Classroom Design Manual

Guidelines for Creating and Remodeling Learning Spaces
North Dakota State University

March 2017

NDSU | NORTH DAKOTA STATE UNIVERSITY

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Table of Contents

INTRODUCTION 3

UNIVERSAL DESIGN 4

GENERAL OVERVIEW 6

- CLASSROOM LOCATION 6
- ACCESSIBILITY 6
- VISUAL CONCERNS 6
- SURFACES 7
- ACOUSTICS 7
- ROOM SIZE 9
- ACCESSIBILITY 9
- EQUIPMENT 9
- LOBBY AREA 11
- VISUAL CONCERNS 11
- SURFACES 12
- ACOUSTICS 12
- EQUIPMENT 12

LABORATORY CLASSROOMS 13

DISTANCE CLASSROOMS 14

CONFERENCE ROOMS 15

SCALE-UP CLASSROOMS 16

REFERENCES AND RESOURCES 17

INTRODUCTION

BOTTOM LINE

- A comfortable and accessible learning environment is important in student learning;
- This manual serves as a guide for designing and renovating classrooms at NDSU.

This manual represents a collaborative effort by North Dakota State University's Learning Spaces Executive Committee to produce a comprehensive guidebook for designing and remodeling learning spaces on campus. Portions of this manual were based on compiled works from the *University of Maryland Classroom Design Manual*[1], as well as other sources listed throughout the manual. This manual is intended to serve as a guide for faculty and staff when considering the construction or renovation of educational spaces at North Dakota State University (NDSU). When renovating a classroom, there are several items to keep in mind when creating a learning environment, such as the classroom's intended purpose, room size and shape, location within a building, and accessibility. The recommendations specified below reflect current knowledge regarding how to improve student learning in a classroom setting.

This manual was compiled with active learning instructional methodology in mind. However, depending on a classroom's intended purpose and size, an active learning environment might not be appropriate or feasible. Active learning, as opposed to the more traditional passive learning, strives to have students actively involved with the learning process. Active learning is a teaching style that deviates from lecturing to students in front of the classroom and, instead, emphasizes engaging students in reading, writing, discussion, and problem-solving to promote synthesis and deeper learning. The approach that active learning instructors take is to engage students so they learn what students are thinking and why they are thinking that way. In active learning, instructors want students involved, and students want to be involved. Active learning is thinking and exchanging ideas as deeply and often as possible. Evidence for the success of the active learning is well documented. Collectively, a number of educational learning studies demonstrate that engaged students learn better than those who are not actively involved[2345].

Evidence for the success of active learning is long and broad. An excellent starting point for making the case is Froyd[2], who reviewed three-dozen studies that support the effectiveness of active learning as an instructional practice. Kuh et al.[3] looked at the impact of student engagement on educational outcomes in a broad-based study that included 18 universities. They reported that "student engagement is positively related to academic outcomes" by grades and retention from the first to the second year of college. While student engagement is effective for all students, engagement was determined to be especially effective for underrepresented minorities[3]. More recent data continue to support the benefits of reducing lecture and promoting active learning in the classroom. Haak et al.[4] shows the positive relationship between high levels of group work in large biology classrooms that nearly eliminated lecture, with the benefits especially notable for "disadvantaged" students, significantly reducing their achievement gap with "nondisadvantaged" students. A more recent seminal meta-analysis of 225 studies by Freeman et al.[1] shows that active learning approaches are effective. Overall, active learning in STEM courses increased exam performance by half a letter grade compared to traditional lecturing, and failure rates using traditional lecturing were 55% higher than the rates observed using active learning[6].

The guidelines described below follow the *Universal Design* mentality, which is the design concept that all learning environments should be accessible to everyone regardless of age and/or disability. This concept is a slight deviation from the better known *Inclusive Design*; in that, with Universal Design the focus shifts from making special accommodations to portions of the design for individuals with disabilities to a focus of accommodating everyone from the start. At NDSU, all students have a right to learn in a safe, supportive environment. The learning does not start or end in the classroom, but when an environment is designed with students in mind, it can help to better facilitate the learning process. There is a richness in our differences that makes it worthwhile to learn together, which means that all students and instructors have experiences and knowledge that are worth sharing with each other.

[1] Clabaugh (2004)
[2] Froyd (2007)
[3] Kuh et al. (2008)
[4] Haak et al. (2011)
[5] Freeman et al. (2014)
[1] Freeman et al. (2014)

UNIVERSAL DESIGN

BOTTOM LINE	
	• *Universal Design* means designing spaces that are equally accessible for everyone; • Many features of a classroom can be changed or adjusted to better accommodate everyone, not just the average student; • There is an eight-step procedure for implementing Universal Design in any classroom.

