Queen Mary's 'Media & Arts Technology Studios' Audio System Design

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ABSTRACT

The 'Media and Arts Technology Studios' is a new multimedia facility at Queen Mary University of London comprising three spaces: an acoustically isolated 'listening room', a studio control room and a large performance lab. This engineering report discusses our design philosophy for our given brief to create a world-class audio recording/playback facility for a space that is a 'blank canvas' for researchers. We detail considerations for making an audio system that is simple to use for standard recording and playback whilst at the same time having a tremendous amount of routing options between the connected spaces for users to create unique projects. The system features two separate spatial audio reproduction systems. The result is a 96kHz/24bit MADI based system using a multimode fibre optic network and dedicated wordclock throughout.

1. THE STUDIOS

Queen Mary's Media & Arts Technology Studios are a new dedicated multimedia facility comprising three separate rooms in the Engineering building at the university's Mile End campus.

The *Listening Room* is an acoustically isolated space that originally housed an anechoic chamber when the building was first built. The chamber fell into disuse in the ninties and was converted to a quiet room with a short reverberation time in 2007 for experiments and recordings.

The *Performance Lab* and *Control Room* have recently been built next to the listening room in a space that used to be a large open plan computing lab area. The performance lab is a black box space for qMedia research groups. In the context of this brief, it can be used as a larger recording space and also and has a Multi-Channel Arbitrary Reproduction System (MARS). The control room is provides facilities to record and monitor audio from the other rooms. All the cabling that connects the spaces is patched to a small plant room located in between the Control Room and Performance Lab (a floor plan of the new facility is shown in figure 1).

This engineering brief deals only with the audio system connectivity and related uses of the studios. Other uses include lighting, motion capture and other arts research but that is not the authors' focus.

1.1. Brief & Design Considerations

The brief given for the audio system design was to provide a 'world class audio recording/playback facility'. Given this brief, a set of use cases were decided upon and offered for review to members of the Centre for Digital Music research group and other research groups of qMedia who will use the studios. The use cases related to audio are:

1. **Multitrack Audio Recording of a Band**
   Musicians perform in the Listening Room and are recorded by engineers in the Control Room. This will require high quality multichannel audio recording from Listening Room to Control Room and return channels from Control Room to Listening Room for musicians' headphones and playback across monitors. Bidirectional MIDI connections may be required where electronic instruments are used. Two-way audio/video communication for talk-back purposes is also required.

2. **Multitrack Recording of a Large Ensemble (e.g. Classical Chamber Group)**
   If the Listening Room is not big enough or the

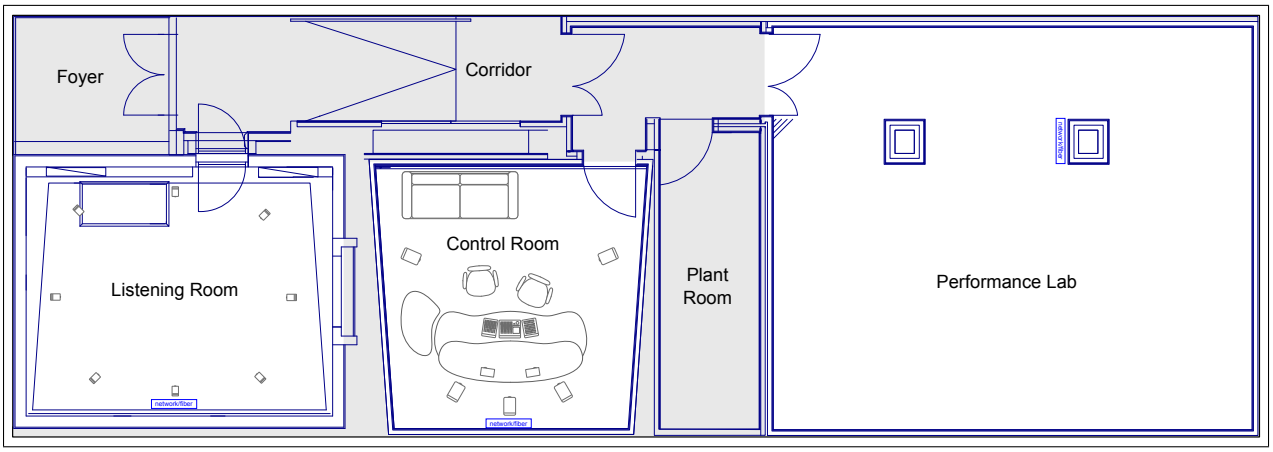

Fig. 1: Media & Arts Technology Studios Floor Plan.

performers require a space that is slightly more 'live' acoustically then audio recordings may be recorded from the Performance Lab. Technical requirements are similar to item 1.

