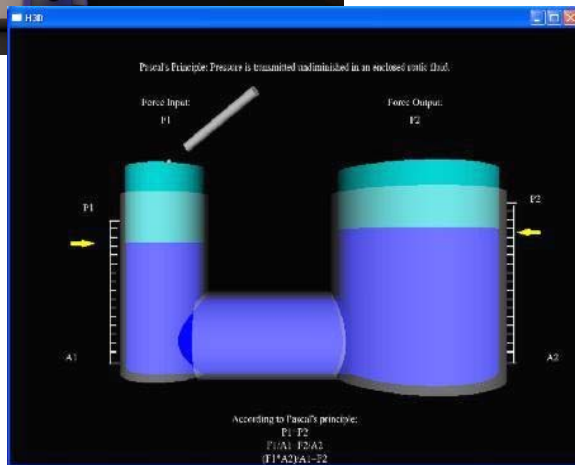


Hear, See, Touch and Learn: HaptEK16



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Outline

- **Reminder ... “Haptics” ?**
- **Devices**
- **Applications**
- **Haptics in Education**
- **Hydraulics & Haptics - HaptEK16 Project**
- **Summary**
- **Future Work**

What is “Haptics” ?

- Derived from the Greek word “*haptikos*” (“able to touch”)
- Working with the sense of touch.
- 5 senses: **sight, smell, taste, touch,** and hearing
- Haptic interfaces

Haptics

Some Haptic Devices

Cyber
Glove



Courtesy of Immersion Corporation



Phantom
Omni



Phantom
Desktop


Courtesy of SensAble Technologies

Phantom Omni

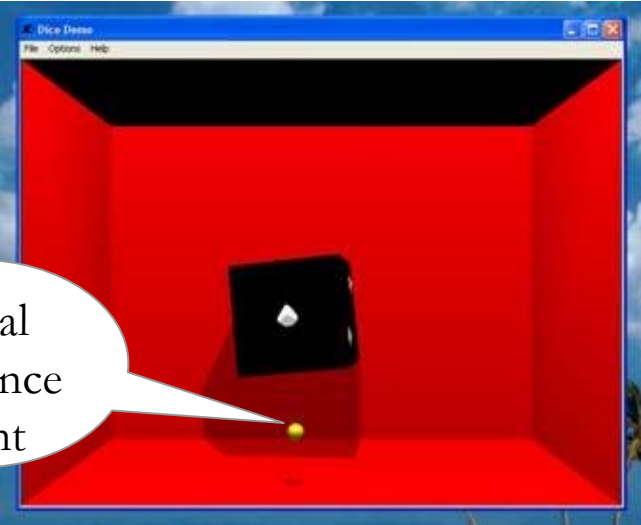
Robotic arm that tracks position and orientation of user's hand.

Updates position and orientation information every ms (1KHz)

Visual representation of physical reference point within virtual application.



physical
reference
point



visual
reference
point

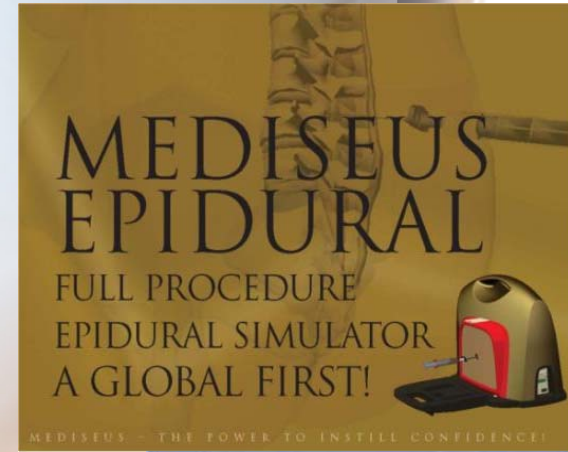
Haptic Applications

Google in 2005: **126,000** hits for haptic applications. (0.19 seconds)

Google in 2007: **1,030,000** hits for haptic applications. (0.28 seconds)

- **Medical**

- Remote Surgery
- Virtual Reality Simulation Training
- Tele-mentoring
- Patient Rehabilitation



