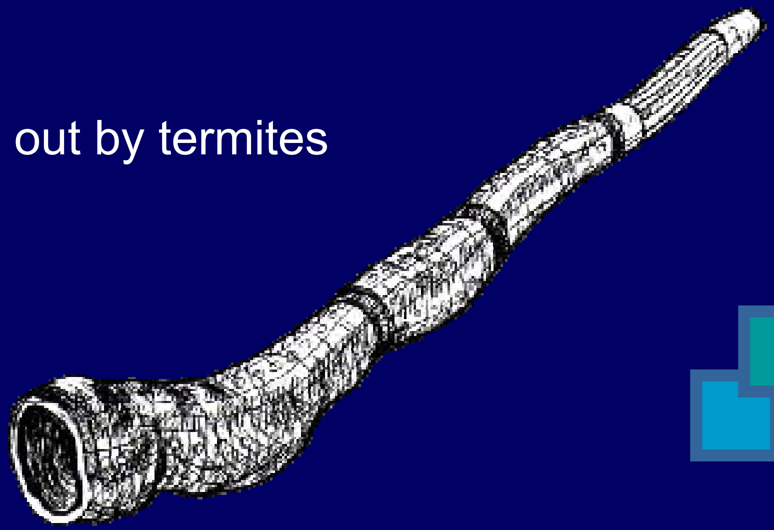
Problem #17: DIDGERIDOO

The 'didgeridoo' is a simple wind instrument traditionally made by the Australian aborigines from a hollowed-out log. It is, however, a remarkable instrument because of the wide variety of timbres that it produces. Investigate the nature of the sounds that can be produced and how they are formed.

Diogo Bercito

1.0 INTRODUCTION

- Origin: Australian aborigines
    - Eucalyptus branches hollowed out by termites



- Accoustic behavior: Cylinder

- Circular breathing (air enters through the nose and goes out through the mouth).

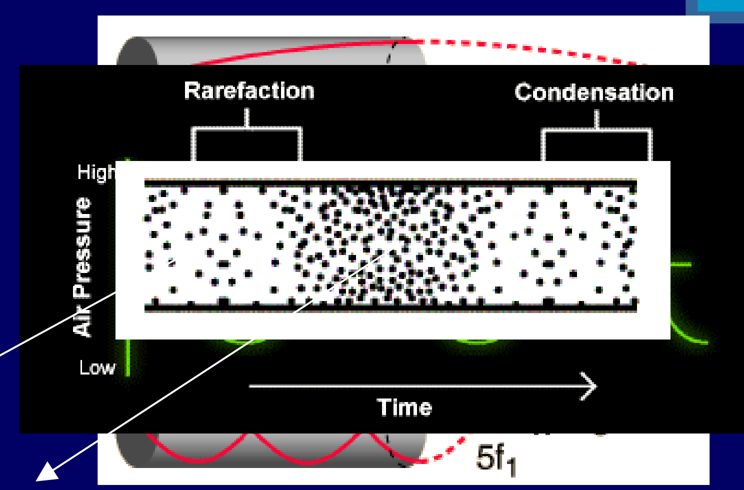
2.0 NECESSARY KNOWLEDGE

a) Resonance

- Natural frequencies of vibration
- Amplification of the sound
- Improvement of some frequencies (usually behind 200Hz)

b) Closed cylinders behavior

- Only produces odd harmonics (1,3,5...)
- Frequency is inversly proportional to the cylinder lenght



Rarefaction

Condensation

2.0.1 NECESSARY KNOWLEDGE (cont.)

c) Didgeridoo functioning

- Many different techniques and individual styles

- The sound is created by the vibration of the player's lips, being amplified by the resonance in some frequencies.

- Result: A bass intense sound that differs from the inicial buzz sound

3.0 EXPERIENCE

- 3.1 Material
- 3.2 Procedure

3.1 MATERIAL

- Three PVC Tubes
- Two Hollow Bamboos
- Sound analysis softwares
- Microphone
- Didgeridoo
- Measuring tape

3.2 PROCEDURE

- Measure each cylinder

- Play each cylinder

- Analyze each sound in the computer

3.3 MEASURE EACH CYLINDER

	Lenght (m)
PVC Cylinder #1	1.230 +/- 0.005
PVC Cylinder #2	1.170 +/- 0.005
PVC Cylinder #3	0.610 +/- 0.005
Bamboo #1	1.000 +/- 0.005
Bamboo #2	0.610 +/- 0.005
Didgeridoo	0.610 +/- 0.005

3.4 PLAY EACH CYLINDER

After playing them, it is possible to make some qualitative statements.