3. **Simultaneous Audio Recording from Performance Lab and Listening Room**
   Where isolation of a particular performer or instrument is required (such as drums or very loud amplified electric instruments), audio from both the Listening Room and Performance Lab might be recorded in the Control Room simultaneously.

4. **Live Performance of a Band with Simultaneous Video Projection**
   A band might perform in the Performance Lab while audio processing and video projection are controlled either from within the space or from the Control Room.

5. **Lab Teaching/Demonstration**
   Some taught modules, such as *audio recording techniques*, might use one or more of the spaces for lab demonstrations in which case there may be a requirement for displaying teaching materials from a projector or large flat screen monitor in any one of the three spaces.

6. **Performance Rehearsals**
   Groups or individuals may wish to use the spaces for rehearsing music or other types of performance. For rehearsals requiring music playback or band rehearsals requiring amplified instruments or vocals, the Listening Room and Performance Lab would need PA speakers and associated audio equipment (microphones, stands, cables, mixer etc).

7. **Ambisonics Experiments** The listening room contains an ambisonics speaker system. This may be controlled from the control room audio equipment or from within the listening room if the user has a laptop with the correct audio connections.

8. **Transducer Array Experiments** Multichannel audio input/output and large arrays of microphones or speakers can be set up in the Listening Room or Performance Lab and measured with equipment in the control room (or in the same space if necessary).

It is clear that the audio system and routing needs to be very flexible for accomplishing many tasks. However, experience teaches us that systems also have to be simple and accessible to all without taking a long time to setup if they are to be tuly useful. With this in mind, careful thought was given to the wiring of equipment; it was made a priority that all equipment be accessible via patchbays with half-normalled connections so that for standard use nothing needed to be 'patched in'. One final point was that a clear and

concise manual with a guides section needed to be written. This hopefully goes some way to addressing the problem of only a handful of researchers knowing how to use the audio system.

2. SYSTEM CONNECTIVITY

As discussed in Section 1, the studio spaces have been built in converted areas of the old Engineering building. Due to the nature of the Listening Room's room-within-a-room architecture inherited from its previous use as an anechoic chamber, the cable runs between that space and the Plant Room are very long and in many places quite narrow. This meant that it was unfeasible to use multicore analogue cabling to connect the spaces for recording audio. Instead we had to make a choice between ethernet and optical fibre for our audio routing between the rooms. We eventually chose to use a MADI [1] audio system over multimode fibre optic cable because the MARS system mentioned in Section 1 was already MADI compatible. MADI offers 64 input and output channels per duplex cable at 44.1/48kHz, but the authors chose to specify the system with all the features to remain at up to 96kHz, limited by the A/D D/A converters used. To give maximum flexibility of routing between the spaces, an SSL MADI X8 unit is used which allows routing and duplication of single MADI channels so audio can be sent to multiple locations. Although the unit will be left with a setup default preset in the majority of cases, it offers a huge amount of flexibility in the system that wouldn't be possible with an analogue wiring system. One downside to MADI is that external wordclock [2] is recommended due to the high jitter rate of the embedded wordclock. The studios therefore link coaxial wordclock cables throughout linked to a master clock in the Control Room.

2.1. Listening Room

The Listening Room has a 24 channel SSL MADI-AX converter which has 20 channels of preamps connected to the A/D. Sixteen of the preamp channels are from the same model of 8 channel Focusrite ISA828 preamp so that the preamps and converter sections are the same. When carrying out research recordings the transfer functions of the preamps should all be identical and thus become negligible within an experiment. The preamp choice was based on the wide and flat frequency response offered by the units. The final 4 channels of preamp is from a Focusrite Red 1. On the D/A side of the converters are PA speakers, Stereo Headphone Mix, 4 individual headphone sends and the 16-speaker spatial audio system. All this connectivity is accomplished over one bidirectional optical fibre connection. There is also a small analogue mixer connected to the PA speakers for use as a rehearsal room. This setup allows brief items 1, 6, 7 and contributes towards items 3 and 5.

