

**CLASSROOM GUIDELINES**  
**for the**  
**Design and Construction of Classrooms**  
**at the**  
**UNIVERSITY OF CALIFORNIA, SANTA CRUZ**  
**December 9, 2003**

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## INTRODUCTION

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The goal of effective classroom design is to deliver information in the most effective manner. These guidelines have been developed for use by architects, engineers and designers as a tool for designing effective classrooms for the UCSC campus. They provide specific criteria for the design of new classrooms and alterations to existing classrooms, and as a means to evaluate the potential success of these alterations. These guidelines were developed from a number of different sources, including consultation with experts in the fields of acoustics, ergonomics and audio technology, faculty feedback, visits to other campuses and learning environments, input by the Campus Classroom Subcommittee and Classroom Client Committee, our past experience and evolving improvements in our own classroom designs. The Classroom Subcommittee approved the Classroom Guidelines on December 9, 2003 and the Advisory Committee for Facilities (AFC) approved the final Classroom Guidelines on February 17, 2004.

These guidelines are not meant to be static nor stand alone. They are not intended to establish rigid standards for the design, construction, and renovation of classrooms. Nor are these guidelines intended to be a substitute for the development of specific program requirements. They are intended to help create a dialog during the early planning process and assist in determining the most important criteria that should be addressed during classroom design.

These guidelines are meant to supplement the UCSC Campus Standards Handbook. For items not specifically addressed in these guidelines, the UCSC Campus Standards Handbook must be consulted.

**Any deviations from these guidelines must be reviewed and approved by the UCSC Classroom Subcommittee, Client Committee, the UCSC Office of Physical Planning and Construction, and UCSC Media Services.**

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December 2003

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## **I. GENERAL CLASSROOM CHARACTERISTICS**

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### **A. Locations of Classrooms**

Classrooms must be located for easy access by students and equipment, yet isolated from noisy gathering places. Classrooms should be concentrated on the lower floors of buildings to provide easy access for general students, as well as the disabled and support services. The uses of adjacent spaces must be carefully chosen to avoid distracting noises and sounds. A classroom should not be adjacent to mailrooms, reception areas, dining facilities, rest rooms, bicycle parking, loading docks, mechanical equipment rooms, and other similar noise producing areas. It is important to provide sound isolation from surrounding rooms that share common walls as well as direct air paths between rooms.

For new facilities consideration should be given during the site planning process for access and parking of vehicles which deliver and maintain presentation media equipment. Considerations include ramps, level vehicle access points, and other provisions for the ease of movement of heavy or bulky equipment.

To avoid the noise generated by their operation and use, vending machines must be located as far away as possible from classrooms. Trash and recycling containers should be located near the vending machines rather than near the classrooms.

Restrooms and drinking fountains should be located near classrooms and should be designed to handle student use between classes, rather than to meet minimum code requirements, which are based solely on room occupant load. To prevent unwanted noise transmission, classrooms and restrooms should not share common walls, floors, or ceilings, or should be designed to minimize sound transmission between rooms.

### **B. Doorways, Corridors and Traffic Flow**

The flow of students should be the major factor in determining the location of entrances. In determining the size of classroom entrances and exits, building codes should not be the only criteria. The design of entrances, exits, stairs, corridors, and exterior paths should take into account between-class student traffic. It is not realistic to assume that a classroom will be completely vacant when students begin arriving for the next class. If classrooms must be located on upper floors, it is necessary to consider the width of the stairs as well as the doors in and out of the stairwells. Corridors should be considered as public spaces that will be used when classes are in session. Therefore, consideration must be given to noise control, seating space, and durable finishes.

### **C. Size of Classrooms**

The size of the classroom should be designed to accommodate the programmed number of occupants as well as provide for additional support space. The support space must take into consideration both the set-up and use of presentation media equipment, access for the disabled, layout of the instructor's materials, circulation space and empty floor space needed to keep students from being seated too close to a chalkboard, projection screen, or video monitor.

## **D. Dimensions and Orientation**

The success with which a student receives information from an instructor is affected by classroom design factors including the shape of a classroom and the classroom's placement within a building. In spaces planned for extensive media use, the configuration can be one of the most significant factors contributing to the effectiveness of the presentation system, the student's comfort and the strength and clarity with which the instructor's voice is heard.

The ceiling height is an important consideration when designing a classroom space. Ideal placement of the bottom of the screen should be 6 feet above the floor. Minimum acceptable height is 4 feet. If the screen is lower than 6 feet, the instructor's body, media equipment and students in the front rows may block the view of text at the bottom of the screen. For a room with a 5-foot high screen, this means the ceiling height should be at least 11 feet. For larger rooms, the ceiling needs to be proportionally higher.

The orientation of a room's surfaces play a major role in how sound is reflected from the sending end of a room to the rear of a room. Careful consideration must be given to the configuration of each wall surface, ceiling plane, and floor finish. In classrooms that require fixed seating, floors should be sloped to provide good sight lines. The ceiling section over the sending end should be inclined toward the students, angled upward from the sending end, to project the instructor's voice towards the rear of the classroom.

## **E. Access for Persons with Disabilities**

All classrooms must be designed to comply with the American with Disabilities Act Accessibility Guidelines, and Title 24 of the California Code of Regulations.

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## II. CLASSROOM SURFACES AND FINISHES

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Some sound absorption is desired in classrooms, regardless of size. The following is the basic criteria for the surface treatment for the sending ends, side walls, rear walls, ceilings, and floors of classrooms. An acoustical engineer must be consulted for the design of large classrooms and Lecture Halls. In addition, small specialty classrooms, such as videoconferencing rooms or similar media intensive rooms, may have special surface treatment needs which may require design and review by an acoustical engineer.