- **Entertainment**

- On-line Haptic Gaming

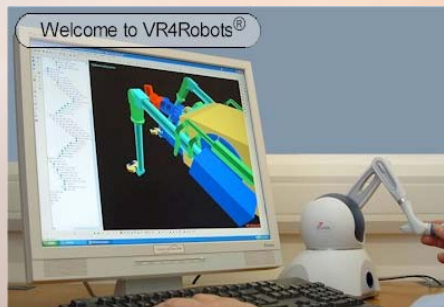


- **Hazardous Environments**

- Remote controlled robotic vehicles
- Land Clearing

- **Academic Research**

- **Education (!!!)**



Haptics in Education

- **Interactivity**
- **Communication Bandwidth**
- **Three Dimensional Representations**
- **Assessment**

Motivation

Hydraulics & Haptics...

- **Students often leave physics courses with faulty mental models**
- **Haptic Environments for K-16**
 - **Complements existing teaching materials**
 - **Helps students understand difficult concepts underlying Pascal's Principle**

Pascal Principle

$F_1 = 10 \text{ N}$ Applied force to the stopper

$A_1 = 5 \text{ cm}^2$

$P_1 = \frac{10 \text{ N}}{5 \text{ cm}^2} = 2 \text{ N/cm}^2$

Like a liquid lever, changing areas in an enclosed fluid permit multiplication of force

Pressure is transmitted undiminished in an enclosed static fluid.

$F_2 = P_2 A_2 = (2 \text{ N/cm}^2)(500 \text{ cm}^2)$
 $= 1000 \text{ N!!}$ plus the force from the weight of the liquid.

Resulting force on bottom of jug.

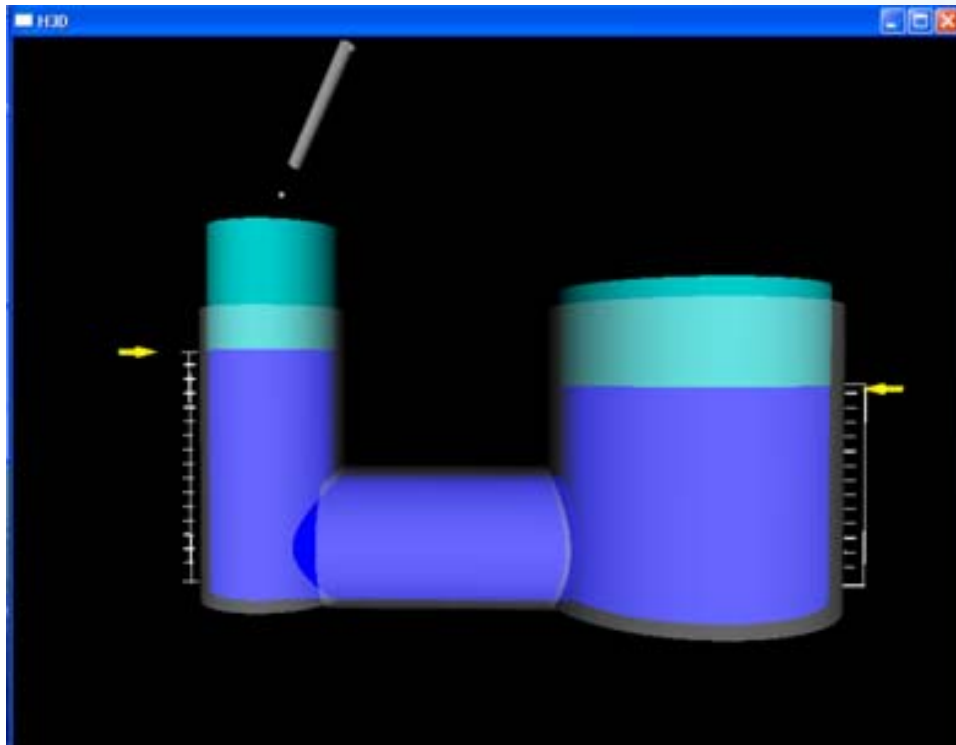
$A_2 = 500 \text{ cm}^2$

$P_2 = P_1 + \rho g h$

Static fluid pressure

HaptEK16

- Each activity is augmented in various ways by haptic feedback so the student can feel and better understand the concept.