2.2. Performance Lab

The audio system is specified for using two fibre connections as part of the MADI network in this room. This is for two 24-channel SSL MADI-AX converters that are part of the MARS rack unit. The inputs to the converters are made using a Yamaha 01V96 digital mixing console via optical ADAT outputs to provide 16 microphone preamplifiers for use as stated in brief item 2. The digital mixer is also connected to PA speakers for in-room monitoring matching brief item 4. The outputs of the converters are used to control up to a 40.1 speaker system via the MARS for spatial audio reproduction of ambisonics, vector base amplitude panning and wave field synthesis to name the main spatial audio types matching brief item 2.

2.3. Control Room

At the centre of the Control Room recording setup is a MacPro computer DAW which has three MADI connections from the Plant Room for connecting to the audio system. We use 16-channel Apogee A/D and D/A converters in this room for monitoring and recording. The master word clock unit is also present in this room to allow user control of the audio system sample rate. Monitoring is provided by a PMC AML2 and SB-100AP 5.1 surround system and alternate Yamaha HS50M reference speakers all connected to an Audient ASP510 surround monitor controller for level control and source/destination routing. All the devices may be used simultaneously by way of an aggregate audio driver on the computer. This room is used for all of the brief items listed in section 1.1.

3. CONTROL ROOM CALIBRATION

Calibration of the Control Room's main 5.1 system is essential for research and teaching purposes. The Audient ASP510 monitor control system allows calibration using the inbuilt pink noise generator. A

'REF' button has a user-defined level which is set in conjunction with individual channel trims to make each speaker sound pressure level equal [3]. The use of this means that inconsistencies in listening experiments carried out over multiple sessions are eliminated due to a predefined level being used. For teaching, students can be given a specification level that their work will be marked at, with this accessible by a simple button push to access the reference level. This means there will be no differences between mixing and marking level as a result of listening curves.

4. MIDI CONNECTIVITY

Part of the Media & Arts Technology Studios brief given in Section 1.1 included the use of MIDI instruments to connect to the Control Room. The problem arose again of connecting the rooms with MIDI with the routing channels available in the building. It is unfortunate that MADI does not offer MIDI within its specifications and neither MIDI or USB cables are specified to the length needed to be used between the studio rooms. To address this problem a USB-to-ethernet converter system is used to provide a transparent connection between a USB MIDI interface and the studio computer. The MIDI interface is stored in a rack bag along with a hardware synth/sampler module for use in rehearsals or connecting to the audio system as described in brief item 1.

5. CULMINATION

The authors have described how they successfully met their given and self-assigned briefs laid out in the engineering report and have designed a professional level recording and mixing environment at Queen Mary University of London as part of the Media & Arts Technology Studios. The resulting system is MADI-based, offering a high level of flexibility for current and future research experiments and installations.We are especially proud of some of the features such as the professional level calibrated monitoring, multiple headphone mix abilities, high quality preamps and high quality documentation of the system design and usage. We believe that we have designed a system that not only meets our needs but is robust in its operation and is upgradable either via patchbays or through the other fibre optic cables that are currently unused. We finally highlight again our approach to make it usable by all audio researchers and other researchers via some basic audio training whilst being a very flexible, powerful and capable system if one wants to delve into the advanced setups offered by MADI routing.

6. ACKNOWLEDGEMENTS

The authors wish to acknowledge the academics at the School of Electronic Engineering at Queen Mary for their support, trust and financing in the audio system described here. We also thank all the researchers who gave their time to help carry equipment.

7. REFERENCES

[1] AES, "Aes recommended practice for digital audio engineering — serial multichannel audio digital interface (madi)," AES Standards, Tech. Rep. AES10-2008, 2008.

[2] ——, "Aes recommended practice for digital audio engineering - synchronization of digital audio equipment in studio operations." AES Technical Council, Tech. Rep. AES11-2009, 2009.

[3] ——, "Multichannel surround sound systems and operations," AES Technical Council, Tech. Rep. AESTD1001.1.01-10, 2001.