DML FAQ

Distributed Mode Loudspeakers are ideal DIY speaker systems offering exceptional results for a small cost. Their performance came as a big surprise to me, and I say this as a long-time builder of OB systems and ELS systems which were competitive with commercial designs. DML's are also comparatively recent technology with lots of room for experimentation as well as some well-tried principles that will give you an impressive performance.

What follows is a summary of DML attributes collated from the contents of this excellent thread posted by more knowledgeable people than me.

In addition to the information in this thread the following people have helped me expand this list with recent contributions XRK971, geosand, lordtarquin, Veleric.

If I have missed anybody please let me know.

Please note there is no 'ranking' of attributes implied in the following list, it's just a list.

Full range/near full range performance

This has a number of benefits.

1. it removes the need for multiple drive units with different diaphragm dimensions to handle high frequencies and low frequencies which adds complexity and cost.
2. It removes the need for crossovers which, no matter how well designed, introduce a number of problems e.g. crossover points at a point where hearing is most sensitive (2000-3000hz), phase change compensation, baffle step compensation, frequency response compensation, efficiency matching, all of which adds complexity and cost (e.g. Myths & Facts about Loudspeaker Crossovers: Identifying Legitimately High Fidelity Designs | Audioholics)
3. Conventional drivers/ speakers have a directional distribution which reduces the listening sweet spot and in addition means that early reflection from walls is significantly different in spectral composition from a natural sound field introducing artificial coloration (Early Reflections 101 - Acoustic Frontiers) DML's avoid this problem.

Open Baffle/ Panel

1. DML's do not need cabinets, removing a significant source of colouration and loss of dynamics (cabinets resonate because they channel energy away from the drive units( ) ([A Whitepaper: The Audibility Of Cabinet Panel Resonances and Pat. Pend. Method Of Reduction Of Audible Coloration - Dagogo)
2. Because there is no cabinet there is no early back reflection from the cabinet walls passing through the cone. This can be reduced but not eliminated entirely.
3. DML wave propagation is by transverse waves, not pistonic (Wave Propagation) . This reduces distortions like Doppler distortion experienced by conventional drivers . Doppler Distortion in loudspeakers

3. Typically DML's have a much larger surface area than conventional drivers which results in better impedance matching with air
(https://en.wikipedia.org/wiki/Impeda...hing#Acoustics

Bipolar Operation

DML's act as Bipoles, not Dipoles i.e. both front and back radiation are in phase. This has a number of benefits.

1. There is no phase cancelation between front and back waves leading to an omnidirectional sound-field
2. Unlike dipoles early reflected bass is additive, not subtractive.
3. Unlike electrostatics, where dipole operation leads to a very directional response with a narrow 'sweet-spot', DML's have a very wide listening area.
4.Due to its almost bipolar omni directionality, the loss of SPL's as you move away from the speaker is about half that of the loss that you get from a piston type driver. I.e., there will be more volume at your listening position with a DML than there will be from a piston driver for the same speaker efficiency.
5. Just to note that there is a reduction in output to the side of DML's, but this is not due to cancelation, it is due to a lack of output from the edges of the panels. This null point is notably much smaller than that experienced with dipoles, especially electrostatics. (My comment are based on 20 years' experience designing and building OB and electrostatic speakers)

Bending wave/Transverse wave operation

I have noted one of the benefits of this mode of operation above but there are further benefits that should be noted.

1. DML's do not move pistonically and therefore have no moving mass. This removes a constraint on loudspeaker performance regarding high frequency reproduction.
2. All frequencies down to the bass cut-off are transmitted equally across the entire surface of the panel giving the typical DML 'window on the performance' effect. Although in principle this also happens with electrostatics, because they are dipoles and not bipolar this advantage is lost to them through phase cancelation.
3. Due to its mode of operation edge reflection is a potential problem with DML's but is very easily dealt with compared to the complex problem of dealing with mechanical vibration in drive units and cabinets. To be clear, it IS a problem, but low order compared to other systems. For balance, electrostatics are free of these problems entirely.

