Research at the ISVR

Matthew Wright
An Acoustical Engineer:

• Understands the physics of sound and vibration
• Understands their effects on people
• Designs systems that control sound and vibration to benefit people
• Designs systems that use sound and vibration to benefit people
Groups

• Acoustics – Phil Joseph
• Dynamics – David Thompson
• Signal Processing and Control – Steve Daley
• Human Sciences – David Simpson
Aircraft noise
Duct Acoustics and Liners – Highlights

- *Steady* flow distortion in 3D drooped intakes with liner patches - the effect on liner performance – analytic models and 3D CAA
- *Unsteady* flow distortion in intakes – understanding Rolls-Royce rig and engine data to develop predictive tools
- Methods for predicting attenuation in swirling flow (interstage liners); mode analysis, comparison to NASA data, liner optimisation
- Feasibility of applying frequency-domain CAA (~$10^7$ dof) to advanced 3D CFD/CAA coupling
- Understanding nonlinear impedance in liners subject to multiple tones at high amplitudes – modelling and testing

**Computed acoustic field in a drooped intake. $M_{\text{fan}} \approx 0.6$. BPF tone (m= 24).**
Virtual Acoustics and Audio Engineering
Head tracking for active sound control

4 monitoring microphones

Active headrest System

Dummy head with 2 error microphones
Ultrasound

• Public health risk from airborne ultrasound
• Cold water cleaning – StarStream and variants.
• NAMRIP: Network for Anti-Microbial Resistance and Infection Prevention
Broadband Noise reduction through leading edge serrations

New design ???
Next Generation Microphones

- Output: Force-feedback MEMS microphone with high dynamic range and bandwidth
- Challenge: Reconciling performance requirements with fabrication constraints
Acoustic Metamaterials

Passive acoustic metamaterial

Active acoustic metamaterial

• 3D printed passive acoustic metamaterials have been shown to achieve significant levels of performance compared to their size and weight.

• Recent work has demonstrated how incorporating an active element into the resonators can significantly enhance the metamaterial performance

Cheer, Daley & McCormick, Smart Materials and Structures, Volume:26, 2017
Acoustic Measurement of Sonar Metamaterials

• Challenge: Measurement of acoustic properties of metamaterials for sonar applications under ocean conditions

• Approach: Use of nearfield acoustic holography and Laser Doppler Vibrometry techniques developed for transducer measurement
Physical Limitations on Scattered Sound Field Control

In the presence of the scattering body, we attempt:

1. **Active Noise Control**: Minimise the total pressure field
2. **Sound Field Reproduction**: Reproduce the freefield sound field
3. **Acoustic Cloaking**: Minimise the scattered field

Modelling the effect of round window stiffness on residual hearing after cochlear implantation

Elliott, Ni and Verschuur  *Hearing Research* 2016

Predicted round window impedance before, solid, and after, dashed, cochlear implantation

Comparison of measured, left, and predicted, right, loss in residual low frequency hearing after cochlear implantation, on same scales
The **Effects** of Dementing Diseases on Language

- Perseverometry – automatic detection of repetitions in natural speech of Alzheimer’s patients using data mining techniques (SAX, PAA, ADM).

- Identification of characteristic speech patterns in Fronto-Temporal Dementia and Alzheimer’s disease (Conversation Analysis).

- Cognitive Archeology – identification of periods of mental illness and onset of dementia in historical figures (e.g. George III) through statistical analysis of features of written language (Change Point Analysis).
Signal Processing for Bioacoustics

• Analysing dolphin whistles (tracking whistle contours)

• Tracking fin whales using ocean bottom seismometers (with NOC)

• Source separation for humpback whale songs
Not to mention…

• Railway dynamics and aeroacoustics
• Neural-based speech enhancement
• Music for Cochlear Implant users
• Innovations in teaching physical acoustics
• [https://www.youtube.com/watch?v=vhHGBKullgo](https://www.youtube.com/watch?v=vhHGBKullgo)