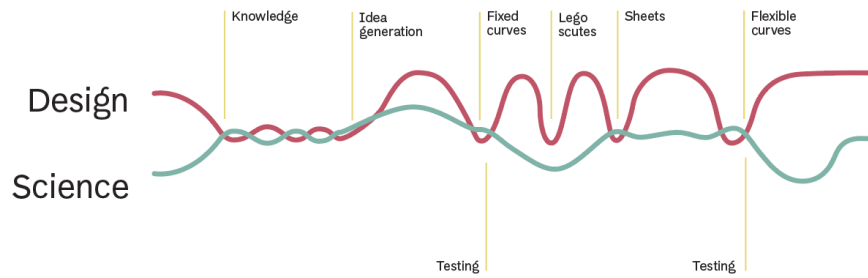


PROJECTS FINAL REPORT		
<b>Call round: 1</b>		
<b>Project Title:</b> Curved metasurfaces for healthcare uses		
<b>PI:</b> Gianluca Memoli	<b>Research Organisation:</b> University of Sussex	
<b>Department:</b> School of Engineering and Informatics	<b>Start Date:</b> August 2022	<b>Duration</b> 6 months
<b>Cost of award (80%):</b> £18,290	<b>Value of co-investment:</b> £5,000 (planned) + £2,000 (patent evaluation) + £2,000 (additional materials) <b>In kind:</b> £5,000 <b>Cash:</b> £4,000	
<b>Co-I and associate RO:</b> Elzbieta Siwy (Kivi Studio), Sebastien Guenneau (Imperial/CNRS), Letizia Chisari (Metasonixx)	<b>Acoustic Research themes:</b> metamaterials, design	
<p><b>Collaborations &amp; Partnerships involved in project:</b> Tell us about bi-lateral or multi-lateral partnerships/participation by the PI or research team in a network, consortium, multi-centre study</p> <p>The project was a close collaboration between the University of Sussex (Gianluca Memoli, Chinmay Rajguru, Yuanyuan Zhao, Abdelhalim Azbaid El-Ouahabi, Laurence Bush), Metasonixx (Letizia Chisari, Jonathan Eccles) and Kivi Studio (Elzbieta Siwy, Britton Kroessler). Prof. Sebastien Guenneau participated to some of the meetings with his invaluable insight. The team worked remotely, in design studios across London and at the University of Sussex.</p> <p>At proposal stage we planned to run the following tasks sequentially:</p> <ol style="list-style-type: none"> <li>a. Simulate the effect of transporting existing phase distributions, already successfully tested for noise-cancellation on flat panels, on 3-dimensional surfaces bound by curvilinear coordinates. This will be achieved using COMSOL and/or finite differences.</li> <li>b. Realise and characterise two prototypes, representing different foldable configurations, to be presented at an exhibition in London or Brighton.</li> </ol> <p>And to produce the following: 2 prototypes, 1 trade show, 1 journal paper.</p> <p>However, we soon realised that this method was not efficient, so we decided to capitalise our different skills and run an interactive process:</p> <ol style="list-style-type: none"> <li>1. Knowledge sharing on acoustics and technical requirements, brainstorming on possible designs (All)</li> <li>2. Design experimentation and prototyping (Kivi), while in parallel simulation of designs (Metasonixx)</li> <li>3. Testing of TRL3 demonstrators (University of Sussex)</li> </ol> <p>Three such iterations took place during the 6 months of the project, as represented by the graph below:</p>		

## TIMELINE



In terms of deliverables, the team produced seven different key demonstrators and presented the first ones at the UKAN+ stand of the New Scientist Live, in London. We did not submit a journal paper yet.

### Project Partners

University of Sussex  
Kivi Studio  
Metasonixx  
Sebastien Guenneau (CNRS/Imperial)

### Value and details of in-kind co-investment: £10,000

£5,000 (Letizia Chisari's time at Metasonixx),  
£3,000 (additional time for Gianluca Memoli at  
Sussex), £2,000 (Prof. Guenneau's time)

### Value and details of cash co-investment: £4,000

i.e., £2,000 (patent attorneys)+ £2,000 (initial contract to  
Kivi)

**Summary:** A summary that can be published on our website (please do consider providing photo/images)



Acoustic metamaterials have been slowly revolutionising sound management. However, until today they have been stuck in two-dimensional planes. The "Curved surfaces" project brought together scientists from the University of Sussex, Metasonixx, with designers from Kivi Studio to create the first curved acoustic metasurfaces.

The project's context was hospitals where noise levels can be as high as 110 dB. It realised over 20 prototypes and introduced new sustainable materials and production methods. Taking inspiration from biomimicry and origami, it opened new possibilities for curved acoustic metasurfaces.

**Objectives:** As stated in the original case for support

- Incorporation of a Design studio – completed.
- Simulations of 3-dimensional surfaces bound by curvilinear coordinates – completed.
- Realisation of two prototypes – completed and beyond. Over 20 prototypes were considered, five were fully measured
- Participation to an exhibition – completed and beyond. First prototypes appeared at New Scientist Live 2022. The final ones will be presented at FutureBuild 2023 (7-9 March).
- 1 journal paper – in progress. This objective has been delayed by Sussex, which took much longer than expected to evaluate the possibility of patenting the results.