$$P = F/A \text{ and}$$
$$P_1 = P_2$$

Therefore,

$$F_2/A_2 = F_1/A_1$$
$$F_2 = A_2 * (F_1/A_1)$$

Hardware

- **SensAble's PHANTOM® Omni™**





Device

Phantom Omni

DOF

6

Workspace

**~6.4 W x 4.8 H x 2.8 D in.
> 160 W x 120 H x 70 D mm.**

Position Resolution

**> 450 dpi.
~ 0.055 mm.**

Max. Force

0.75 lbf. (3.3 N)

Max. Stiffness

**X axis > 7.3 lbs. / in.
Y axis > 13.4 lbs. / in.
Z axis > 5.9 lbs. / in.**

Software

- **Python® Scripting Language**
(python.org)
- **SenseGraphics' H3D API**
(h3d.org)
- **X3D open standard (replaces VRML)**
(web3D.org)
- **wxPython Graphical User Interface (GUI) toolkit**
(wxPython.org)

Software (cont.)

- **wxPython**
 - **Cross platform toolkit for building a GUI program**
 - **Combination of the Python programming language and the wxWidgets toolkit**
 - **Less complex and easier to use than Java/Swing**
 - **Can create and manipulate common interface elements**
 - **Can create a wide variety of more complex elements**

HaptEK16

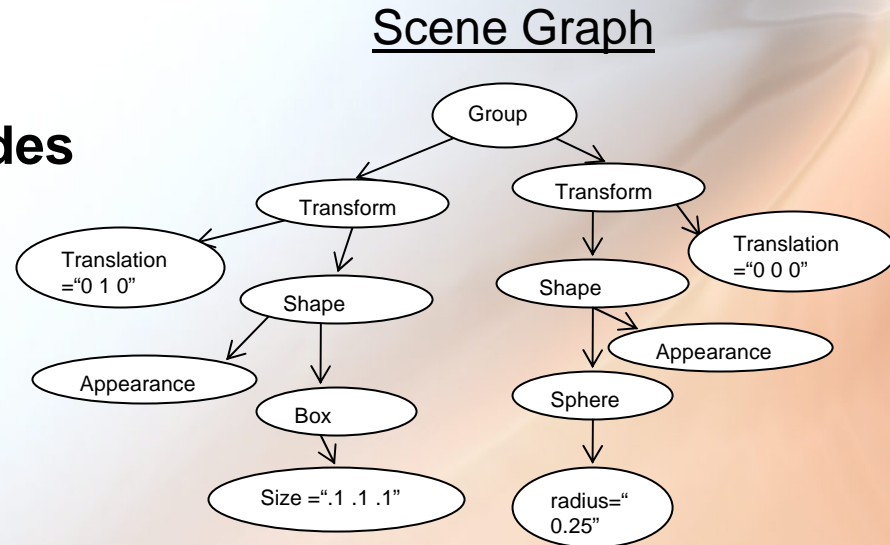
The Design Process

More information on X3D

- **Two types of Syntax**
 - **Open Inventor of the Virtual Reality Modeling Language**
 - **XML**

- **Predefined Essential Nodes**

- **Transform**
- **Group**
- **Shape**
- **Material**



- **Attributes**

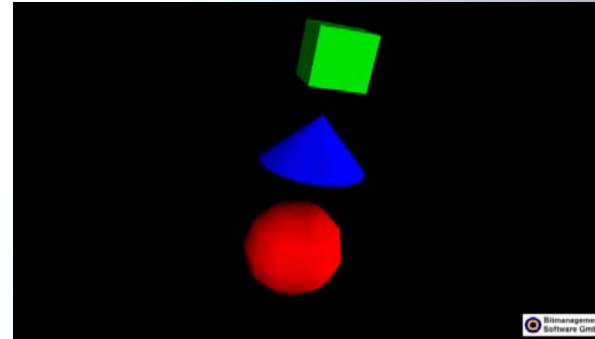
- **Fields that define the characteristics of a Node**
 - **Color**
 - **Size**

