APPENDIX 9

ARCHITECTURAL GUIDELINES FOR
UNIVERSITY OF COLORADO CLASSROOMS

With special notes for lecture halls with seating capacity greater than 175 students
Guidelines communicate technology requirements to administrators, architects, and contractors, but each classroom requires individual interpretation. Emphasize easy to use hardware, user-friendly controls and clear signage.

CLASSROOM ORIENTATION

While square classrooms are preferred, many rectangular classrooms have been constructed and there is a question of *long & skinny* versus *wide & shallow* orientation. Technical professionals often choose *long & skinny* for narrower viewing angles from screens, but faculty usually request *wide & shallow* to keep the teacher closer to the students and provide a larger front wall for more board space & multiple screens. Media designs have to be functional in either layout.

SEATING CAPACITY

While interpretation of standards varies, the maximum number of loose tablet-arm chairs that can be accommodated in a college classroom can be approximated by taking the total square footage of the room, subtract 100 sq. ft. for teaching area then divide by 15 sq. ft. per student.   A computer classroom often requires 30 to 35 sq. ft. per person.

In computer classrooms a 36" wide work surface is minimum for one person, 42"- 48" is preferred. The height of the work surface should allow the keyboard to be at a comfortable level (29"- 31").

Classrooms with only one entrance/exit door are limited to a maximum of 49 occupants.

Fixed seating generally increases the capacity of a classroom. When seats are fixed, as little as 12 square feet per student may be required by code.

PRESENTATION SPACE & FLOORS

Since classrooms/lecture halls will continue to be used for traditional instruction, the front center of the room needs to accommodate chalkboards or whiteboards, overhead projectors, screens, as well as walking space for pacing professors, and open space for displays and experiments.

It is important in classrooms with a computer at each student station that the room layout encourages the presenter to walk around the perimeter of the room to all students.

Avoid raised platforms in the front of classrooms so faculty can easily interact with students.

Consider raised floors in computer classrooms for flexible connectivity & cable management.

Carpeting absorbs unwanted sounds such as chairs being moved or feet being shuffled.

Allow adequate space in the front of rooms so transparency images will be legible in the rear.

Space required in the front of a classroom to ensure that transparencies on an overhead projector (with a standard 14" lens) will be legible in the back of the room:

  A small classroom, less than 27' deep, with less than 30 students needs 9' of space in the front of the room

  A small classroom, 27' to 32' deep, with 30-50 students needs 10' of space in the front of the room
  A large classroom, 32' to 37' deep, with 50-100 students needs 11' of space in the front of the room
  A large classroom, 37' to 42' deep, with 100-150 students needs 13' of space in the front of the room
  A lecture hall, 42' to 48' deep, with 150-210 students needs 15' of space in the front of the room
  A lecture hall, 48' to 54' deep, with 210-300 students needs 16' of space in the front of the room
  A lecture hall, 54' to 60' deep, with 300-400 students needs 18' of space in the front of the room

Special note for LARGE LECTURE HALLS:
Large halls need tiered floors and staggered seating to improve sight lines and sound transmission.

CHALKBOARDS and WHITEBOARDS

Every inch of available space on the front wall of the room should have chalkboard or whiteboard.

Mount writing surfaces 36" above floor and include a tack strip above it.

Chalkboards should be black for high contrast.

Add flag pole holders to tack strip above the chalkboard as map holders

CLOCK
A large easy to read clock shall be in each classroom and lecture hall mounted at the back of the classroom.

LIGHTING ISSUES

It is critical to prevent ambient room light from washing out the images on the screen. During projection, room light should be bright enough (30-40 foot candles) for student interaction, not just dim for note taking. Sufficient light is needed at the computer lectern and on the board, but it must be controlled to minimize ambient light that washes out the image on the screen. When room lights in the student zone of the classroom are turned on, no more than 3-5 foot candles of ambient room light should fall on the screen. This requirement tends to preclude indirect lighting.

To control lights so that someone can turn on lights just in the front, just in the center, or just in the rear of the room, switch the banks of lights parallel to the front of the room.

Design lighting to minimize glare on computer screens in classrooms with computers at each student work station.

