The Teaching Center’s approach to Washington University classroom design begins with an understanding of how various elements come together to shape teaching and learning, including specific teaching methods and approaches, available technology and other tools, as well as the physical layout of a classroom.

How to Design a University-managed Classroom
A Guide to Better Classroom Design at Washington University

The Teaching Center

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How to Design a University-managed Classroom at Washington University

**Philosophy:** The Teaching Center's (TCC) approach to classroom design begins with an understanding of how various elements come together to shape teaching and learning, including specific teaching methods and approaches, available technology and other tools, as well as the physical layout of a classroom. This document describes, in detail, the design of the physical layout and characteristics of a standard University-managed classroom. It also provides information about classroom furniture, which is durable and functional, and the classroom multi-media systems that have been designed to be intuitive and easy for faculty to learn and use. Additional information is provided, where needed, for auditorium layout, design, multi-media and seating.

The multimedia (e.g., PC, DVD player, and laptop connector cables) are all located in the instructor’s desk; however, the desk has been designed to facilitate the use of technology without losing functionality for more traditional teaching methods. The touch-panel control systems have been designed with teaching in mind making it easy for faculty to use. The technology components have been set up in a similar way in most classrooms, making it easy for faculty members to move from room to room.

Functional, long-lasting, flexible, and well-designed student seating and tables completes the standard classroom design.

This document does not address ADA (American with Disabilities Act), LEED (Leadership in Engineering & Environmental Design) or University Design Standards. For design and construction standards and requirements please see the Design Standards: Architectural Design Standards, Engineering Design Standards, CAD Standards Manual and Design & Materials Standards under the Capital Projects and Records links by visiting [Washington University Facilities Planning and Management website](#).

1 **Physical Features of the Classroom**

The physical features and layout of a classroom can affect, to some extent, the teaching and learning that takes place in the space. For instance a poorly designed layout may have sightline issues for one or more students, ill-placed columns may obstruct viewing part of the teaching space, or a door or window may break up the best wall on which to place the chalkboard and viewing screens.

1.1 **Shape, Orientation and Size**

**New Classroom Construction**

- The preferred **shape** of a classroom is *square*.
  - If the room has to be rectangular then the preferred dimensions should be a 4 X 3 ratio (length by width).
- The front, or teaching wall, is determined by where the windows and doors are located. The teaching wall should be on a long,
flat, unobstructed, wall. If possible, the door should be opposite the teaching wall on one side of the room or the other. (See Figure 1.)

- The Teaching Center maintains a list of classroom sizes and types that the University requires and should be consulted on all new construction of University-managed classrooms to determine the proper size classrooms to build.

- Milling Space. Milling Space is defined as the amount of useable space students have to wait in, directly outside classrooms or auditoriums, when moving between classes. Although no definite guidelines exist for milling space the designers should follow these principles:
  - Milling space should be located close to the vicinity of the classrooms they are to support. Students simply won’t wait in a space that separates them too far from the classroom doors.
  - Milling space should be a comfortable size to accommodate the quantity of students moving in and out of the classrooms. Some estimates have been made, but exact ratios (square foot per student) have not been defined.
    - Currently the minimum required is 5 sf/person for standing space (a standard set by the International Building Code) at 50% of the total seat count.
  - Built-in benches can help accommodate more students, at 18”/person.
  - This information provided above is based on research and estimates from the architects of the Brown Hall Expansion Project - 2014-2015.

**Remodeled Classroom or Repurposed Space into a Classroom**

- When remodeling an older classroom or turning a space not originally designed for teaching into a classroom shape must be considered. Some spaces are simply the wrong shape to make a good classroom, for instance a space that is extremely long and narrow. Odd layout of rooms may provide for closets or nooks to store extra furniture, trash receptacles or podiums, but in general odd layouts are undesirable. Poles and columns and other structures that block views and hinder communication between the students themselves or students to the teacher are also undesirable.
- Some spaces are simply too small in size (those that would seat less than 15) to make good classrooms.
- If it is determined that the space is to be used as a classroom, care must be taken to choose the correct wall to designate as the front, or teaching wall, of the room. TTC should be consulted to determine which wall is the teaching wall.
- Location must also be taken into consideration when considering turning a space into a classroom. Locations that are central to the campus are preferred, to aid in travel time between classes for the students; other locations will be taken into consideration.

### 1.2 Room Dimensions

The square footage of a classroom generally determines the number of students that will be comfortably accommodated. TTC has developed a “square footage per student” formula for five styles of classroom layouts based on the space needed for student seating, student movement, aisles, teaching desk, teaching movement and other factors.
Types of Classroom Layouts

Tablet Style Classroom:

- Definition: tablet chairs in a row
- 19 sq. ft. per seat average
- Example: Eads Hall Room 115

Tables and Chairs in Rows Style Classroom:

- Definition: moveable tables and moveable chairs
- 24 sq. ft. per seat average
- Example: Lab Science Room 201

Seminar Style Classroom (open):

- Definition: tables in an open square
- 32 sq. ft. per seat average
- Example: Seigle Hall Room 305
Seminar-Style Classroom (closed):

- Definition: single conference style table
- 26 sq. ft. per seat average
- Example: Eads Hall Room 109

Auditorium (fixed seating over 100 seats, sloped and stepped):

- Definition: fixed tablet arm chairs (8% to 10% left handed)
- 15 sq. ft. per seat average
- Example: Lab Sciences 300
- Note: This square footage per seat does not include the square footage requirement for ramping if it is required by ADA code.

1.3 Ceiling Height

The ceiling height is measured from the finished floor (AFF-above the finished floor) to the finished ceiling. A vertical distance of 11’6” to 12’ from the finished floor to the finished ceiling is required at the front of the teaching wall to accommodate vertical sliding chalkboards. A clear line of sight must be maintained from the top of the chalkboard at its highest point to the back row of seats.

Ceiling Height

- **Tablet Style and Table and Chairs in a Row Style Classrooms**
  - 12’ is preferred
  - 11’2” is the minimum height allowed
    - If 11’2” is the minimum to work with the architects must take great care to make sure that the height of 11’ 2” is kept. This involves careful planning, measuring and installation by the architects and the construction team. Care must be taken...
during the planning, measuring and installation phases to make sure the ceiling height is kept.
  o Vertical-sliding chalkboards must be used which is one reason the ceiling height is required.

- **Seminar Style Classrooms (open and closed)**
  o 12’ is preferred
  o 9’ is the minimum ceiling height allowed
  o Vertical-sliding chalkboards must be used in ceiling heights of 11’2” or higher however, if ceiling is between 9’ to 11’2” tall, a single, fixed back, non-sliding board may be used.
    ▪ Horizontal sliding boards may be used under certain circumstances, however TTC must be consulted.

- **Auditoriums**
  o 12’ is the minimum height allowed, although ceilings may be taller.
  o Vertical sliding chalkboards must be used.

1.4 Flooring

Standard classroom flooring should be long lasting, easy to clean and inexpensive to maintain. The type of flooring chosen is based on whether the room is a standard classroom or an auditorium and the quality of finishes in the room. A typical auditorium may have up to three different flooring types. A high-finish classroom or auditorium floor will have the qualities of a standard floor but the material used may be more upscale to fit the style of the room.

Classroom Flooring

- **Wood flooring** is highly desirable in high-finish rooms or if it fits in with the other general finishes of the classroom.
  ▪ Dense, hardwood is preferred due its wear-ability, whereas soft woods tend to dent easily and cannot withstand the high traffic of a classroom environment. Reclaimed wood is fine if it is hardwood and can withstand high traffic.
  ▪ Examples: Seigle L006: bamboo (soft wood) curled up on the sides and does not make a nice, flat floor. Cupples II: wood floors (made from reclaimed softwood) had to be refinished after only 6 months of wear.

- **Resilient hard-surface flooring** is the next preference.
  ▪ 12 X 12 inch, or other size, tiles are preferred over continuous sheet vinyl.
  ▪ The 12 X 12 inch (or other size) tiles are easy to install, are long lasting, and are less likely to chip, scratch or bubble during installation and over time than continuous sheet vinyl. (Note: See various Seigle classrooms where continuous sheet vinyl is buckled and is being worn down by cleaning machines.)
o **Baseboards** - High-finish rooms require wood baseboards while standard rooms may use wood or plastic cove base.

o *Carpet* is not good for general-use classrooms. Carpet does not last long enough or wear well and is difficult to keep clean. Carpet may be used in certain locations in an auditorium such as aisles and entrances. (See photos and sketch of auditorium flooring below.)

**Auditorium Flooring**

o **Seating area** - Painted hard-surface flooring is preferred.
  - Painting with epoxy (a resin and a hardener) with grit creates a very hard surface that withstands traffic, is long-lasting and keeps its’ color; is easy-to-clean and helps prevent slipping when the area is wet.
    - When installing epoxy flooring the contractor should require an on-sight mock up for approval by the architect and/or TTC prior to installation.

o **Teaching area** - Wood is desirable but other long lasting and easy-to-clean surfaces such as VCT (vinyl composition tile), laminate (made from melamine resin, a hard, plastic material) or linoleum (made from renewable, all-natural materials) are acceptable.
  - Faculty spends many hours standing on the teaching area floors of auditoriums. Use of hard-surface products that have a slight ‘give’ to them to cushion the concrete floor is preferred.
- **Aisles and Entrances** — Carpet is preferred.
  - Carpet helps contain foot traffic noise (for students who arrive late) and has a non-skid quality.
    - Carpet must be cut pile (less likely to run), tight weave (more fibers), and level looped (wears better).
    - Carpet must be high quality, longwearing (at least 10+ years), and stain-resistant.
  - Aisle edging should be finished with edge binding if at all possible. If plastic edging is used, it must fit snugly over the carpet edges to keep it intact.
    - Black, or another receding color that coordinates, should be used as the plastic edging color.
1.5 Doors

Doors should be placed towards the back of the room (if possible) on either wall adjacent to the teaching wall. If possible, the door should be opposite the side of the room where the screen is hung. Doors should be finished in the same style as other trim in the classroom.

Doors

- Sizes
  - Classroom doors should be at least a standard 36” wide.
  - Auditorium doors should have at least one set of double doors (dictated by how many students the room holds) with at least one of the doors having a 36” wide opening. It is desirable to use a vestibule at the entrance of auditoriums to minimize sound and air exchange. The inside double set of doors should be free-swinging.
  - Doors leading directly to the outside should be equipped with auto locks so that they can be opened and closed electronically.

