FACULTY OF MEDICINE

Design Guidelines for Learning Space AV Systems & Associated Infrastructure S-M Lecture Theatres

AUGUST 28, 2012

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Draft-v0a	July 23, 2012	Incorporating feedback from Dan Lyzun and Associates, Jo-ann Chubb	Updated based on feedback
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Final-v1	August 28, 2012	Finalized with sponsors	Added lighting diagrams

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1 INTRODUCTION

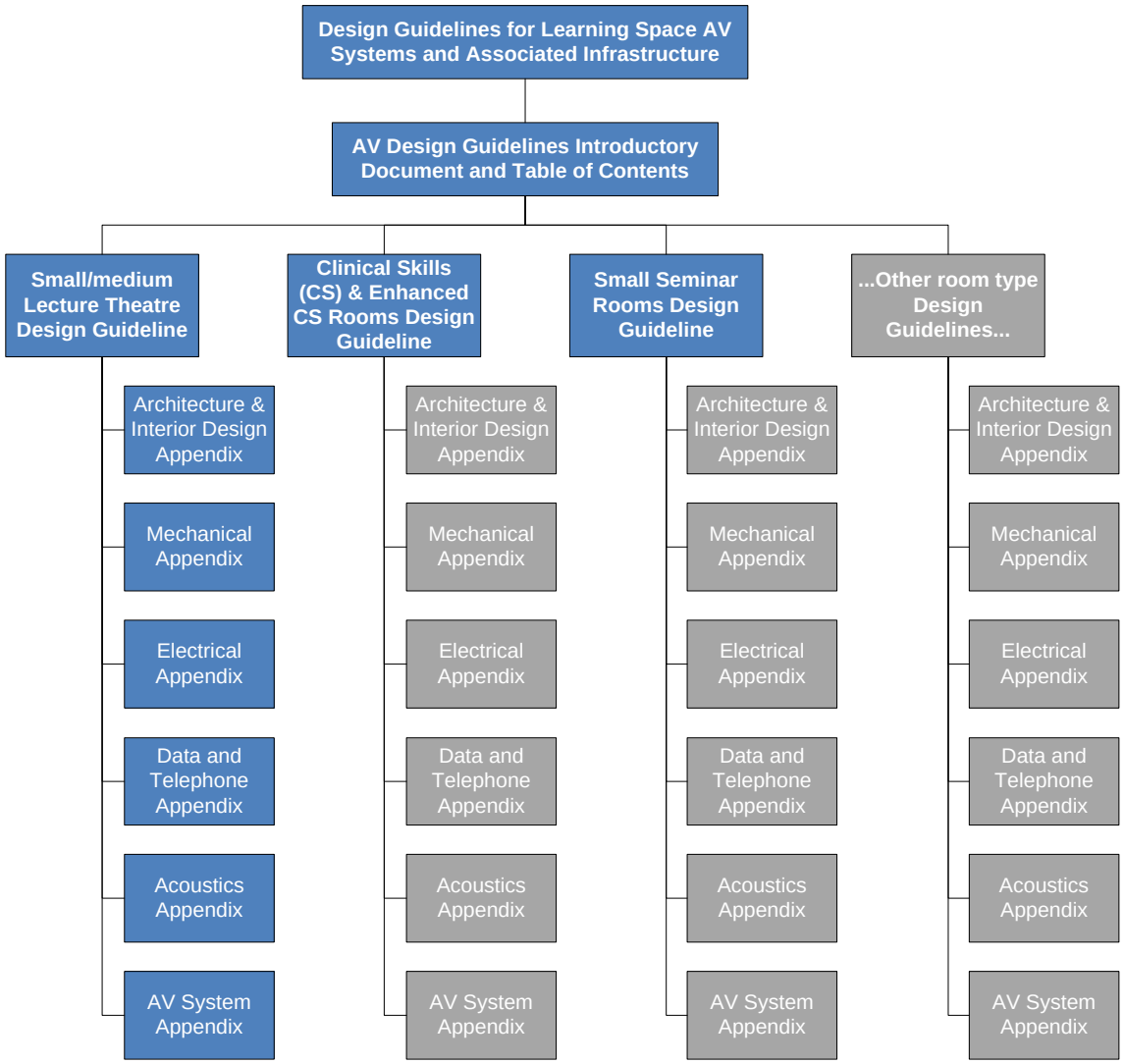
1.1 FACULTY OF MEDICINE DISTRIBUTED MEDICAL PROGRAM