Universal Design suggests that spaces should be equally accessible to everyone, irrespective of age or physical or cognitive needs. *Universal Design* is an architectural term meant to emphasize that an environment or space needs to be built as **universally accessible and aesthetically pleasing** as possible. Classroom spaces at NDSU incorporate these design principles to accommodate use by individuals with a range of physical and cognitive needs. Compliance with the Americans with Disabilities Act[1] and other relevant statutes and codes is still essential, but the Universal Design principles shift the design discussion from accommodating special needs to designing for inclusive and accessible access for all.

Universal Design includes factors related to the size and shape of the classroom, potential safety concerns of the design, and compliance with industry standards and regulations. Universal Design can sometimes mean additional costs, but when designers focus less on the average user and more on **all users** from the start, then many of those cost barriers can be minimized. For example, making steps into ramps or providing extra space in student areas are aspects that should be considered when designing a classroom.

Replacing standard stationary desks with mobile desks is an example of using Universal Design in a classroom. This accommodates blind, visually impaired, deaf, or hard of hearing individuals by allowing them the freedom to move closer to the front of a classroom or closer to sign language interpreters. Mobile desks also enable students to move about the classroom to locations that better accommodate their learning style. Replacing standard tables with tables that have adjustable heights accommodates both tall and short individuals, in addition to individuals with physical or mobility disabilities. Wider seats and multiple screens throughout the classroom are other ways of implementing Universal Design in a classroom.

The Center for Universal Design (CUD) at North Carolina State University[2] lists seven principles of Universal Design to keep in mind when providing guidance in the design of learning environments.

1. **Equitable use**. The design is useful and marketable to people with a wide range of abilities. For example, a website that is designed to be accessible to everyone, including people who are blind and use screen reader technology, employs this principle.
2. **Flexibility in use**. The design accommodates a variety of individual preferences and abilities. An example is a museum that allows visitors to choose to read or listen to the description of contents in a display case.
3. **Simple and intuitive**. Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level. Science laboratory equipment with clear and intuitive control buttons is an example of this approach.
4. **Perceptible information**. The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities. An example of this technique is when captioned television programming is projected in a noisy restaurant.
5. **Tolerance for error**. The design minimizes hazards and the adverse consequences of accidental or unintended actions. An example of a product applying this principle is software applications that provide guidance when the user makes an inappropriate selection.
6. **Low physical effort**. The design can be used efficiently, comfortably, and with a minimum of fatigue. Doors that open automatically for people with a wide variety of physical characteristics demonstrate the application of this principle.
7. **Size and space for approach and use**. Appropriate size and space is provided for approach, reach, manipulation, and use regardless of the student's body size, posture, or mobility. A flexible work area designed for use by those that are either left- or right-handed and have a variety of other physical characteristics and abilities is an example of applying this principle.

[1] United States Department of Justice (2010)
[2] Connell et al. (1997)

The University of Washington[1] compiled a list of major steps in applying Universal Design to a space or environment. Their eight-step process considers both the large- and small-scale views of classroom design.

1. **Identify the application**. Specify the product or environment to which you wish to apply Universal Design.
2. **Define the universe**. Describe the overall population (e.g., users of service) and the diverse characteristics of potential members of the population for which the application is designed (e.g., students, faculty, and staff with diverse characteristics with respect to gender, age, size, ethnicity and race, native language, learning style, and abilities to see, hear, manipulate objects, read, and communicate).
3. **Involve consumers**. Consider and involve people with diverse characteristics (as identified in Step 2) in all phases of the development, implementation, and evaluation of the application. Also, gain perspectives through diversity programs, such as the campus disability services office. Make these processes known with appropriate signage, publications, and websites.
4. **Adopt guidelines or standards**. Create or select existing Universal Design guidelines/ and/or standards. Integrate them with other best practices within the field of the specific application.
5. **Apply guidelines or standards**. Apply Universal Design in concert with best practices within the field, as identified in Step 4, to the overall design of the application, all subcomponents of the application, and all ongoing operations (e.g., procurement processes, staff training) to maximize the benefit of the application to individuals with the wide variety of characteristics identified in Step 2.
6. **Plan for accommodations**. Develop processes to address accommodation requests (e.g., purchase of assistive technology, arrangement for sign language interpreters, etc.) from individuals for whom the design of the application does not automatically provide access.
7. **Train and support**. Tailor and deliver ongoing training and support to stakeholders (e.g., instructors, computer support staff, procurement officers, volunteers). Share institutional goals with respect to diversity, inclusion, and practices for ensuring welcoming, accessible, and inclusive experiences for everyone.
8. **Evaluate**. Include Universal Design measures in periodic evaluations of the application, evaluate the application with a diverse group of users, and make modifications based on feedback. Provide ways to collect input from users (e.g., through online and printed instruments and communications with staff).