Locate front row of lights near the chalkboard. Light on the chalkboard improves readability.

Light switch controls should be simple to use, clearly labeled, and conveniently located at room entrance and at the front of the room, near the technology cabinet, so the teacher can adjust lighting.

Engrave labels on light switch cover plates so faculty know which switch controls what lights.

Light from outside the room needs to be controlled. Vision panels in doors should be narrow to reduce spillage of light from the hallway.

In any dimming system the lights must dim down to 5% of output with no light flicker.

<table>
<tr><td>Special notes for LARGE LECTURE HALLS
There should be separate pairs of front podium "spotlights" to focus on a speaker at stage left or stage right, to provide some light on the presenter while showing slides or images from video/data projector.
There should be separate lights for the lower chalkboard and the upper chalkboard/screen so that the lower chalkboard can be used while slides are being shown on the upper screen.
Control lights from the booth and from the front of the room so they can be switched from either location.</td></tr>
</table>

ENTRY DOORS

Vision panels should be installed in or near doors to allow students to check whether the classroom is in use. Panels should be narrow to reduce spillage of light from the hallway.

Install paper holders on the wall just outside the door near the entrance of each classroom.
Faculty can use them like bulletin boards to post grades, notes etc. without tape or thumbtacks.

Some faculty prefer entry doors at the rear of the room so late comers don't disturb the class, while others prefer entry doors at the front to encourage students to sit up front.

<table>
<tr><td>Special notes for LARGE LECTURE HALLS
Often lecture hall doors are designed for students to enter from the rear and exit at the front.
All entry and exit doors in the room should be designed so that no light from outside the room falls on the screen when doors are opened. It is distracting when students who enter late, open the door and wash out an image on the screen.</td></tr>
</table>

WALLS & CEILINGS

To prevent seats from gouging walls, 8" chair rails should surround the perimeter of classrooms.
Top of chair rail should be 33" AFF to accommodate backs of chairs. Bottom should be 25" AFF to accommodate tablet arm edges.

Sound Panels should be used in rooms with 50 or more students to control sound reverberation.

All classroom should have at least a 9 foot high ceiling.

<table>
<tr><td>Special note for LARGE LECTURE HALLS:
Ceilings should be at least 15' high at the front of the room and, even with tiered seating, at least 9' high at the rear.
An angled ceiling at the front of the room can better deliver sound to the rear.</td></tr>
</table>

WINDOWS & WINDOW COVERINGS

If there are windows, they should be capable of being opened in the spring and fall.

Sunlight shining into the room can wash out projection images so window coverings are imperative. Venetian blinds, room darkening shades and/or drapes need to cover all windows to block light and assure that glare from windows does not appear on computer screens, TV screen or projection screen(s). Dimming and blackout capabilities are identified as continuing concerns in college classrooms.

Each window should have two window coverings to provide a range of light control and the assurance that if one device malfunctions, the teacher still has an alternative. Blinds inside the window well prevent most direct sunlight and glare. Shades outside the window well, extending several inches past window edge, minimize light seepage around the edges.

> **Special note for LARGE LECTURE HALLS**
> Windows should be avoided in large lecture halls.

VENTILATION

Classroom thermostats should keep temperatures at 65˚- 68˚ in winter and 72˚- 74˚ in summer. Humidity levels should be maintained close to 50%.

CONNECTIVITY

Include telephone lines (category 3), TV distribution (coax) and data connections (category 5).

Classrooms must have Ethernet service that has a transfer rate of 100 Mbps or higher over twisted pair wiring or fiberoptic cable.

In addition, there is growing demand for classrooms that originate distance education.

All classrooms will have "ring down phone" service so that faculty members can call for assistance.

At each Data/Video Projector location a data jack shall be present for connecting the projector to the campus LAN.

ELECTRICAL POWER

Each room needs a double grounded three-prong electrical outlet in the front center of the room, 18" above the floor, for an overhead projector and other instructional equipment.

In the rear of the room, a double grounded three-prong electrical outlet should be located 6" above the fold-down projection table to power film and slide projectors.

