Field Verification and Drafting

Standards for the CWRU Architectural Services Department

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Purpose:

These standards will outline the method used by the Architectural Services Department for creating base floor plans for CWRU buildings in AutoCAD. Creation of these base floor plans allows Case Western Reserve University (CWRU) to maintain accurate, up-to-date, digital floor plans for the buildings on campus. In an effort to obtain accurate AutoCAD drawings for all the buildings on campus, the Architectural Services Department implements a careful process of field verification and drafting to create floor plans that allow for space analysis and future planning.

Checking for Existing AutoCAD Drawings:

In some cases, CWRU already has AutoCAD floor plans for a building from recent renovation projects. Thus, the first step in developing a building footprint is to search the Archive Database for any relevant AutoCAD drawings.

- Begin by opening the database and searching for the building of interest. From experience, projects from 2003 to current are more likely to have AutoCAD drawings. As time progresses, more projects are generated in AutoCAD. Therefore, it is more likely to find a project in AutoCAD from 2008 than from 2004.

- If AutoCAD floor plans do not exist within the database then skip this step. If such floor plans do exist, check the accuracy of the drawings before moving forward. Take several field measurements (see Field Verification section for process) of significant building features such as overall hallway lengths, large room dimensions, or wall locations. Compare these measurements to the corresponding dimensions in the AutoCAD drawing.

  - If the measurements and the digital file agree to within half of an inch, accept the drawing as accurate. Convert the drawing to CWRU standards (see the “Standard AutoCAD Documentation” guide for details) and proceed to the next drawing.

  - If the measurements disagree with the AutoCAD drawing by more than half of an inch, assume that the drawing is not accurate and proceed with the field verification process.
Gathering Information for New Drawings:

When existing AutoCAD drawings are not available, it is necessary to create new floor plans based on existing conditions. Because various renovations and projects occur throughout the lifetime of the building, it is likely that no singular set of drawings will contain all of the information needed to accurately draft the plans. Thus, it is necessary to collect information from multiple existing drawings, as well as taking field measurements.

- While in the Archive Database, search for the most recent project that shows an entire floor plan for the area of interest. Print copies of these floor plans on 11x17 (tabloid) sized paper, breaking the plans up onto multiple sheets as necessary to allow room for writing and note-taking. Be sure to overlap the floor plans between sheets so as to allow all notes for one room to be included on one page. These prints will serve as the sheets on which field verifications will be recorded.

- Search the database for original construction documents for the building of interest. Though in many cases these drawings are old and out-dated, they contain valuable information for creating new floor plans.
  
  - Though much in a building may change through renovations, the exterior walls and columns are highly unlikely to be changed or moved without major building reconstruction. Thus, the column grid and exterior walls from the original construction documents should be equivalent to existing conditions.

  - Using dimensions from the original construction drawings, draft in AutoCAD a building footprint containing the exterior walls as well as the column grid.

- With a footprint created and note sheets in hand, proceed to the building for field verification.
Field Verification:

Measurements taken in the field are significantly more accurate than those taken from blueprints with an architect’s scale. Additionally, it has been found that the dimensions on blueprints may vary from those actually built. As such, accurate AutoCAD drawings can only be generated from field verification. This process involves measuring the location and size of every wall, window, door, and stair set contained within the building.

- All field measurements should be rounded to the nearest ¼” when recorded in order to maintain a high level of accuracy while allowing for some small error.

- Beginning with a known base point (such as a column, exterior door, stairwell, etc.), measure all wall, window, and door lengths and placements. Avoid continuous measuring whenever possible, favoring baseline measuring instead.

  - Continuous measurement (i.e. measuring the distance from one wall to a window, the length of the window, and the distance from the window to another wall) results in a summation of error. If each measurement is incorrect by ¼”, the distance from one wall to the other could be incorrect by as much as ¾”.

  - Baseline measurement (i.e. measuring the distance from a wall to a window, the size of the window, and from the initial wall to another wall) reduces error. If each measurement is incorrect by ¼”, the error in the distance from one wall to the other would only be ¼”.

- All walls should be measured from one corner to another except when dealing with overall room or hall dimensions, in which case a representative measurement is acceptable.

- When possible, include a wall thickness measurement, as this will help dictate the structural distance between rooms. This measurement is obtained easiest at doors or other entrances to each room.

  - In more contemporary buildings that use studs and drywall for walls, the interior walls are generally 5” thick. However, depending on the building materials, wall thickness can range from 2” to 24”. Check original construction documents for external wall thickness.
All doors should be measured to include both jamb and door swing.

- The door measurement should be recorded in fractional form, such that the door jamb is included in the numerator and the swing in the denominator. For example, a door measuring 40/36 would have a 36” swing with 2” jamb on either side.

- The direction of the door swing should be clearly indicated on the drawing notes.

All windows should be measured to include both jamb and pane, as per the specifications for door measurements.

In the event that multiple doors and/or windows have shared jambs, list the dimensions of each door, window, and jamb individually.

Each staircase must be measured to show placement, number of stairs, dimensions of stairs, and dimensions of runners.