- Features and Hardware
  - Thresholds, Hardware, Keys and Locks
• Door threshold must be flat to allow for smooth movement of wheeled furniture over the threshold (a ‘low hump’, or ‘no lip’ threshold).
• An electronic door lock dogging mechanism should be used to minimize the sound a door makes when opening and closing. Door hardware must be quiet.
• Doors should be keyed to correct TCM (Teaching Center Master) core; The Teaching Center will coordinate with the lock shop.
• If using mechanical locks, locks should be key lock only and NOT push-button locks.

- **Locking and Vision Panel**
  - Classroom doors remain unlocked 24/7, which is consistent with current policy.
  - Policy concerning auto locking of classrooms, auditoriums and building doors is currently being discussed at the University.
  - Main access doors must have a vision panel for viewing of room while door is closed.
    - Approximate size (of vision panel) is 24” x 4”, installed at 38”- 42” above the floor.
    - Half or full-glass panels in doors are not desirable because these panels let too much light into the room especially when using multimedia. Too much glass can also be distracting if movement is going on in the hallways.
    - Sidelights are not desirable, but if there is a side light it must have frosted glass. Shades on the sidelight may also be required to reduce light.

### 1.6 Windows

Daylight reduces eye fatigue because it is flicker free therefore windows are desirable and should be included in classrooms when possible. However all windows should have a dual shade system to control daylight. Windows, like doors, should be finished in the same style as other trim in the classroom.

**Windows**

- **Presence of windows**
  - Required in rooms ≤ 50 student seats, unless not possible at all
  - Preferred for classrooms 51 ≥ 199 student seats
  - Not necessary, but desirable, for auditoriums ≥ 200 student seats

- **Window treatments** should be included on all windows no matter which way the window is facing. It is preferred that windows have two shades each, one room darkening and one light filtering. The windows should not have any rails or tracks to guide the shades. The shade colors should be determined by the room colors.
  - **Room Darkening Shades.** The room-darkening shade should be closest to the window. It should be 100% blackout vinyl or fabric with a 0% or less openness factor.
    - The intent here is to make the room dark when the room darkening shades are down. The room-darkening shade should be sized and mounted in such a way as to minimize or completely block any light
leakage from around the window when the shade is closed. Shades should not be put in tracks or rails because these systems malfunction.

- **Light Filtering Shades.** The light-filtering shade should be closest to the classroom. It should be a fabric or vinyl mesh (95%) and have a ± 5% openness factor.
  - The intent here is to remove glare from the sun entering the room, to slightly darken the room and to obscure the view so that outside movements are not a distraction.

- **Blackout Shades**-considered only in specialty classrooms
  - Definition: Blackout shades are made of blackout fabrics, with 0% openness; these shades, combined with front tracks ensure that no light transmits into the interior.
  - Blackout shades are rarely used in University-managed classrooms except when requested by a department that has a very specific need.
  - If blackout shades are installed only front tracks should be used to control the shade and light leakage because dual track shades are difficult to maintain and break easily.
Control of Shades – Manual vs. Electric

For energy conservation, low cost, and easy maintenance, manually controlled shades are preferred. Electronic shades should only be used when the shades themselves are difficult to reach because they are too high (such as Louderman Hall 458 or Busch Hall 100) or because the window well is very deep and the windows themselves are too hard to get to (such as Cupples II 001). In some instances, electronic shades may be used if the style of the room is high-finish like Ridgley 107.

- **Manually controlled shades**
  - Metal chain is preferred over plastic. Plastic chains tend to get tangled more easily and break more frequently. Metal chains are heavier and more durable and perform better than plastic chains in the shade pulley system.
  - The chain should drop to a point of easy access for the user; this is usually the window sill.

- **Electronically controlled shades**
  - Electronically controlled shades must have controls that are located in two places; one control is located on the touch panel on top of the desk and the other control is located on a wall near the chalkboards.
    - The shade controls are located on a wall near the chalkboard to provide easy access for when the speaker is not using multi-media and merely wants to control the shades in the room (i.e., to control light and glare.)
    - The Room Control page will have shade buttons labeled Left, Center, or Right when facing the students.
    - The shade controls on the wall will be labeled Left, Center, or Right when facing the wall.
- For more convenient operation of shades, shade controls should be grouped to operate by location (left side, center or right side) and by purpose (room darkening and light filtering).
- Each shade control should be labeled up/stop/down.
- Shade controllers should not be overly complicated but suited for the job. In all instances, care should be taken to provide the least complicated control. After a switch is selected it must be presented to TTC for approval.

- Shades too high to reach so shades are electronic.
- Shades are ganged together by location (east shades separately controlled from north shades).
- Shades are controlled by purpose (room darkening and light filtering).

**Hanging of Shades**

The purpose of the shades is to block various degrees of light from entering the classroom. The shade box and shade should be hung on the *interior* of deep window-wells to eliminate light-streak leakage. The shade must drop from the back of the roller and as close to the window as possible.

If no window well exists, or if the window well is shallow, then the shade should hang on the outside of window with minimum 2” overlap onto the walls, again to prevent light-streak leakage. The shade must be hung as close to the wall as possible and the shade must drop from the back of the roller.
1.7 Walls

The walls of a classroom offer an opportunity to add interest to the overall look of the classroom. They can also be used to help control acoustics.

Walls
- **Paint** is the usual wall cover of choice. Paint is used to color, protect and provide texture to walls. Paint colors should be selected to add interest to a classroom.
  - Upscale or high-finish rooms may have different wall finishes such as wainscoting or wood paneling.
  - Acoustic paneling may be added for sound absorption, if needed.
- **A chair rail** is desirable for several reasons. First, it offers an opportunity to “break-up” the long expanse of a wall. A chair rail also allows for different paint colors to be applied above and below the chair rail adding warmth, beauty or interest to the room.
  - A *wood* chair rail is preferred over a plastic product; however plastic and other products may be used if they match the room finishes.
  - A chair rail also protects the wall from damage caused by the chair tablet or the backs of the student chairs rubbing up against it. For this reason the chair rail should be hung at 26” (measured from the bottom of the finished floor to the bottom of the chair rail) and should be 5” wide to protect the walls. The chair rail should run the length of all walls possible for consistency.

- Wood chair rail
- Two colors of paint
- Adds warmth and interest

1.8 Closets

Closets offer a convenient place to store extra items for a classroom such as furniture; however they should only be planned in a classroom if they do not take up valuable classroom seating space.
Closets

- Closets must have a self-contained light and switch located inside.
- Closet doors should be lockable and keyed according to the correct Teaching Center Master. (Please see TTC for the proper key information.)
- There should be no, or a very low threshold between the closet and the classroom floor. This allows equipment and other items to be easily moved in and out of the closet.

Example of “no threshold”, or a flat floor, between the closet and the classroom.

### 1.9 Signage and Wayfinding

The proper signage inside and outside of the classroom offers needed information and direction. Wayfinding helps the instructor, student, and visitor navigate the building.

**Classroom Signage**

- **Classroom Sign** (outside of the room)
  - Each University-managed room must have a sign on the outside of the classroom next to the door displaying the room’s number, the university hall it is located in, the approved WU logo and the type of room it is, such as a classroom or an auditorium.
  - Classroom Signage should be in keeping with the look and finish of the building. Currently the university is using FullView graphic display system signs by APCO signs. If the APCO signs are in keeping with the look and finish of the building they should be used. If not, the architect and The TTC will design or choose the proper signage.
Classroom Sign Holder (inside of the room)
- The Classroom Sign Holder displays the Classroom Contact and the Classroom Layout sheets inside the classroom itself. (See Appendix A: Sample Classroom Layout Sheet and Appendix B: Sample Classroom Contact Sheet.) A Classroom Sign Holder must be placed in each University-managed room. The holder should be hung in a convenient location for the faculty member to view. TTC should be consulted on the exact location where the holder is to be hung.
- The Classroom Sign Holder should match the look and finish of the room, and for that reason should most often be custom made.
  - The holder must be a framed bulletin board, have a back panel in cork or other tack-able surface, and have a tempered hinged glass door that catches (with magnets or a flat lock) to help it stay closed without a key, if possible.
  - It must have inside viewable dimensions of 11” x 24” so that two standard sheets of paper can be placed in the frame and can be easily seen.
  - If an off-the-shelf product must be used, The TTC prefers one as close to the inside viewable dimensions as possible, but do not select a product with less than 11” x 24” inside viewable dimensions.
  - The choice of a landscape or portrait for the holder depends on the shape of the room and the location where the sign will be displayed.

Wayfinding (inside the building)
• Wayfinding techniques should be used by the architect when designing University-managed classrooms in new buildings. At a minimum, proper signage and other elements inside the building should allow the instructors, students or campus visitors to easily locate classrooms within a building.

1.10 Classroom Acoustics

The study of room acoustics is the science and engineering of achieving good sound within a room. Superior acoustics in a classroom achieves good speech and program audio intelligibility while also suppressing outside, inside and mechanical noise to make classrooms a more productive and pleasant place to teach and learn in.

Classroom Acoustics

- Acoustics
  - Acoustics must be taken into account during the building or renovation of a classroom. Inside building noise such as HVAC systems and hallway traffic, as well as outside disturbances such as landscaping equipment and building construction can all affect the quality of the learning experience.
  - The standard acceptable Noise Criterion for a classroom is: 35-40 dB (decibels) or under. This is according to the Noise Criterion (NC), which is a standard for rating indoor noise coming from mechanical equipment, etc.
  - The acoustics of rooms must allow for speech and other audio intelligibility.
  - The acoustics of a room must help prevent classroom sounds (normal conversation, chalkboard tapping, and audio av, (especially base sounds)) from travelling to other rooms.
    - Typical solutions include the design of noise barriers (like building of walls from deck to deck), sound absorbers (such as acoustic panels), silencers (the use of acoustical caulk at attachment points), and buffer zones (free space between walls).
    - The Teaching Center must be involved in the acoustic discussion in classrooms because the inclusion of audio sources in teaching is increasing.

2 Chalkboards

Currently, the majority of University faculty prefer chalkboards over whiteboards. Chalkboards are durable. If the mechanics of the board are maintained and the surface treated properly, chalkboards will last 25+ years. Chalkboard surfaces are also easy to clean, which means that the cleaning and training on cleaning boards is easy. Maintenance of chalkboards is minimal and can be done in-house requiring only some procedures to be handled by outside contractors. Chalk is an easy tool to keep on hand, and does not dry out or ruin clothes like markers.