[1] Burgstahler (2015)

GENERAL OVERVIEW

BOTTOM LINE	
	• Design considerations regarding classroom location, accessibility, flooring, lighting, and acoustics are universal to almost any learning environment; • Design guidelines for architects and engineers have already been compiled by NDSU's Facilities Management, found at: **https://www.ndsu.edu/facilities/constructionrenovationandproject/**[1]

This section discusses common design elements of a general classroom learning environment. Design considerations regarding doorways, flooring, and lighting are ones that are universal to almost any learning environment. The Facilities Management Office at NDSU has compiled extensive and detailed guidelines to assist architects and engineers who have been commissioned to design projects for the University. These guidelines can be found at https://www.ndsu.edu/facilities/constructionrenovationandproject/[6] and cover more practical considerations, such as site construction regulations, masonry, and metal material industry requirements. The recommendations are based on current standards and practices of classroom design, taking Universal Design and active learning into consideration.

CLASSROOM LOCATION

Classrooms should be easily identifiable and accessible to students when entering a building. Ideally, classrooms in a mixed-use building should be located on the main floor of a building and as close to the main entrance of a building as possible. This is meant to ease access for students and limit the amount of hallway traffic through non-instructional areas of the mixed-use building. Many buildings on NDSU's campus are mixed-use and contain research laboratories, staff and faculty offices, or rooms serving functions other than as a classroom. If a building is multi-use, classrooms should be segregated as much as possible from other functional rooms. Heavy hallway traffic by students on the way to and from a classroom can disrupt classes in session and distract campus employees located in the other dedicated rooms in the building.

Noise management should also be considered when deciding on classroom locations within a building. A classroom should be isolated from noise-generating activities as much as possible. This includes noise generated by adjacent rooms (i.e., bathrooms, elevators, lobby areas, etc.) and exterior activities (i.e., garbage pick-up areas, street and parking lot high-traffic areas, dormitory areas, etc.).

ACCESSIBILITY

Keeping Universal Design and accessibility in mind, doorways should be equipped with a visual panel, which is either a window in the door itself or a window near the door. This allows students to easily determine if the doorway is clear when opening, minimizing collision injuries. The base of a visual panel should not be higher than 3.5 feet (1.1 meters) from the ground so it is accessible to those with physical or mobility disabilities.

Doorways should swing open into a classroom, and not into the hallway or outside area. This is done to limit congestion in the hallway between classes. The door itself should be fitted with hinges or similar hardware that slows and silences its closure to limit accidents and sound disruptions. If a doorway is unable to open into the classroom, but instead opens into a hallway or other area, then a visual identification on the door itself or in an immediately adjacent area must be used to indicate the potential hazard and amount of space required for the door to operate appropriately.

VISUAL CONCERNS

Using multimedia in the classroom makes adequate and easily adjustable lighting critical. Unfortunately, lighting is commonly one of the most overlooked aspects when renovating older classrooms. Lighting within a classroom should be in accordance with the National Electrical Code[2] and the guidelines described by NDSU's Facilities

[1] North Dakota State University (2016)
[2] National Fire Protection Association (2017)

Management webpage[1]. Lighting levels should be reviewed based on the application and equipment being used. When appropriate, classrooms should have a variety of different lighting possibilities to suit the varied needs of classroom activities, such as reading, presenting, interacting, watching multimedia, and taking notes.

Lighting requirements will vary depending on the specific intentions and purposes of each classroom. For example, if a projector is used in a classroom, then there should be a quick and easy way to dim or turn off the lights that affect the projected image, while allowing other lights to remain on. If a podium area is planned to be used in a classroom, then there should be independent lighting located in the instructional area. Lighting of specific areas of the classroom may also be appropriate so sign language interpreters can be seen by hearing-impaired students.

Special attention should be placed on the accessibility and maintenance of the lighting systems within a classroom. In particular, lightbulbs need to be easily accessible to ease replacement. Replacing lightbulbs in high-traffic classrooms may be difficult, so using long-lasting light sources is the best course of action to consistently provide the ideal learning environment.

In general, lighting should be evenly distributed throughout the classroom. In most classrooms, recessed light fixtures are preferred to descended light fixtures because they can better accommodate sprinkler systems, projectors, speakers, ventilation, emergency lighting, or other items which may share the classroom ceiling. If a classroom has a higher ceiling, special care needs to be taken to ensure that lighting does not wash out the projector screen or other special lighted areas.

