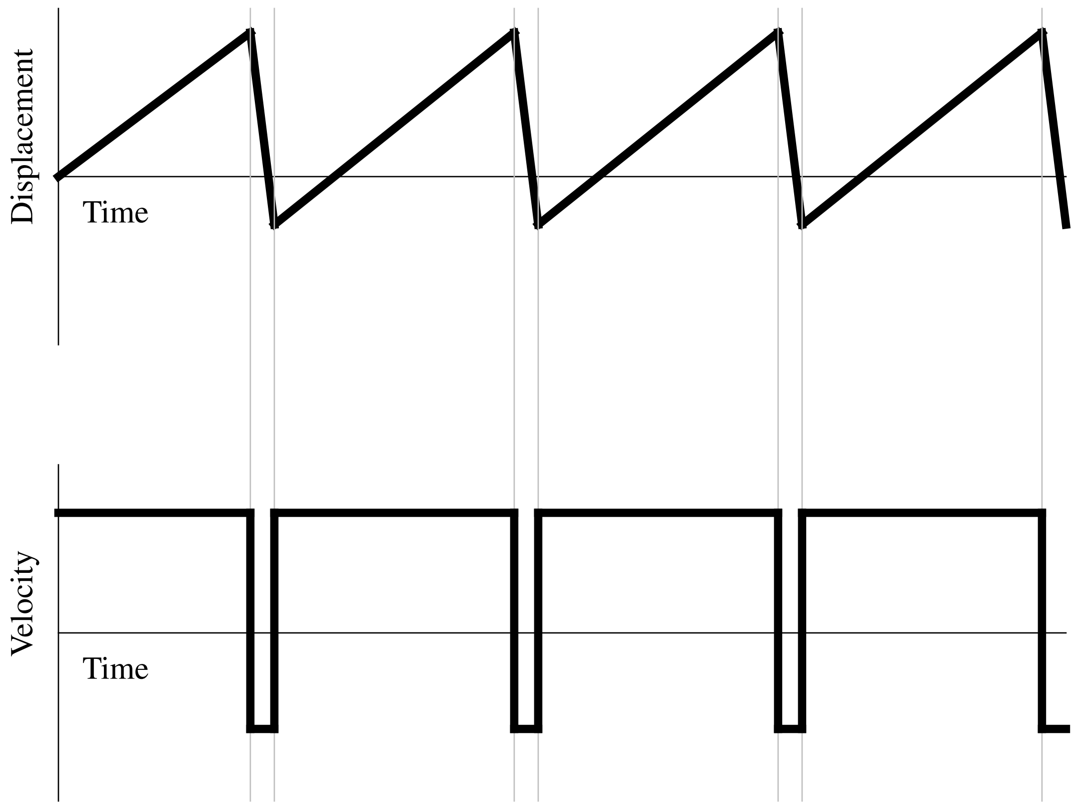

The bridge induces vibration in the top plate. This is transferred to the back plate via the sound post that connects them. Air between the two plates resonates in response to the vibrating top and back plates. Since the resonance is a function of the top and back plate shape and materials, each violin has a unique resonant frequency response. This is what separates a good violin from a bad one. Prof. Gold showed pictures of the frequency response of two violins of different quality to illustrate this.

In reality, the displacement and velocity graphs shown above are too simple. We often get half slips and other non-linear behavior. Physical models have been able to simulate this. One particularly weird behavior that can occur is a Wolf note. A Wolf note occurs when the resonance of the wood and the strings interfere with each other creating a sound that is not the desired note but instead is a cacophonous noise.

Prof. Gold played two samples of a simulated violin at this point in the lecture.

5.0 Back to Standing and Travelling Waves.

As a last point, Prof. Gold showed that the standing wave vs. travelling wave relationship held for tubes as well as for strings.

3.0 Violin

The various parts of the violin and the function they provide to the physical model are described below:

Strings:

Provides vibrating element. The length of the string is measured from the bridge to the finger if pressed, or the nut if not. The tension of the string is controlled by the pegs at the end of the violin. Velocity is related to tension and thus we can control frequency.

The 4 strings are usually tuned to:

G_3 (196 Hz.)
D_4 (293.66 Hz)
A_4 (440 Hz.)
E_5 (660 Hz.)

The letter designates the note and the number designates which piano octave. The octave begins with the note C.

Bow:

Creates vibration in string. The tension of the bow is also adjustable. The rosin used on the bow changes the coefficient of friction between the bow and the string and determines how the string moves as a function of how the bow moves.

Violin body:

Provides resonance. The wood produces the sound by resonating. The top and back plates of the violin vibrate, thus vibrating the air between them as well. All of this resonates to produce the sound.

4.0 Bow Action

The bow pulls the string along, increasing tension, until the string snaps back. This simple description, however, doesn't quite capture the full extent of this system since the relationship between bow and string is non-linear.

The bow/string action can be graphed in two ways: string displacement over time and string velocity over time. Examples of these are shown below:

EECS 225D Lecture 9

Music Production Models I

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1.0 Physical Modelling.

The "physical" part of physical modelling is an important distinction that separates this approach from other types of models. Here we try to simulate the actual physics of the different parts of the instrument in question. We can break down musical instruments into classes according to their physical characteristics. Here is one reasonable breakdown:

TABLE 1. Instruments classified.

Class	**Subclass**	**Examples**
Strings	Plucked	Guitar
	Bowed	Violin
	Struck	Piano
Wind	Vibrating Reed	Clarinet
	Lip Reed	Trumpet
Percussion	Drums	
	Bells	
	Vibrating Bars	Xylophone
Others	Glass Harmonica	

2.0 Travelling vs. Standing Waves.

The solution to the wave equation we've discussed before is really two travelling waves, one forward and one backward. But we can look at this situation in a different way by seeing the combination of these two waves as a standing wave. We may want to do this because a standing wave can be a more convenient representation for analysis given its harmonic motion.