Two sets of double grounded three-prong electrical outlets should be located in the base of the lectern to provide power for laptop computers and peripherals.

Eight grounded three-prong electrical outlets should be located inside the media cabinet to provide power for the VCR and the television receiver.

All electrical outlets must be surge protected.

Special notes for LARGE LECTURE HALLS
Ample electrical power is needed in the booth and at the presentation area of the lecture hall.
An accessible raceway should connect the projection booth and the front of the room.

CONDUIT FOR SLIDE REMOTES, TV, VIDEO/DATA PROJECTION & LECTERN

Conduit needs ¾" conduit for co-ax, power, phone & cat 5 data; 2" for multi-coax.

The campus closed-circuit cable TV system needs ¾" conduit for co-ax (RG-6) into the room.

In classrooms with a ceiling mounted video/data projector, a single 2" conduit for control cable and multi-coax should run from the panel in the front corner of the room to the ceiling.

In classrooms with a lectern for laptop computers, conduit must be run from the corner control panel, up through the floor into the small lectern: one ¾" conduit for phone and cat 5 data; one ¾" conduit for power; and one 2" conduit for multi-coax.

Slide projector table in the rear and a jack in the front need to be connected with ¾" conduit.

ACOUSTICAL TREATMENT

Acoustical treatment should address the twin concerns of hearing the presenter more easily and containing the room sound so it does not bother nearby classrooms and offices.

Appropriate "voice-friendly" acoustical treatment permits faculty to teach without sound reinforcement, except in the largest classrooms.

Carpeting, acoustical ceiling treatment, sound absorption panels on the back wall and sound absorbing fabric below chair rails help minimize unwanted noise in the classroom.

Mount speakers for computer, CD and television sound in the ceiling. Ceiling mounting helps contain the sound in the room.

Special notes for LARGE LECTURE HALLS
Side walls should not be parallel, nor should they be a continuous hard surface.
Front wall should use hard surface materials. Sound-dampening should be applied to rear & side walls.
The back wall may need to be completely covered with acoustical absorption materials.
Ceiling speakers around the room and an amplifier are necessary for voice, CD, TV & computer sound.

FURNITURE: STUDENT SEATING - TEACHER'S TABLE & CHAIR

In college classrooms, tablet-arm chairs are almost obligatory, and tablets should be large at least 130 square inches.

Chairs should have the dorsal-back hinged chair style.

10% of tablet-arm chairs should be for left-handed students.

When possible, in larger classrooms, continuous writing surfaces, common in professional schools, should be used to provide students with room to spread out materials.

A chair and a 60" x 30" teacher's table are desirable in the front of each classroom. If the table gets too large, it becomes a barrier between the teacher and the students.

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Special notes for LARGE LECTURE HALLS
Theater-style seating is often used in large lecture halls, but it is still important to provide the students with large, fold-down tablet arms for note taking, calculators and examination materials.
A minimum seat width of 21 inches should be specified.

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VISUAL PRESENTATION REQUIREMENTS for COLLEGE CLASSROOM

SCREENS

In the majority of classrooms, one or two matte projection screens mounted above the chalkboard in the front of the classroom will fill video, data, slide & overhead projection needs.

Matte white screens can be viewed over a wide angle, typically 100° or wider. (50° off-center axis).

Screens today are slightly rectangular, in a 3 units high x 4 units wide ratio. A new 30% wider ratio of 3 x 5.3 (9 x 16) for DVD & HDTV is necessary. A screen trough recessed up into the ceiling creating a pocket across the entire front of the room will permit easy screen exchange in the future as wider proportions become standard.

Fit the screen to the size of the audience and the distance from the furthest seat. (See chart below)
Rough rule of thumb: No one should be closer than 2x the image height nor further than 7x the height.

Mount screen high enough for the students in the back of the classroom to see the bottom of the screen, typically 4 feet above the floor. (See chart below for mounting height)

Multiple screens, for simultaneous projection in a classroom, provide more flexibility than one screen. Faculty projecting materials and wanting to use the board at the same time feel a large screen obstructs the board.

