



ten page summary



# SUMMARY

**Rune is a re-imagined transmission line speaker, created to take advantage of modern advanced materials and manufacture.**

Designed as an avant garde rebellion against traditional wooden, box-shaped speaker design, rune combines inspiration from the blobism design movement with state-of-the art Multi-Jet Fusion manufacture.

Excellent sound quality is achieved through the use of internal dynamic micro-lattice damping, created to the customer's specifications.

Runes are designed to sit upon plinths, isolating them from the surface they are placed upon, as well as offering options to connect to standard speaker stands.

Targeted at the affluent discerning lover of style, rune is proposed to be available with a number of customisation options, including surface finish, engraving and bespoke features.

User



## There are two types of high-end audio consumer.

Users can be categorised into two groups:

- **Discerning lovers of style**
- **Affluent Audiophiles**

These two types have wildly different needs as an audio consumer, and therefore should be treated as individual groups, rather than a general 'high end audio user'.

Process



## Regular loudspeakers are boring boxes

Audio has always been an industry looking to the past - to woodworking and carpentry to create beautifully made artisan furniture.

What happens if this mindset is changed? What would speaker design look like if designers looked forward to future manufacturing processes?

Material



## Traditional foam damping comes in flat panels

In speaker cabinet design, damping is integral to product function. The cheapest and best way to do this is to line a cabinet with acoustic damping foam.

This foam comes as large sheets, and therefore is most efficient to work with in flat panels to reduce wastage. This further encourages the traditional 'box' speaker design.

Manufacture



## Exotic materials, processes and USPs are highly valued.

Discerning lovers of style love 'conversation pieces' that stand out compared to traditional speaker systems.

# insight

# form



Inspired by the blobist works of Starck and Van Berkel, Rune consists of compound twisting curves, contrasted with a regular, circular cross section.

The form is designed to sit on two sides, providing a stereo pair from a single shape, streamlining customisation and manufacture workflows.

Standard banana plugs and screw terminals are used to allow for seamless connection from pre-existing hi-fi amps to Runes.