Room surfaces should be designed as follows:

**A. Sending End (includes the front wall, adjacent side walls and adjacent ceiling)**

1. The area where the instructor stands should be level with or below the area where students are seated. Raised platforms cause sightline problems and should be avoided.
2. Classrooms that seat fewer than 50 students should have the sending end hard-surfaced (gypsum board, blackboards) with no special acoustical shaping required.
3. Classrooms that seat between 50 and 75 students may require the sending end to be hard-surfaced, with special acoustical shaping, depending on the overall room design and configuration.
4. Classrooms with a seating capacity greater than 75 should incorporate some or all of the following design features as feasible (the larger the classroom, the more the features are required):
  - a. Chalkboards should be divided into two or three sections. Outer sections are to be angled to help reflect sound to the rear of the classroom and to reduce the acuteness of viewing angle for viewers on the opposite end of front row seats. The typical angle is 15° - 30°. The wider a room, the more angle is required for the outer blackboards. Closer listeners will generally receive sufficient direct sound. These angles must be determined using cross-sections and floor plans drawn to scale, using ordinary geometric techniques to calculate angles of incidence and reflection.
  - b. The side walls to the immediate left and right of the chalkboards should be angled to help provide useful reflection to the rear of the classroom.
  - c. The surface above the chalkboard should be sloped to help reflect sound reflections to the rear of the classroom. Note the required angle for reflections to the rear of the classroom may be created with a saw-toothed surface rather than with an unbroken planar surface.
  - d. The distance from the chalkboard and projection screen to the first row of seating should not be excessive. Requirements from the latest edition of the Uniform Building Code (U.B.C.) with regard to exits are to be followed. Large classrooms with demonstration benches or rooms with large projection images will require greater distances from the screen to the first row of seating. The standard formula



to use when calculating the distance from the projection screen to the first row of seats is:

Minimum distance to front row = 2 x image height.

Maximum distance to back row = 6 x image height.

For example, in a room with 6' image height the minimum distance to the front row should be 12'. The maximum distance to the back row should be 30'. For data projection, a minimum character height is 1/150th of the viewing distance. For longer presentations larger character size is desirable.

## **B. Side Walls**

1. Classrooms seating fewer than 75 students should have hard side wall surfaces with no special acoustical treatment required.
2. Classrooms seating more than 75 students should have side walls designed to reflect desired sound (early reflections) and to absorb undesired sound (late reflections), as follows:
  - a. The front three-quarters of each side wall should be of hard, acoustically-nonabsorbent materials, such as gypsum board, masonry, or wood paneling. These hard walls can be painted or vinyl surfaced, but should not employ fabric covering or any other acoustically absorbent finish.
  - b. The rear quarter of each side wall should have an acoustically absorbent finish. This is to absorb useless reflections and to dampen standing waves (this reduces the room's "boominess").

## **C. Rear Wall (wall opposite "sending end")**

1. Classrooms seating fewer than 50 students should have a rear wall with a hard surface, with no special acoustical treatment required.
2. For classrooms seating between 50 and 75 students, the shape of the room, the orientation of the seating, and the type of seats will determine the acoustical treatment for the rear wall.
3. Classrooms seating more than 75 students should have an acoustically absorbent finish on the rear wall.

## **D. Ceiling**

1. For classrooms seating fewer than 50 students, ceilings may be acoustically absorbent, although a nonabsorbent finish is preferred.
2. Classrooms seating between 50 and 75 students should have acoustically nonabsorbent ceiling surfaces.
3. Classrooms seating capacity greater than 75 students require the following ceiling treatments:
  - a. Ceiling should be hard and acoustically nonabsorbent, such as painted gypsum board.

- b. Openings and penetrations should be minimized if noisy conditions exist above the ceiling. For example, lighting fixtures should be surface-mounted rather than recessed.
- c. The front one-third of the room's ceiling should be sloped to assist in projecting early sound reflections to rear seats.

#### **E. Floor and Seating**

- 1. In classrooms seating fewer than 50 students, if ceiling is acoustically absorbent, the floor may be non-absorbent.
- 2. For classrooms seating fewer than 75 students, some or all of the following should be installed:
  - a. Acoustically absorbent material on rear wall.
  - b. Upholstered seats.
  - c. Acoustically absorbent ceiling material.
  - d. Carpeting

Note: For State funded projects the use of carpet flooring may require special justification and approval by the University of California Office of the President and the State of California Legislative Analyst's Office.

- 3. For classrooms seating more than 75 students, the following considerations apply:
  - a. Fixed seating is suggested. Fixed seating enables the use of a sloped floor and/or risers toward the rear of the room, allows more seating per assignable square foot and provides improved sight lines.  
  
If fixed seats are used, they should swivel if possible so students can work in pairs if directed to.
  - b. If a flat floor is dictated by physical or budgetary constraints, rear risers should be installed. If only a one-step riser height is possible, this should be broken up into two or three smaller steps spread across several rows.
  - c. When fixed seating is used, it should be upholstered for acoustical absorption. The floor surface under the seating should have a hard finish such as sealed concrete or sheet vinyl. Side aisles should be floor carpeted for acoustical damping and reverberation control.

#### **F. Architectural Finishes and General Guidelines**

- 1. Architectural materials specified should be chosen primarily with durability, maintainability, and acoustical properties in mind.
- 2. Floor carpet should be cut-pile, stain resistant, low-static carpet of the best institutional quality. Glue-down carpet or carpet tiles are acceptable. Carpet tiles are

less desirable but allow selective replacement in high traffic areas. Carpet pads should not be used.