Overhead transparencies are projected from a table in the front of the classroom, video and data from a ceiling-mounted video/data projector and slides from a table in the rear of the room.

Attach Velcro to bottom of the screen cord and top of the chalkboard to prevent screen cord from hanging down the middle of the chalkboard.

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Special notes for LARGE LECTURE HALLS
Lecture halls with capacity exceeding 200 students are equipped with 10', 12' or 14' motorized screens.
Lecture halls need two or more screens for projection of more than one image at a time.

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Depth of the room & seating capacity determine the size of the screen installed in each room.

Room (4x3) Depth Required for HDTV:	Seating Required Capacity	Measurement from Center of Screen to Rear Corner Seat: Approx. Diagonal	Mounting Height AFF	Standard Screen	Wider Screen (16x9)
less than 25'	15 - 25	Less than 30'	6 foot screen (72" wide x 54" high) *7 foot screen (84" wide x 54" high)*	7.5 ft.	8.5 ft.
25' to 30'	25 - 50	Between 30' and 35'	7 foot screen (84" wide x 63" high) *8 foot screen (96" wide x 63" high)*	8.75 ft.	9.25 ft.
30' to 35'	50 -100	Between 35' and 40'	8 foot screen (96" wide x 72" high) *9 foot screen (108" wide x 72" high)*	10 ft.	10 ft.
35' to 40'	100 -150	Between 40' and 45'	9 foot screen (108" wide x 81" high) *11 foot screen (132" wide x 81" high)*	11 ft.	10.75 ft.
40' to 45' 11.5 ft.	150 -210	Between 45' and 50'	10 foot screen (120" wide x 90" high) *12 foot screen (144" wide x 90" high)*		12.5 ft.
45' to 50' 12.5 ft.	210 -275	Between 50' and 55'	11 foot screen (132" wide x 99" high) *13 foot screen (168" wide x 99" high)*		14 ft.
50' to 55' 13 ft.	275 -400	Between 55' and 60'	12 foot screen (144" wide x 108" high) *14 foot screen (192" wide x 108" high)*		15 ft.
55' to 60' 14.5 ft.	400 -500	Between 60' and 65'	14 foot screen (168" wide x 126" high) *16 foot screen (228" wide x 126" high)*		17.5 ft.

For additional flexibility, add one or two screens on either side of the one center screen as sized above. Sometimes a classroom will lend itself to an additional corner screen mounted at an angle.

LECTERN

The lectern for a *PLUG & SHOW* computer needs to be small and placed on the right or left front edge of the room, facing the students. This arrangement is similar to slide presentations, where the presenter is at a lectern on one side and the visuals are presented on a screen in the center of the room. Include display connections, data jack and AC power in the lectern. The user-supplied computer is connected to the video projector with a multipin connector at the lectern.

The small lectern is 41" high. The work surface for a laptop computer is 22" wide x 14" deep and it is angled down slightly toward the presenter with a slight lip at the front.

The lectern should face the center of the back of the room.

TECHNOLOGY CABINET with RECESSED CONTROL PANEL in rooms with a ceiling-mounted video/data projector

A ceiling-mounted video/data projector requires a control panel recessed into the front corner of the room. The panel contains a standard 19" sliding equipment rack. Controls for the ceiling mounted projector and audio amplifier are located in the panel. This media panel also incorporates a recessed VCR, the wireless transmitter for the assistive listening device and external audio & video jacks. ADA requires controls no higher than 54" above the floor. A locked door below provides storage for additional media hardware.

A 2' x 2' polycarbonate sheet covers the panel. A supplier follows a custom template with cutouts for the VHS tape recorder and the projector remote.

Each cabinet has eight AC outlets inside to power the VCR, the audio amplifier, the transmitter for the assistive listening device and other electronic equipment.

Simple clear signage completes the panel. A sign specifies the basic information necessary to utilize the hardware, and a phone to call for assistance or more information.

Special notes for LARGE LECTURE HALLS

A booth in the rear of the room is desirable both for media equipment storage and operation with least disruption to the class. Entrance to the projection booth should be in rear of lecture hall.