In 2004, the University of British Columbia (UBC) Faculty of Medicine (FOM) initiated its Distributed Medical Program (DMP), the purpose of which is to provide equal access to medical teaching and training for students, residents, and practicing physicians across BC. The DMP is made possible by technology-enabled learning spaces located at university sites (UNBC, UBCO, UVic, and UBC) as well as Clinical Academic Campuses and Affiliated Regional Centres located across the province. Many of these spaces are also videoconference (VC)-enabled and are connected to each other via the central VC Bridge, all of which rests on a dedicated network called the Distributed Medical Program Audiovisual (DMP-AV) network.

1.2 DOCUMENT PURPOSE

This document is part of a collection of documents referred to as the **UBC FOM Design Guidelines for Learning Space AV Systems and Associated Infrastructure** (henceforth referred to as AV Design Guidelines). They provide guidelines for technology-enabled learning spaces based on best practices and extensive organizational experience developed since 2004. Each learning space type has (or will have) an associated AV Design Guideline document with high-level information about that space type. Each AV Design Guideline, in turn, has (or will have) associated Appendices with more detailed information tailored to the various trades commonly involved in a space development project (please see Figure 1 for a diagram of the document suite).

Figure 1: Document Library Tree Diagram



The AV Design Guidelines are generally used in the early stages of a facilities project, along with the Functional Program and/or Project Plan, to align various stakeholders around a common, high-level vision of a given space. Where a functional plan includes technology-enabled rooms, the corresponding AV Design Guideline document(s) should accompany it. If a project is approved, the applicable AV Design Guideline Appendices will be provided to the appropriate audiences at the appropriate time.

This document in particular presents high-level guidelines for small/medium size (70 - 150 seats) VC-enabled lecture theatres (LTs).

The AV Design Guidelines and associated Appendices are intended to encourage and facilitate conversation between designers and the UBC FOM project team to confirm that all designs match the intended use of the space. Information contained in this document (and all UBC FOM AV Design Guidelines and associated Appendices)

should be considered guidelines[1]. In every case, the project design team must consult with the UBC FOM's project team to clarify requirements and develop and approve designs specific to the space. The contents of this document will never supersede UBC project team decisions, a specification document, detailed design, or any other source that is considered by UBC to be more directly relevant to the project at hand. Furthermore, the contents of these documents must not be used as contract language

1.3 ROOM USAGE DESCRIPTIONS

Small/medium LTs are VC-enabled teaching and learning spaces for between 70 and 150 local participants. They are used to connect large groups of students in a lecture-style classroom setting. Usually, there would be multiple LTs connected for a synchronous lecture delivered by an instructor at one of the sites. All participants (both in the same physical space as the presenter or in a distributed space) must have equivalent ability to interact with the instructor. LTs are primarily located on academic and clinical campuses and are used primarily by students and instructors in core curriculum delivery-type interactions.

Examples of Small/medium LTs include the St. Paul's Hospital LT (SPH 1500), the University of Victoria LTs (MSB 150 and 160), the University of Northern British Columbia LTs (NHSC 9-200 and 9-235), and the University of British Columbia Okanagan LT (HSC 260). Tours of these facilities are available upon request.

1.4 FUNCTIONAL REQUIREMENTS

LTs must enable all participants (both on site with the instructor and in a distributed, VC-connected site) to see, hear, and ask questions of the instructor, regardless of which site the instructor is physically located. All participants must also be able to see (and hear, where applicable) the instructor's presentation material.

LTs must enable the instructor to see all participants, hear student questions, see the student asking a question, and engage in dialogue with that student. The instructor must be able to display for all participants (local and remote) from a laptop, lectern PC, document camera, annotation tablet, and other media sources (e.g.: DVD).