3. Cut-pile carpet is acceptable as an acoustically absorbent material for wall installation at lower frequency ranges. It has proven the most durable and cost-effective acoustically absorbent wall finish in an institutional setting.
4. Each classroom should be equipped with a black (not "colored") porcelain on steel chalkboard. A white chalkless board may be used in certain instances at the discretion of the University. In some cases, both may be desirable. Generally slate chalkboards are the board of choice for mathematics, statistics, and chemistry faculty, however slate is difficult to locate and is cost-prohibitive.
5. All classrooms requiring projection should have effective, easily operated, and durable closures over the windows in walls and doors allowing the room to be completely darkened.
6. Doors should be at the back of the room, or if not possible, at the sides. The audience should not enter at the front of the room, as it interferes with instruction. The use of an entry vestibule is desirable to control external noises as well as prevent daylight from spilling into the classroom during presentations. Doors into the classroom should be provided with vision panels to allow students to see if the classroom is in use or that they have the right class. The vision panels should be narrow enough to reduce exterior light that may spill into the classroom or should be equipped with durable shades.
7. The projection screen's lower limit stop should be set to allow for the various projected images that may be viewed in the classroom. Consideration must be given to the location of the image in relation to the instructor's teaching location. Typically the lower limit switch should be set so that the lowest setting is two inches above the level of the chalkboard chalk tray.
8. The instructor should be able to control the lights, sound levels, the projection screen, and the slide projector in a convenient location at the front of the room. The control panel should be positioned in a cluster at a height in compliance with accessibility standards. If the room is equipped with a projection booth, all these functions should also be clustered and duplicated in the booth. See Section IX, Classroom Projection Booths, for information regarding projection booth requirements.
9. Adequate storage space must be provided in close proximity to classroom for media equipment.

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### III. CLASSROOM FIXTURES AND FURNITURE

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#### A. Furniture

1. All fixed furniture (platforms, tables, fixed seating, etc.) should be permanently attached to the floor. All furniture should be selected for durability and be of a brand, model, and color that permits efficient repair, exchange, and replacement.
2. All fixtures, cabinets, table and counter tops, and furniture should be covered with high pressure plastic laminate, unless selected surfaces must match existing materials in the room.

#### B. Paint

1. UCSC standard colors must be used for all painted surfaces.

#### C. Media Equipment

1. All media cabinets should be mechanically fixed to walls and/or floors.
2. All hanging equipment, including video projectors, speakers, and televisions/monitors, should be fixed with securely fastened safety cables designed to meet seismic requirements.

#### D. Seats

1. Left-handed writing tablets should be provided for 10% of the seats.

#### E. Projection Screens

1. All classrooms shall be equipped with at least one motorized projection screen. In most cases, the size of the projection screen is related to the Media Package specified for that room. Sometimes it is desirable to install two or more screens for various presentation purposes. In large classrooms, a separate projection screen should be provided for use with a standard overhead projector. This screen should be located so it can be used when the main screen is also in use.
2. There are often times when faculty will want an image on the projection screen while simultaneously using the chalkboard. Screens and chalkboards should be located with this need in mind. In some cases, it may be desirable to install two side-by-side screens and another, larger screen centered in front of them. This allows use of both the screen and chalkboard when desired, while still allowing theatrical projection on the larger screen when needed.
3. Screens should be installed a sufficient distance in front of chalkboards so that light fixtures illuminating the chalkboard are positioned behind the screen. Chalkboard lights should be aimed toward the chalkboard to avoid light spilling onto the screen.

**F. Chalkboards**

1. All chalkboards should be equipped with chalk trays, and along the upper edge, 2-inch cork strips and map hooks that cannot be removed. For classrooms which require large sliding tiered chalkboards, separate cork boards with map hooks should be provided near the front of the classroom.
2. The following should be used when determining the minimum chalkboard size requirements for classrooms:

<u>Number of Students</u>	<u>Minimum Chalkboard Size</u>
0 - 25	12 feet long X 4 feet high
25-75	20 feet long X 4 feet high
76-100	30 feet long X 4 feet high (may consider tiered type)
Lecture Halls	3 sections @ 12 feet long X 4 feet high (each section 2 or 3 tiers high)

3. In all classrooms, chalkboard space should be provided that can be used when the projection screen is down and in use. The projection screen should be positioned so that one contiguous chalkboard section of at least 8 feet in length is available when the screen is down.
4. If it is necessary to have a door near the front of the room, the portion of the chalkboard which is available when the screen is down should be on the opposite side of the room from the door so students coming in late do not have to cross in front of the instructor.
5. Chalkboards should extend the full length of the front wall of the classroom.
6. If possible, additional chalkboards and a bulletin board should be mounted on side and back walls so announcements do not take up space on the front boards and so that students can work on group projects using chalkboards when directed.

**G. Floor Space and Seating Capacity**

1. For the design of new classrooms, **20 square feet per student** should be used for preliminary planning purposes. This will allow for seating, circulation, media equipment, lecture space, and sufficient space to meet accessibility standards within each classroom.

**H. Other Fixtures**

1. A large, easy to read clock is desirable. The clock should be located where it is easily seen by the presenter.
2. All classrooms shall be equipped with at least one manual pencil sharpener.

Note: See Appendix for standard classroom specifications regarding fixed seating and other materials and equipment.