FOLD-DOWN PROJECTION TABLE

Each classroom needs a fold-down projection table with AC power and slide remote jack at the rear center of the room. Hinges allow the tabletop to be raised or lowered. The fold-down table is capable of supporting 80 pounds and is mounted to the rear wall of the classroom.

When raised, the tabletop is 50" above the floor, a height that allows projected images to appear above the heads of those seated directly in front of the projector. The tabletop is 28" wide and 16" deep so that two slide projectors may be used at one time. Faculty often request two slide projectors so that they can compare and contrast images in the classroom.

Special note for LARGE LECTURE HALLS

Projection booths in lecture halls provide surfaces for film and slide projectors.

AMERICANS WITH DISABILITIES ACT (ADA)
The ADA, enacted in 1990, prohibits discrimination against persons with physical and mental disabilities. Title II of the ADA states, public institutions can choose to follow either UFAS (Uniform Federal Accessibility Standards) or ADAAG (Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities) standards. The goal for classroom designers is to keep in mind persons with mobility, hearing, vision, and mental disabilities.

MOBILITY IMPAIRMENTS

Set aside 2% of classroom seating for wheelchairs. While fixed tables are normally 29" high, 31" clearance above floor is needed for wheelchair access.

Locate and design the teaching station, including the boards, audiovisual controls and projection screens to be barrier free. A 60" diameter is necessary for wheelchair turnaround.

Controls for technology devices in classrooms cannot be higher than 54" nor lower than 9" above the floor and must accommodate a parallel approach by a person in a wheelchair.

Ramps must not exceed one foot rise in twelve feet of run (1:12 ratio).

HEARING IMPAIRMENTS

For new construction, if classrooms accommodate at least 50 persons, or, if they have audio-amplification systems, and they have fixed seating, they must have a permanently installed assistive listening system. These systems often broadcast audio as an infrared or FM signal which is picked up by listeners wearing special receivers and headsets or earphones.

In existing locations, assisted listening systems may be portable or permanently installed.

VIDEOTAPE PLAYERS

In larger classrooms where the picture is displayed with a large screen video projector mounted in the ceiling, VHS videotape players are incorporated in technology panels and recessed into the wall in the front corner of the classroom.

VIDEO PROJECTION & VIDEO/DATA PROJECTION

Video projectors are permanently mounted in the ceiling, with controls located in a panel near the front corner of the room. Calculate 2 times the width of the screen to approximate the distance between the screen and the lens of the video/data projector.

Brightness is measured in ANSI lumens. 1100 ANSI lumens is considered minimal.

Some factors to consider in the selection of a video/data projector: Ability to automatically display any video or any computer source; Ability to automatically return to a pre-set normal position; Ability to automatically turn the projector off after 10 min. of sync loss; and a quiet fan.

FLAT TV / PLASMA SCREENS - Flat Panel display for TV and Computers

A new alternative to a television monitor is a flat panel plasma-gas screen to display both video and computer images. With a 60" wide picture in a unit less than 6" deep they can be wall mounted much like a painting.

COMPUTER CAPABILITY FOR THE PRESENTER (PLUG-&-SHOW Classrooms & Laptops)

In a typical *PLUG & SHOW* computer presentation classroom, faculty bring in a laptop computer, already loaded with the necessary configurations, applications, files, and appropriate cards or adapters to access still and moving images via the classrooms' Ethernet. A ceiling-mounted video/data projector with a user-friendly interface makes it possible to show computer displays from laptops or workstations as well as campus cable TV, and VHS videotapes. A single, commonly available cable connects the user-supplied computer to a small lectern, with AC power, computer display connection, network jack and audio input, in the front corner of the room. The control panel, recessed into a corner wall, at eye-level, contains controls & VCR.

TYPICAL *PLUG & SHOW* PRESENTATION CLASSROOM

FEATURES:

Video/Data Projector

Lectern & connections

Recessed media panel

Controlled Lighting

2 Screens & 20' of Board

Moveable chairs
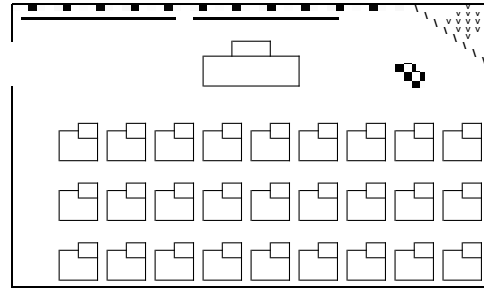
25' wide x 20' deep. 500sf. 27 students. 17sf. per student.