SURFACES

All painted surfaces inside a classroom should have a durable, non-glare finish. In any general classroom, lighter colors are preferred over darker ones. This is especially true in classrooms that use projectors or distance education technologies, where a lighter blue or gray color gives better contrast. In order to reduce reflection and glare from painted surfaces, the reflectance value, vinyl covering, and laminates of a paint type should be selected to enhance the illumination of the classroom working area. Armstrong World Industries[2] recommends the following reflectance values for a classroom environment, which are based on currently available research of daylighting in classrooms:

Surface Reflectance Values	
Ceiling:	70-90%
Walls:	40-60%
Floors:	30-50%
Desktops	30-50%

The flooring of a general classroom should either be an industrial grade stain-resistant carpet or vinyl tile with a smooth finish. While the tile is easier to clean, there is an added acoustics benefit when carpet is the flooring of a classroom. There are a number of features to consider when deciding on which type of flooring is best suited for a classroom. These include the type of classes that will be offered (i.e., a laboratory class or a lecture class), how the teaching will be conducted (i.e., if students will be frequently moving around in class), if the furniture, including desks and/or tables are going to be stationary. The color of the flooring should be medium to light with subdued patterns that will easily hide stains or dirt. In an effort to prevent more common wear and tear, a vinyl wall base should be installed around the perimeter of the room.

ACOUSTICS

Holistic designing of any learning environment relies heavily on proper acoustics. A student's ability to learn in a classroom can be dramatically impacted by background noise levels and reverberation of sounds inside and outside the classroom. Background noise is considered any unwanted sound that interferes with what is intended to be heard, which includes anything from footsteps in the hallways to students whispering in the back of the classroom. Reverberation is the persistence of sound within an environment, which is the process that creates an

[1] North Dakota State University (2016)
[2] Kennedy (2015)

echo. Reverberations in a classroom are caused by sound reflecting off of walls, desks, chairs, or other surfaces. Reverberation of sound can make speech and listening in a classroom muddled or difficult to hear clearly. When designing a classroom, it is important to minimize reverberation time.

Walls within a classroom should have as low of a sound transmission class (STC) rating as possible. A STC rating determines of how effectively a wall reduces airborne and structure-borne sound. A higher rating reflects a more noise-resistant structure, with concrete walls being an example of a high-rated STC. Walls with a STC rating of 50 is ideal between classrooms and between classrooms and public spaces, such as hallways, according to Section 1207 of the International Building Code[1]. A higher STC rating is required for classroom walls directly adjacent to noisier environments, such as restrooms, mechanical rooms, or elevator shafts. Overall, the wall should aid in reducing as much sound as possible.

Classroom ceilings should be designed to help facilitate the distribution of sound throughout the room. A classroom's ceiling plays an important role by acting as a sound mirror by reflecting sound back down toward the students. However, a ceiling composed entirely of sound-absorbing acoustic tile offers no sound reflection and would effectively nullify the sound in a room. This would dramatically effect what can be heard at the opposite end of the sound source. In every classroom, a balance needs to be found between reducing reverberation and background noise and reflecting sound back toward the students. The ceiling's proportion of sound-absorbing material-to-hard-reflecting-surface-materials is directly related to the height of the room. A general guideline has been constructed by the University of North Carolina[2]:

Ceiling Height	Proportion of Acoustic Tile
8 feet (2.4 meters)	40-50%
10 feet (3.0 meters)	50-60%
12 feet (3.7 meters)	50-60%

In smaller classrooms, reverberation is less important and less noticeable than in a larger auditorium-style classroom. If a noticeable reverberation is detected in a smaller room, the addition of sound-absorbing material on the classroom walls will typically reduce the issue. In larger classrooms, it is more difficult to balance reverberation and sound reflection, so an acoustics specialist may be required.

A. G. Hill Center 110

[1] International Code Council (2015)
[2] Hoskins (2000)

STANDARD CLASSROOMS

BOTTOM LINE	
	• A *standard classroom* typically consists of a podium area for the instructor and desks or tables and chairs for 20-75 students; • Seating capacity of a room is calculated from the total area of a room minus the instructor's area and divided by the area per type of seating.

A *standard classroom* is defined as any room with at least 350 square feet (32.5 square meters) of space that seats 20-75 students. These rooms typically contain fixed or mobile student seating, a stationary instructor podium, and an immobile projector screen, which are the most common classroom spaces available at NDSU. When designing or renovating classrooms on campus the tenets of Universal Design help guide the process.

ROOM SIZE

When considering the layout of a standard classroom, it is always important to keep the student's perspective in mind. How physically comfortable will they be? What are their viewing angles from every seat? How close should the seats be? Even with projector screens in a classroom, special consideration needs to be placed on the size and shape of the physical learning space and not arbitrarily place chairs around a screen. If a classroom is too wide or too narrow, there can be wasted space that can contribute to poor visibility in some areas. In general, smaller classrooms should have flat floors in both the student seating area and the instructional area. This helps accommodate various teaching styles and activities including group discussions and team projects. Raised platforms, tiered classrooms, or sloped/ramped flooring raise accessibility concerns and creates additional safety issues, which is why they should be avoided as much as possible in most standard classrooms.