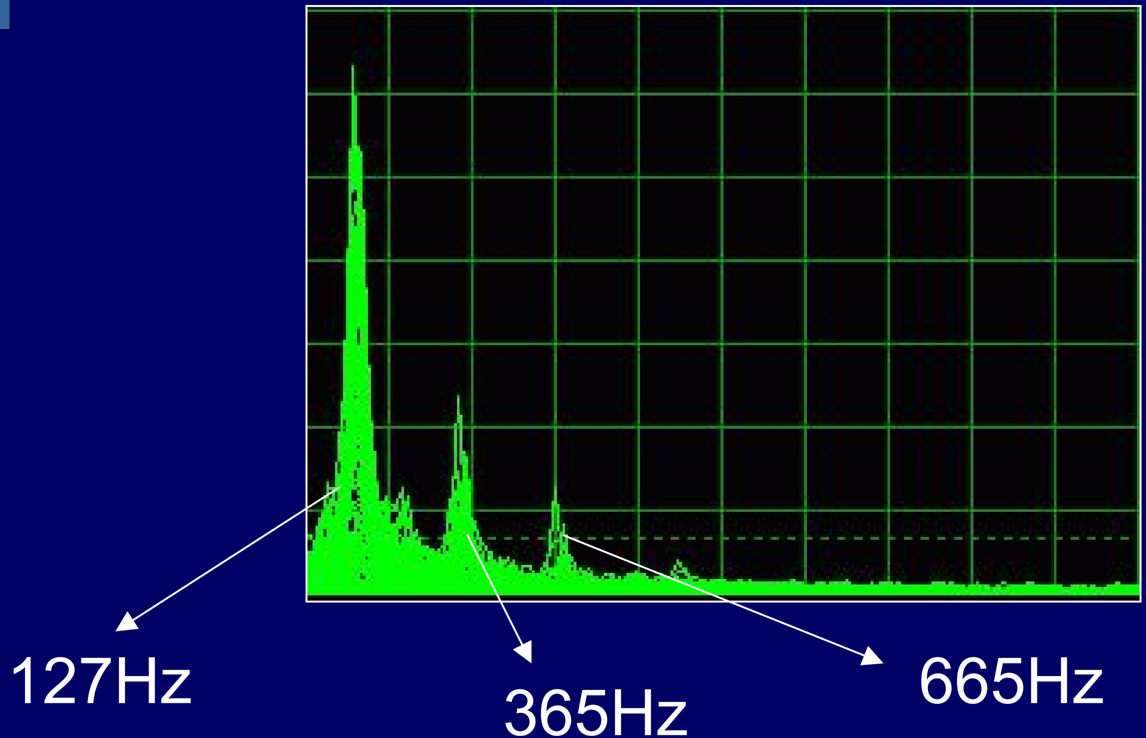
- The bigger is the cylinder, the basser is the sound

- Playing it with more intensity, the sound is more high-pitched

- The lips must be relaxed in order to have a bass and clear sound.

3.5 ANALYZE EACH SOUND ON THE COMPUTER

- Opened or closed cylinder?



127/127 =1

365/127=3

665/127=5

(approximated values)

Odd harmonics!

3.5.1 ANALYZE EACH SOUND ON THE COMPUTER (cont.)

Procedure:

- Create a white noise in the mouthpiece of the didgeridoo

- Close the other extremity

- Measure the sound using the microphone

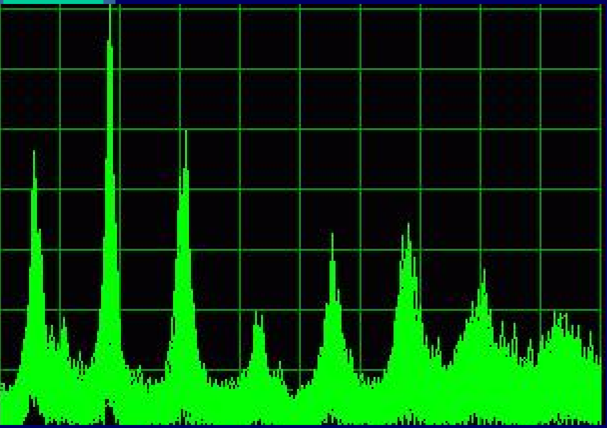
White noise – Sound with almost all frequencies