Easy Drive Characteristics

This is a much overlooked benefit of DML's but coming from a background of electrostatic speaker development where substantial cost and complexity is required to provide a decent load to an amplifier (from using expensive transformers with phase and bandwidth problems up to and including building custom direct drive amplifiers from scratch- a difficult and dangerous task) I can assure you this is a major benefit.

1. DML exciters exhibit a simple largely resistive impedance to an amplifier opening the door to the use of all sorts of purist through to exotic amplifier designs.
2. DML exciters are ridiculously inexpensive devices for their performance.
3. Although some early papers report sensitivity and efficiency failings in my experience this is overstated- DML's play LOUD. Thats very loud and very clean.

Inherently Low Distortion Devices

I know I am going to catch some flack for this claim but its based on my listening experiences and also some of the measurements reported in this thread.
From my measurements a 3mm beech ply DML panel crossed over at 100hz to a subwoofer measures a maximum of 1% THD+n dipping to 0.3% at 500hz. For reference speakers in the Bowers & Wilkins 800 range, e.g. the 805 D3 stand mounted model measures 1% to 0.6% THD+n.
(https://www.bowerswilkins.com/sites/...fo-sheet_0.pdf) The 805 D3 costs £4,500 the pair. Maybe I measured it all wrong, happy to be challenged on that, but they do sound like low distortion devices to me.

Construction methods

There are a number of methods you can employ, none of them difficult or expensive, making DML's great for DIY. There is a lot of guidance in this thread and also in other sites across the web so a quick Google search will get you started. Currently methods can be broadly grouped into ultra-minimal designs, a panel suspended from wires, an exciter and that's it, through to designs that use frames, spines to position the exciter or exciters, and careful application of damping materials to control the frequency response. DML technology seems to be very tolerant of design hacks and it's difficult to get a bad sound.

Well researched and proven techniques include:

- 'Golden section' rectangular panels promote good mode distribution
- Radiusing of rectangle corners which improves mode density.
- Large panels increase the number of modes and improve frequency balance
- For the panel material EPS/XPS foam, Plywood, Carbon fibre and composite sandwich materials all work well
- Subwoofers can be used to reinforce bass performance to keep panel size to a domestically acceptable size and increase slam.

Links to other sites on a site on DML design

The Parts Express blog http://projectgallery.parts-express.com/speaker-projects/dml-flat-pannel/

And a site with a good overview and a useful panel size calculation app.
https://dmlspeakers.com/articles/101%20-%20Introduction%20to%20Distributed%20Mode%20Loudspea

Some links to materials

Foams https://www.3accorematerials.com/en/products/airex-foam
https://www.tridentfoams.co.uk/airex---baltek.html
http://www.emkayplastics.co.uk/rohacell#rohacell-1

N.B. XPS/EPS foam you can get at any large DIY or Home Improvement store

Plywood https://www.kitronik.co.uk/materials/laser-plywood.html
https://www.sculpteo.com/en/lasercutting/laser-cutting-materials/plywood-material/
http://laserply.melbourne/

Balsa (Endgrain) https://www.corelitecomposites.com/balsasud-core

Carbonfibre and composites https://carbonfibreshop.com/
http://www.protechcomposites.com/shop/
http://www.superleggera.com.au/ready-made-sheets/

Technical Papers

There are a lot of academic papers on DML design which are easy to read and, for the engineers and the more mathematically orientated amongst us, contain detailed design formula. This is a sample

http://publications.lib.chalmers.se/records/fulltext/154618.pdf

https://pdfs.semanticscholar.org/aa90/bff6113cfcb5ce4979e757d8b749f13ea168.pdf

https://www.tectonicaudiolabs.com/wp-content/uploads/2018/10/DML-Theory-and-Practice.pdf

https://www.tectonicaudiolabs.com/wp-content/uploads/2018/10/Research-of-the-DML-Loudspeakers-Properties.pdf

Commercial Design Reviews

So you can get a taste of DML performance here is a link to the 6moons review of the Podium DML speaker

https://www.6moons.com/audioreviews/podium/1.html