ACCESSIBILITY

Ideally, there will be at least two doorways that serve as an entrance/exit to any classroom. If two doorways are not possible, a single doorway at the front of a classroom is preferred over a doorway located at the rear, as the front entrance helps with crowd control and with filling the room to its maximum capacity more efficiently. A single doorway at the rear of the room reduces the disruption caused by students entering late for class or leaving early, but one doorway located in the front of a classroom is still preferred for optimal space usage. In rooms seating more than 50 students, ease of access and egress dictate the requirement of two doorways.

Windows in a standard classroom can distract students. They should not be placed on walls facing parking lots, walkways, or overlooking large equipment such as exhaust fans. Windows in any classroom generally serve only two purposes, aesthetic or environmental. The presence of a window in a classroom provides sensory stimulation of the outside world to students and instructors. Depending on the type of class, a windowless environment may be more appropriate. This is especially true when taking into consideration light control challenges and excess heating or cooling lost in rooms with older windows. Windowless rooms also reduce the noise pollution from outside the classroom, which is more easily transmitted through glass than a wall.

Windows installed on the south side of a building should be tinted glass with a low-emissive rating to reduce heat transfer from the exterior into the classroom. Multiple-paned windows will also help reduce heat transfer and provide noise insulation from outside. When installing windows in a classroom solely for aesthetic purposes, the actual glass surface should be minimized as much as possible and located at the sides of the room, not in the front or rear. Window panels placed high on walls can admit incidental light into a classroom and can lead to lighting control issues during class, particularly if projection screens or other multimedia equipment are used. Window treatments in a classroom should be opaque to help reduce exterior light interference on projector screens. Functional blinds, window shades, or roller blinds that cover the window surface should be installed on all classroom windows.

EQUIPMENT

Standard classrooms at NDSU are considered general purpose rooms and contain a dedicated instructional computer and laptop connection, document camera, ceiling-mounted projector, touch-panel control, Apple TV,

and an audio system. Variations in equipment include the addition of wireless microphones, interactive technologies such as Smart Boards or Smart Podiums, and camera capture equipment used for class-recording capabilities. The instructor's area should have an easily accessible instructional podium with classroom controls and a nearby stool or chair available.

All standard classrooms at NDSU should have marker boards that cover as much of the instructional area wall as possible. The instructional area can vary depending on the physical space and types of classes intended to be taught in each room. While there are several advantages to a chalkboard over a marker board, including increased visual contrast for students and decreased expenses for writing utensils, the use of chalk can be overly dusty and even agitate students with allergies and asthma. Additional regulations on marker board placement within a classroom can be found within NDSU's Facilities Management Design Guidelines[1]. In any case, a marker board should never be used as a substitute for a projector screen.

When determining the seating capacity of a room, the traditional formula is the total measured area of a room minus the instructor's area, which is then divided by the area per type of seating. For example, a classroom that is 28 feet by 28 feet (784 feet^2), with an instructor area of 28 feet by 8 feet (224 feet^2), and each student seating area takes up 4 feet by 4 feet (16 feet^2) each, then the classroom can seat 35 students[2]. This formula depends heavily on the type of seating that is chosen, whether mobile desks, fixed chairs, or tables. At NDSU, mobile student seating is preferred in classrooms seating less than 50 students. The Node Chair by Steelcase™ is an example of a mobile desk used in standard classrooms throughout campus. These types of desks provide adequate surface for students to write on or use laptops. In addition, they provide students with the mobility and storage to be useful in teaching environments. In larger standard classrooms seating 50 to 75 students, special consideration should be made as to whether or not to provide fixed or mobile seating, which will depend heavily on the types of classes that will utilize the room.

A. G. Hill Center 334

[1] North Dakota State University (2016)
[2] (784 feet^2 – 224 feet^2)/16 feet^2 per student = 35 students

AUDITORIUM CLASSROOMS

BOTTOM LINE	
	• An *auditorium classroom* typically consists of a podium area for the instructor and fixed seating for 75+ students; • Due to the large size of auditorium classrooms, special attention must be made to ensure adequate visibility and audibility.

An *auditorium classroom* is any classroom that seats more than 75 students in fixed seating. NDSU offers several auditorium classrooms across the main and downtown campuses. Auditorium classrooms are often needed to accommodate the demand for introductory courses, so the space must be equipped with technology and design features to accommodate the larger audience including more lighting and better sound features, while still maintaining the same accessibility as standard classrooms.

Any design flaw that might go unnoticed in a smaller classroom becomes readily apparent in a larger space. Three main features govern designing an auditorium classroom. All students should: (1) be able to see clearly from any seat without obstruction, (2) be able to hear clearly from any seat without distortion, and (3) be physically comfortable in their seat.