2.1 Number

- Seminar-Style room
- Typically 2 boards hung side by side.
- Prefer vertical slider with a fixed back and 1 sliding board; minimum is fixed back (flat panel) and no slider.
- If it's a high-finish room, possibly consider concealing chalkboard enhancing its looks.

Chalkboard concealed by sliding wood doors.
Seigle Hall 205 – Seminar Room

Chalkboard concealed by being encased in a fully closing cabinet hung on the wall.
Rudolph Hall (formerly EPS) 282 – Seminar Room

Chalkboard recessed into wall and surrounded by 5’ high wood walls and flanked on left by a SmartBoard.
Ridgley Hall 107 – Seminar Room
- Tablet and Table and Chairs in Row Style Classrooms < 75 student seats
  - Minimum, but typical, is two vertical sliding boards hung side by side.
  - Fixed back (top and bottom are chalkboard) and 2 sliding boards.

  Seats 40 students in tablet arm chairs
  Louderman Hall Room 461

- Tablet, Table and Chairs in Rows and Auditoriums ≥ 75 student seats
  - 3 vertical-sliding chalkboards hung side by side are required.
  - Fixed back (top and bottom are chalkboard) and 2 sliding boards.

  3 each 10" chalkboards, fixed back with two sliding chalkboards.
  Laboratory Sciences Room 300
2.2 Size, Quantity, Color and Brand

- **Size and Quantity of Boards**
  - All sliding chalkboards are custom made to fit the room and maximize writing space.
  - Boards should extend either the full length or near the full length of the front of the room however a maximum of three 10’ wide boards is sufficient.
  - Each set of boards and frames should have an outside measurement of approximately 10’ X 4’; however, 8’ X 4’ boards are acceptable if their size is a better overall fit in the room, however, this decision must be approved by TTC.
  - In a 10’ X 4’ board the **writing surface** should measure at least 108” horizontal (wide) and 40” vertical (tall) to a maximum of 116” horizontal (wide) and 42” vertical (tall). The maximum amount of writing surface is the most desirable. This measurement is variable due to changes in frame widths and the specifications when ordered.
  - In each set of boards, the top, back and front boards should be the same size, so that when a board is raised or lowered all of the remaining boards are visible.
  - 12’ or wider boards are not recommended because they do not slide easily and they become unaligned due to their weight. (Wilson 214 and Brown 100 boards are examples of boards that go out of alignment due to being 12’ wide.)

- **Color of Chalkboards, trim and chalk-tray**
  - Black is the preferred color for Chalkboards. Claridge #501 NP3 Black. Charcoal Brown had previously been used but that color has been discontinued.
  - Gray/black tones are best overall. Never use green or blue boards.
  - Trim and chalk-tray should be matte black finishes to avoid the glare from glossy surfaces.

- **Brand of Chalk Board**
  - Claridge brand boards should be used in all cases because of their superior mechanical design, ease of use, and maintenance.
  - The desired boards should:
    - be made of Vitracite (porcelain enamel over steel).
    - require no more than 5-7 lbs. of pressure to lift each board.
    - have re-moveable front frames (as opposed to re-moveable side frames) for easy access for maintenance.
  - Do not use electronic chalkboards, they malfunction frequently and are slow to maneuver.
  - Note: TTC must see and approve the exact measurements of the frame and the actual writing surface of the chalkboards before they are ordered.
2.3 Accessories

- Pulls on Chalkboards
  - Recessed pulls should be sufficiently deep so that a person can grab them and easily pull down the board.
  - No pulls should be hung on the underside of the sliding boards.
  - Each board should have two pulls per board spaced equally apart.
- Chalk Tray
  - A chalk tray should be purchased with each chalkboard and have the following features:
    - continuous and run the full length of the chalkboards.
    - be made out of anodized aluminum or similar product.
      - A chalk tray should not be made out of wood because chalk is abrasive to wood.
    - Chalk tray depth should be at least 2.5”-3” to accommodate a standard eraser which is 2” wide.

Example of continuous custom made chalk tray.
Seigle Hall Room L006

2.4 Placement

- Usual placement is center of the front “teaching” wall.
- Odd architectural details may change this placement but any deviation from the center of the wall must be discussed with TTC.
- Boards should be hung next to each other (do not leave any space between the frames of the boards.)
- Boards should be hung at 35” off the finished floor when measured to the bottom of the writing surface. This is done for several reasons:
  - One is so that students can see the bottom of the writing surface of the board when a standard height teaching table is placed in front of the board.
  - Another is so that a person of approximately 5’4” can reach up and pull down a raised board. If board sizes and hanging heights are correct, the pull of the raised board will not be higher than 78” to 80” from the finished floor.
  - The exact measurement of the bottom of the chalkboard writing surface, at time of install, must be verified by TTC.
• In the design phase, the architects should work very closely with TTC to get this measurement correct. The 35” measurement off the finished floor must take into account the height of the finished floor, plus the widths of the bottom of the chalk tray, the board frame, and the trim. Chalk trays, board frames, and trim can measure anywhere from 3”-5” in width, so the architects need to know the exact measurement of all of these items when laying in the chalkboard to have the writing surface start at 35” off of the finished floor.

  o View-ability of the entire chalkboard. The entire top of the chalkboard should be viewable when it’s fully raised from every seat in the classroom; in other words, none of the chalkboard may be blocked by the ceiling, soffits, vents, HVAC or any other obstruction.

2.5 Installation and Maintenance

  o Recessed boards are the standard for a more finished look; surface mounting of boards is okay if the boards are trimmed out.
    • Boards may be clad in wood for a more finished look.
    • No matter how the boards are installed and trimmed out, any cladding around the board front must be easily removable for maintenance or the cladding should be affixed in such a way as to not interfere with board maintenance.
      • Note: Board frames may extend to the floor on some models, the architect must make sure that the entire board frame is accessible.
    • The boards should be adjusted so that each board is stable (not move on its own).
  o TTC will check the chalkboards several times a year to make sure they move easily and do not require maintenance.
    • If maintenance is required, TTC, along with Facilities, will determine if Facilities can perform maintenance or if a professional should be called in.
    • Example of good cladding:
      • Louderman 458 wood cladding is mounted and held on by z-clips which allow for removal of cladding without tools or harm to the wood for board maintenance.
    • Example of inferior cladding:
      • Seigle Hall 106 wood cladding is affixed with screws and a small amount of glue. The screws have to be removed and the cladding popped off of the boards to allow for board maintenance. After the cladding is reaffixed the screw holes must be covered with wood putty and stained for a clean, finished look.
Z Clips hanging system allow for removal of board cladding without tools or harm to the woodwork.

Cladding that has been replaced. Screw hole with putty and stain.

Screw holes every several feet.
3 Screens

Projection screens are used to display material at the front of the classroom large enough for all students to see. Classroom projection screens should be recessed into the ceiling and be re-tractable to reveal the chalkboards hung behind them. Each screen should cover the least number of board sets possible, usually just one set, so that the faculty can have the viewing screen down and chalkboard space available at the same time. (See Appendix C: Sample of Screen Placement over Chalkboards) Space must be open above the finished ceiling at the front of the room to accommodate recessed screens. TTC must be consulted on the amount of open space required.

<table>
<thead>
<tr>
<th>Recessed projection screen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eads Hall Room 102</td>
</tr>
</tbody>
</table>

3.1 Quantity and Type for Screens

- **Quantity**
  - Number of screen should equal the number of data projectors in a classroom or auditorium.
  - Rooms that are wide and not very deep may require two projectors and two screens to ensure good line of sight for all students. (See Lab Science 250.)

- **Type**
  - Electric screens are required.
  - Non tab-tensioned, black back, matte white fabric, black side borders, with no top border is standard.
    - Although classrooms would benefit from tab-tensioned screens, which provide slightly better image quality, tab-tensioned screens take up more horizontal space and require wider boxes, so they may not be considered in any installation where they cover up more than one 10’ chalkboard.

3.2 Size and Aspect Ratio of Screens

- **Size**
• Screen size depends upon room size, depth and shape; much consideration should be given to the size of the screen when designing a classroom.
  o The distance from the screen to the farthest seat in the classroom is a key factor in determining the overall size of the screen.
  o The shape of the room (square or rectangle), the desired “front teaching area” of the classroom and all viewing angles should also be taken into consideration when selecting a screen size.
  o Typical Sizes
    • Classrooms < 50 student seats, typically use a 100” diagonal screen (7’ horizontal).
    • Classrooms 50 < x < 100, typically use a 120” diagonal screen (10’ horizontal).
    • Classrooms ≥ 100 student seats or more, consult TTC.
  o TTC must be presented with size options, and the final size will be determined by TTC.

• Aspect Ratio
  • **Box housing** with a 16 x 10 aspect ratio and **screens** with a 4 x 3 aspect ratio are currently installed.
    • This is to ensure that the horizontal space is available in the ceiling when screen viewing goes to a wide-screen format (most likely 16 x 10). At that time, the 4 X 3 screen material will be replaced with the 16 X 10 material.
    • What this ensures is that no mechanical, electrical, plumbing or structures are in the way above the ceiling at the front of the classroom that might prohibit the larger screen from being installation at a future date because the case is already there.
  o Great care must be taken by the AV installer, or the screen vendor, to install the 4 x 3 screen material in the correct location in the 16 x 10 box. Please consult TTC for the correct placement.
  • 16 x 10 ratio screens may be appropriate for some classrooms, consult with TTC.

### 3.3 Placement and Installation Tips for Screens

- **Classrooms**
  - Generally, the screen should be placed right or left of center, and cover only one set of chalkboards or the least amount of board space possible.
- **Auditoriums**
  - In auditoriums with 3 sets of 10’ each chalkboards, generally, the main screen should cover the Left or Right set of chalkboards, and if the screen is wider than 120” (which is determined by the depth of the room) the screen should extend into the wall space right or left of the chalkboards.
    o The second screen case should be so close to the main screen that the cases touch. This is to ensure that side by side images shown are as close as possible. This can be achieved by careful planning in the design stage and by careful execution in the building phase. And, as always, viewing angles must be taken into account for student seating.
  - The bottom of screen must fall slightly above chalk tray (or approx. 35” above the finished floor).
  - The screen must hang as close to the chalkboards as possible. This is to allow for maximum chalkboard view-ability from every seat in the classroom (line-of-sight issue).
  - Good access, next to the motor, should be provided in the ceiling for repair and maintenance.
  - Installation tip: low voltage control on the screen is required for manual wall switch.