2 OVERVIEW OF TECHNICAL SOLUTION

In order to meet the functional requirements described above, small/medium LTs are generally equipped with a permanently installed VC system which includes:

- A VC codec that sends and receives the audio and video signals to/from the other sites via the VC hosting system.
- Two side-by-side displays at the front of the room (behind the presenter area) for simultaneous display of images. These can either be:

[1] A guideline is a general rule, principle, or piece of advice. As used in this project, guidelines are not considered mandatory. They are to be used to determine a course of action and are intended to enable alignment towards common designs. (Oxford Dictionaries Online: http://oxforddictionaries.com/definition/english/guideline?q=guideline)

  - Two projection screens at the front of the room with two projectors in an adjacent projector room (booth) at the back of the theatre (opposite the projection screens), or
  - Two HD flat panel displays at the front of the room.
- A booth at the back of the theatre which houses the main equipment racks and provides space for a technician to sit, observe, and control the theatre.
- High resolution VC cameras in strategic locations within the room to send video feeds of the instructor and students to remote locations.
- One push-to-talk microphone for each pair of student seats as well as a wireless, hands-free microphone and a fixed lectern microphone for the instructor.
- Speakers for local student and instructor voice and content amplification as well as sound projection from remote sites.
- A lectern at the front of the room, with a height-adjustable table, to facilitate source inputs and a control panel.
- Two confidence monitors so the instructor can see him/herself, the remote sites, and the presentation material while facing the audience.
- A control system with touch panel interfaces (at the lectern and in the booth) to control room audio, video, environmental settings, and codec.

The room should have VC-appropriate architecture, acoustical treatments, wall and furniture colours, lighting, cooling, power and data ports, and conduits. The following sections describe guidelines for additional aspects of room and VC system design.

UBC FOM technology-enabled learning spaces have active AV equipment 24 hours per day, 7 days per week. Spaces are primarily used during business hours (6am-6pm Monday-Friday), but can be used at anytime.

The AV equipment in this space has a life cycle. The best practices included herein consider renewal as part of this cycle.

3 TECHNICAL SOLUTION DESCRIPTION

The following content is divided into trade specific sub-sections related to specific infrastructure needed in order for the VC system to function as intended. The sections are as follows:

1. Architecture & Interior Design
2. Mechanical
3. Electrical
4. Data & Telephone
5. Acoustics

3.1 ACOUSTICS

- Acoustical requirements are subject to an acoustical report generated by a qualified acoustical engineer. This report will address acoustical requirements for the HVAC system, ambient noise levels, lighting ballasts, reflective surfaces, treatments, reverberation, and other noise mitigation methodologies.

- Room acoustics play a key role in ensuring presenter and audience speech intelligibility.
- There are three key parameters:
    - Background noise which considers ambient noise from HVAC and other systems that may create continuous/intermittent noise in the space,
    - Sound isolation which considers noise transfer from outside the space to inside the space, and
    - Interior acoustics which considers the movement and reflection of sound waves within the room.

3.1.1 BACKGROUND NOISE

- In order to provide good speech intelligibility for local and remote listeners:
    - The background noise target should be Noise Criteria (NC) 25-30 with no pure tones.
    - The projection booth and central VC operator/rack rooms should meet a background noise criterion of NC-35 from ventilation only, before the rack is installed.
- Achieving these low NC levels means very tight control of fan noise and air flow conditions.
- Noise-producing HVAC equipment including mixing boxes, fan-powered mixing boxes, and fan coil units should not be located inside VC rooms or within the ceiling plenum space.

3.1.2 NOISE ISOLATION

- It is critical to the proper functioning of the VC room to achieve adequate sound isolation between the rooms and adjacent spaces. The adjacent spaces may include, but are not limited to, the booth, other VC rooms, regular meeting rooms, lecture rooms, washrooms, and corridors.
- All perimeter walls should achieve a Sound Transmission Class (STC) rating of STC 55 (double stud walls only). The door should be targeted for a purpose built STC 45-50, depending on circumstances.
- Noise isolation to rooms above and below should be set an optimal level of STC 50, depending on circumstances.
- A target Impact Isolation Class (IIC) 65 minimum rating should be set for the floor/ceiling system. This may not be practically achievable unless the floor above is concrete and topped with carpet.

3.1.3 INTERIOR ACOUSTICS

- LTs should have appropriate acoustical conditions to optimize the rooms for presentations, VC, and/or monitoring. Appropriate acoustical treatment should be installed to control reverberation, minimize reflections, flutter echo and other acoustical issues that may adversely affect the microphone pickup.
- The design target for reverberation time should be 0.45 to 0.55 seconds in the mid and high frequencies, with controllable low frequency energy.