LOBBY AREA

An easily forgotten, but important, feature of auditorium classrooms is the lobby area immediately outside of the classroom. To accommodate the large number of students, adequate space needs to be provided as a waiting area that supports the flow of students entering and exiting the classroom. The area should be indoors and sufficiently large to shelter incoming students from inclement weather conditions and to prevent hallway congestion. Seating should also be provided in the lobby area to accommodate students with disabilities. While a lobby is often the most visited and recognizable portion of a building, it is important to properly balance features that are aesthetically pleasing with those that are practical, functional, and durable.

VISUAL CONCERNS

An auditorium classroom environment should be sloped or tiered to provide the best sight lines for students sitting toward the back of the room. However, Universal Design should always be considered when making any decision. Design standards complying with the Americans with Disabilities Act[1] dictate that if a sloped area extends for thirty feet, a flat landing area needs to be provided for those in wheelchairs. Smaller auditorium classrooms can manage with an entirely flat floor and well thought-out chair placements that clear the line of sight from every seat.

A fan-shaped environment is preferred when designing any auditorium space, with the rear section of the classroom being wider than the front. This provides better viewing angles for students and improves the acoustics of the room. The side walls of any auditorium should never be completely parallel to one another. Additionally, there should never be posters, banners, or other hanging objects from the ceiling of an auditorium that would obstruct viewing.

Ceiling height is a concern in larger auditorium classrooms. If the room is sloped, a low ceiling can interfere with a student's ability to see the front of the room. The appropriate ceiling height depends on a number of factors such as distance to the back of the room, number of seats per row, and the slope of the room. A rough guideline of ideal ceiling height compiled by the University of Maryland[2] can be found below:

Distance to Last Row	Rear of the Lecture Hall	Front of the Lecture Hall
50 feet (15.2 meters)	10 feet (3.0 meters)	17 feet (5.2 meters)
75 feet (22.9 meters)	10 feet (3.0 meters)	22 feet (6.7 meters)
100 feet (30.5 meters)	10 feet (3.0 meters)	28 feet (8.5 meters)

[1] United States Department of Justice (2010)
[2] Clabaugh (2004)

One of the key features of most auditorium classrooms is the projector screen. Depending on the size of the auditorium, several projector screens may be appropriate. In larger auditoriums, the projector screen should not cover the instructor's writing area, but instead should be displayed above it.

SURFACES

The flooring of an auditorium should be durable concrete or a nonskid surface, such as vinyl or rubber tile. Alternately, industrial grade, stain resistant carpet can be installed in areas of the room, preferably only in aisles, entryways, and the instructor's areas. If the instructor's area will be used for demonstrations using substances that can stain or are difficult to clean up, as often occurs with chemistry demonstrations, then the vinyl or rubber floor tile is the preferred flooring choice. Additionally, students may be prohibited from bringing food or drinks into the classroom, but some will do so anyway, a key reason that floor tiles are preferred over carpeting for the student area of the classroom.

ACOUSTICS

Acoustics are important in large auditorium classrooms. Mitigating and amplifying sound across the large area varies depending on the shape and size of the room. Therefore, the placement of acoustic materials and speakers may require acoustical consultants, who have specialized training. Ultimately, this is the most cost effective way of creating a sound-efficient room.

Due to the large size of most auditorium classrooms, voice amplification systems should be installed throughout the room. Ideally, a wireless microphone should be linked with the speaker system of the room to allow for instructor mobility during class. A stereo sound system in the room should also be able to amplify multimedia such as YouTube videos or DVDs. The stereo sound system needs to be independent from the voice amplification system used by the instructor.

EQUIPMENT

As opposed to the standard classroom equipment requirements, a podium, chair, and/or table are no longer sufficient equipment for an instructor in an auditorium classroom. The instructor's station should possess extra features to accommodate the additional lighting and sound options. Electrical and other outlets, lighting and projector controls, voice amplification systems (microphones and speakers), and other controls for equipment in the room need to be readily accessible to the instructor. The podium area should possess a command console, along with enough space to accommodate equipment or materials the instructor plans to use for class. At no point should the placement of the podium area impede the students' ability to see or hear information pertinent to the class.

For the majority of auditorium classrooms, seats should be at fixed locations and mounted to the floor. Mobile seating or tables may be appropriate in some niche auditorium classrooms. However, a large amount of mobile furniture in a classroom will increase the amount of time needed to organize the classroom structure and to move into and out of the room. The potential downsides of having mobile furniture need to be weighed against the value they would have during class.