### 3.4 Screen Control and Placement of Switches
Most new classrooms should have screen controls in two places. Auditoriums may also have additional screen controls on the touch panel in an optional booth.

**Screen Control Locations**

- On the wall near the chalkboard.
- On the touch–panel control system.
- Additional in auditoriums – on the touch panel control in optional booth

### 4 Lighting

Lighting in classrooms should achieve the practical effect of correctly lighting the chalkboards, teacher area, and student seating area. The chalkboards should be lit evenly with no “pools” of lights. Fixtures and bulbs should provide 40 -50 foot candle of light for the teacher and student areas. Lighting should be zoned front to back to allow for scenes to be created that lighten and darken the classroom for better view-ability of multi-media. Lighting must be designed in such a way as to complement, and not interfere with, the multi-media in the classroom. All lighting in auditoriums must be dimmable.

#### 4.1 Type of Light Fixtures

Light fixtures are typically chosen by the lighting consultant, the lighting consultant must show the cut sheets to TTC before deciding on a particular fixture.

- All lighting fixtures must be hung so that a data projector can shoot under or between fixtures without obstructing the image on the projection screen or the top of the chalkboard.
- Prefer recessed lighting vs. pendant lighting
  - Pendant lighting may interfere with the correct placement of the data projector.
    - Pendant fixtures must be presented to TTC before being included in a project with an explanation of why they need to be used. Cut sheets must be included.

  ![Recessed lighting - preferred](image)

- Can lights are preferred to provide lighting such as task lighting over the teaching desk or ambient lighting. (See photo of can lights below.)
- Some classrooms benefit visually from architectural (mood) lighting. This lighting can be used as long as its light or fixture does not interfere with task or multi-media lighting and is separately and easily controllable. (See photo below.)
4.2 Bulb Type

LED energy efficient bulbs are the preferred lighting bulb type. However, a combination of energy efficient, non-florescent bulbs will be considered if the resulting lighting scheme falls within University energy standards.

- Fluorescent lighting should not be used. Fluorescent lighting may cause health issues with some students/faculty/staff. The use of fluorescent lights should be discussed with TTC and Facilities Management before becoming a part of any classroom project.

4.3 Light intensity

- Without natural light, the preferred foot candle is 40-50; a deviation of ±10 foot candles should be corrected. The measurement should be taken at student desk-top (average of several locations) and the teaching desk.
  - Reason: the University has classes at night and you cannot count on natural daylight as a light source at night. Also, some university classrooms have no windows.
- The teaching desk also needs to be well lit. In many cases faculty are older than students and appreciate a well-lit teaching desk.
- Uniform lighting across the student seating area is also required.

4.4 Light Control for Energy Efficiency

- Currently the university does not have a standard to install occupancy (or vacancy) sensors however they are being installed in most new or large classroom renovations to meet the universities efficiency goals. The next version of ASHRAE (American Society of Heating, Refrigeration and Air-Conditioning Engineers) code will require occupancy sensors and similar devices to be installed.
  - Passive (infrared) & motion (ultrasonic) sensors are available.
  - Single and dual type sensors will be employed depending on the application.
  - A 360° spread or a spread that covers the entire space will be used.
  - Time outs are not standard, but room specific, however the sensors are usually set to 10 or 15 minutes.
4.5 Placement of Light Switches and Controls

- Light Switches at entrances to classrooms and auditoriums
  - A single-gang light switch is required by all entrances of classrooms and auditoriums.
    - Easy to use, on/off only.
    - Should be isolated from other controls.
    - Should be the first, obvious, switch to use upon entering room.
  - Where applicable, light switches at entrance must operate independently of AV control system (Crestron) but must also be controllable by AV control system (Crestron). This is made possible through the combined use of the Crestron control system and a Lutron GRAFIK Eye lighting control.

- Other light switch locations for rooms and auditoriums
  - Classrooms < 100 students
    - New rooms (see rooms in Seigle and Busch Halls)
      - May have full set of lighting scenes on 6 button Crestron/Lutron switch on wall by chalkboard.
      - Must have full set of lighting scenes in touch panel.
    - Remodeled rooms (see rooms in Eads Hall)
      - Toggle switches by chalkboard for lighting scenes are acceptable.
      - Do not have to have full set of lighting scenes in touch panel because the cost to connect the lights and the Crestron control system may be prohibitive on remodeled rooms.
  - Auditoriums (usually) > 100 students
    - New and remodeled rooms
      - Must have full set of basic lighting scenes (usually 6, the TTC must be consulted) on Crestron/Lutron switch on wall by chalkboard.
      - Must have full set of lighting scenes, basic and additional, in touch panel.
      - May have full set of lighting scenes, basic and additional, in touch panel in optional booth.

4.6 Zone Concept

Zoned lighting gives TTC the ability to control light levels in classrooms from the front of the room to the back of the room in order to darken the front of the room for display purposes. Zoned lighting allows TTC to do this without relying on expensive dimmable ballasts to lower light levels. (When dimmable ballasts become less expensive they will be used in conjunction with the zone concept to provide even more lighting control.) Most of the light “dimming” comes from the turning on and off individual bulbs.
in a light fixture and turning on and off of the light fixtures themselves using zones. Auditoriums typically have more zones than classrooms.

- Classrooms < 100 student seats (see illustration below)
  - Minimum of 3 zones
    - Chalkboards (zone 3 & 4 or alternate zone 3)
      - Lighting to provide continuous coverage, no “pools” of light.
    - Teaching Area & Seating Area
      - Zoned front to back
        - Front 1/3 of the room (zone 1- includes teaching area)
          - Consult TTC for final decision on if the Teaching Area has its own zone or is included in zone 1.
        - Back 2/3rds of the room (zone 2)

Typical Light Zones for a Classroom < 100 student seats

- Auditoriums > 100 student seats (See Appendix D: Sample Lighting Zones for an Auditorium)
  - Minimum of 6 zones
    - Chalkboards (3 zones)
      - Lighting to provide continuous coverage, no “pools” of light.
    - Teaching Area (at least 1 zone)
    - Seating area
      - Zoned front to back (2 zones)
        - Front 1/3 of the room
        - Back 2/3rds of the room
  - Typical 8 zones
    - All 6 zones above
    - Zone 7- side lights
    - Zone 8- back of room lights or other
  - Consult TTC for the final decision on how many zones will be in an auditorium.
4.7 Using Zones to Create Lighting Scenes

Zones can be used in various combinations to create lighting scenes that can be recalled through the wall panel switches or the touch-panel control system. The number of scenes created depends on the size of the room, the number of zones and the particular scenes that are being created. Generally speaking, classrooms have 6 scenes and auditoriums have 6 or more scenes.

- Definition of Typical Lighting Scene for a classroom < 100 students
  - ALL ON—all lights in the room on except chalkboard lights.
    - This setting is used to generally illuminate the entire classroom for teaching when the faculty member is not using the chalkboard.
    - This setting is also the setting recalled by the “ON” (of the ON/OFF switch) by the classroom door.
    - The intent is to not waste energy by lighting the chalkboards when they are not in use.
  - ALL OFF—all lights in the room off.
    - This setting turns all of the lights off in the classroom.
    - This setting is also the setting recalled by the “OFF” (of the ON/OFF switch) by the classroom door.
  - Scene 1 (High) – all lights on including chalkboard lights.
    - This setting illuminates the entire classroom and the chalkboards.
  - Scene 2 (Medium) – zone 1 & 3 off (back lights on and one board light on)
    - This is a multi-media setting where the intent is to reduce the light shining on the front of the room in order to see the projected image better and be able to write on the adjacent chalkboard.
      - Chalkboard light over the screen is OFF.
      - Chalkboard light over the adjacent chalkboard is ON.
      - The front part of the classroom is OFF.
      - The remaining back lights are ON and spread to light the back of the room while spilling enough light onto the students in the front to take notes.
  - Scene 3 – (Low) zone 1, 3 & 4 off (back lights on but both chalkboard lights off)
    - This is a multi-media setting where the intent is to reduce the light shining on the front of the room in order to see the projected image better.
      - Chalkboard light over the screen and the adjacent chalkboard are OFF.
      - The front part of the classroom is OFF.
      - The remaining back lights spread to fully light the back of the room while spilling enough light onto the students in the front to take notes.
  - Scene 4 – doc cam toggle on & off, or special lighting on/off or empty
    - Note: In rooms without separate board lights, there is one less scene.

Typical Crestron Lighting Scene panel for a classroom by scenes.
Seigle Hall Room 104
4.8 Lighting Auditoriums

The overall concept of lighting, zoning and creating scenes in an auditorium is the same as a classroom except that it is a larger space. The teaching area may have to have separate lighting as well as aisles and emergency exits. Most auditoriums also contain architectural lighting and it must be designed in such a way as to not interfere with the teaching and av lighting; it must also be easily controllable. When designing lighting for auditoriums, uses for the auditorium other than teaching (such as for speakers and presenters), must be kept in mind, however the primary focus should be on lighting to support teaching. In working with auditoriums, designing lighting scenes should be done in close consultation with TTC.

- Chalkboard area
  - Directional flood lighting
    - Continuous and uniform coverage from top to bottom and left to right, no “pools” of light.
    - Number of zones is equal to the number of chalkboards.
    - Zoned left to right.
    - Current fixture is: Luxeon Elliptipar with fraction LED, style S215.
      - Two- 4’ long fixtures per 8’ or 10’ board.
        - Provides an average of 30.9fc
          - Illuminating Engineering Society (IES) recommends a minimum average value of 15fc on this kind of visual display surface.
        - With the board lighting dimmable, and integrated into the Lutron control system, these lights can be adjusted to create the consistent, continuous spread across all of the boards.

- Even and continuous spread of lights across chalkboards.
- However these lights could be shining more on the boards instead of above them.
- Currently looking into fixtures and placement to achieve a uniform spread.

- Teaching area
- Directional lighting
  - Number of zones depends on the size of the teaching area. If practical, create one zone for the teaching desk so that the desk can be lighted while using multi-media.
  - One zone should light the teaching desk.
    - Zoned left to right.

- Student area
  - Even lighting spread over entire seating area.
  - Zoned front to back.
  - Number of zones depends on size of room.