6. AV System

The information contained in this AV Design Guideline is relatively high-level and intended to be used for early project planning (e.g.: budget estimates) and to create a common understanding of what is necessary for a small/medium VC-enabled LT to be fit for intended use. Additional AV Design Guideline Appendices with further detail will be made available after the project has been approved. The Appendices contain detailed information that can be used to support the detailed space and AV design phases.

All information in this document should be considered as in support of the AV system. There may be additional infrastructure requirements unrelated to the AV system, and thus not contained herein, but that are still necessary for the space to be fit for intended use. For example, power outlets not required for AV components, door sizes, handicapped access, etc. These should be included in the space design developed by the architect.

3.2 ARCHITECTURE & INTERIOR DESIGN

3.2.1 GENERAL DESCRIPTION

- Small/medium LTs seat between 75 and 120 people.
- The space should be between 155 and 280 net sq meters, depending on the number of seats.
- The space should be rectangular with an aspect ratio of side walls to front/back walls of approximately 1:1.168.
- Site lines to the main screens at the front of the room should be unobstructed from all seats.
- Seating is generally tiered with the presenter area lowest with each successive row of seats a step above the preceding row, moving towards the back of the room. There should be a minimum of 800mm between seating rows (or as per municipal bylaw, whichever is greater).
- The entrance should be at the back of the room (opposite the presenter area). Entry vestibule requirements are room specific.
- There should be a projection booth at the back of the room (opposite the presenter area). See section 3.2.2 for additional information about the booth.

Figure 2: Side view of a small/medium LT to demonstrate tiered seating

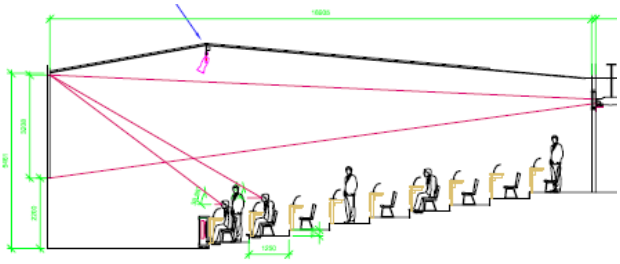
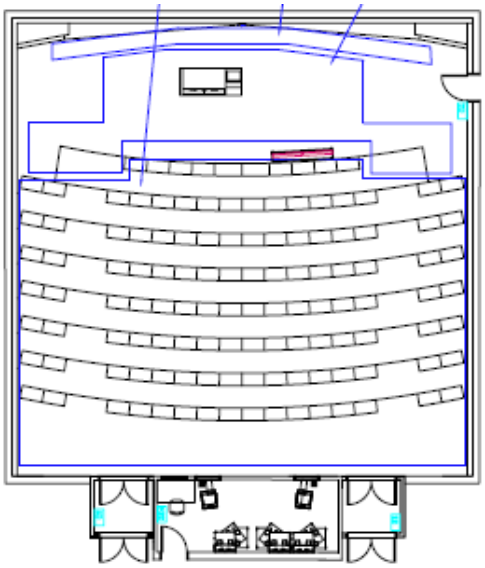


Figure 3: Overhead view of a small/medium LT showing presenter area at the front and booth at the back



3.2.2 BOOTH

- The projection booth at the back of the space houses the projectors and main equipment racks.
- The booth should be at least 17 net square meters.
- The booth must have an adjoining wall opposite the main projection screens (presenter area) with one (or more), non-reflective glass window(s) joining the booth to the LT space. The projection path from both projectors will pass through this window.
- The booth should have a fixed table facing the glass, with room for a chair and site lines into the room for the technician to monitor room operation.
- The projection booth should provide sufficient space for the projectors to be securely mounted in the required positions projecting through the projection windows onto the front wall screens. The projectors may be mounted from the floor, braced between the booth front and back wall, or suspended from the ceiling.
- The booth should be designed to provide the required structural support for the two projectors and should include any required vibration isolation measures to prevent the projectors (and the projected image) from shaking.
- The main equipment racks will need to be opened for maintenance, with adequate clearance for technical staff to maneuver comfortably.
- Cooling in the booth is necessary due to the heat load generated by the equipment.
- Access to the booth should be from the outside hallway, the entry vestibule, or inside the main theatre space (in that order of preference). If access is from inside the main theatre space, consideration should be made to ensuring proper sound isolation for the door.