Drawing shapes with X3D

- **Scene Graph**
 - Cartesian coordinate sys.
- **The three shapes**
 - **Sphere, Box, Cone**

X3D Example

X3D Representation

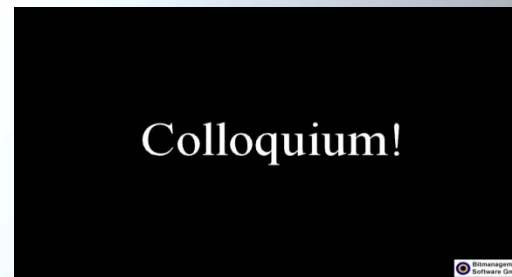


```
<Group>
<DirectionalLight on="TRUE" intensity="1" ambientIntensity="0" color="1 1 1" direction="0 0 -1"/>
  <Transform translation = "0 0 0">
    <Shape>
      <Appearance>
        <Material diffuseColor="1 0 0"/>
      </Appearance>
      <Sphere radius="0.0025"/>
    </Shape>
  </Transform>
  <Transform translation = "0 .01 0">
    <Shape>
      <Appearance>
        <Material diffuseColor="0 1 0"/>
      </Appearance>
      <Box size="0.0025 0.0025 0.0025"/>
    </Shape>
  </Transform>
</Group>
```

Text with X3D

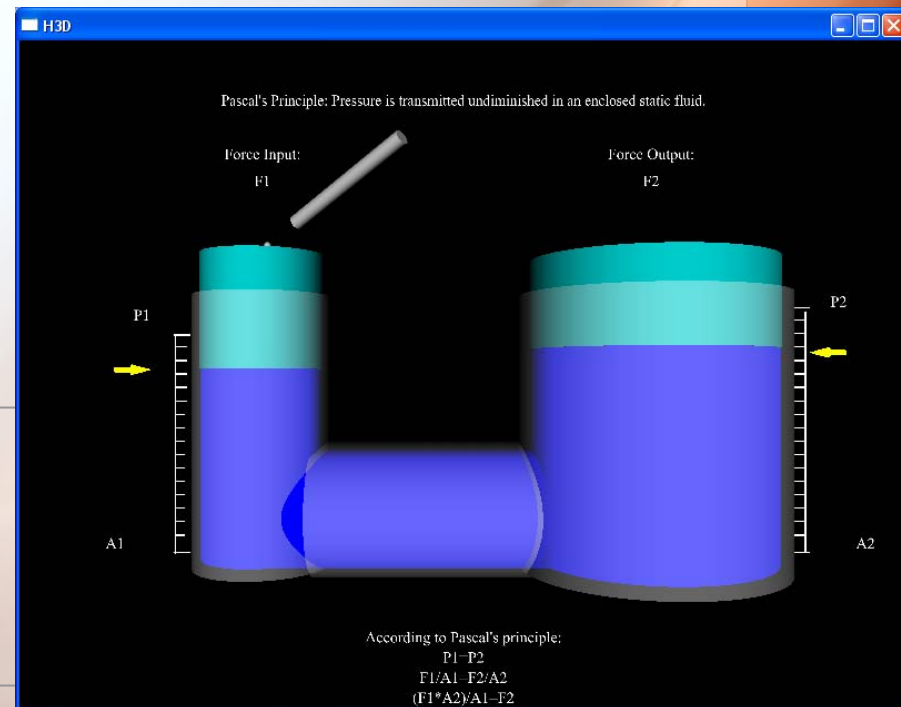
- **Billboard Node**
 - Optional
 - Forces the text to face the user
- **FontStyle Node**
 - Optional, but essential