- Aisle Lights
  - The use of aisle lights must be discussed with TTC. Aisle lights are not required; however, they are highly desirable for added safety and in auditoriums without windows.
  - Examples of acceptable auditorium aisle lighting:
    - Down-lights as part of aisle seats.
      - Exact location of electrical conduit must be coordinated between the electrical drawings, the seat installers’ layout and the main Contractor.
      - Seat installers typically work with exact field measurements, not scaled drawings, so they may become involved too late in a project to coordinate aisle lighting from seats.
      - Every attempt must be made to conceal exposed electrical boxes that house aisle lighting wiring. The architects and electrical consultants must find a way to keep the electrical boxes out of the way of student’s feet.
    - Down lights installed on an outside wall.
      - If the architecture and layout of the room makes this a viable option, it should be chosen.
    - Lights incorporated into steps.
      - Lights must be in center of the step. On compressed time frames, an aisle light and installation solution is necessary to allow for last minute coordination between final shop drawings and the framework for the concrete pour; fixture location adjustments may have to be made.
    - Lights incorporated into seats.
      - Must get electric for lighting and seat manufacturers and installers to work together. Architect to insist seat manufacturer come sooner to the job site and measure, create a CAD drawing and force seat manufacturer to 1) layout seating to maximize seating and to 2) get EXACT location of electric for seat lighting to be located on electrical drawings.
    - LED strip/runner lights on both sides of aisle.
      - LED lights will last a long time, and if one or two bulbs go out the strip is still effective and useful.
      - However, these lights are run into a channel in the concrete and fed by one end they are difficult to maintain.
      - Because of the maintenance issue these are the last choice of acceptable aisle lighting.
  - TTC will not accept a lighting option that includes a box with a light next to the aisle, they are clunky looking and no easier to install than lights from fixed seating.
  - TTC will not accept lighting aisles from the ceiling with down lights due to the interference it causes with AV use the distraction of looking through shafts of light.
Emergency Lighting

- Placement of emergency lighting depends on room size and other factors. Unless there is an emergency, the emergency lights should be off on the “off” setting of the lighting controls.
- Definition: emergency lighting is triggered ON by a loss of power to the fixture. For example, when an emergency light does not receive normal building power, it switches to battery back-up in the fixture and is activated. In the case of generator operated emergency lighting, it’s similar but the sensor is at the generator itself and not in the fixture.

4.9 Master Lighting Controls

- The preference is for each new and remodeled classroom and auditorium to have a separate lighting control system consisting of a Crestron control panel and a local control panel (usually a
Lutron GRAFIK Eye. The system should be self-contained within the classroom to allow easy set-up, troubleshooting, and control. This particular lighting set-up allows TTC to have local lighting control over each classroom and allows us to fix or correct lighting issues more quickly. The Crestron control panel and Lutron GRAFIK Eye also allows the user to control the lights from several locations: from the single gang switch at the door, from the button panel located by the chalkboards and on the touch-panel control located on the desk and in the (optional) booth at the back of the room.

- Example: In Psychology 249, the Lutron GRAFIK Eye is located on the back wall of the classrooms and is digitally locked from casual use. The scenes are set from here and programmed so that they work from the button panel by the chalkboard and from the touch panel control screen. A simple, ON/OFF switch is located by the door for general room lighting.

- Classroom < 100 and smaller auditoriums (usually less than 200) may only require a Lutron GRAFIK Eye that controls 6 scenes, while larger auditoriums may require a larger Lutron GRAFIK Eye controller that can control 6 or more scenes.

- Universal Building Lighting Control Systems
  - A Universal Building Lighting Control System is not preferred and should only be used as a last resort to control lighting in classrooms.
  - Seigle Hall has one central lighting control system for the entire building located in a basement closet far away from classrooms; therefore there is no local room control to set lights.
  - Reason: Maintenance personnel have to be trained in Lutron and Crestron programming to locate fixtures and reset control settings. Since these full building systems are complicated, and maintenance personnel do not work with Lutron and Crestron on a consistent basis, it is possible that understanding how to operate and manipulate building systems will be lost. TTC already had to call in a Lutron programmer once to re-build a miss-placed building program code.
    - If, for cost purposes, central lighting control has to be installed, it is preferable to have one central lighting control station per floor.
5 Conduits, Cabling, Floor Boxes, Electric and HVAC

Conduits are used both inside the classroom and outside the classroom for running (mostly low-voltage) AV cables, security, network, and cable TV, etc. from the teaching desk to other AV components, control booths (if any) and to other building locations such as electrical and communications closets. Currently these conduits, both inside and outside the classroom, are not routinely integrated into the electrical drawings and can be forgotten in a project and missed on drawings. Therefore, TTC, the AV consultant and the electrical consultant must discuss conduit, cabling and low voltage needs and these must be coordinated and integrated into the electrical drawings.

5.1 Conduit Runs

- Inside the classroom
  - Classrooms < 100
    - In general, 4 each 1.5” conduit should be run from the Teaching Station, underneath the floor, and up the wall to above the ceiling so that the cabling can be brought to various locations. One of the conduits should remain empty to provide for future growth.
  - Classrooms > 100
    - In general, 4 each 2” conduit should be run from the Teaching Station, underneath the floor, and up the wall to above the ceiling so that the cabling can be brought to various locations. One of the conduits should remain empty to provide for future growth.
    - Core drilling or trenching can be performed on existing spaces to run conduit.
    - New construction should include conduit runs in the initial design.
    - Exact location of these conduits, are crucial and must be discussed with the architects and TTC. (See Figure 2: Diagram of Conduit Runs in a Typical Classroom below.)
      - TTC should be part of the discussion concerning the exact quantity and size of conduit needed for a particular classroom or auditorium as size and quantity of conduits depends on what AV is being installed in the classroom and planning for future growth.

- Outside the classroom
  - Conduits outside the classroom are used to run cable from the classroom, either from the Teaching Station or the booth, back to the electrical and communication closets. Size and quantity of conduit is determined by the TTC, the AV consultant and the electrical contractor.

Figure 2: Diagram of Conduit Runs in a Typical Classroom
Conduits must be checked for water inside of them before cables are pulled through especially if they are on the ground level or underground. Cables should not be pulled through until the conduits are checked for water. If water is found, then the source of the problem must be identified and fixed before pulling cables through.

5.2 Floor Boxes or Stub Ups

Floor boxes or stub ups are strategically placed under the Teaching Stations to be used as the junction between the cabling in conduits and the components in the Teaching Stations (podiums, desks, or seminar tables) or other multi-media/audio interface points (such as those floor boxes used mainly for audio cabling in auditoriums).

- The decision to use floor boxes or stub-ups should be discussed with TTC, but in general, any place where furniture needs to be moved on a regular basis should have a floor box, in those cases where furniture does not move, stub-ups are required.
  - Floor boxes are preferred in locations where the Teaching Station needs to move because av and other cables can be disconnected at the floor box.
    - Rectangular floor boxes installed flush to the floor are preferred.
    - Circular floor boxes do not allow for plugs or connectors, which are typically square or rectangular to fit well inside the curved box.
  - Stub-ups are preferred in locations where Teaching Stations do not need to be moved because they provide solid cabling between points, thus having one less point of failure.
    - After conduit and stub ups are run, and before cabling is installed, stub-ups must be cut approximately 3 1/4” above the floor; this ensures that no one will move the desk.
    - Placement of floor boxes/stub-ups relative to the Teaching Station
      - Floor boxes/stub-ups are located beneath the Teaching Stations so that the cabling can be pulled through, connected and concealed inside the center of the back (student side) of the Teaching Station.
  - A typical classroom has one stub up and a fixed teaching desk.
  - A typical auditorium has 2 to 3 floor boxes, or 1 to 2 floor boxes and one stub-up (if the desk or podium is not moveable.)
    - Exact location of floor boxes/stub ups are critical and must be discussed with TTC and be presented on drawings.
    - TTC must be present at the install of the stub-up or floor box conduit placement to check its exact placement.
  - Classrooms < 100 students
Stub-ups are preferred because the Teaching Station is not moveable.

- Power (duplex), 3 network lines (for computer, laptop and Crestron controller (for RoomView)), and 1 electronic security loop with an add-on. (The security loop is required to provide electronic security to the projector and at the desk for the desk components.)

- Auditoriums > 100 students
  - If the Teaching Station is moveable, a rectangular floor box is required so that the cabling can be disconnected from the desk so the desk can be moved.
    - The floor box should be sufficiently sized to accept the conduit and cabling needs of the auditorium.
  - If the Teaching Station is fixed, a stub-up is required.
  - A typical main or central floor box/stub up contains enough conduit space to run cabling for (depends heavily on each individual room):
    - Power (quad), 3 network lines, (for computer, laptop and Crestron controller (for RoomView)), coax cable for cable TV, and 2 electronic security loop with an add-on. (The security loops are required to provide electronic security to the projector and at the desk for the components.)
    - Additional 1 or 2 floor boxes may be needed for connecting portable podiums. However, these floor boxes can contain everything in the main floor box, depending on the needs of the auditorium relative to the type of programs expected to be held there, so the decision of how many floor boxes there are and what they contain must be discussed with TTC.
      - Typically, the additional floor boxes contain power, network and XLR (audio) cables.
      - Usual placement of additional floor boxes is far right and left of the center box

5.3 Electric

The correct quantity and placement of electrical outlets is necessary for the operation of AV equipment, cleaning personnel, students (if electrical outlets are being provided for their use, etc.) and for convenience.

- In classrooms seating under 200, one duplex per side is a minimal requirement unless structural issues make this impractical.
- In auditoriums seating more than 300 students a convenience outlet should be placed every 30’ – 40’ where it’s practical.

5.4 HVAC

The HVAC system should be sufficient to heat and cool the classroom as needed.

- The Architects should not design “open/exposed air spaces” that show the exposed ceiling as part of the HVAC return air system. Grills or other coverings should be used to cover all “open air spaces”. If an “open/exposed air space” is the best choice for a certain situation this must be discussed with TTC.

6 Classroom Furniture

The classroom furniture should be functional, comfortable, durable, and fit the space allowing for movement in and around the teaching desk and in and out of the classroom. It should be easy to clean and maintain. In general, student furniture is bought off-the-shelf and Teaching Stations (desks, lab desks,
podiums, and seminar desks) are custom made. Re-setting of moveable classroom furniture is performed each night by cleaning staff, for that reason each room has a “Classroom Configuration” sheet posted with the layout of the furniture.

6.1 Type of Teaching Stations

Teaching Stations are custom designed to facilitate technology use without losing functionality for more traditional teaching methods. The technology is located inside the Teaching Station and is controlled through a control panel on the top. The Teaching Station can be a standard height desk, lab height desk, seminar style desk or a podium. Teaching Stations are custom-built to fit the size of the room, integrate with the type of classroom being designed (tablet classroom, seminar style classroom, etc.), and to match the existing décor.

