Friction 2 (Grip-release)

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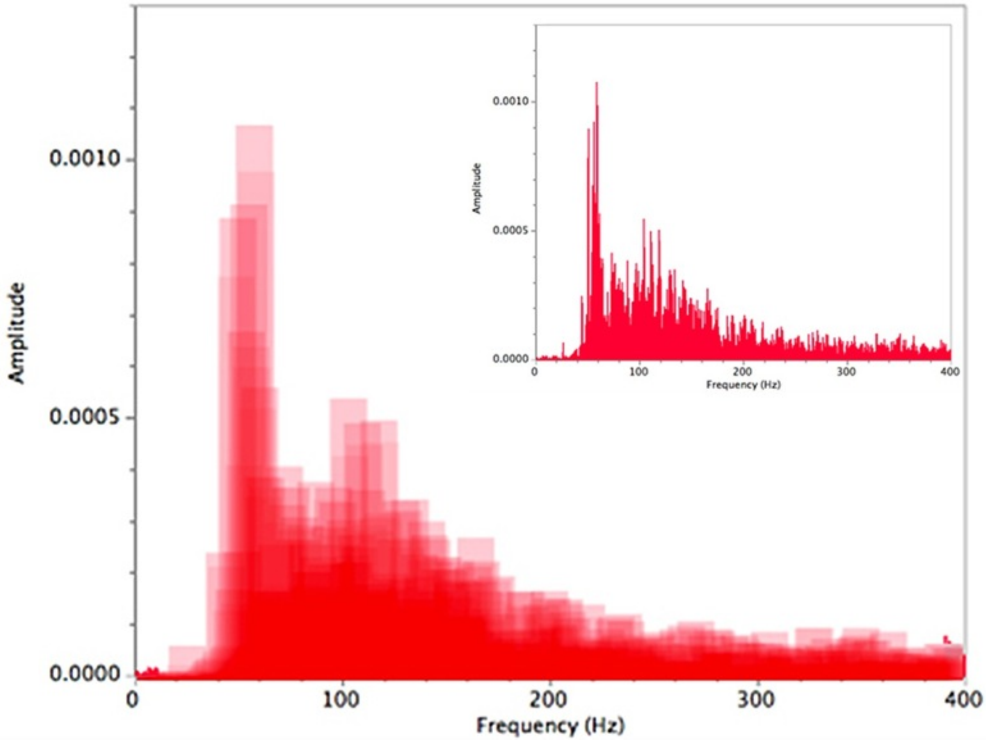
We found in *Friction 1* (linked above) that there are two coefficients of friction, static and dynamic, where $\mu_s > \mu_d$. Care was taken in that work to select two surfaces (clean uniformly rough cardboard) which gave an apparently steady retarding force when the box was sliding. Under different conditions, because $\mu_s > \mu_d$ friction may become a grip-release process.

Part 1: a hand slides on leather

A hand is dragged upwards on the back of a leather chair.

The leather over the back of the chair is a stretched single sheet, separated from the structure of the chair by an air filled space. As I drag my hand over the leather I hear a faint low frequency *roar* (a little like distant thunder) and I feel a low amplitude vibration in my hand and arm. The effect depends on the pressure I exert on the leather. The sound and vibration cease if I press very lightly or very firmly. The frequency spectrum for moderate pressure is shown below.