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## IV. CLASSROOM MECHANICAL SYSTEMS

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Classroom mechanical systems should be designed to promote a level of comfort which will provide optimum conditions for studying, listening, reading, and interaction.

### A. Heating, Ventilating & Air Conditioning (HVAC)

1. Air handlers (including heating and ventilating units) serving classrooms shall be equipped with economizer cycle controls to allow for cooling with outdoor air.
2. All classroom HVAC systems shall be designed to provide outdoor air for ventilation as called out in ASHRAE Standard 62-1989; "Ventilation for Acceptable Indoor Air Quality".
3. Classroom thermostats shall be equipped with tamper-proof covers.
4. Start / stop control of classroom HVAC systems shall be provided by the campus Energy Management System controlled from the Central Heat Plant.
5. Classroom systems shall use the following criteria as the basis of design;

- a. Indoor air temperatures;

70° F (winter)

75° F (summer, for rooms with air conditioning)

For rooms without air conditioning, provide a ventilation rate sufficient to maintain the indoor temperature within 10 degrees of outdoor air temperature under summer design conditions.

- b. Outdoor air temperatures;

32° F (winter)

88° F (summer dry bulb)

66° F (mean coincidence summer wet bulb)

6. Diffuser locations shall be selected to distribute supply air uniformly in the classroom at occupant level velocities as recommended by applicable ASHRAE design standards. Diffusers shall be selected based on design air volume and a **maximum sound rating of NC-30**. Supply diffusers shall be equipped with opposed blade dampers. Balancing dampers shall be provided at ductwork branch connections.
7. Projection booths should be equipped with separate HVAC systems or zoned independently of the classroom.
8. Classroom HVAC systems **shall not** produce room noise **in excess of NC-30**.
9. System components (fans, ductwork and diffusers) shall be selected to meet the following sound criteria:

**New Classrooms:** NC 20 to NC 25  
**Renovations:** NC 25 to NC 30

10. For small classrooms, ventilation may be enhanced by windows that open. Air movement may be desirable to avoid the feeling of air stagnation in a completely enclosed room.
11. In areas where heat generating media equipment will be located, such as projection booths, media equipment closets, and cabinets, ventilation and/or cooling must be provided to lengthen the life of the equipment.
12. Santa Cruz has a mild summer climate. In general, most cooling loads can be accommodated through the use of outdoor air ventilation. The use of air conditioning is not allowed for most applications on the UCSC campus. In situations where meeting the design cooling load with outdoor air is impractical due to high distribution velocities, oversized fans, large oversized ductwork, large air intake louvers, or high system noise, the use of air conditioning may be considered.



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## V. CLASSROOM LIGHTING SYSTEMS

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### A. Guiding Concepts

Classrooms require lighting that can produce enough brightness for note taking and reading. Lighting systems also should provide for illumination on chalkboards, demonstration areas, and other work surfaces. Control of illumination, especially control of light spillage onto the projection screen, is extremely important in classrooms where media equipment is used.

Lighting fixtures and lamps should be specified for minimum light intrusion onto projection screens and for energy efficiency, low heat generation, and easy maintenance. General guidelines for the selection of light fixtures include the use of recessed lamps in sharp-cutoff luminaires to provide controlled lighting with minimal light spill on projection screens and to avoid shining light directly in the viewers' eyes. The use of incandescent lamps should be minimized to reduce maintenance, conserve energy, and reduce heat generation.

For large classrooms, a suitable system may include low-intensity PL fluorescent downlighting for note-taking during projection screen use and higher-intensity fluorescent fixtures for general illumination purposes. The note-taking light fixtures should provide enough light for the students to read and take notes, while not bouncing light around the room or washing out the image on the projection screen.

For smaller classrooms, fixtures in the front half of the room should be able to be switched off. Fixtures in the rear of the room should be able to be switched to half level, and/or every other fixture turned off. Some particularly effective small classroom installations have utilized pendant-mounted, 2-tube, parabolic lens, direct/indirect fixtures installed so that one of the tubes can be turned off. With this system, the fixtures near the front of the room still must have the capability to be turned completely off to darken the area around the projection screen.

### B. Lighting Zones

All classrooms should have a minimum of four lighting zones:

1. One zone should control the classroom's general-use fluorescent lights to provide full brightness for general activities.
2. One zone should control low level lights for note taking. These lights should not shine on the screens and must not shine in the eyes of the audience. These should be fully dimmable.
4. One zone should control chalkboard lights (either incandescent or fluorescent) to illuminate the writing surface at the front of the room.
5. Optionally, a zone can control incandescent spot lights that highlight the instructor and demonstration area. In special circumstances, this zone can be further divided into two zones, one for the instructor's area and one for the demonstration area.

### C. Lighting Levels

Classroom lighting levels must be carefully selected and coordinated with furnishings, walls and blackboards. High levels are not necessarily better than low levels. Energy use is an important consideration. Contrast between chalkboard and background and between screen and background is the key to good lighting design.

Classroom lighting should generally utilize the following three lighting levels:

1. Full Lighting: **25-50 Footcandles**

Overall illumination adequate to read, at the worst, poor photocopies. Our experience has shown that a range of 25 to 50 footcandles is generally acceptable, but these levels must be designed to not overpower chalkboard and lectern illumination. Fixture glare control should be provided to avoid annoying bright spots in the field of vision from an audience position looking toward the front.

2. Note-Taking Lighting: **2 Footcandles at the Desktop**

Note-taking light levels must be designed to avoid washing out video images. Two footcandles has been found to be an acceptable level in large classrooms with high ceilings allowing separate fixtures to be used. Uniformity, again, is important.