- Typically recommend a desk or seminar table for classroom size < 30 students.
- Typically recommend a desk for classroom size < 74 students.
- Typically recommend a desk or a lab height desk for classroom size >75 students or more.
  - A podium can be used as a Teaching Station if it is requested by the departments that routinely use the classroom and fits the overall design and shape of the room. In these instances, TTC and the department will decide together whether a podium best fits the teaching needs of the classroom.
    - Example: Rebstock 215 has a less wide teaching space than most auditoriums and therefore a podium takes up less floor space.
- The Teaching Station is custom built to fit technical requirements for multi-media (ask The Teaching Center for exact requirements).
  - A WashU approved logo should be affixed to the center of each desk and podium (on the front facing students/audience). The logo should match the level of the finish of the room.

| Desk custom made to match wall paneling in room; Washington logo on front of desk. Louderman Hall Room 458 |
| University logo attached to front, center of desk. |

- General location of Teaching Station placement in a classroom
TTC will decide the exact placement of the desk in a classroom which is designed to maximize student seating. Items to consider are the overall look and feel of the room and the location of where the teacher stands in relationship to the projected image from the data projector. Placement of the Teaching Station is also relative to the chalkboards, student’s line of sight, and seating arrangement. In many cases, the center of the teaching wall is where the desk should be placed.

Every attempt should be made to keep the faculty member, when standing behind the center of the desk, out of the light of the projected image.

Classrooms < 100 student seats
- The recommended distance between the teacher station and the edge of the chalk tray is 42” to 48”. The minimum distance is 36” from the edge of the chalk tray.
- The recommended distance between the teacher station and the student seating is 48”. The minimum distance is 36” from the edge of the chalk tray.

Classrooms > 100 student seats
- The recommended distance between the teacher station and the edge of the chalk tray is 42” to 72” (spacing is determined by room size). The minimum distance is 36” from the edge of the chalk tray.
- The recommended distance between the back (student side) of the teacher station and student seating is 60” or longer. This distance depends heavily on room size, quantity of seats desired and seating layout. This allows for some distance between the teacher and the student and allows for movement around the teaching desk.
  - Example: Lab Sciences 300; front-to-back of room is approximately 70’.
    - Desk to chalkboard is 72”.
    - Desk to first row of seats is 84”.
  - Example: McMillan G052; front-to-back of room is approximately 43’ 7”.
    - Desk to chalkboard is 36”.
    - Desk to first row of seats is 64”.

6.2 Teaching Desk
The teaching desk is custom built to fit technical and aesthetic requirements; in general a large desk shall be used most of the time, but a small desk will be used if a large desk overwhelms the room. (See Appendix E: Sample Classroom Teaching Desk Drawing.)

- **Dimensions of desk**
  - **Large (standard) desk**
    - 82” x 30” x 32” (l x w x h)
      - Height allows teacher to sit, if desired.
      - In rooms >100 student seats, the height may be 35” instead of 32”.
    - Two cabinets that contain equipment for user on one side and equipment for technician on the other side.
    - Optional side drawer for document camera.
  - **Small desk**
    - 60” x 30 “x 32” (l x w x h)
      - Height allows teacher to sit, if desired.
    - One cabinet that contains both user and technician equipment.
    - Cannot be used if a desk doc cam is being installed.

- **Basic Features of Large Desk**
  - The front of the desk is the student’s side; the back of the desk is the teacher’s side.
  - Front-of-desk has removable panels for easy access to equipment.
  - Back-of-desk has a pocket door on the user side and a swinging door on technical side.
o Any user door, cabinet or drawer is keyed to C415A. The technician cabinet and front access doors are keyed to C390A.
o Mount for computer monitor must allow for monitor to be recessed below top of desk and be tilt-able to allow the user to view it from both a seated and standing position.
o Design must allow for:
  ▪ Ventilation
    • Inside of cabinet, front of desk, venting to the side of desk (this is a fan).
  ▪ Openings (holes, shafts, etc.) for cabling to pass through
o Multi-media
  ▪ Full size PC (with internal DVD player) and monitor
  ▪ Laptop connections
    • VGA and HDMI
  ▪ Network, power and audio cables
  ▪ Blu-ray DVD player
  ▪ Touch panel control
  ▪ Non-user technical equipment
o Power and cabling
  ▪ Single quad unit mounted to front inside
  ▪ Cable – path holes drilled in top front inside corner of both cabinets.
  ▪ Cable cubby – placed front, on top, centered above monitor.
o Accessories
  ▪ Grommet –1 ½” – 2” circular hole, placed on top, front.
    • Used for touch panel control system cabling and electronic security
  ▪ Keyboard tray
    • Must have lip on all sides, with a cut out for a mouse cable.
    • Must slide in and out for access.
    • Installed as near as possible to the glass to allow for knee room under desk.
o Top
  ▪ Glass on top of monitor must be tempered and have as little glare as possible (no smoked glass).
    • Black Sparkle, by Formica, is the preferred material for the top of the desk.
o If desk is moveable it must have recessed full turn wheels; the back wheels (on side facing teacher) should be lockable. Current wheel is: Arch Caster model T3TP35GI4406YY (gray) or T3PP35GP4706YY (blue) with a capacity of 240-300 lbs., and cushioned support.

6.3 Teaching Podium

Some locations, mostly auditoriums, benefit from a podium over a teaching desk as the main Teaching Station. Even if a teaching desk is used, some auditoriums will benefit from including a podium to be used for non in-class teaching presentations. If a non-teaching, or presentation podium, is desired in an auditorium, TTC would be happy to consult with Facilities Management on the design of the podium. Presentation podiums should be designed to fit each situation but should all be light and portable and have a space to be stored when not in use.
o Custom built to room, but basically:
  o Dimensions
    ▪ 30” x 36” x 48” (in front, student side is: l x w x h).
    ▪ 40” height in back from where the user presents.
  o Basic Features
The front of podium is the student’s side; the back of podium is the teacher’s side.

- Front-of-desk has a removable panel for easy access to equipment.
- Back-of-podium has a pocket or swinging door.
- Back-of-podium door is keyed to C415A; front access is keyed to C390A.
- Monitor should be recessed as much as possible to not block the presenter.
- Some or the entire top surface of the podium must be flat.

- Design must allow for:
  - Ventilation system: backside of podium below cabinet doors in front of podium
  - Inside of cabinet, front of desk, venting to the side of podium (this is a fan).

- Multi-media
  - Full size PC (with internal DVD player) and monitor
  - Laptop connections
    - VGA and HDMI
  - Network, power and audio cables
  - Blu-ray DVD player
  - Touch panel control
  - Non-user technical equipment

- Conduits and power
  - Single quad unit mounted inside of podium.
  - Cable cubby – front, on top left.

- Accessories
  - Grommet – front, on top, placed in corner opposite the touch panel.
  - Little light (built into the podium) – front, on top, side.
  - Gooseneck microphone– front, on top.
  - Plate covers over non-user equipment.
  - Keyboard tray
    - Recessed, pull-out design, must have lip on all sides; do not design a drawer to place it in.
  - If moveable, wheels same as desk.

| Custom built podium with monitor, touch panel, cable cubby, little-light and gooseneck mic on top. | McDonnell Hall Room 162 |

### 6.4 Teaching Seminar Style Desk

- Dimensions
  - 60” x 30” x 29” (l x w x h) to fit a standard configuration of 60” tables
  - Size of desk can be completely customized to maximize seating in room.
Basic Features
- The front of the desk is student side; back of desk is the teacher’s side.
- Modesty panels, to hide cabling and equipment, on front and sides.
- False front panel 8” from front of desk to create a chase for the cable to move freely without the teachers’ feet getting tangled in the cables. False front panel is keyed C390A.
- Mount for monitor should be recessed to height of the table when monitor is flat.

Multi-media
- Full size PC (with internal DVD player) and monitor
- Laptop connections
  - VGA and HDMI
- Network, power and audio cables
- Blu-ray DVD player
- Flip-Top Touch panel control
- Non-user technical equipment
- Design must allow for:
  - Ventilation system
  - Inside of cabinet, front of desk, venting to the side of desk (this is a fan).

Conduits and power
- Single quad unit mounted to front inside of false chase.
- Flat, flip top touch panel – placed on table top above chase, usually on the right hand side
  - All cables included; no additional grommet holes needed.

Accessories
- Keyboard tray
  - Must have lip on all sides, with a cut out for a mouse cable.
  - Must be retractable.
  - Installed as near as possible to the glass to allow for knee room under desk.
- Top
  - Finish to match table tops of other tables in square/rectangle to have a consistent look

Placement in Room
- The seminar teaching desk should be approximately 48” from the chalk tray; this space is provided so that a faculty member can move freely to teach.

Custom seminar teaching desk with 60” table top space for faculty member and self-contained user and non-user AV.
Cupples Hall II Room L007

6.5 Student Seating

The University-managed classrooms are in use a high percentage of the time and the furniture used needs to be strongly built and durable. TTC prefers to buy high quality tables and chairs for student seating (usually KI or Steelcase). The furniture has a lifetime guarantee; on the rare occasion of a broken chair,
it is repaired or replaced in a timely fashion. The chair fabric and cushion can be replaced relatively inexpensively, which increases the usefulness and life-span of the chairs. Overall, 8% - 10% tablet arm chairs and fixed tablet seating in auditoriums should be designed for left handed seating.