X3D Representation



X3D Example

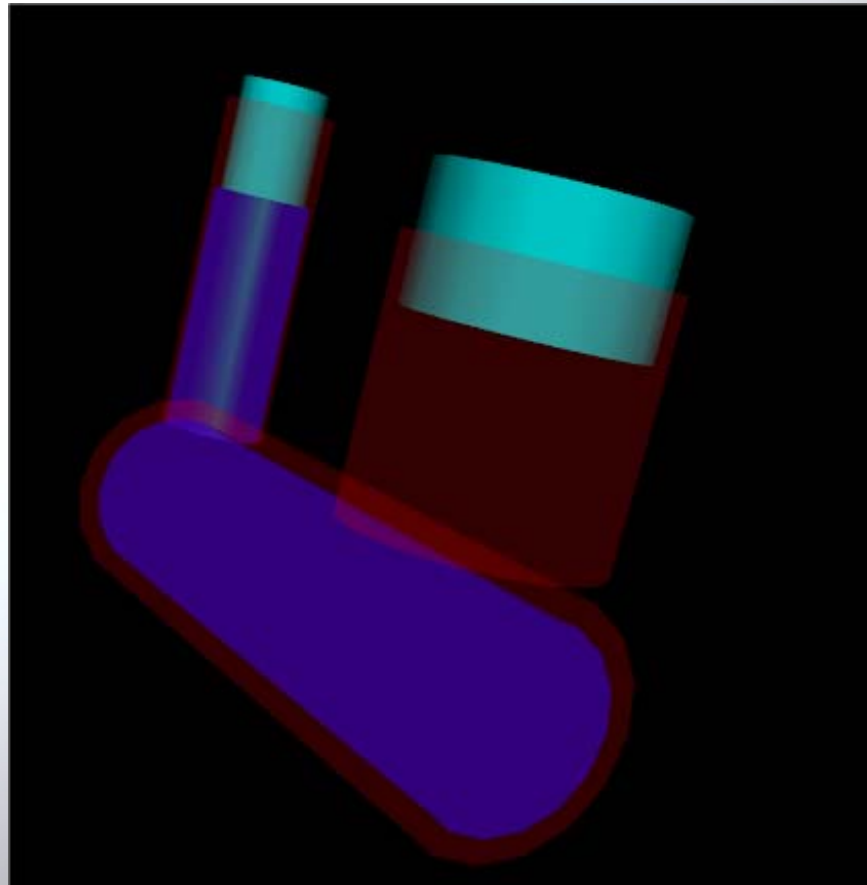
```
<!-- Text-->
<Group>
  <Shape>
    <Text string="Colloquium!">
    <FontStyle family="SERIF" justify="MIDDLE" size=".013"/>
    </Text>
  </Shape>
</Group>
```



HaptEK16 – First steps

- **Goal: basic representation**
 - Two pistons interconnected
 - Simulate water in each piston

First X3D Representation



X3D and H3D

- **Investigating Visual/Haptic Rendering**

- H3D API by SenseGraphics
(www.h3d.org)



- BSContact VRML/X3D Player
(www.bitmanagement.de)