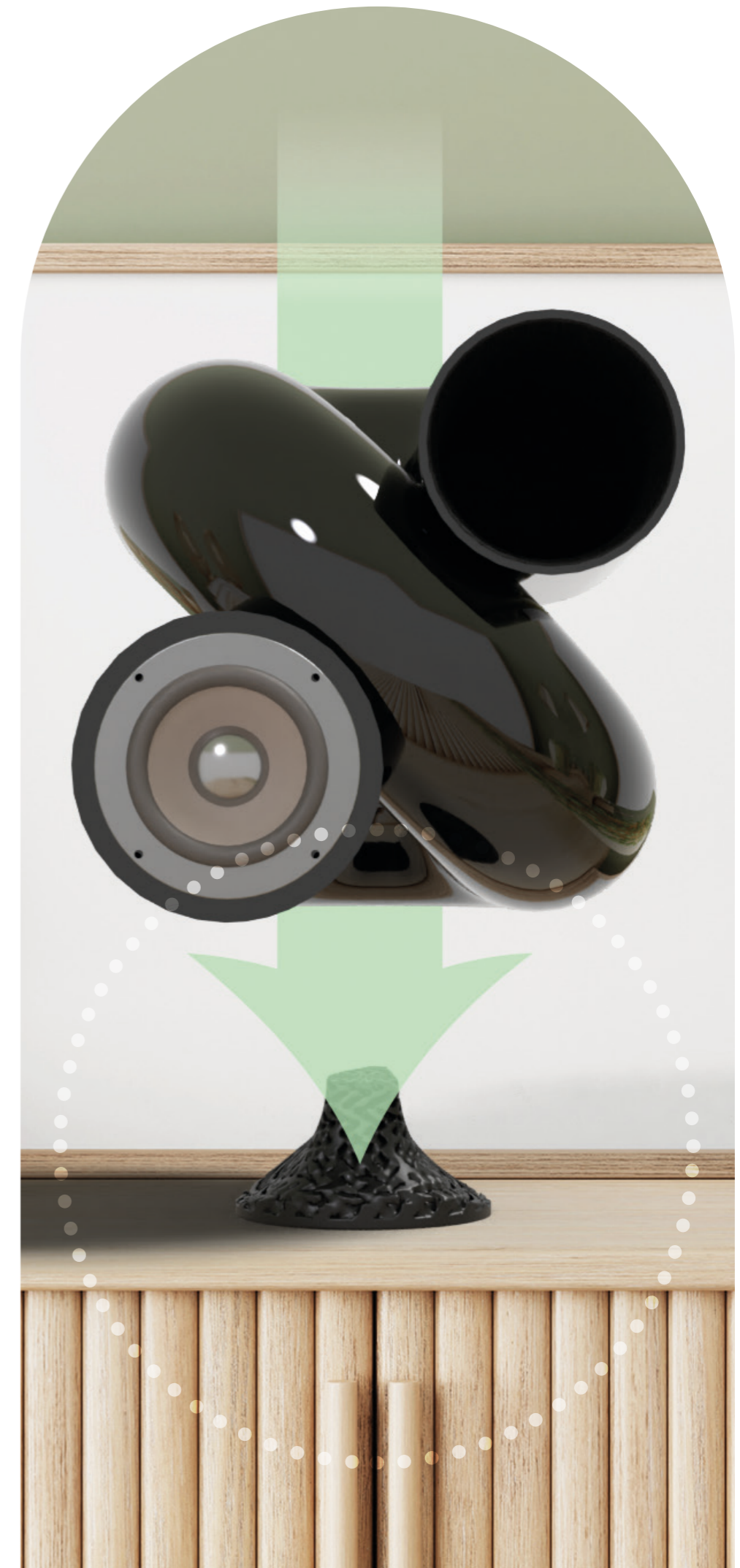
Runes sit upon plinths, designed to isolate the speaker from environmental vibration as well as to elevate the rune from the surface to give an impression of levitation.

Standard 1/4 20 and 1/2 40 screw threads are built into the bottom of the plinths, allowing them, and therefore the runes to be mountable to standard stands.

Using the plinths, the user can rotate the form to access the rear terminal connections without fear of scratching the surface finish.

The plinths are the first object the user interacts with during the setup process, giving the user an introduction to the lattice geometry that lines the inside of the rune form.

# plinth



**By using Just In Time (JIT) manufacture, the surfacing of rune can be easily customised.**

Current generation processes allow for three distinct surface finishes, which can be specified at customer request. This customisation step is critical in the high-end audio user experience.

- **Natural** - A textured pebble grey, celebrating the MJF process, raw and unpolished with a distinct and unique grain
- **Ultramatte** - A deep matt black created by submersion into a vat of pigment.
- **Polished** - A shiny piano black, achievable through vibrational polishing, dying and vapour smoothing.

Near future updates of the MJF manufacture process should enable full colour and texture customisation.

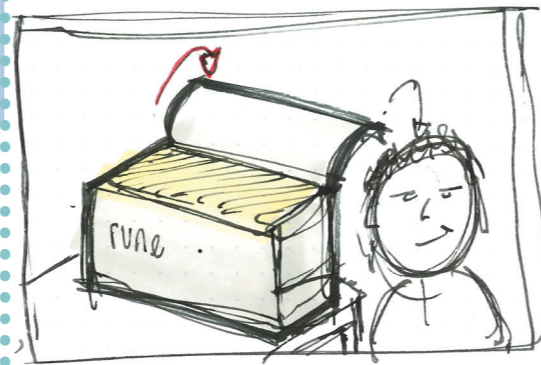


# Journey

Abridged user journey, from point of purchase to full set-up.

This journey is designed to be simple but pleasant, minimising user touchpoints, and making sure necessary touchpoints are as satisfying a user experience as possible.