3. Presentation Area Lighting

Chalkboard and demonstration table lights should be designed to provide visibility with room lights at full intensity and consequently must be at least as bright as the room levels. Uniformity of illumination and lack of shadows is at least as important as level. Bright bands of light directly above a dark chalkboard should be avoided.

#### **D. General Requirements**

1. All light switches should be clustered and simple to use, with clearly labeled functions on the switch plates. Light controls should be conveniently located at the front of the room and in the projection booth (if provided).
2. All light switches should be in the **UP** position when the fixtures are **ON**, and in the **DOWN** position when in the fixtures are **OFF**.
3. Aisle lights (on a separate circuit) should be provided for safety.
4. All fluorescent light fixtures should have electronic ballasts for noise control.
5. Dimmers must not hum or inject electrical noise into audio systems.
6. Some light controls should be placed at every entrance to control enough lights that instructors can see to cross to the room to the main switches. For rooms with entrance vestibules, the switches should be inside the classroom itself, not in the vestibule. The light switches at the front of the room which control these safety lights should be clearly labeled as such so instructors know which lights they can leave on until they reach the door when leaving.

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## VI. CLASSROOM ELECTRICAL SYSTEMS

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All electrical equipment, including contactors, lighting fixtures, dimmers, etc., should be of selected brands, models, and specifications to conform to campus standards (see UCSC Campus Standards Handbook).

### A. Conduit

1. All conduit should be of continuous EMT, electrical metallic tubing (conduit) type material where possible.
2. In areas and situations where EMT is not possible, junction boxes or flexible conduit should be installed only by prior approval of the University.
3. Junction boxes should not be located in hidden or inaccessible corners.
4. All conduit should be at least 3/4" inside diameter or larger. Larger conduit is generally installed to ensure space for future expansion.
5. Low voltage cables (e.g. audio, video, and control cables) are all required to run in a separate conduit from any AC wiring.
6. All conduit and electrical circuits should have the same ground reference.

### B. Circuits

1. All audio, video, and control electrical circuits should be fed from "clean" legs from the transformer free of high inductive loads. There should be no elevator motors, compressor motors, blower motors, etc. on the side of the power transformer that feeds the media equipment.
2. All electrical control circuits should come to a single location.
  - a. This location should be large enough for the lighting contactor cabinet.
  - b. The location should be convenient for maintenance and secure from vandalism.
  - c. If possible this location should be isolated from the classroom to eliminate repair and contactor noise.
3. Utility AC outlets on separate circuits from the media equipment should be provided inside the classroom for overhead projectors, portable media equipment, laptop computers, vacuum cleaners, etc.
  - a. There should be at least one duplex outlet on each wall, as well as on the front, classroom side, of the projection booth.
  - b. In larger rooms which have fixed seating on risers, an outlet should be provided in the face of the first riser (centered in the room), and on the face of a riser mid-way back in the middle of seating (centered in the room).

- c. There should be at least one duplex outlet every ten feet along the front wall of the classroom, on the underside of any teaching tables and on any fixed lecterns.
  - d. There should be one duplex outlet approximately 12 feet in front of the center of each projection screen for portable projection equipment. These outlets may need to be in recessed floor boxes.
  - e. Unless otherwise specified, power and audio/video outlets shall not be floor mounted to avoid the intrusion of water and debris. Outlets shall be mounted on the rear stage wall and/or the front stage wall or other vertical surfaces (such as the risers of tier seating). If this is not possible, outlets should be placed in recessed floor boxes which allow covers to close flush with the floor surface when cables are connected.
4. A dedicated circuit with quad outlet should be provided for the media equipment, in a location coordinated with Media Services. The number and locations of outlets will increase with the size of the room. Consult Media Services for specific requirements pertaining to outlet quantities for media equipment.
5. Video Projection - Provide a duplex 120V outlet in the ceiling at each video projector location. In addition, provide two 1.25-inch conduits from each video projector location to the Faculty Workstation Podium and to the location of the media equipment rack. This conduit is to be used for low voltage projector control and signal cables.

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## VII. CLASSROOM SIGNAL CABLING, CABLE TELEVISION, TELEPHONE AND DATA NETWORK OUTLETS

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### A. Signal Cable and Wiring for Media

General cable specifications conform to the UCSC Campus Standards Handbook. Individual project specifications will be specified precisely. The following are general guidelines.

1. **Audio cable**- All microphone and line level signals lines should be paired, 100% or better shielded, low-loss, stranded, tinned copper, audio quality wire of no smaller than 22 SWG, with a drain wire, and have PVC, polyethylene, rubber or similar insulation. Nominal capacitance between conductors should be approximately 50 pF/ft. or less. The minimum number of pairs should be chosen according to the number of signal paths necessary for the project.
2. **Speaker cable**- Speaker cable should be 100% shielded, stranded, tinned copper wire 14 SWG or larger. E.g.. Belden #83652 or 83702.
3. **Video cable**- Video cable should be Belden #1505A .Verify exact requirements and final cable selection with UCSC Project Manager.
4. **Control cable**- Control cable should be 7 or 8 conductor (minimum), 100% shielded, stranded, tinned copper wire 24 SWG or larger. Capacitance between conductors should not exceed 11 pF/ft. and cable should be data grade. E.g. Belden #8134. Verify exact requirements and final cable selection with UCSC Project Manager and Media Services.