UNIQUE FEATURES OF "PLUG & SHOW" PRESENTATION CLASSROOMS
Laptop Computer, *PLUG & SHOW* Lectern & Intelligent Panel

Presentations require little set-up in the classroom

Laptop computers are powerful, user-friendly, non-intimidating hardware with choice of platform

The PLUG & SHOW CLASSROOM is self-service so staffing costs are minimized

Connecting a computer in the PLUG & SHOW CLASSROOM is simple
    One cable connects the laptop at the lectern to the ceiling-mounted projector in the classroom

Ethernet connectivity provides access to information outside the classroom

CLASSROOMS WIRED FOR STUDENT LAPTOP COMPUTERS AT EACH STATION

Technology classrooms may be moving away from installed computers in the classrooms. Students and faculty will carry laptop computers with them and simply connect at classroom scholar stations. These wired classrooms will have power outlets and data connections for computing and communicating on and off campus, providing fingertip access to information.

Case-Study or U-shaped Layout:
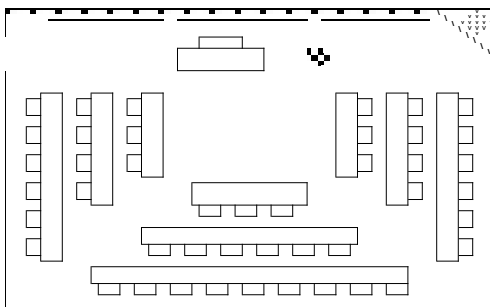
34' wide x 27' deep. 900sf. 45 students. Fixed tables, loose chairs. 20sf. per student

Seats facing each other encourage student interaction
Aisles make it easy for the presenter to walk to each student
Moveable chairs make it easy for students to work in teams
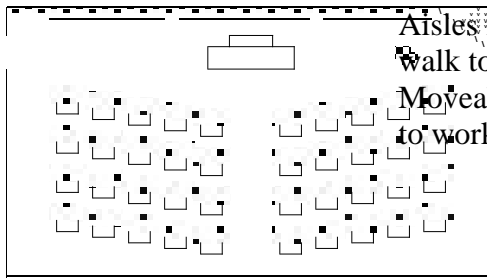
FEATURES:

Video/Data Projector

Lectern & connections

Recessed media panel

Controlled Lighting

3 Screens & 20' of Board

Fixed Tables, Moveable chairs

Power & Data Network connections for each student

Semi-Circular or Chevron Layout:

Aisles make it easy for the presenter to walk to each student

Moveable chairs make it easy for students to work in teams

34' wide x 23' deep. 800sf. 40 students. Fixed tables, loose chairs. 20sf. per student

A minimum of 36" wide is sufficient, although 40"- 48" is preferred.

COMPUTERS AT EACH STUDENT WORKSTATION IN THE CLASSROOM

Furniture layouts in computer classrooms depend on the type of computer use in the class.

Intermittent use of the computer for simulations, science experiments, investigations, writing classes, etc., suggest a layout where the presenter can see all the student computer screens.
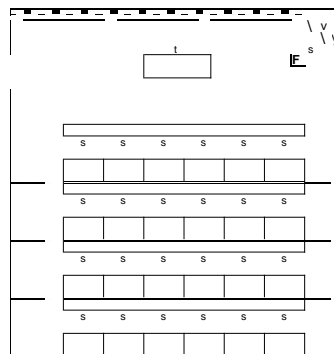
Constant use of the computer for interactive question and answer sessions and computer-accessible dialectic instruction demand that the students can see each other.

Each work space must allow sufficient room for the computer and any peripherals, as well as for student notes and papers.