3.5.2 ANALYZE EACH SOUND ON THE COMPUTER (cont.)

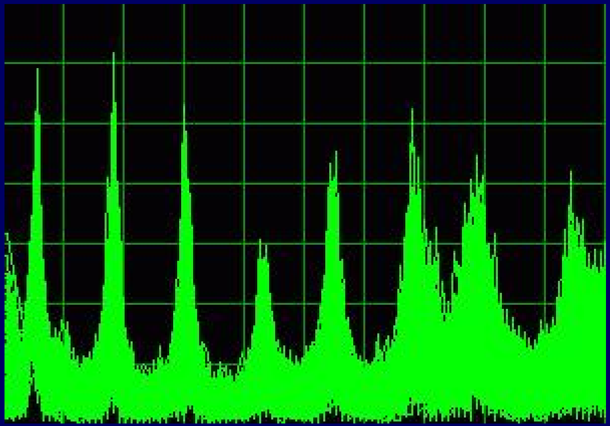
	FUNDAMENTAL FREQUENCY	1ST HARMONIC	2ND HARMONIC	3RD HARMONIC	4TH HARMONIC
PVC Cylinder #3	132Hz	390Hz	678Hz	921Hz	1216Hz
Bamboo #2	125Hz	412Hz	671Hz	950hz	1218Hz
Didgeridoo	133Hz	415Hz	678Hz	958Hz	1231Hz

Software error: 12 Hz

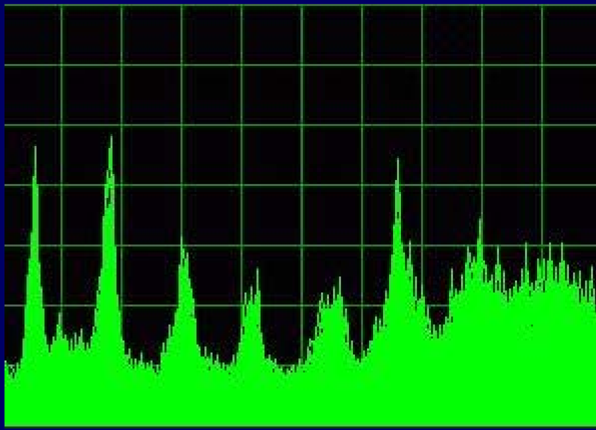
3.5.3 ANALYZE EACH SOUND ON THE COMPUTER (graphs.)



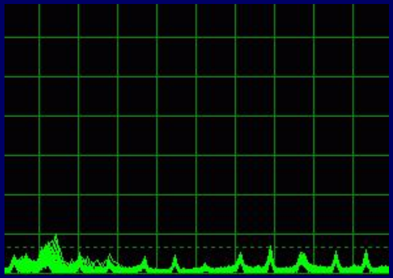
PVC #3



Bamboo #2



Didgeridoo



The white noise

4.0 DATA ANALYSIS

- It was already said that the bigger the cylinder is, the basser the sound is. We can apply the formula for closed cylinders to explain it.

$$f = v/4L$$

(Velocity of sound, at 16 ºCelcius, is 341m/s)

- Comparing the theoretical values with the experiment data for the three tubes of 0.61m (PVC #3, Bamboo #2 and Didgeridoo).

	Theoretical values	Experiment Data
PVC TUBE #3	139Hz	132Hz
Bamboo #2	139Hz	125Hz
Didgeridoo	139Hz	133Hz

4.0.3 DATA ANALYSIS (CONT. 3)

- The most intense it was played, the most high-pitched was the sound. We can apply the formula to explain it

$$v = \lambda \cdot f$$

- It is possible to calculate the wave lenght for the three cylinders of 0.61 (PVC #3, Bamboo #2 and Didgeridoo)

$$341 = \lambda 132 \rightarrow \lambda = 341/132 = \boxed{2.6m}$$
$$341 = \lambda 125 \rightarrow \lambda = 341/125 = \boxed{2.7m}$$
$$341 = \lambda 133 \rightarrow \lambda = 341/133 = \boxed{2.6m}$$

5.0 ERROR SOURCES

- Microphone
- Technique

6.0 CONCLUSIONS

- Timbre
  - Intensity of each harmonic

- It is possible to vary the timbre by:
  - -Varying the material of the didgeridoo
  - Playing it with different intensities
  - Varying the lenght of the didgeridoo