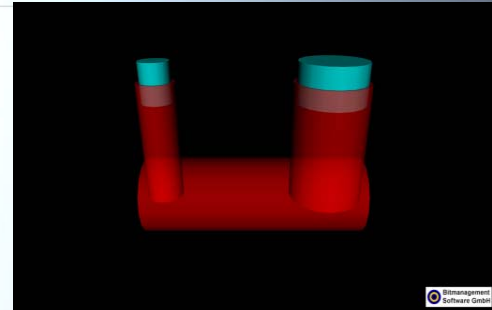
- **Visual Issues**

- Transparency of Objects
- Text

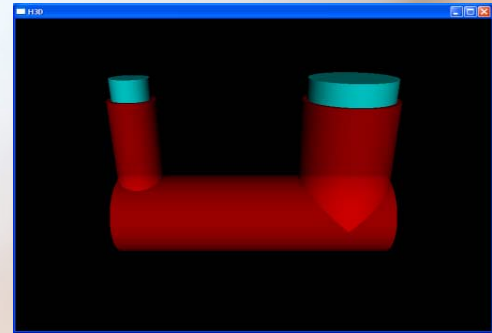
Transparency Issue

- **Rendering issue**

- Transparent in X3D →



- Opaque in H3D →



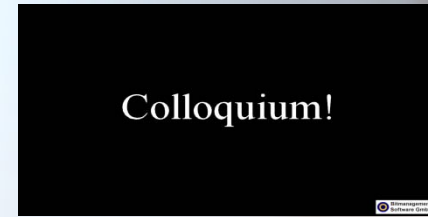
- **Solution**

- Translucent objects must be rendered specifically

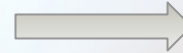
- From the back to the front

Text

- **Rendering issue**
 - **Displayed in X3D**



- **Does not display in H3D**



- **Solution**

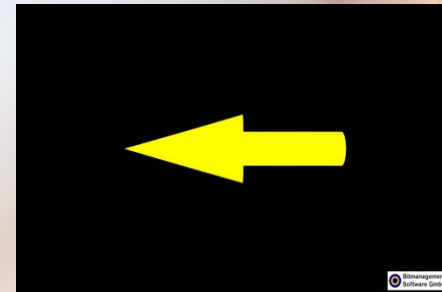
- **FontStyle Node**

- This helped form the text in H3D
 - X3D has a default format for Text

Scales and Arrows

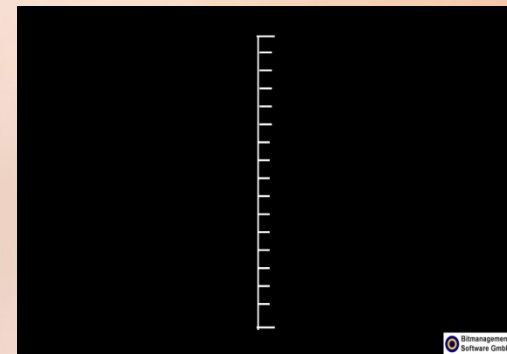
- **An Arrow for indicating the cylinder's level**
 - **Cone**
 - **Cylinder**
 - **Rotation attribute**

X3D Representation



- **A scale for a precise measurement of cylinder's level**
 - **Many thin boxes interconnected**