- **General Requirements**
  - **Moveable Tables**
    - Student space requirement per table – 30” width per student; example: 60” wide table – seats 2 students
      - Height - 29” with adjustable feet (industry standard height).
      - Width - 18”
      - If wider tables are desired, TTC must be consulted because it affects total seat count.
  - **Table Top Surface**
    - Laminate finish – departmental requests for a different finish must be determined by TTC.
  - **Legs**
    - Fixed Legs
    - C-legs or cantilevered T-legs positioned near the ends of 60” tables. Placing the legs at the end of the table provides more room for comfortable seating.
    - C-legs or cantilevered T-legs positioned for stability of 90” tables. (For instance three sets of legs, not four, would stabilize the table and allow for students to be seated comfortably.)
    - Color-Follow building or room color.
  - **Additional Tables**
    - 2 extra tables (18” X 60” with collapsible-legs) per room if storage permits.
  - **Standard**
    - Manufacturers: Steelcase or KI
  - **Chairs**
    - Armless
    - Flex-back
    - Fabric seat and back
    - Width of seat – 20”
    - Sled-style legs (easily stackable)
    - Tablet
      - Function – rotates from flat position to 90°
        - Example: Eads Hall KI Perry chair
      - Size tablet – 12” X 13” writing surface.
    - Color-Follow building or room color.
  - **Quantity of Left Handed tablet chairs**
    - 8-10% of tablet chairs should be for left-handed individuals
  - **Additional Chairs**
    - At least 2 additional chairs should be purchased to seat guests in classrooms if storage permits.
  - **Standard**
    - Manufacturer: Steelcase or KI
6.6 Tables and Chairs in a Row Style Seating

- Spacing of Tables and Chairs in a Row Style Seating
  - Tables
    - Combination of 60” and 90” tables to maximize seating.
    - 30” space allocated per student
    - Distance between rows of tables
      - Measured from the back edge of table to the front edge of the table behind it.
        - Prefer 36”, minimum distance is 30”.
    - Distance between teacher desk and first row
      - Prefer > 48”, minimum distance is 48” (to allow for teacher circulation)
    - Distance from back row to back wall
      - Measure from back edge of table to back wall.
      - Prefer 42”, minimum distance is 36”
    - Distance from side table to side wall
      - Measured from side of table to wall.
      - Prefer > 36”, minimum distance is 36”.
  - Chairs
    - Armless, flex-back, fabric seat and back, width of seat 20”, sled style leg.

6.7 Seminar-Style Seating (open or closed)

Spacing of Open or Closed Seminar Style Seating
- Tables
  - Combination of 60” and 90” tables to maximize seating and still be comfortable.
  - 30” space allocated per student
  - Teaching (teaching area) gets 60” of a table top to use.
  - No shared knee space at corners
  - Distance from front row to teaching table
    - Measure from front wall to front of teaching table
    - Prefer > 48”, minimum distance is 48”
  - Distance from side table to side wall
    - Measured from side of table to wall.
    - Prefer > 36”, minimum distance is 36”.
- Chairs
  - If standard finish room: armless, flex-back, fabric seat and back, width of seat 20”, sled style leg.
  - If high end finish room: armless, fully adjustable, fabric seat and back, width of seat 22”-23” with 5 point caster base and wheels for easy pivoting.
• Wheels: Sample “low noise” casters used in the Active Learning Classroom (especially to cut down on noise on concrete or other hard surfaces, but also creates a more comfortable sitting experience)
  o NMI PHT55058BK-02524-55MM TWIN WHEEL SOFT TREAD/CASTER
  o NMI PRE22023ZN-TPR-SINGLE WHEEL SWIVEL WITH GRAY SOFT TREAD
    ▪ Purchased from RBF Interiors

6.8 Moveable-Tablet Chairs

Definition: moveable-tablet arm chairs set up in columns, front to back.
  o Spacing of tablet style seating
    o Tablet chairs should be placed in columns.
      ▪ Distance between columns-designed to maximize seating and still be comfortable.
        • Prefer >30”, minimum distance is 30” (this is the aisle between columns).
          o Measured from the side edge of chair to the closest edge of the chair beside it.
      ▪ Distance between rows of tablet-arm chairs.
        • Measured from the back edge of the chair to the front of the tablet.
        • Prefer 3” (to allow for comfort and flex back.)
      ▪ Right-handed chairs can be placed next to the wall; all chairs can be placed next to the back wall; there is no need to leave room on the sides and backs of classrooms if the aisles provide access to every tablet chair.

6.9 Fixed Tablet Arm Chairs in Auditoriums

Definition: non-moveable, fixed tablet arm chairs set in rows. Note: The teaching chair should be a rolling task chair with arms and be fully adjustable. The current practice is to purchase teaching chairs with mesh backs and padded seats; the color of the frame, seat and back should be black.

  o General Requirements
  o Type & Size of Chair
    o Chairs should not be ganged (physically linked together) and each student seat should have two armrests.
    o Chair size: prefer 23” and 24” sizes if using them does not reduce total chair count desired; minimum size is 22”; seats smaller than 22” will not be accepted
      ▪ standard measurement is “center armrest to center armrest”
      ▪ To maximize seating, field measurements should be taken and multiple chair layouts should be presented using 23” and 24” size seats in new construction using 22” and 23” seats in rooms that are being remodeled.
    • Chair arms should touch each other to maximize seating unless one extra seat cannot fit in the row, and then the seats may be spread evenly to fit the row.
    • The layouts should be from the chair manufacturer since they have the expertise/software and precise measurements to perform this work.
  o Writing tablet
    ▪ Writing tablets come in different sizes; the size of tablet must be discussed with TTC.
- The tablet must be retractable; this feature involves ADA standards; how the tablet retracts and which model is chosen must be discussed with TTC.
- Example:
  - McMillan G052, American Seating, Stellar Chair, Stellar Laptop writing tablet (surface area 185 sq. in.)

- Row Clearance
  - Measurement is defined as the horizontal distance from the back of the row ahead to the front of the row behind.

- Passage Clearance
  - Measurement is defined as the horizontal distance from the back of the row ahead to the farthest protrusion of the row behind.
  - Currently recommend 14” to 15” between rows for passage clearance
  - Can allow 12” row spacing if tablet can return to its stowed position in one motion

- Recently Used Manufacturer
  - American Seating—made out of cast iron instead of steel; therefore it is more durable than other manufacturers who use cast iron.

- Replacement Parts
  - Each project should add 1% of the total number of seats to the order for replacement seat pans and seat backs.
  - Zone manager will store or they can be stored in the auditorium.

- Clear Visibility
  - Care must be taken so that all students can have a clear and unobstructed view of the front of the room, teacher, projection screen and chalkboard. This can be achieved by either sloping the floor or by having steps and levels.

  - Sloped auditoriums
    - January 110 is a 1:8 slope
    - McMillan G052 is a 1:10 slope
    - Umrah 140 is a 1:12 slope
    - Brown Expansion Auditorium B (proposed) is a 1:8

  - Stepped auditoriums
    - Wilson 214
    - Lab Science 300
    - Louderman 458
- Sample passage clearance (samples of several measurements in each room)
  - Jan 110 - 12¼” - 13 ¾” (slope)
  - Busch Hall - 12¼” – 13 ¾” (stepped)
  - Brown Hall 100 - 13” -14 “ (sloped floor only)
  - Brown Hall 118 - 10”-11” (sloped)
  - Brown Expansion B (proposed) - 15” (sloped)
  - McDonnell 162 - 16”-17” (stepped)
  - Wilson 114 - 12”-13” (stepped)
  - Reckstock 215 - 14” - 15” (stepped)
  - Seigle L006 - 27½”-28” (stepped)
  - McMillan G052-14” - 15” (sloped)
  - Lab Science 300 - 17” - 20” (stepped)
  - Louderman 458 - 13½” 16” (stepped)

- Sample Measurements for Fixed Tablet Arm Chairs in Auditoriums

  - Lab Sciences 300 (renovated 2007)
    - Seating - widths:  21.5” – 22” – measured center armrest to center armrest
    - Armrest to tablet is 23.5”.
    - Cushioned seat is 17” wide.
    - Front-to-back reclined seat is 23”.
    - Height – from floor to back of seat is 32”.
    - Height – from floor to arm is 21.5”.
    - Seat manufacturer-Theater Solutions, Inc., Teatro B2
    - Custom tablet:  9” x 11 ¾” X 13 11/16”
    - Contractor Tarlton Corporation

  - McMillan G052 (renovated 2013)
    - Seating–widths:  21” – 23”- measured center armrest to center armrest
    - Seat Manufacturer: American Seating, Stellar Chair

  - Wilson 214 (renovated 2006)
    - Seating – widths: 23.5” – 24”- measured center armrest to center armrest
    - Seat Manufacturer – Hussey Seating, Quatro Chair
    - T2m tablet

  - Louderman 458  (renovated 2011)
    - Seating: mostly widths 18.75” –measured center armrest to center armrest
      - Very few and in the center column only – 20.25”
      - Side columns – 20.75” – 21”

  - Umrah 140 – (renovated 2012)
    - 23” – measured center armrest to center armrest
    - Seat Manufacturer-Hussey Seating, Quatro Chair, Laptop T2M tablet
7 Classroom Technology

7.1 General

Washington University classroom technology is designed to be fully functional, easy to use and flexible. Much time and effort has been put into thinking about the teacher interface (the technology desk), classroom support and the maintenance of equipment to keep the technology functioning near 100% of the time. This section describes the general requirements as they relate to the audio-visual system in a standard University-managed classroom and auditorium. Currently, these technology standards are under review. Although these standards exist, they are a baseline to begin the conversation with our faculty about current and future needs they may have in a classroom. On many projects infrastructure is put into place to support future technology needs or to finish outfitting when funding becomes available.

7.2 Standard Multi-media System

Typical Classroom
- A standard multi-media system at Washington University has a data projector with a screen; a PC with monitor (with multiple USB ports); a table top touch-panel for control, laptop connectivity for both VGA and HDMI outputs, internet capability, a Blu-ray DVD player and audio input. Document cameras are available in select classrooms.

Specialty Equipment/Classrooms (as of 2014)
- Eight classrooms have SmartBoard interactive whiteboards.
- One classroom is an Active Learning Classroom.

Physical security for multimedia equipment
- Hasps installed by AV vendor for touch panel and DVD.
  - All hasps must be secured using Teaching Center’s supplied glue.
- Projectors should use locking projector mounts to secure them to the pole attached to the ceiling.
- Computers should be secured using a Kensington type lock.
- Installer should use security screws for all rack equipment.

