Flying a Driver / Introducing Impulse Compensation for Speakers
or,
do we really have to do what makes no(n) sense - just because it always has been done so ?

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Foreword

As an other out spin form my interest in open baffle speaker design I'd like to outline what hardly ever get touched in speaker design neither for Pro nor for home-fi, and present some thoughts about interesting aspects when considering variants to keep a driver in place.

What is daily work for pro audio guys done in order to get good coverage of audience can be seen from a radically different angle and become highly beneficial for loudspeaker design with open baffles but isn't necessarily restricted to these.

Though flying of drivers is a simple alternative to bolt a driver to a rigid structure reaching ground - its be no means common nor widely considered by speaker makers or DIY community.

To explore the advantages of flying drivers some further and put things into perspective lets go through a quick calculation and some (hopefully) enlightening side notes.

Jump into the topic right away

To keep things simple - lets take a speaker / driver with a total mass of 10kg and a membrane mms of 10g.
Lets further assume the motor of that speaker is capable to apply a peak force to the membrane of 10 Newton.

Given the above, the membrane will move a certain amount of excursion depending on frequency.
Now lets imagine the speaker being in outer space.
The force produced by the motor will not only move the membrane towards one direction but also will move the speaker (as a whole) towards the opposite direction.

This can be seen as a simple result of action and reaction – in physics and in this particular case described as "conservation of momentum".

The ratio of movement is determined simply by the ratio of masses.
In our example the speaker (as a whole) will move 1/1000 the excursion of the membrane - the ratio of 10g to 10kg – a very simple formula indeed.

Without too much penalty exactly the same applies when hooking a real world speaker by a string – like a pendulum - in our living room!

If we calculate the membrane excursion from a sinus force of 10N (peak) to a 10g membrane mass, at 150Hz. we roughly get 1mm one way excursion of the membrane and 0,001mm excursion of the speaker (as a whole).

At 1500Hz we would get 0,01mm excursion of the membrane and 0,00001mm excursion of the speaker (as a whole).

Just remember:
a constant force over frequency from the motor - in case of an ideal speaker - means the same current flow through the voice coil and it also means a constant SPL over frequency for any frequencies (way above resonance and not considering lobeing at least)!

Comparing two alternatives at its impact on structure

Now we come to the most interesting part - comparing the two alternatives.

What is the most interesting point isn't what does the speaker do in terms of its movement as a whole as outlined above.
What counts much more is what does it take to keep a speaker in place
Especially we should think about "can a speaker be held in place *at all*" a little bit more "in depth".
This really isn't as trivial as one would think.

Variant one (speaker bolt to a ideal rigid structure):
It is easy to imagine that if the speaker is bolt to an ideal rigid structure than this structure has to withstand the 10N peak over the whole frequency range. NO excursion of the speaker (as a whole) would – ideally - happen then.

Variant two (flying the speaker):
If the speaker is hooked by a string of lets say 100mm the (sinus-) horizontal force can be calculated without too much error by the ratio of string length to excursion multiplied by the weight of the speaker.
In case of 150Hz we already calculated a excursion of the speaker of 0,001mm which translates into a peak horizontal force at the hook of about 0,001 Newton (100N of speaker weight multiplied by 0,001/100mm)
In case of 1500 Hz we get a peak horizontal force the structure behind the hook has to withstand of 0,00001 N.

Bottom line:

Given the above example – which easily could apply to a midrange speaker – we can achieve a force attenuation of around 80 dB at 150Hz and of around 120 dB at 1500Hz to whatever structure we'd like to build by rather flying the speaker than bolt it down.

Well, this is quite something to chew on - no?

Don't consider 10N over the full audio band to be something that is easy to handle.
It will rattle your structure – no matter how rigid you made it. Many resonant frequencies will be excited leading to rather unpredictable movements of the speaker (as a whole).

In addition to that, a bolt down speaker will move by exactly that unpredictable movements due to structure resonances where as a flying driver will have isolation from the structure a second time when the structure kicks back.

This way you gain three times by flying a driver

- first time you have the benefit of a structure radiating a considerable lower amount of sound as you force it to move several orders of magnitude less
- and second, the movement of the structure due to its own resonances gets pretty well isolated from the speaker - also meaning - you wont have almost any frequency dependent movement of the speaker (as a whole) due to the kick back resonances of the structure itself
- and third, the movement of a flying driver (as a whole) isn't something resonant at all. – pretty immediate decay compared to the resonant behaviour with long decay times from drivers attached to an unavoidable resonant structure

So - why everybody is bolting a driver down ?

Keep swingin' !

Austria, in August 2008