carrie, and Eric.

WORKSHOP EVALUATION SUMMARY

There were 24 teachers preregistered for the workshop; 21 participated and 20 completed the following survey, which was administered at the end of the workshop (one teacher left early for personal reasons)

Please respond to the following statements according to this 1 to 5 scale:

5-strongly agree; 4-agree; 3-neutral; 2-disagree; 1-strongly disagree

1. *The material was presented in a clear manner that facilitated understanding.*
   Mean average of responses = 4.6

   Comments: Great resources;
   Clear communication for understanding;
   More explanation on concepts may be helpful for those w/out a strong science background;
   What a great day!
   There was a lot of material covered;

2. *The pace of the course was appropriate for me.*
   Mean average of responses = 4.6

   Comments: I realty appreciated the time to "play" with the supplies!
   Great for the middle school & high school level;
   It was more appropriate for the high school teachers;

3. *The instructor demonstrates a thorough grasp of the course material.*
   Mean average of responses = 4.9

   Comments: Awesome
   He was phenomenal!!! Jack is awesome;

4. *The instructor is well organized and uses class time efficiently.*
   Mean average of responses = 4.5

   Comments: More exploratory…very interesting;
   Will be useful in the classroom;
   He used every bit of time. Time was not wasted;

5. *The materials will be useful in teaching fluid dynamics.*
Mean average of responses = 4.9

Comments: Excellent materials;
Yes!! I will be able to use everything!!
I plan on using most, if not all, of the activities in my classroom;
Excellent;
I will share this w/ teachers at my school;

6. *I would recommend this workshop to others.*
Mean average of responses = 4.9

Comments: Absolutely!
This workshop was very helpful & inciteful (sic)!
Excellent;
For sure;

Other comments:

Excellent workshop! Thank you for your time & consideration put into the workshop!
This workshop was great!
More hands-on work & a little less talking;
This was the best class I've had in a really long time;
Very educational & informative!!!
Really glad I came. The free goodies were fabulous! Lots of good ideas;
This was a great use of time! I appreciated the time & supplies.
Having the workshop at the end of summer was good timing to getting ready for the new year!
This is the best workshop I have ever attended! Very informative, kept my interest, and the handouts were fantastic! I will definitely use them this year;
THANK YOU!!
Thank you very much for the free and incredibly useful workshop!
A great use of time;
Nice!
Nice job. Keep up the good work.
Having materials to play with & bring back makes all the difference in jumping into these activities;

FLUID DYNAMICS, FLUID POWER RESOURCES for TEACHERS & STUDENTS

www.nfpa.com	National Fluid Power Association
www.pathfindersdesignandtechnology.com	Pathfinders Design & Technology
www.teachersource.com	Educational Innovations
www.arborsci.com	Arbor Scientific
www.sciencekit.com	Science Kit
www.kelvin.com	Kelvin
www.pitsco.com	PITSCO
www.sciplus.com	American Science & Surplus
www.vernier.com	Vernier Software & Technology
www.ck12.org/flexbook/chapter/1891	Flexbooks, Fluids Chapter

FLUID FACTS !

*Fluids can be a gas like air or a liquid like water; liquids and gases behave much the same.
*Gases are easily compressed into a smaller volume; liquids are not easily compressed
*PRESSURE is the amount of area over which a force is spread (Pressure = Force/Area)
*Areas of high pressure tend to push things towards areas of low pressure
*When the pressure on a gas is increased, its volume will decrease
*When the temperature of a gas is increased, its volume will increase
*When the pressure on a gas decreases, its volume will increase
*The earth's atmosphere exerts pressure on objects, due to the weight of the gases in air
*Air pressure at sea level is greater that on a mountain top, because at sea level there is more air above you
*Air is a form of matter and has mass that can be measured
*When the volume of a gas increases, its temperature will decrease
*The density of a fluid = mass/volume (fresh water has a density of 1.0 g/cm^3)
*The deeper in water you go the greater the water pressure, because there is more water on top of you; pressure is due to the weight of the water on top of you
*Objects float in a fluid if their density is less than the fluid's density (this is called positive buoyancy), and sink if the object's density is more (negative buoyancy)
*When an object has NEUTRAL buoyancy, it neither sinks nor rises and its density is the same as the fluid (like a submarine that remains at the same level in the water)
* **Pascal's principle** states that "pressure exerted anywhere in a confined fluid is transmitted equally in all directions throughout the fluid." When you step on the brakes of a car, pressure is applied at the brake pedal, but that pressure is transmitted to all the brakes at each wheel (through the brake fluid that connects to each brake)
***Bernoulli's principle** states that as the speed of a fluid increases, the pressure goes down; this explains the lift force on an airplane wing