7.3 Control System

- Table Top Touch panel control system.
  - Crestron is standard and is the only acceptable control system for University-managed classrooms.
  - Remote monitoring & E-control are required (e.g. Fusion Room View & X-panel for Crestron).
  - Approximate size of Crestron touch panel is 5” for seminar rooms (which utilize flip top panels), 10” for classrooms and 12” – 15” for auditoriums.
    - No third party vendor will be accepted.
  - No touch panel combination monitor units allowed.
  - Touch-panel control system program must be designed in conjunction with and approved by The Teaching Center prior to the start of the installation. (See Appendix F: Sample Touch Panel control Program Page Flips.)
7.4 Standard Classroom System Components

Classrooms seating < 100 students
- **PC Computer**
  - USB ports are provided on the front of the computer (usually 4)
    - Ordered and installed by TTC technical staff
- **Monitor**
  - 19” - 22” LCD or LED flat panel
    - Ordered and installed by TTC
    - VESA-mount compliant
  - Vesa-mount
    - Ordered and installed by desk maker
    - Tilt-able
- **Blu-ray DVD Player** – region-free
- **Extron Cable Cubby-500 S** (square shape)
  - Ordered and installed by desk maker
  - Laptop cables (extending from the cable cubby)
    - VGA cable -6’ length
      - VGA cables are standard for PC laptops, Mac laptops require a dongle provided by the user
    - HDMI cable -6’ length
    - Audio (separate from VGA cable); ¼” phono plug, -6’ length
    - Network cable -6’ length
    - Power – duplex
- **Document camera (optional)**
  - Desk mounted document camera (CMOS image sensor technology)
  - Comes with own light source
  - Controllable with the AV touch-panel control system
  - Requires mounting in drawer in teaching station
- **VCR’s (optional)**
  - VCR’s are no longer a standard in University-managed classrooms.
- **Display Equipment**
  - **Data Projector**
    - Minimum requirements
      - Specifications for 16 X 10 aspect ratio
      - WXGA (1920 X 1200)
      - 2000:1 contrast ratio minimum
      - Lumen requirements
        - Classrooms < 100 student seats -6000 lumens minimum
      - RS232 two-way communication with feedback.
    - Installation notes
      - Requires one dedicated 110-volt duplex outlet mounted flush to the ceiling.
      - Surge protection required-surge protector outlet (not plug in type).
      - Color of projector and piping must be same as ceiling (usually white) if at all possible.
  - **Interactive display** (optional equipment, may be used in smaller classrooms instead of a data projector)
    - LED/LCD TV with or without overlay.
    - 80” +/- widescreen 16 X 10 aspect ratio
    - 32’ maximum distance from interactive display to farthest seat.
Top of touch-able part of screen no higher than 78”-80” from finished floor (same height as a raised chalkboard).
Smaller displays can be used if they better fit the overall size of the room.

- **Non-User Equipment**
  - Switcher/scaler
  - Amplifier (for program audio)
    - Speaker type and placement determined by room size and acoustics
  - Power Conditioner
  - Computer Interface
  - UPS systems
    - 1000-1200 voltage amps
    - 10 min battery
    - Required for:
      - Touch panel processor
      - Computer
      - Digital whiteboard control and projector
    - Number of UPS systems dependent on amount of equipment.
  - Crestron Integration
    - Crestron DMPS-all in one is the digital matrix switcher, mic mixer, audio DSP, control system, and amplifier
  - Optional Microphone Sound System for Voice Amplification for classrooms > 75
    - Some classrooms that seat over 75 students may benefit from an additional Voice Amplification system so that microphones can be used in the classrooms.
    - The audio consultant, and TTC, will determine which classrooms > 75 will benefit from the addition of a Voice Amplification Sound System.
  - Assistive Listening Systems (ALS) may be added to classrooms and this option will be discussed at the beginning of each project.

### 7.5 Specialty Classroom System Components

An Active Learning Classroom is one type of specialty classroom that is being piloted at the University. The first Active Learning Classroom in the University-managed classroom pool, Eads 016, has been designed to foster interactive, flexible, student-centered learning experiences. It has been designed with grouped seating to foster interaction and engagement, and linear seating for test taking. It has a very high level of technology.

Although some of the multi-media system components are similar to a standard classroom, many other components are used to create each specialty classroom. Please consult with TTC closely when designing a specialty classroom.

### 7.6 Standard Auditorium System Components

Classrooms seating over >100 students

- Same as for standard classroom except for the following:
- Display Equipment
  - Data Projector
    - Minimum requirements
    - Specifications for 16 X 10 aspect ratio
    - WXGA (1920 X 1200)
    - 2000:1 contrast ratio minimum
    - Lumen requirements
o Classroom > 100 -300+ student seats – 8,000+ lumens
  o Amount of lumens required also depends on how far away the projector is from the screen and if additional lenses are used
  * RS232 two-way communication with feedback.
    * Color: If projector is in a booth, color is not an issue; if it’s in the classroom, color of projector and piping must be same as ceiling (usually white) if possible.

- **Non-user Equipment**
  o Crestron 8 X 8 or 16 X 16 Digital Media matrix switcher (no substitutions for Crestron will be accepted)
    * Audio DSP, control system, distribution system and amplifier are separate components
    * Allows switching at desk rather than at the projector.
  o Amplifier (for program audio)
    * Speakers
      * Speaker type and placement determined by room size and acoustics
  o Power Conditioner
  o Computer Interface
  o UPS systems
    * 1000-1200 voltage amps
    * 10 min battery
    * Required for:
      * Touch panel processor
      * Computer
      * Switcher/scaler
      * Number of UPS systems dependent on amount of equipment
  o Control Booth
    * A control booth offers a convenient and sometimes necessary location from which to record classes, run multi-media, and house non-user equipment.
    * A control booth may have sliding glass windows so that the person inside can hear true house sound. This must be discussed with TTC.
    * A control booth is required for auditoriums > 300 seats
      * The booth should be no less than 60 SF (6’ X 10’)(size of McMillan Room G052 booth) but 96 SF (12’ X 8’’ is preferred (size of Hillman Hall 060).
      * It is highly desired to be centered in the back of the classroom.
        * Access to the booth is preferred to be from outside the auditorium, however, if inside access fits the architectural scheme better it is allowed.
    * The booth houses
      * Non-user tech equipment (in a wheeled rack)
      * Audio recording connectors for external recording
      * Network and security cables
      * Extra microphones and accessories
      * Table top with videotaping location
      * Lutron control interface
      * May contain other Lutron lighting controls
      * May contain room data projector
      * May contain other peripheral equipment such as lecture capture devices
    * A control booth is optional but highly desirable for auditoriums <300 seats
      * If space is available the architects should include a booth in auditoriums

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• A booth should not take up valuable seating space if a minimum requirement of seating can only be met by not having a booth.
• It is highly desirable to be centered in the back of the classroom.
  o This decision should be made in consultation with TTC.
    • If an auditorium does not have a booth, audio feeds and connectors are required on the back wall.
  • ¼” phono plug and XLR for audio feeds, both mic and line level
• A control booths interior should be painted a flat black paint

  Sample booth sizes
• Rebstock 215 booth - 5’8” X 16’ 7”
• McMillan G052 booth - 5’ X 9’
• Brown Expansion Auditorium A (proposed) - 8’ X 12’
• Brown Expansion Auditorium B (proposed) - 12’8” X 9’
• Simon 1 - 10’ X 12’

7.7 Audio System for Voice

A typical sound reinforcement system for auditoriums or large classrooms consists of microphones, which convert sound energy into an electronic signal, signal processors which alter the signal characteristics, amplifiers, which add power to the signal without otherwise changing its content, and loudspeakers, which convert the signal back into sound energy. In designing auditoriums and large classrooms the architect must take the room acoustics into account as needed for better sound control.

• Microphones
  o Wireless microphones are the preferred style of microphone for teaching.
    • Countryman mic heads are preferred over lavaliere mic heads.
  o Each microphone system includes 1 receiver, 2 microphone heads, and 2 body packs (1 head and 1 body pack is for backup).
    • Number of wireless microphone systems:
      • For 75 > seats <100 – 1 microphone/receiver system using lapel heads.
      • For 100 > seats – 4 microphone/receiver system, 1 lapel, 1 countryman & 2 handheld wireless microphones
    • Wired – podiums only
      • Only in classrooms >100
      • One gooseneck, wired, microphone at podium
      • Back-up microphones are required and are kept in TTC.
  o Speakers
    • Speakers should be recessed within walls or incorporated in the ceilings at all times. In the instance that speaker performance will be inhibited by recessing, surface mounted speakers may be used after approval from TTC. All surface mounted speakers should have custom color finish to match adjacent surfaces.
    • Characteristics depend on classroom size and conditions.
    • Type – ceiling is preferred.
    • Location – so that audio is evenly dispersed over the student area and aisle ways and entering and exit areas.
    • Number - depends on room size; must be decided by audio expert.
    • Color to blend in with ceiling.
  o Audio outputs-for recording voice or program
    • Audio feed in the booth or the back of the classroom ≥100 seats
• ¼” phono plug and XLR for access to audio feed; both mic and line level
  • Used for taping/recording purposes.
  • Exact location to be determined by TTC.
• Future consideration must take into account audio capture devices and what kind of cable and connectors they accept. This needs to be discussed with TTC each time an auditorium is built.

7.8 Network, Security Lines and IS&T Faceplate

Network and security cable runs can be missed on drawings. In general, TTC IS&T (Network Services & Support) and the architects must check communication/network, audio-visual or electrical drawings to ensure cables runs for network and security are present & complete from classrooms back to head end closets. Check IS&T specs for the cable type and manufacturer for cable runs outside of the classroom. IS&T also places a specialty faceplate on the wall behind the teaching desk or podium. Please consult IS&T for the faceplate specifications and TTC for its exact location.

Network, Security and Cable Lines
  o Network lines—most equipment is network addressable
    • Classrooms 7-10
      • Installed computer, laptop, crestron controller and other
      • May require a network line at projector (check with TTC)
    • Auditoriums 10-15
      • Installed computer, laptop, crestron controller and other
        o Optional booth may require additional network lines
      • May require a network line at projector (check with TTC)
  o Security Lines for electronic security
    • Classrooms and Auditoriums – 1 line
      • One electronic security line should be run from card access panel to the classroom to create a continuous loop to secure the following:
        o Teacher’s station—various components
        o Data projector
    • Wash U Communications typically terminates all electronic security lines.
  o Cable lines for cable TV
    • Auditoriums only—1 line run from the desk/podium back to the telecommunications closet

7.9 Wireless Network in Classrooms

Washington University has wireless networks in many locations throughout campus. At this time the policy of the Classroom Monitoring Committee is to NOT have wireless active in University-managed classrooms or auditoriums, however this policy is currently under revision.

  o New construction and renovated classrooms are required to have wireless equipment installed in them. Renovated classrooms will have access points terminated but the wireless not activated unless it has been discussed with TTC. If installed, the wireless environment should be robust enough to cover all of the students occupying the space.
    • The location, type and quantity of access points should be determined by IS&T.
    • The wireless access points must be accessible for future activation, occasional maintenance and upgrading.
Appendices

Appendix A Sample Classroom Layout Sheet
Appendix B Sample Classroom Contact Sheet
Appendix C Sample of Screen Placement over Chalkboards
Appendix D Sample Lighting Zones for an Auditorium
Appendix E Sample Classroom Teaching Desk Drawing
Appendix F Sample Classroom Touch Panel Control Page Flips