3.2.3 WINDOWS

- Exterior windows should generally be avoided in videoconferencing spaces because exterior light creates problems for videoconferencing and video presentation.
- If exterior windows exist, blackout blinds will be needed for these windows to make it possible to display video or use video cameras.
    - Blackout blinds should be powered and controllable using the AV control system.

3.2.4 CAMERA POSITION

- The cameras require wall positioning for appropriate image angles and complete visual coverage for all different educational usage scenarios.
- The cameras require appropriate protection from theft and damage, where applicable.
- The primary audience camera(s) should be positioned such that when the audience is looking at the screens, they appear to be looking in the direction of the camera.
- Instructor camera(s) will be positioned such that when the instructor is speaking to the room occupants, he/she is also facing in the direction of the camera.
- Adjoining spaces should be carefully selected to avoid structural borne vibration. High Definition cameras have a low tolerance for structure borne vibration, and magnify the problem when using zoom function. Spaces that have a detectable vibration should use dampening material to stabilize the image.

3.2.5 LECTERN & FURNITURE

- The UBC FOM owns the design for a standard lectern that is used for these spaces. UBC FOM will provide the design team with the conceptual design drawings.
- Lectern: The LT should have a permanently installed lectern in the presenter area.
    - The lectern should be the AV systems control point, housing the DVD, lectern computer interface, AV system control touch screen, document camera, and all auxiliary inputs.
    - The lectern should have an 18" LCD touch screen monitor which serves as a preview monitor, confidence monitor, and annotation screen. This provides the presenter with the ability to annotate the computer-generated image displayed on the local and remote screens.
    - Conduits providing power, network, and AV lines will terminate inside the lectern millwork. See section 3.4.3 for more information on conduits.
- Student Tables: LTs typically have independent seats with bench-style tables with modesty panels where necessary. More traditional lecture theatre row seating with fold-out leafs for note taking is not acceptable.
    - One push to talk microphone is needed for every pair of seats. Microphones should be installed in the tables along with power for each seat. Internet will be provisioned for users of the space via Wi-Fi provided by the building host. These require electrical infrastructure to permit the wiring to connect from the audience desk locations to the equipment rack locations. See section 3.4.3 for more information on conduits.

3.2.6 COLOURS

- The colour of the walls, carpeting, and chairs should be either grey or solid blue to provide visual definition to the presenter relative to the background. The purpose of the solid colour is to avoid adding unnecessary bandwidth to the video conferencing signal, and to avoid the reflected light from the background affecting colour quality of the images.
- The colour of the tables or lectern surfaces should be either antique white, light grey, or light maple to allow the 45-degrees light to bounce off the surface and reflect light upward helping to illuminate the faces of the presenters and eliminate the dark shadows under the chin/nose. This also minimizes changes in light quality when the participants place paper in front of themselves on the desk.

3.3 MECHANICAL

3.3.1 HVAC AND HEAT LOAD

- LT and projection booth space HVAC designs should account for all AV equipment and maximum occupancy to maintain temperatures comfortable for occupants and safe for AV equipment.
    - There is a significant amount and variety of equipment used in AV systems, such as projectors, computers, video displays, switching units, and other signal processing equipment. This equipment generates a substantial heat load. Some of this equipment is on 24 hours per day, 7 days per week and needs to be cooled at all times.

  - Long-term ambient room temperature target for these rooms to operate in is 21 degrees Celsius with a humidity level of 30-50%.
  - Booth maximum short-term (up to 60 minutes) sustainable ambient temperature for these rooms is 24 degrees Celsius with a humidity level of 30-50%.
- Small/medium LTs generally require 3-5 tons of cooling capacity depending on the room size and existing mechanical infrastructure.
- Consideration should be given to the location of the compressor such that it does not interfere with the acoustical requirements and does not introduce vibration into any wall or bulkhead that supports a camera.

3.3.2 PROTECTION FROM WATER DAMAGE

- All VC rooms should be designed and constructed to protect the AV equipment from damage caused by plumbing failures and excessive condensation.
- Where AV equipment racks must be located directly beneath plumbing lines, equipment must be shielded from potential non-sprinkler related water damage.