POSSIBLE ROOM CONFIGURATIONS FOR INTERACTIVE COMPUTER CLASSROOMS with computer at each student workstation
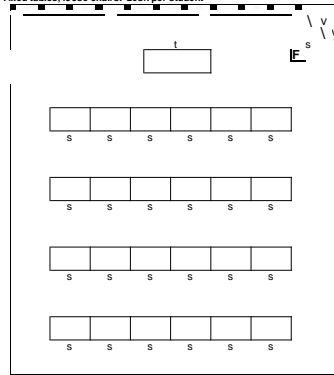
Conventional Layout Computers are placed in rows parallel to the front of the classroom facing the students. Presenter cannot see the computer screens and there are some sightline problems between students and presenter. Aisles on both sides makes it easy for the presenter to walk around to all students. Acceptable design for some computer instruction.
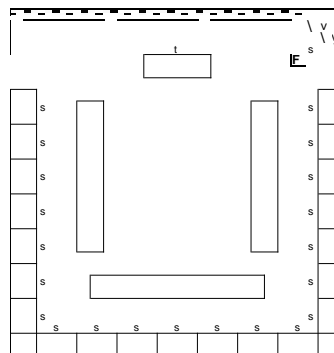
Swivel Chair Design I Computers in rows parallel to the front of the classroom, face presenter instead of students. Students swivel 180 from the computers to small tables for good sightlines. Three sets of risers let students see over the computers and let presenters see all of the computer screens. Good design for writing lab, and any intermittent computer use. Notre Dame uses a variation of this design.

Swivel Chair Design II
Computers are placed around the perimeter of the classroom. Students can swivel around to small tables for ideal sightlines. Presenter can see the computer screens. Good design for any course with some

computer-based and some group discussion elements. Easy for the presenter to walk around to all students.
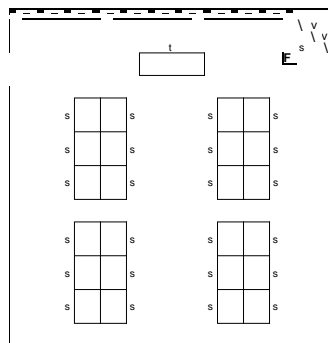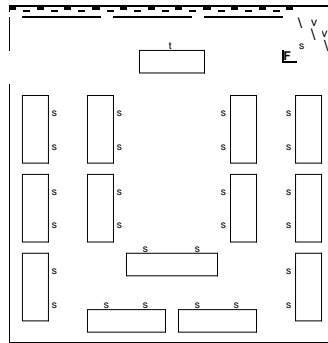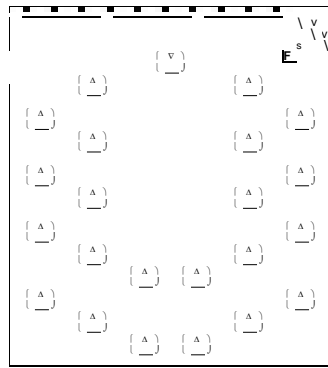
Flexible Class-Lab
Furniture can be rearranged to provide computer access, but it is time-consuming.
Laptop computers use floor junction boxes for connectivity.
Good for humanities classes and interactive instruction.
Easy for the presenter to walk around to all students.
Beanbag Classroom example at Stanford University.   http://rits.stanford.edu/rooms/flexlab/index.html

Socratek Classroom Design
Computers are placed in rows perpendicular to the front of the room. Aisles make it easy for presenter to walk to every student. Design accommodates small groups. Students can swivel 90☐ for better sightlines between students & presenter. Ideal collaborative environment for interactive, question & answer, computer-accessible, dialectic instruction.

Virtual Studio Classroom
Computers in concentric ovals. Computers don't disrupt sight- lines between presenter and students. Presenter can see computer screens. Often used for computer-based instruction in physics, chemistry & biology lab courses. This team-based collaborative working environment concept used at Rensselaer Polytechnic. www.ciue.rpi.edu/about.html

Classroom drawings are schematic and not drawn precisely to scale. Each room is approximately 25' wide x 31'deep for a total of 775 sqft.   Approximately 32 sqft per student.

END OF SECTION APPENDIX 9