1



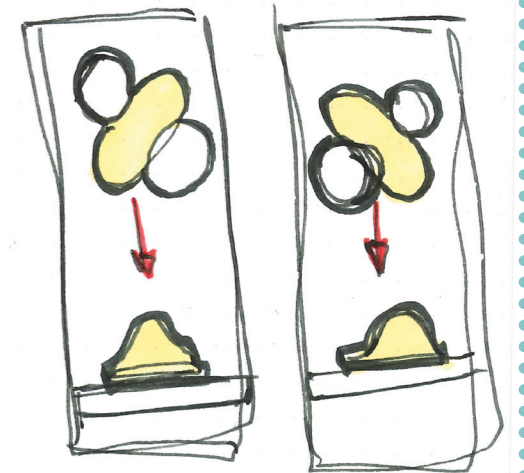
User receives packaged product, either ordered directly B2C online or bought from a hi-fi dealer. The user opens the box and examines the contents.

2



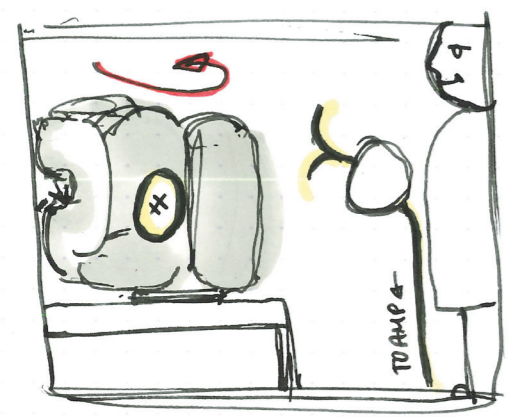
By handling and interacting with the plinths, the user experiences the internal latching material for the first time.

3



The user carefully positions their Runes on the plinths.

4



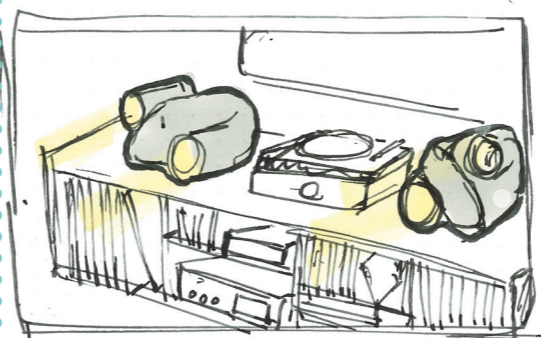
The user rotates their Runes in order to connect them to an amplifier using the plinth, making sure the surface finish is not harmed.

5



Using the screw terminals, the user connects the speaker to their amplifier.

6



The user positions their Runes, and enjoys listening to them.

## Rune is a passive transmission line loudspeaker.

In a nutshell, a transmission line (TL) loudspeaker consists of a drive unit coupled to a resonant tube where the natural frequencies and mode shapes of the air in the tube are used to tailor the total system response.

By perfecting the geometry of this tube, Rune creates rich, deep bass and clear mids and highs from an enclosure smaller than comparable bass-reflex, baffled or loaded horn designs.

Using damping, the frequency response of this second port can be controlled and tailored for the ultimate listening experience.

In Rune, this is done by altering the void fractions of a layer of absorbant microlattice geometry that lines the main duct. This allows for precise control over the damping coefficient at different lengths of the TL.

# Technology





## Rune is proposed to be manufactured using Multi-Jet Fusion out of PA-12 Nylon in a JIT workflow.

This allows for a layer thickness of 70 micron, giving an excellent surface finish with minimal post-processing.

Dimensional accuracy of  $\pm 0.2\text{mm}$  allows the creation of semi-flexible microlatticework.

Rune is proposed to be printed at 100% infill, to create the stiffest, most rigid and most acoustically isotropic structure possible.

The isotropic tensile strength, and near isotropic elongation and tensile modulus of MJF using PA-12 sets it apart from other additive manufacture processes, allowing for more predictable damping.