3.4 ELECTRICAL

3.4.1 LIGHTING

- Lighting is a key factor in a properly functional VC room. It should be designed to:
  - Allow the participants and presenter to be well-illuminated for the VC cameras;
  - Avoid light reflecting off projections screens and video display surfaces;
  - Avoid an overly illuminated or glaring presentation area, and/or a presentation area where the instructor cannot see easily;
  - Avoid hot spots or shadows on the presenter;
  - Allow the instructor to easily control the lighting conditions;
  - Illuminate the entire stage/presenter area, not just the lectern area.
- Lighting zones and light placement should be determined by a qualified lighting engineer.
- A commercial stage lighting array should be installed in the ceiling at a 45 degree angle of incidence from the instructor position (see Figure 4 below). Light positions should illuminate the instructor from both the left and right sides at a minimum of 20 degrees from the path between the instructor camera and the presenter (see Figure 5 below).

Figure 4: Lighting angle above the presenter

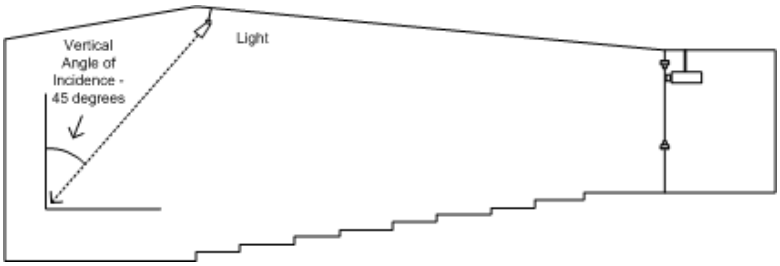
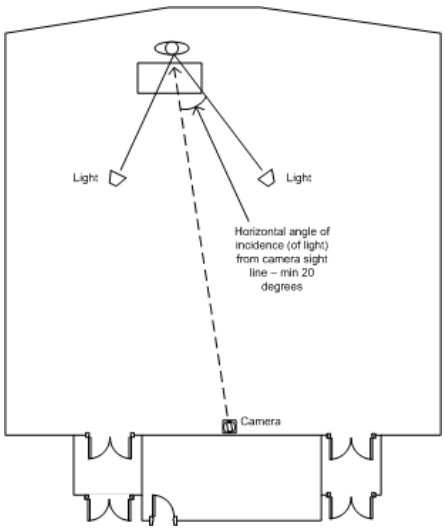


Figure 5: Lighting angle from either side of the presenter



- Colour temperature should be 3500 degrees Kelvin in a VC room. Different lights/colour temperature should not be mixed.
- Lighting for the lectern area should provide a minimum brightness of 80 foot-candles.
- Lighting for the stage area should also provide a minimum brightness of 80 foot-candles on a separate control.
- The lighting array and attached lights should not interfere with the projection path.
- Lighting should be divided into zones to enable adequate control of lighting. The lighting control interface needs to be accessible from the booth, near the rack location.

3.4.2 POWER OUTLETS

- At a minimum, there should be separate circuits and power outlets for:
  - Each camera (15 Amp duplex);
  - Inside the lectern (20 Amp quad);
  - The top of the lectern (15 Amp duplex);
  - Each confidence monitor (15 Amp quad);
  - Each projector (20 Amp duplex);
  - The booth rack (2 x 20 Amp quad); and
  - The booth table (2 x 15 Amp quad).
- There should be one outlet (15 Amp duplex) for each pair of student seats (one plug per student). Students typically use these for laptops, cell phones, and other portable computing equipment.

3.4.3 CONDUITS

- Infrastructure should be provided to connect electrical, AV, and data cables from desired locations to the equipment rack (or other necessary location).
- Appropriate quantity and size of conduits or cable pathways will be needed to facilitate AV, IT, and power cable runs between:

  - The lectern rack and the booth rack,
  - The booth rack and the fixed tables for push-to-talk microphones,
  - The booth rack and the speakers,
  - The booth rack and each camera position,
  - The booth rack to the confidence monitors,
  - The booth rack to the house ladder tray servicing the building (depends on the room design).
- For any location that requires a power outlet (as described in section 3.4.2), appropriate conduits or cable pathways should be installed.

3.5 DATA & TELEPHONE

- The projection booth/rack room will require up to 6 ports on the house network (2 for codecs, 1 for cobranet (digital audio network), 1 for control, 1 for PC control, and 1 for analog telephone). The actual quantity will be dependent on the AV design. These ports should be near or in the rack.
- If the room requires a telephone for booth operator's use, an additional telephone line (or data port for IP telephones) will be required.
- If a telephone is desired at the lectern, a telephone line (or data port for IP telephones) will be required.
- If the Functional Program that includes this room also covers other spaces, there may be a requirement to reserve common communications closet space to facilitate telephone & data connections for rooms within the plan.
- Room design should account for Wifi coverage with sufficient density for the number of occupants and multiple devices per occupant.
- The lectern should have two data ports on the top of the lectern (one for laptop connectivity and one for other secondary devices), and one data port inside the lectern.