**Outcomes/Impact\*:** Please refer to stated objectives. What impact has this had on the Acoustics Sector? How are the results being applied? Please provide specific examples/evidence to support the provided statements.

**Outcomes:**

\* We explored seven different design directions

\* Produced over 20 prototypes

\* ...of which 5 were tested using scientific methods

**Impact of collaboration:**

1. The project was a successful example of a collaboration of an acoustic team with a design studio. Scientific teams are often focused on the technological aspects of innovation, while designers were focused on end users and sustainable manufacturing. The project has established a framework for such future collaborations, overcoming challenges like the need for a common language. This is a precedent for collaborations within the multifaced aspects of the acoustic community in UKAN+.
2. This project brought to TRL4 three of the prototypes and these results were used to apply for funding by the European Innovation Council (“Transition” scheme). The project was not funded, but the team was invited to interview and (under Metasonixx’s flag) received a Seal of Excellence.
3. The project focused on design for hospital wards and MRI machines, so a collaboration with researchers in France and Spain has been discussed
4. The projects produced several viable concepts for acoustic products for home and offices, some of which have been incorporated in an ERC synergy application.
5. The project introduced new manufacturing methods, which are potentially more sustainable than the ones previously used. Kivi also introduced cork, which is aesthetically more pleasing.

We have a presentation that showcases the prototypes, concepts and overall process of the project, however some of the prototypes are going through a patenting evaluation and cannot be shared at this time.

**\*What activities have you undertaken to engage with research users, special interest groups and the general public to inform them about the research?**

\* Participation in the UKAN+ stand for New Scientist Live.

\* Once released by Sussex, the details of the project (i.e., the presentation) will be showcased on the different websites, with a focus on the methodology and process used.

\* Results will be presented at a conference later in 2023 (e.g., Forum Acusticum or METAMat).

**\*Have any new research tools or methods been created or commissioned, if so, provide details: -**

A framework for explorative science-design collaborations has been established i.e.

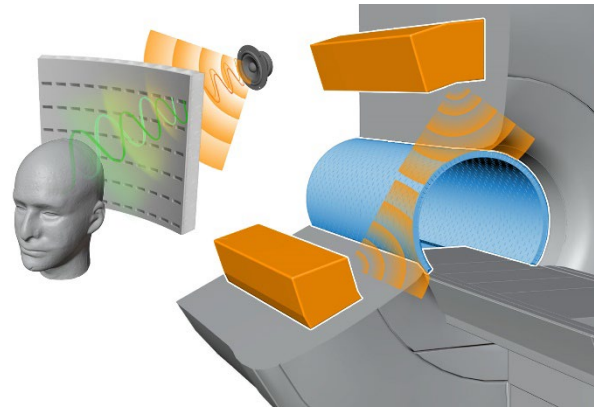
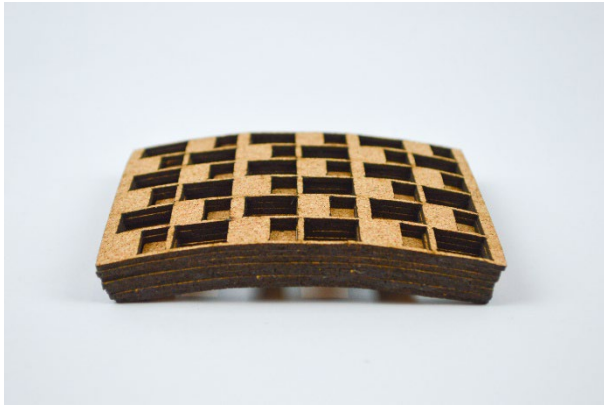
1. Knowledge transfer and establishment of common language between scientists and designers
2. Design exploration in the realm of feasible solutions
3. Several iterations of unbound design exploration, refined by scientific methodologies.
4. Further refinement of the feasible solutions

We had to devise methods to measure the properties of curved surfaces, for which the locations where measurements are taken is extremely crucial important.

**\*Have any new research datasets, databases and models making, or potential to make, significant difference to your research (or that of others), been created, if so, provide details: -**

We had to change the ways our COMSOL modelling was performed, to allocate for curved surfaces while keeping simulation times low.

**Conclusion:** What is the primary outcome of this research?  
We now have the first ever curved acoustic metasurfaces.



**Plans for follow-on activities/grants:** How are these results being used to further the area of research or its application in an industrial setting?

- \* We are further developing the feasible prototypes to evaluate them in relevant environments
- \* The project will be a case study for science-design collaboration services provided by Kivi Studio
- \* We will re-submit to EIC Transition
- \* We will submit to UKRI for the lower TRL ideas

**Weblink:** (to the outcome of the project, the Open Access repository for the data<sup>1</sup>, or press releases):  
<https://acoustics.ac.uk/funding/funded-projects/>

**List of publications:** in peer reviewed or non-peer reviewed literature. If no publications are available, what are the plans to publish? Please follow UKRI guidelines for Open Access <https://www.ukri.org/manage-your-award/publishing-your-research-findings/>

Following the evaluation from the patent attorneys, we plan to present to international conferences and to collate the concepts into a journal paper.

<sup>1</sup> As a UKRI award holder you must follow their research data policies- <https://www.ukri.org/manage-your-award/publishing-your-research-findings/making-your-research-data-open>