70 micron surface finish



HP MJF 4200 System



# development

Rune was iteratively designed, based upon some initial style and engineering decisions.

These were:

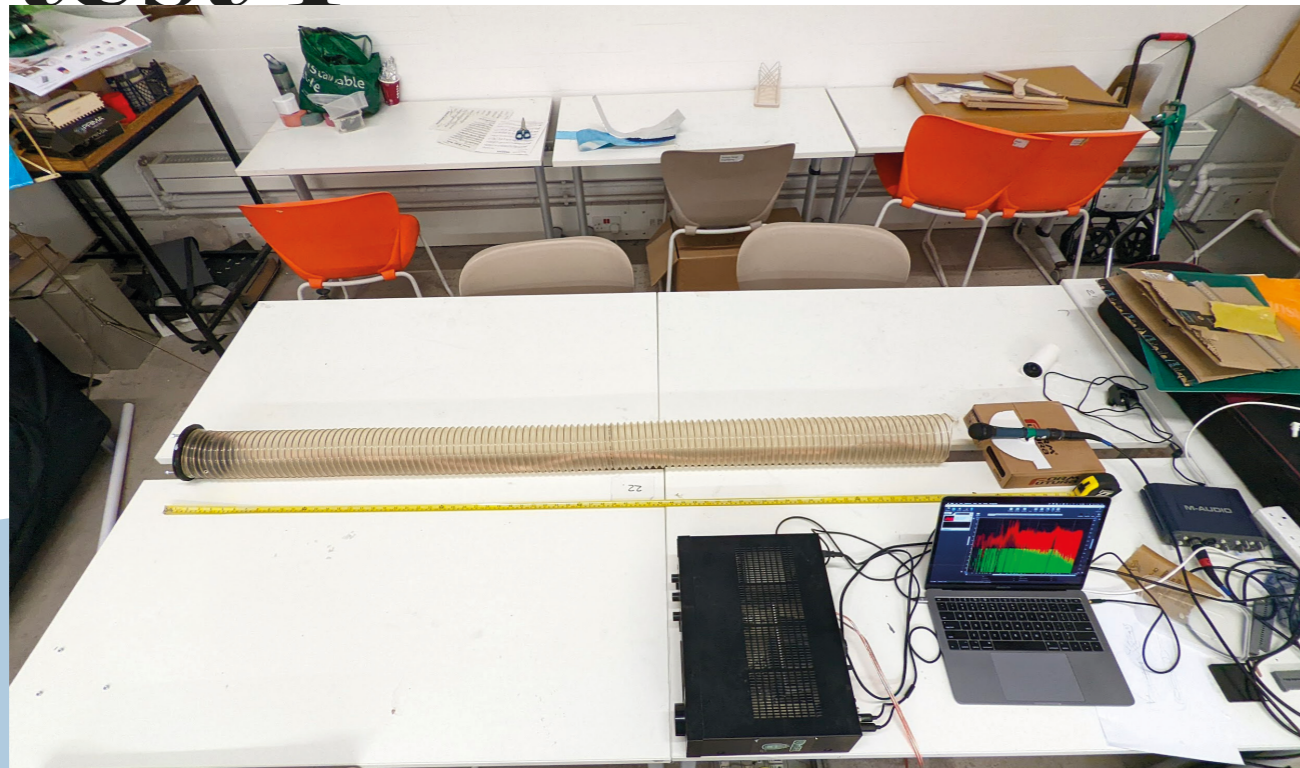
- The use of a **single full-range drive unit** in order to simplify the computation of line geometry,
- The goal of a **constant-width tube** to promote laminar flow
- The use of **curved, knot-like forms** to as inspiration.

Initially, concepts were drawn out, illustrating cabinet designs that were deliberately not grounded in reality. From this, quick physical form prototypes were made, using flexible hosing, clips and string. This allowed the translation of these ideas to forms possible in real life.