X3D Representation



Current Representation

- **Adjustments and Fine-tuning**

- **Piston size**

- **Color scheme**

- **Text**

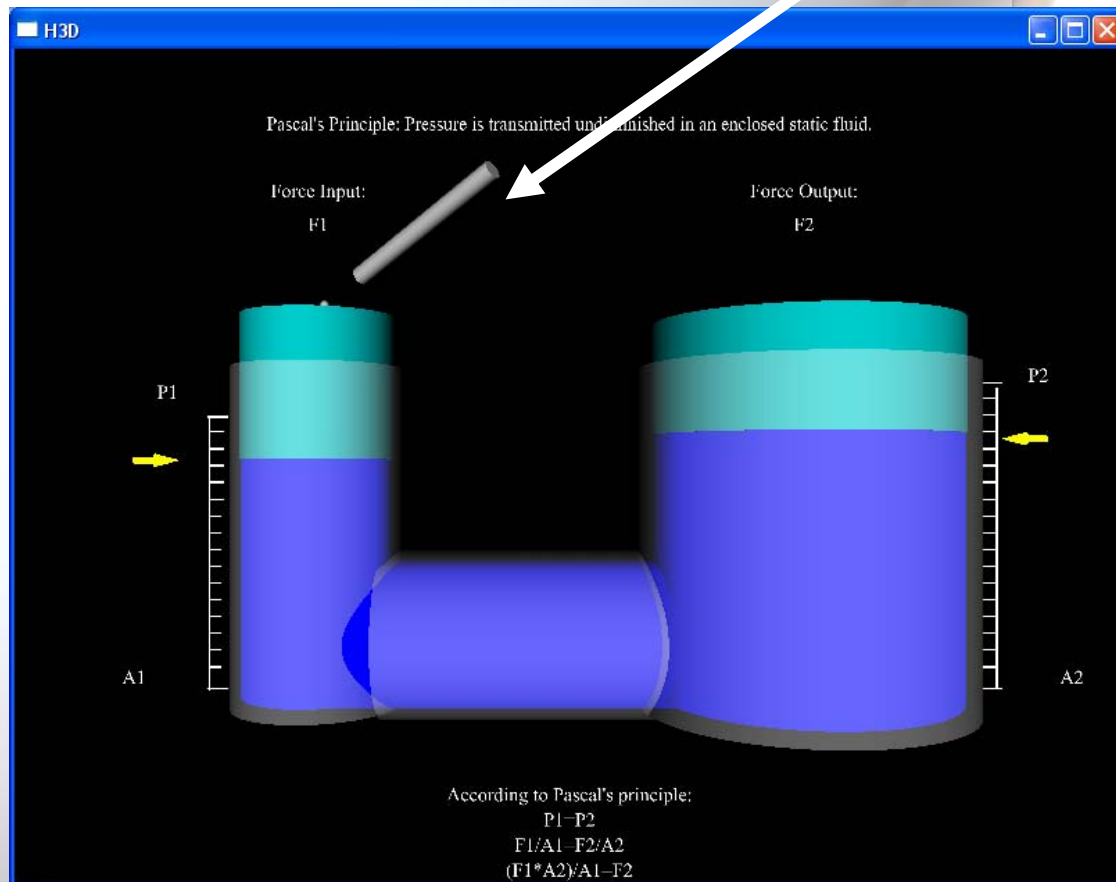
- **Pistons**

- **Scale size**

- **Too large**

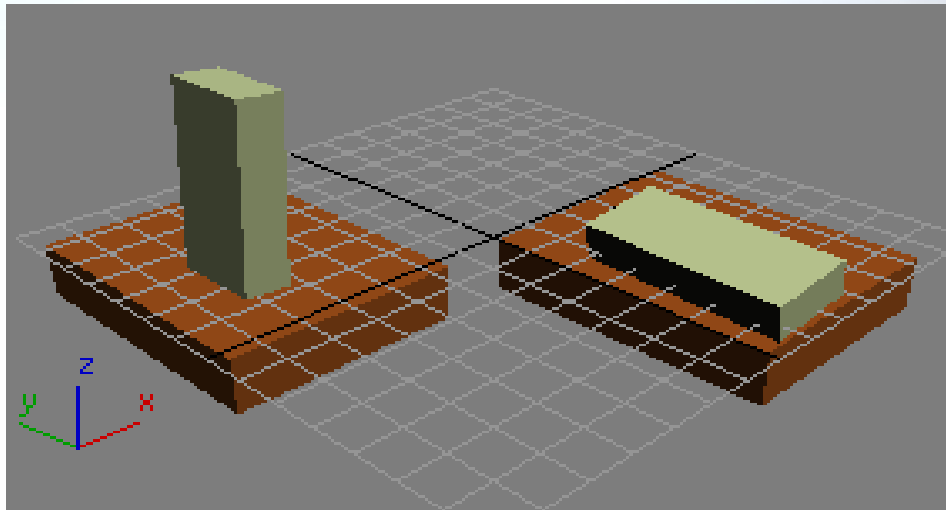
- **Arrow size**

- **Too large**

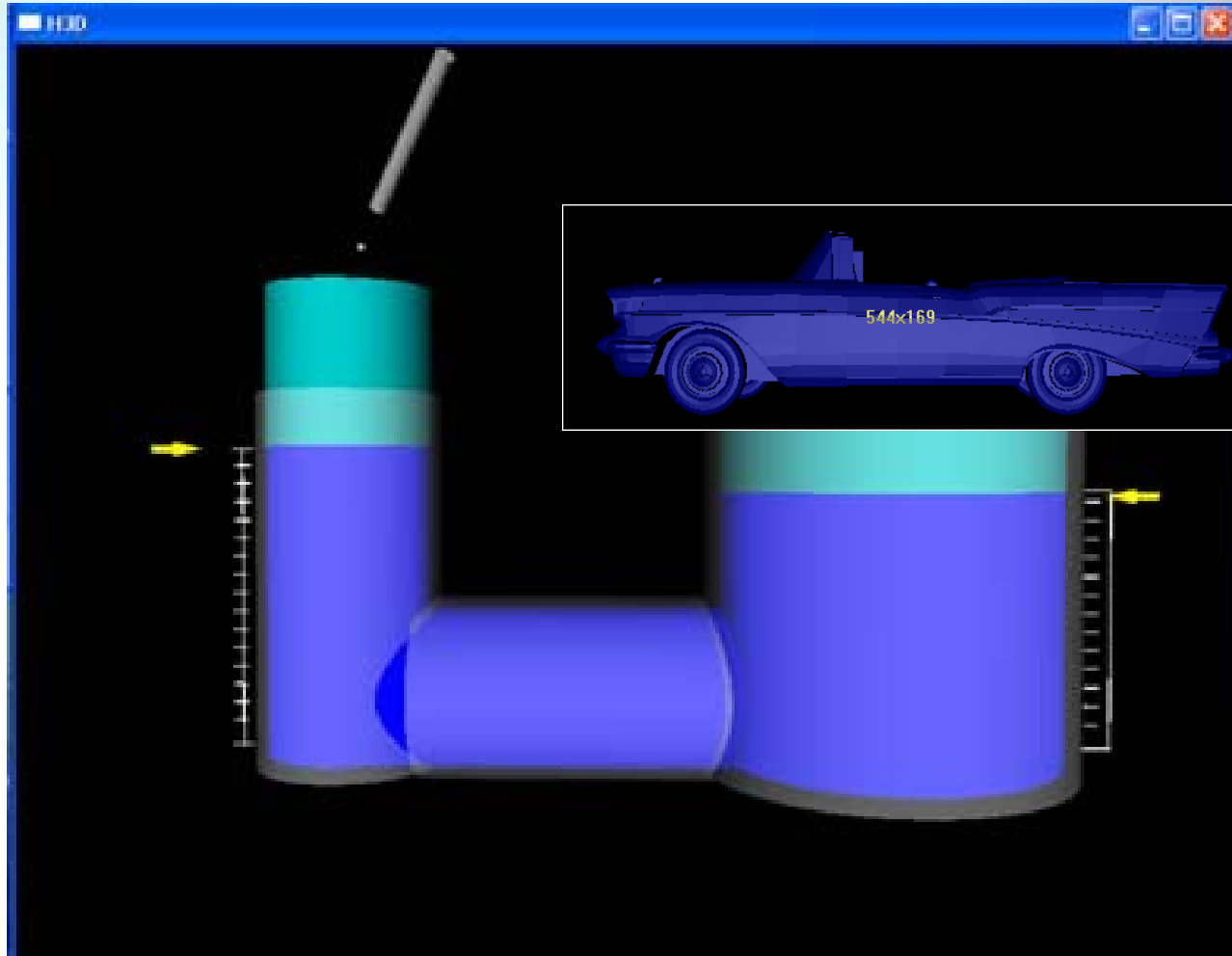


Work in Progress (Assessment)

Activity : Pressure = Force/Area



Activity : Hydraulic Car Lift



Next month

Working with Richmond Hill High School in Richmond Hill, Georgia for the assessment of the efficiency and usability of this tool

Summary

- **Costs of the haptic hardware components continue to decrease**
- **Haptics technology allows us to simulate another sense besides visual and audio.**
- **Remember how successful augmenting the **visual** and **audio** interfaces were? **(TV & Radio)****

Acknowledgments

- James Blondin (*undergraduate Computer Science*)
- The hardware for this project has been supported by the Research Seed Grant for Dr. Felix Hamza-Lup from School of Computing, Armstrong Atlantic State University. (Thanks Ray)

Questions ?

Pascal's Principle

- **A multiplication of force can be achieved by the application of fluid pressure**
- **Allows the lifting of a heavy load with a small force.**
- **Practical applications: car lifts, hydraulic jacks, artesian wells, and forklifts.**
- **HaptEK16 - Students work with a number of arrangements and sizings of the components involved**

Haptic Interfaces

- **Several types are commercially available**



**PHANTOM®
Omni™ -
Courtesy of
SensAble
Technologies**



**CyberGlove® II –
Courtesy of
Immersion
Corporation**



**ScreenRover -
Courtesy of
Betacom**