Gate City Bank Auditorium

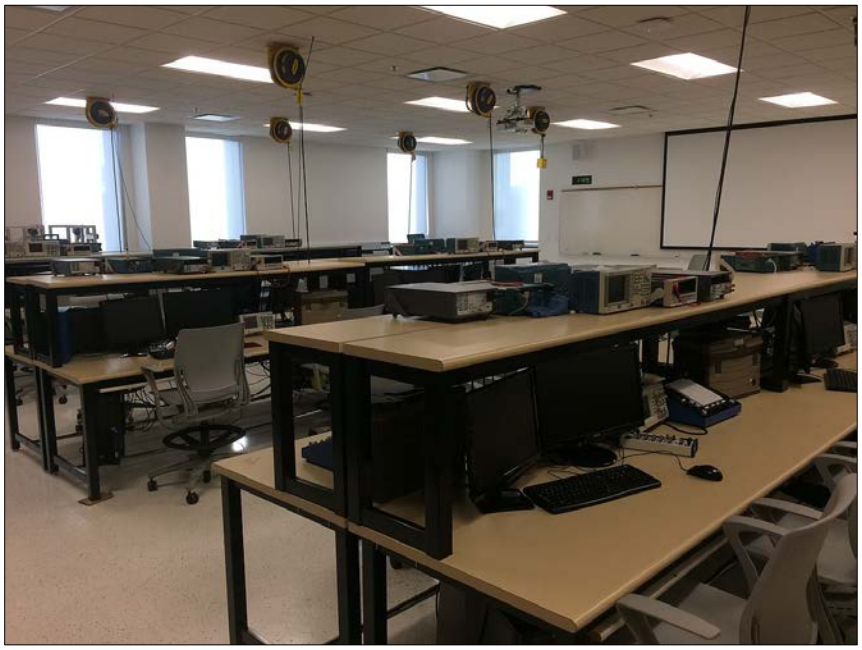
LABORATORY CLASSROOMS

BOTTOM LINE	
	• A *laboratory classroom* is one where a student can participate in unique activities specific to the class at hand; • Laboratory classrooms can vary greatly among disciplines and can consist of computer clusters, open studio areas, or science laboratory benches.

A *laboratory classroom* is one where a student can participate in unique activities specific to the class at hand. A laboratory classroom varies depending on the intended purpose of the room and can consist of computer clusters, open studio areas, or science laboratory benches. The majority of computer clusters at NDSU are open for students to use individually and are available for scheduled course selections. Studio areas on campus are typically only dedicated to students belonging to a specific discipline, such as art, music, or architecture majors. Science laboratories on campus remain inaccessible for student use outside of class time. Ideally, instructors who plan to teach in the laboratory classrooms should be involved during the design process so their teaching needs can be included.

The most highly-used laboratory classrooms at NDSU are the computer clusters. Many computer clusters are located on NDSU's main campus and downtown campus for student use. These laboratory classrooms provide students access to course materials and resources that might otherwise be inaccessible without owning a personal computer. The quick printing options at a majority of the computer clusters also allow students to quickly print course materials between classes on campus. When a computer cluster is used as a classroom, the computers often have preloaded software or peripherals pertinent to the classroom activity, which students can access for assignments or other course work. Computer software is often very expensive or requires high-end computers to run optimally, so providing access to these software programs on campus eliminates unnecessary financial stress on students.

Computer cluster-based classrooms should be equipped with comfortable chairs since students will be required to sit for long periods of time with limited movement. Computers should be oriented within the room to easily view the instructor. Exterior windows without retractable shades need be avoided within computer clusters due to the potential glare issues on computer screens.



A. G. Hill Center 228

DISTANCE CLASSROOMS

BOTTOM LINE	
	• A *distance classroom* is meant to serve at-a-distance students through video conferencing capabilities and onsite students attending in-person; • Distance classrooms need to be equipped with cameras for on- and off-campus students, ceiling-mounted microphones, and projector or LCD displays.

Distance classrooms are meant to serve both at-a-distance students through video conferencing capabilities and onsite students attending in-person. Several at-a-distance learning opportunities are available at NDSU. These opportunities require special classroom designs and layouts to promote student learning on- and off-campus. In addition to the equipment necessary in a standard classroom, the on-campus and off-campus rooms also need to be equipped with video conferencing capabilities. This equipment includes cameras for on- and off-campus students, ceiling-mounted microphones, and projector or LCD displays.

Distance classrooms typically seat anywhere from 5 to 30 students at the onsite location. These classrooms are connected electronically to one or more telecommunication networks through microphones and video cameras. The technology requires additional technical support from trained staff who remain on-call to address technological complications. When designing distance classrooms, a specialist from NDSU's Information Technology Service (ITS) will assist with strategically placing audio and video equipment throughout the room.

The size of an off-campus classroom usually requires an additional 30-40% space from a standard classroom with the same number of students. This additional space is necessary to accommodate the added equipment and camera space needed. The instructor should have full control of camera angles, sound system, recording systems, or other technology in the off-campus classroom at their console station.