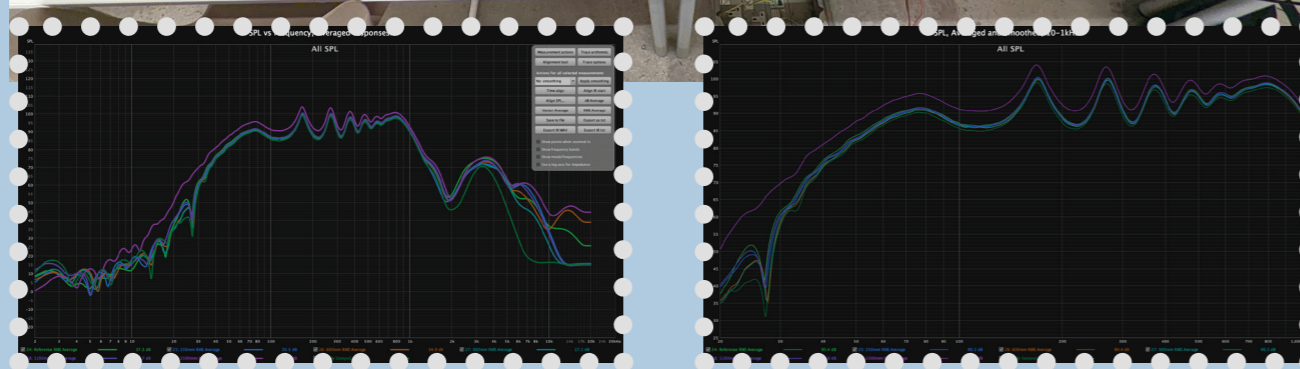
From here, further working prototypes were developed, analysed and redesigned, first using cardboard & rubber gloves, then flexible tubing, finally culminating in a range of 3D printed prototypes.



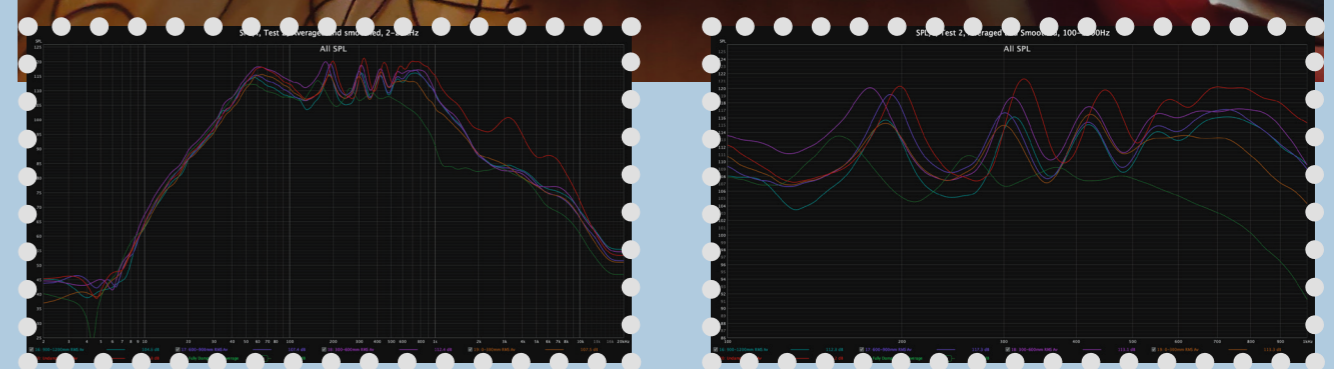
# test 1



SPL/f Output Traces



# test 2



# experimentation

In the course of this project, two engineering tests were undertaken in regard to the effect of damping placement in the frequency response of a TL.

The first test consisted of placing wool damping along the outside of a TL, conducting a frequency sweep and measuring the output. However, this was inconclusive due to method errors, and a further tests were proposed.

The second test was an iteration of the first, but this time with calibrated equipment, as well as damping the inside rather than outside of the line. Conclusive results were achieved, showing the placement of absorbent material effects the frequency response observed at the end of a TL.