3.6 ACOUSTICS

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3.6.1 BACKGROUND NOISE

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  - The background noise target should be Noise Criteria (NC) 25-30 with no pure tones.
  - The projection booth and central VC operator/rack rooms should meet a background noise criterion of NC-35 from ventilation only, before the rack is installed.

- Achieving these low NC levels means very tight control of fan noise and air flow conditions.
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3.6.2 NOISE ISOLATION

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- The design target for reverberation time should be 0.45 to 0.55 seconds in the mid and high frequencies, with controllable low frequency energy.

3.7 AV SYSTEM

3.7.1 AUDIO

- The audio systems for the lecture theatre perform three key functions:
  - Playback of multimedia material from various sources,
  - Voice amplification for local presenter and participants, and
  - Processing and playback of the incoming audio from remote sites.
- The LT should have one wired lectern microphone and two or more wireless, hands-free instructor microphones.
- One wired push-to-talk microphone should be shared between each pair of seats for all participant seating areas. These microphones will be gooseneck type microphones, permanently mounted to the audience area fixed tables.
- The AV playback system will use loudspeakers flanking the large projection screens located on the front wall.
- The ceiling will house reinforcement speakers, the quantity of which will be space-specific.

3.7.2 DISPLAYS

- LTs should have two LCD preview/confidence monitors located in front of the first row tables. They should be secured with an anti-theft device. The purpose of these monitors is to provide the lecturers with the ability to move freely while still seeing the selected sources and students in remote locations.
- The front screens take the form of a display wall, separate screens, or one very large screen that can accommodate the dual 16x9 projections. The size of the main screens will depend on room size and distance to the most distant viewer.
- Projection screens need to be of adequate size to enable all participants to clearly see the content on the screen. Screen size is a function of room size and dimensions.
    - Ratio of the distance from the projection screens to the most distant viewer (MDV) to image height (IH) will not exceed a factor of 6.7 (MDV divided by a single IH) for 95% of all seats. A maximum of 5% of seats may be at a maximum MDV to IH factor of 7.2.
- The plane of the screen surface needs to be perpendicular to the direction of the projector image.

3.7.3 CONTROL

- The control system should integrate the functions of the many devices in the AV systems.
- All of the required remote-controllable devices will be connected to central processors, allowing control from 15” colour control touch panels housed in the lectern and the booth.
- The control system will also be connected to the LAN to facilitate web-enabled control panels.

3.7.4 VIDEO CONFERENCING

- For the purpose of connecting to remote sites, the LT should be equipped with a maximum of two videoconferencing codecs, allowing simultaneous transmission of up to three high resolution graphics channels. The control of the codecs and source assignment will be managed by the control system.

3.7.5 RACK

- The rack should be located in the projection booth.
- The rack should contain most of the AV components including:
    - Audio components
        - Amplifiers – audio signal amplification
        - Audio transformers – device to create balanced audio
        - Digital signal processor (DSP) – audio processor
        - Logic boxes – sensors for push-to-talk microphone buttons
        - Wireless audio receivers – wireless microphone components
    - Video components
        - Foxboxes – video converters (analog or digital to fiber and vice versa)
        - Scalers – video signal format adjuster
        - Video switchers – fibre-based video signal switcher
    - Control components
        - Codec(s) – videoconferencing (audio and video) transmitter and receiver

        - Crestron controller – central control system that transmits user commands to all controllable hardware devices in the space
    - Other components
        - Ethernet switchers – IP-based switching device
        - Fibre optic patch panels – fibre cable termination points
        - Power conditioners – power protection device
        - Uninterruptable power supply (UPS) – battery backup and power protection
        - Other equipment required for the AV system

3.7.6 CAPITAL RENEWAL

AV designs and associated infrastructure consider life cycle management and equipment renewal.

4 CONTACT

If you have questions or require additional information, please contact Izaak Housden, Sr. Technology Analyst, Island Medical Program at ihousden@uvic.ca or 250-418-5506.