Durable and comfortable mobile chairs and tables are recommended for the on-campus students, and depending on the location of monitors or microphones in the classroom, additional work space may be required. Due to the extra heat created by the equipment and technology, there may also be a need for specialized heating, ventilation, and air conditioning systems within distance rooms.

In general, distance classrooms should not have windows. Natural light from the windows can easily create balancing problems with the cameras, leading to an unfocused image for distance students. For this same reason, video projection usage is not recommended. Shadows cast into the classroom through the windows can also lead to problems when recording colors. Additionally, background or exterior noise that is easily transmitted through the windows can be picked up by sensitive classroom microphones, making learning more difficult for off-campus students.

In contrast to the standard classroom set up, lighting within a distance classroom should be increased by 50-100% to provide better illumination for video recording, especially around the instructor's area. The walls of a distance classroom should be of a non-reflective light neutral color such as blue or grey, which makes an optimal backdrop for video camera surfaces. Glare or reflection issues can arise if a marker board is used, which needs to be kept in mind when adjusting camera recording angles. The ceiling of a distance classroom may need to be higher than a standard classroom to accommodate the lighting instruments, microphones, and/or video cameras. In general, a higher ceiling will allow better camera angles for off-campus students.

Sound quality is the key to effective communication in any distance classroom. High quality auditory recording devices are preferred, with those specifically designed for distance classrooms considered ideal. Voice-activated microphones need to be placed throughout the student area, and a wireless microphone system should be available for the instructor. Additional acoustic materials may be required to improve the sound quality for off-campus students.

Monitors located at the on-site location should be used for viewing off-campus students. The height and placement of the monitors must provide equal viewing from any seat in the room, which can lead to a fairly sizable monitor being required. Another option is to provide multiple smaller monitors throughout the classroom.

CONFERENCE ROOMS

BOTTOM LINE	
	• A *conference classroom* are smaller rooms that typically seat fewer than 20 students around one large table; • Conference classrooms need to be multi-functional in order to serve students, staff, and faculty, depending on the circumstances.

Conference classrooms are smaller rooms that typically seat fewer than 20 students. These rooms are designed for small classes and meant to facilitate face-to-face discussions. Conference classrooms serve other purposes in addition to being a classroom. Faculty and staff frequently make use of these rooms for meetings or conferences. When designing a conference room, it is important to keep the wide range of target audiences in mind.

Conference rooms typically have one large table with several mobile chairs. When used as a classroom, the room should allow plenty of space for each student to work effectively without feeling cramped. The location of the projector screen, display, or marker board defines where the front of the room is located. Ideally, projectors would be mounted on the ceiling and not be placed on the table, which could distract or obstruct the view of some students. Additional guidelines for conference room designs on campus can be found online at https://www.ndsu.edu/facilities/constructionrenovationandproject/[2].

[1] North Dakota State University (2016)
[2] North Dakota State University (2016)

SCALE-UP CLASSROOMS

BOTTOM LINE	
	• A *SCALE-UP classroom* is a large room equipped with multiple projectors, television screens, and laptop connections, in addition to round tables and mobile seating. • SCALE-UP classrooms are designed to facilitate active learning within a large classroom setting.

Student-Centered Active Learning Environment with Upside-Down Pedagogies (SCALE-UP) classrooms were first implemented by North Carolina State University[1]. These are larger rooms that can accommodate upward of 100 students in a studio-like setting. SCALE-UP rooms are designed to facilitate active learning within a classroom. Equipment and technology are used to establish a highly collaborative, hands-on, interactive learning environment. These spaces make extensive use of technology, with multiple projectors, television screens, and laptop connections located throughout the room. The majority of SCALE-UP rooms at NDSU are located within the A. Glenn Hill Center on the main campus.

SCALE-UP classrooms should consist of several round tables that fit between five to ten students comfortably. Chairs should be durable and mobile to complement an active learning environment. The round tables better facilitate small group discussions and student interactions than seating facing one direction. At each table, there should be electrical outlets and computer connection capabilities for laptops. These connectors are linked to a display screen near the tables that can project what a student has on her or his laptop screen. An alternative method would be to provide smaller marker boards for use at each table. The rooms should also be equipped with a dedicated computer station for the instructor, complete with a touchscreen control panel that provides the instructor with direct control over lighting in the room, as well as over projector and television screens located throughout the room.

A. G. Hill Center 300

[1] Beichner et al. (2000)

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Other Sources:

- **Learning Spaces Information for Requesting Renovation or Repair**
  https://www.ndsu.edu/provost/academics/learning_spaces/

- **NDSU Facilities Management Design Guidelines**
  https://www.ndsu.edu/facilities/constructionrenovationandproject/