### B. Cable Television (CATV)

1. General requirements:
  - a. Design of the cable television (CATV) distribution system, including signal levels at the inputs and outputs of each device in the system, must be approved by the UCSC Project Manager and Media Services Engineering.
  - b. UCSC uses a two-way, sub-split CATV system to allow programming originating in classrooms and other locations to be fed back to the headend. The cable television system must be designed and constructed with this capability in mind.
  - c. All F-connectors are to be tightened to 15 foot-pounds.
  - d. CATV signal level is to be between +5 dB and +15 dB at all outlets.
  - e. The maximum leakage allowed anywhere in the system is 20 uV/m at 10 feet.
  - f. Active and passive devices shall be bandpass rated at 750 MHz or greater.
  - g. Inter-building underground cables are to have flooding compound.

- h. Long runs may require amplifiers with slope adjustment to provide a balanced signal.
- i. Outlets should be self-terminating.
- j. One outlet is required at the location of each media equipment cabinet.
- k. In rooms with projection booths, one outlet is required in the booth as well. Coordinate location of this outlet with the UCSC Project Manager and Media Services Engineering.

## 2. Cable requirements

- a. **Runs under 100 feet indoors** should be Quad Shielded RG-6. E.g. Times Fiber Co. #2245.
- b. **Runs between 100 and 300 feet** should be Quad Shielded RG-11. E.g.. Times Fiber Co. #2262.
- c. **Runs over 300 feet** should be aluminum-jacketed, flooded hardline coaxial cable, either 0.565 or 0.840 inch diameter.

## C. Outlet Locations for Data, Cable Television and Telephone Service

### 1. Data, telephone and cable television network outlets should be located as follows:

#### a. Small and Mid-sized Classrooms (up to 75 seats)

##### 1. Dual duplex data outlets should be located at each of the following locations:

- the front of the classroom
- the video projector
- all wireless network access points
- the media equipment rack.

##### 2. One campus cable television outlet should be provided at the media equipment rack.

#### b. Large Classrooms (over 75 seats):

##### 1. Data outlets should be located at each of the following locations:

- dual outlets at each of at least two locations at the front of the classroom
- dual outlets at each video projector
- one outlet at each wireless network access point
- four outlets in the projection booth
- four outlets at the media equipment rack
- four outlets at the Faculty Workstation Podium

##### 2. Cable television outlets should be located at each of the following locations:

- the media equipment rack
- the projection booth
- the Faculty Workstation Podium

3. Campus telephones should be located in the following locations:
  - in the projection booth
  - the front of the room near the lighting and media equipment controls

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## VIII. CLASSROOM MEDIA SYSTEMS

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### A. Guiding Concepts

Instructional technology is an essential, integrated part of many classes. Because new buildings will serve for many years, classrooms should be designed for flexibility, to accommodate both current technology and technology of the future.

While most classroom media equipment is generally provided by the University, provisions and infrastructure to accommodate the equipment should be considered within the overall design of the classroom. Note that projection screens are generally provided and installed by the contractor as part of the building construction contract.

All media equipment, whether provided by the University or by contractors, should conform to the following guidelines, and to the media package specifications provided later in this document.

1. Projection screens should be provided with:
  - a matte white surface
  - a quiet motor
  - automatic stop settings
  - controls at the front of the classroom and, for rooms with projection booths, in the booth as well. Screen control should also be integrated with the media control system where feasible.
2. Lenses and screen heights should be optimized so the vertical heights of video images, 16mm film images, and vertical slides are the same.
3. Equipment should be secured in a rack, located in either a media equipment cabinet or an equipment closet which provides easy access to the back of the equipment for service and maintenance.
4. A closet for media equipment should be located within each classroom or cluster of classrooms with access from outside of a classroom. The closet should allow room for equipment on carts to be stored and should provide sufficient power for testing equipment, recharging battery packs and other needs. The closet should have a light and should be keyed independent of the classroom key.
5. A sound system should be provided in all classrooms containing media equipment. In all but the smallest classrooms, the sound system should provide voice reinforcement as well as sound from media equipment. After all equipment and seating is installed, the sound system should be optimized using a calibrated microphone spectrum analysis system.
6. Loudspeakers should be aimed to provide a coverage pattern for the entire seating area. Satisfactory service can be obtained from broad-coverage speakers.
7. Where a sound system provides voice reinforcement, an Assistive Listening Device (ALD) is required to conform to the Americans with Disabilities Act (ADA). An FM system is preferred rather than an infrared system. The minimum number of receivers must be equal to 4 percent of the total number of seats, but never less than



two receivers. A sign indicating the availability of the system should be installed in classroom.

8. A drawer should be available in the media equipment rack or Faculty Workstation Podium for storage of wireless microphone transmitters, batteries and a battery charger.
9. A control system is required for all classroom media systems.
  - a. In small- and mid-sized rooms, the control system should provide a central location for controlling the video/data projector, switching between projection sources, and adjusting the sound level.
  - b. In large rooms, the control system should use a touch panel to provide a central location for controlling the video/data projector, switching between projection sources, adjusting the sound level, and viewing video and computer images as they are projected. The control system should also provide for control of lights, screens and shades or drapes as necessary.
10. Each classroom media system should have an Auxiliary Input Panel. The Auxiliary Input Panel allows portable equipment to be connected to and displayed by the installed media system.

## **B. Media Packages**

UCSC has defined standard "Media Packages" of presentation media equipment for classrooms:

- **Media Package 1-** for classrooms seating up to 30 students
- **Media Package 2-** for classrooms seating between 30 and 75 students
- **Media Package 3-** for classrooms seating more than 75 students

Note: These are **targets** that have been adopted by the campus. Individual circumstances may require some modification to these specifications.