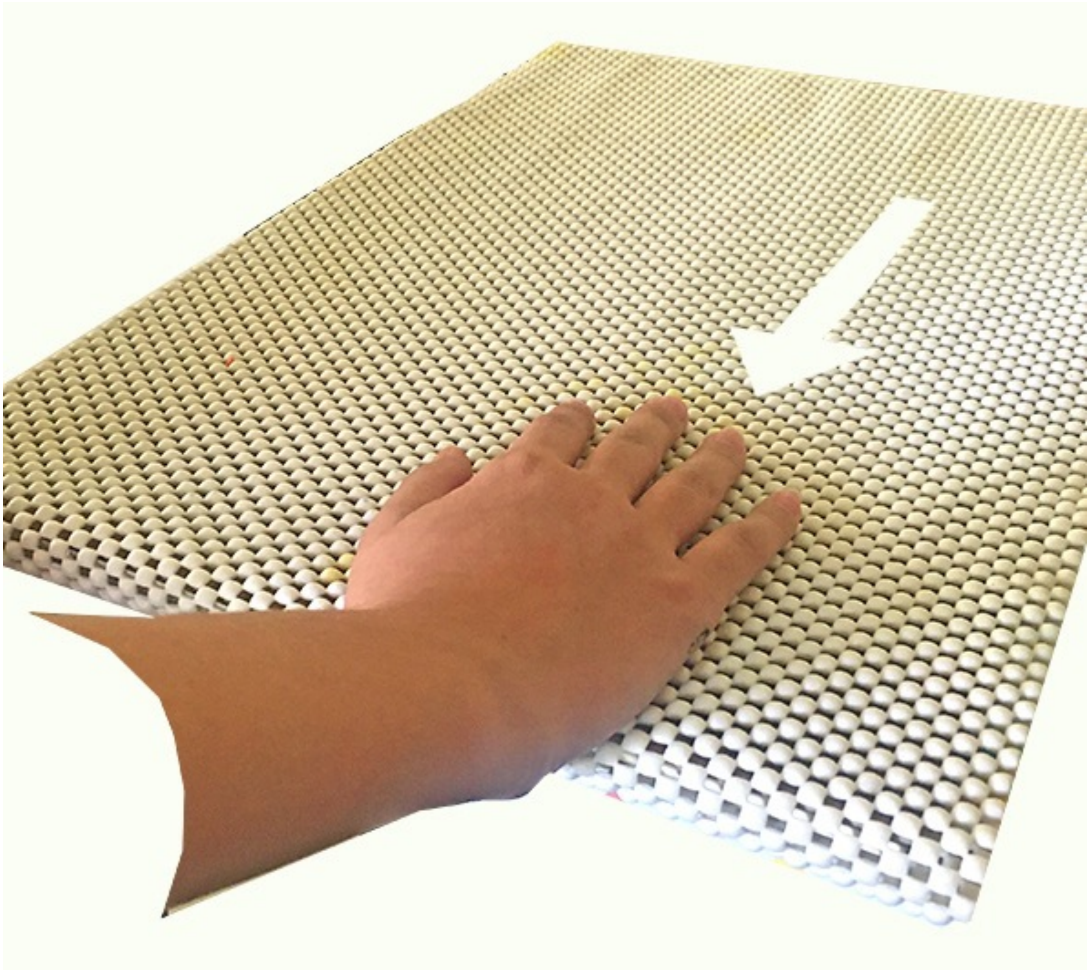
The original high resolution sound spectrum (inset) has been blurred to show the structure in lower resolution. There are two resonance peaks: one at ~55 Hz and a lower amplitude broader peak at ~110 Hz.

Excluding frequencies below 40 Hz, there is low amplitude sound across all the upper range to 400 Hz. Dragging human skin (my hand) over the leather leads to low amplitude vibration over a wide range of frequencies. The leather responds principally in the frequencies of natural resonance (55 and 2x55 Hz). These frequencies are emphasised in the spectrum.

Dragging a hand-held cardboard box or a cup over the leather with similar pressure does not produce this sound. Human skin is involved in the grip-release mechanism that leads to the vibration of the leather.

Part 2: a box slides on a soft surface

The cardboard sheet used in *Friction 1* was covered with a rubber net that is put under mats on polished floors to prevent them from slipping when walked on.