Media Packages are developed and refined with the following principles in mind:

- **Ease of Use.** Media systems are designed to be intuitive and simple to use.
- **Uniformity.** Operation and layout of media systems should be consistent from classroom to classroom.
- **Self-Service Operation.** Faculty will be expected to independently use any media equipment that has been installed in the classrooms.
- **Use of Off-The-Shelf Technology.** Equipment must be commercially available and easily interchangeable to permit maximum 'up time' of our classrooms.
- **Upgradeability.** Systems must allow for future technology to be integrated as new products and concepts become available.
- **Reliability and Serviceability.** The media packages and their individual components must allow for high reliability and fast repair.

### **C. Faculty Workstation Podium**

Large rooms containing Media Package 3 systems include a teaching console called the Faculty Workstation Podium. The Faculty Workstation Podium combines nearly all items that an instructor needs to teach a class in one compact piece of furniture. It serves as a lectern and a work surface. On top is the media control system touch panel, providing a central point of control and monitoring of the media presentation system. Mounted inside are the VCR, DVD player, audio cassette recorder, computers and matrix switcher, all of which are at hand and ready for use so the instructor does not have to turn away from the audience.

The Faculty Workstation Podium houses these items in a manner that provides easy access for the instructor and security against theft. Folding shelves provides a work area for instructors in wheelchairs and space for the document camera. The podium has power outlets and cables to connect an instructor's laptop computer to the media system and to the Internet. An access hatch on the side facing the audience provides quick and easy technician access to the rear of the media equipment for maintenance, and the inside is sufficiently deep and roomy to allow for easy connection and maintenance of equipment.

The podium sits fixed in place over a shallow open floor box, which provides access to conduits for signal cables and electrical power for its equipment. The floor box is typically about 12 x 16 x 4 inches, and open on top. The podium bottom has a large opening to allow passage of cables.

Media Services works with a particular manufacturer who has helped us develop the design and builds each piece for us. Although the pictured podium has an oak exterior, we can custom order whatever exterior surface is desired by the architects.

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## IX. CLASSROOM PROJECTION BOOTHS

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Larger classrooms, as well as those designed for distance education, require a projection booth in the rear of the room. The projection booth isolates projector noise from the classroom and provides a secure location for valuable equipment. Because of its limited size, careful design of the projection room is critical to efficient use of this space.

### A. General Booth Design Criteria

1. A minimum practical size for a projection booth is 12 feet wide by 7 feet deep. A booth this size can efficiently and permanently accommodate two slide projectors, two 16mm film projectors, two video/data projectors, an equipment rack, counter space for sorting slides and trays, storage space for reels, trays, and spare lamps, and room for two operators.
2. To minimize light intrusion, the projection booth door should not open to the exterior of the building, nor should it be positioned where glass lobby doors will allow sunlight to enter the booth and classroom.
3. A single projection window shall be installed providing good visibility for the operator and flexible locations for the projectors.
  - a. The window should be as high and as wide as practical. The window must be wide enough to allow for projection on the perpendicular centerlines of each screen. The glass should be optical quality or select water white seamless glass, without any visual imperfections. The single layer of glass should be installed with gasket seals to help control sound between booth and audience. The use of double pane glass is not acceptable. The window should be set high enough to enable the projected images to pass over the heads of the audience.
  - b. To prevent acoustical reverberation in the classroom, the glass should be tilted. If the front of the glass (audience side) can be cleaned without special equipment, then the top of the glass should tilt into the booth.
4. The booth should be equipped with a monitor speaker for the sound system, and also an intercom speaker so the booth operator can hear what is being said in the classroom.
5. The booth should be equipped with two lighting systems: a general fluorescent system to function for high illumination level during maintenance and set-up, and a system of dimmable work lights to illuminate the work space during programs.
6. The projection booth floor, window and counter height should be designed to allow easy operation of equipment, viewing of lecture area and quick movement of people and carts from one part of booth to another.
7. Because most 16mm film projectors load from the right side, the right sides of the 16mm film projectors should be clear for the operator to thread and focus.
8. Because most slide projectors are also controlled from the right side, the right side and front of the projector should be accessible. There must be enough distance

between the slide projector's front and the projection window to allow changing of long lenses.

9. To permit showing feature length 16mm films without interruption, or to show several short excerpts quickly without having to wait for the operator to re-thread the same projector repeatedly, a changeover system should be installed.
10. Each projector location should be provided with a fourplex AC receptacle from a dedicated circuit.
11. Counter space with AC power should be provided for sorting slides, stacking trays, placing notes, rewinds, etc.
12. Holes should be cut into counter top to allow equipment cords direct access to areas below and to plugs.
13. Storage space should be provided for lamps, reels, slide trays, etc.
14. Space shall be provided in a convenient maintenance location for a media equipment rack. The rack should be positioned to allow maintenance access to the rear of the equipment.
15. A restricted-access telephone should be installed in the booth for on-the-spot trouble calls. The telephone should be supplied with a handset cord long enough for the operator to reach the projectors while on the phone.
16. A connection to the campus cable television system shall be provided in the vicinity of the media equipment rack.
17. At least one duplex connection to the campus computer network shall be provided in the vicinity of each video/data projector and another at the media rack..
18. A fire extinguisher should be installed as directed by the UCSC Campus Fire Marshal.
19. An 8-inch wide pass-through opening should be provided from the booth to the classroom with doors at both ends for temporary wiring needed for special events.
20. Video/data projectors should be mounted in the projection booth rather than the classroom in order to isolate noise, facilitate maintenance access and provide increased security against theft and vandalism. Video/data projectors should be mounted to the booth ceiling on the perpendicular centerlines of their respective screens.

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## X. ACCESSIBILITY

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### A. Guiding Concepts

Considerations must be made during the planning and design of classrooms for the special requirements of students and faculty with disabilities. The construction or alteration of any building must comply with the Americans with Disabilities Act (ADA).

Special consideration should be given for people with disabilities that who use wheelchairs, crutches, or guide dogs. In addition, consideration should be given for people with other disabilities such as limited vision, hearing loss, energy limiting conditions (such as cardiopulmonary disorders), environmental sensitivities, and mental disabilities.

Below are listed some considerations for the design of classrooms. This list must not be considered exhaustive and all current guidelines and codes for accessibility must be followed.

1. Doorways and aisles should have a minimum width of 36 inches to allow for easy passage of wheelchairs.
2. It is required that all classrooms have an accessible route. The use of thresholds, stairs, or other barriers should be minimized. An accessible route must be provided to connect building or facility entrances to all accessible spaces within the building or facility.
3. Space at the sending end of the classroom, including teaching platforms where required, must be accessible to wheelchairs. All presentation media equipment and room controls must be as accessible as possible.
4. For persons with disabilities, wheelchair stations must be provided with a choice of sight lines that is comparable to those provided for persons without disabilities.
5. To reduce conditions that can cause environmental sensitivities, whenever possible, the use of materials with chemical aromas, including carpet glue, paint, and roof tar should be minimized.
6. Due to many medical conditions which are referred to collectively as cardiopulmonary medical problems, fresh air or clean recirculated air must be provided for classrooms. Windows and fresh air intakes for classrooms should be located away from loading docks, mechanical areas, exhaust vents, roadways, and other sources of potential irritants.
7. To assist in directing pedestrian traffic, signage must be provided at all inaccessible entrances directing users to an accessible entry or to a location with information about accessible entries.
8. Entrances to rooms equipped with an assistive listening device shall be clearly labeled as having such systems.

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## XI. CONVERGENCE DISTANCE EDUCATION CONSIDERATIONS

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### A. Guiding Concepts

Emerging communication technology throughout the next decade will continue to grow rapidly. A major trend of merging technologies in hybrid configurations combining microcomputer technology, video technology and networks will allow the functionality of online text and graphics with features of television production in new formats. The hybrid video/computer technology will allow educational offerings to be delivered via cable television or the Internet. Classrooms that are programmed as convergence distance education origination sites require special consideration in room design and media equipment. This is a future direction at UCSC, and should be considered in the design of campus classrooms.

### B. Room Design

#### 1. Instructor area

The instructor must be clearly visible not only from all seats but from all camera positions, since the primary function of this type of classroom is to facilitate the transmission and reception of instruction with minimal interference. A raised accessible platform of 6-8 inches may be needed depending on the size of the room and slope of the seating. However, because raised platforms can cause sightline problems between students and the chalkboard, use of such platforms should be minimized.

A fixed table or lectern at the front of the room serves two important functions:

- it establishes a 'stage' area for the instructor within the limits of the cameras
- it provides the instructor with space to lay out books, and papers

#### 2. Noise and Acoustical Treatments

Special consideration must be given to the acoustic characteristics and soundproofing of a convergence distance education classroom. Noise from HVAC systems, adjacent halls or exteriors must not intrude into the classroom or control room. Acoustic treatment of walls, floors, and ceilings to reduce unwanted reflections is critical for clear sound transmission. "Class in Session" warning lights next to the classroom doors in the hallway are recommended. Ideally, the convergence distance education room should be located in a low traffic area.

#### 3. Lighting and Window Treatments

The convergence distance education room requires extra lighting on the stage area to ensure the best possible video image. The standard provisions for three levels of lighting apply in this situation as well. If the room has windows, it should be oriented so that direct sunlight does not enter the room at any time of day or year. Windows should have drapes or blinds to allow the room to be completely darkened. Light controls should be duplicated at the front of the room and in the control room.

#### 4. Control Room

An adjacent control room should be raised above the seating level to give the operator an uninterrupted view of the classroom. The operator must have control over the

room lighting, any amplified sound, camera remote controls, video switcher, DVD or VCR playback/record units, and other classroom media. A telephone should be provided on the wall of the control room. Internet connectivity and email should be provided. Entrance to the control room should be separate from the classroom.

### **C. Media Equipment**

In addition to the usual complement of classroom media equipment, convergence distance education rooms require the following:

#### 1. Video

A minimum of three remotely controlled cameras with pan/tilt mechanisms is required for an effective convergence distance education classroom. One is located at the back of the room to capture the instructor. A second camera should be mounted at the front of the room to focus on students when questions are asked or activities take place. A third camera should be located at the side to allow different perspectives, which can provide welcome visual relief and help maintain attention for the viewer. A document camera to display course materials is essential. A large wide-screen plasma television or video/data projector is required for display of video and data. A small monitor on the lecturer's table allows the instructor to easily position materials for the document camera.

#### 2. Audio

A dedicated wireless microphone for the instructor is required. At least two extra microphone inputs should be provided for guest lecturers and panel discussions. Depending on the size of the room, one or more ceiling microphones are needed to pick up student comments. Mixing of the microphone signals may be automatic or manual. A wall or ceiling mounted speaker for amplification of student interaction from remote locations is required.

### **D. Distributing the Content**

Various methods can be used to distribute the content. Current technologies include WebCasting on the Internet, cable television, fiber optics, T-1 lines, satellite uplinks, Broadband and Wi-Fi.