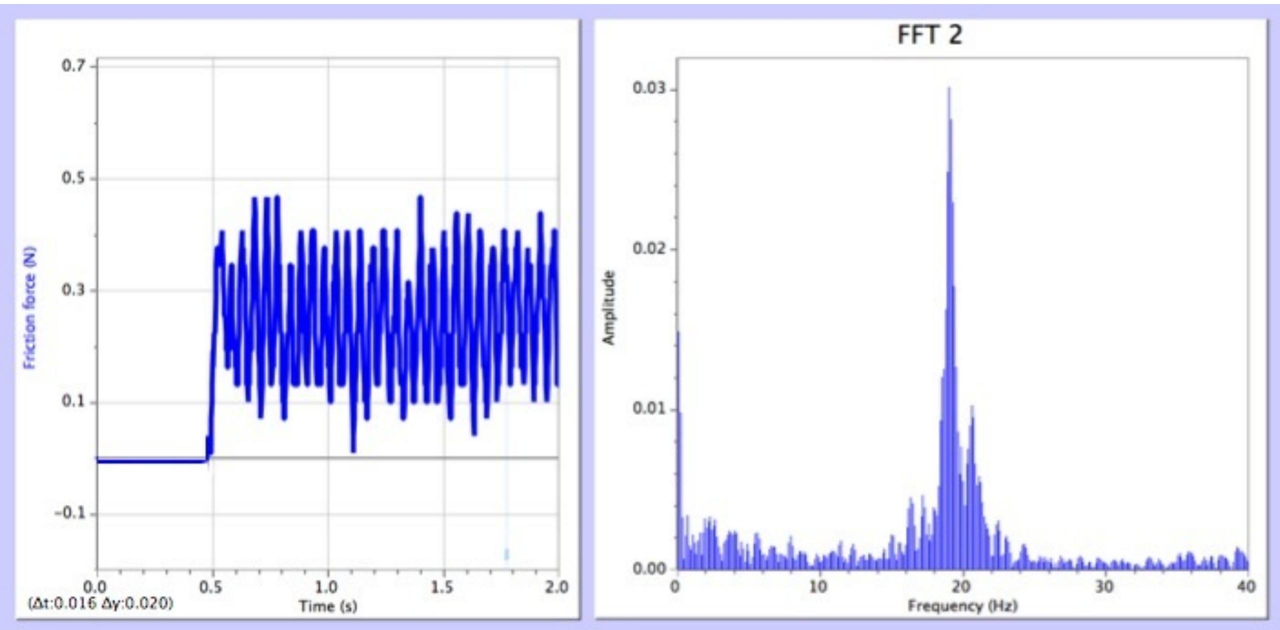


Human skin (my hand) was dragged over the soft rubbery net. Pressing firmly gave the impression of a constant retarding force due to friction. Pressing lightly gave a small apparently constant retarding force, with the addition of what felt like a “tingling” high frequency vibration in the hand and wrist.

> *(It might be possible to put the soft net and cardboard sheet on a trolly with low friction wheels and pull them under the hand with the hand-held force probe to examine the effect, but the trolly and load would have inertia that might damp the response.)*

As an alternative a light (empty) cardboard box was dragged slowly over the net with the hand-held force probe as in *Friction 1*.

The results are shown in the two plots below.



A force-time plot is on the left.

The sound spectrum is on the right.

The static friction force is around 0.4 N. The average dynamic friction force is about half that at 0.2 N but that is obscured by large regular oscillations due to a grip-release process.

The box vibrates at a frequency of 19 Hz. This frequency is too low to be heard as sound in the room, but semi-regular grip-release cycles can be felt as a weak vibration of the hand-held force probe.

The demonstrations above show that for some soft surfaces, human skin over leather and a soft underlay mat, friction becomes a grip-release process and the dynamic friction force varies about a constant average value.

A ringing wine glass

Stroking the rim of a wine glass with a wet finger excites the glass wall to resonance. The glass rings, strongly suggesting that the friction involves a grip-release process.

A singing bowl

Rubbing the rim with a leather-wrapped rod has a similar effect on a brass “singing” bowl.

I am stroking the rim of a large brass bowl that was made in Northern India and bought by my Dad in Kathmandu in Nepal. The bowl rings beautifully.

The mechanism that excites the oscillations of the glass and the bowl may or my not be the same. A detailed study is suggested.