- The distance from the top and/or bottom stair to a known wall should be measured.

- The width of the stairs as well as their runners should be measured similarly to the process of door/window measurements, such that the total width is listed over the stair width.

- The number of stairs, tread, and width should all be listed together. For example, a stair set with ten stairs, one foot tread, four foot width, and two inch runners on either side should be listed as “10 @ 12” T, 52/48.”

- The upward or downward direction of each staircase should be noted.

- The staircase landings between floors are not required for drafting.

All room numbers should be recorded. When unavailable, assign a description to each room that will identify it and separate it from other rooms of similar purpose.
Figure 1. Standard Drawing with Field Measurements Indicated in Red
Drafting Floor Plans:

Once the field measurements have been obtained, the floor plans can be drafted within the building footprint that was developed from the original construction documents. This process shall be carried out according to the standards defined in the “Standard AutoCAD Documentation” guide. Other standards and guidelines also apply for floor plans created from field verifications.

- When drafting from field measurements, everything should be drawn with an error of 1” being considered acceptable.
  - When field measurements cause walls, windows, etc. to be out of line by less than 1”, adjust the objects as necessary to maintain continuity.

- When creating floor plans for an entire building, begin with a floor that has verifiable base points or a floor plan that can be easily reproduced.
  - Rooms with rounded corners as well as windy corridors can prove very difficult to place. As such, floors containing these features should be avoided, when possible, until other, simpler floor plans are drafted first.
  - Each subsequent floor should be drawn using base points from the floor that was drawn first. Stairwells, elevator shafts, or other constant structures should be used to place the later floors.
  - As later floors are added, any structure that remains constant (stairwells, elevator shafts, etc.) throughout the building should be checked on all floors and adjusted as necessary.

- Dynamic blocks should be used for all door swings with correct directions shown and with the jambs shown as rectangles to either side.
  - Rectangles on the 0 (zero) layer should be used to connect walls that are otherwise broken by doors.

- All window jambs and stair runners should be shown in the AutoCAD drawings.
• All room numbers (or descriptions) should be included in the AutoCAD drawings on the U-SPAC-RMNO or U-SPAC-IDEN layer, as appropriate.

• When room numbers are unavailable, fill the typical label with XXX instead of a number.

• If there is a construction project going on during the time of field verification and drafting, no measurements of the area should be taken. The drafter is to wait until the project is completed and As-Built drawings are submitted, for more on this see Architectural Services Department section of the Project Close Out Procedure green sheets.

**Spatial Analysis:**

One major purpose of these floor plans is to provide accurate spatial analysis of each of the buildings and departments on campus. Once the drawings are completed, AutoCAD makes a square footage analysis relatively simple.

• Using the U-SPAC-NET layer and “Boundary Creation” tool (“bpoly”), boundary polylines should be created for each room.

• The area of each boundary should be displayed in a field that will be shown within the space of that room. All areas should be rounded to the nearest whole number and displayed in square feet without a unit label.

  • Area fields can be created quickly by loading the “laf” AutoLISP application (“Tools” > “AutoLISP” > “Load Application”). The “t2” AutoLISP should also be loaded at this time.

  • Once loaded, the command “laf” will allow the user to create an area field that will automatically center itself within the room simply by clicking on the boundary polyline.

  • For some non-rectangular rooms, the center (and thus the field) will not be within the confines of the room’s walls. When this is the case, move the field to a suitable location within the room.

  • In the event that a room contains an isolated column or any other “island,” the area of the island must be manually subtracted from the area of the boundary polyline.
• Ensure that the field has the correct properties (U-SPAC-SQFT layer, 9” text height, etc.).

• A square footage table that displays all room numbers or descriptions and their associated square footages should be created. Each room number and square footage in the table should be a field that obtains its information from the text or field already displayed in the drawing.

• To quickly create fields within the table, the AutoLISP application “t2” should be used. Simply type “t2” and select the text, mtext, or field that needs to be represented in the table. Then, click in the cell in the table in which the object belongs.

• A boundary polyline should also be created for the exterior building footprint on the U-SPAC-GROSS layer. This can be done by creating a box around the exterior of the building and using the “bpoly” command, clicking between the box and the footprint. This method will create additional boundary polylines within the building, and these must be deleted accordingly.

• A boundary polyline should also be created for any areas that are open to below. “Open to below” is defined as any area within the space of the building footprint that does not have a floor on a particular level of the building.

• The area of the exterior footprint boundary should be represented by a field in the table. This field should be in a cell next to another cell labeled “GROSS SQ.FT.” The table should also include cells labeled “NET SQ.FT.” and “STRUCTURAL,” though values for these will not be included in AutoCAD. In some instances, an “OPEN TO BELOW” cell will be necessary. Such a cell should only be included as needed, along with a field representing the sum of all areas that are open to below.

• Once the table is completed, it should be exported as a comma delineated file (.csv). To do this, simply select the table, right click, and choose export. Then, this file should be opened in Microsoft Excel and saved as an Excel Workbook.

• Format the table in Excel such that all column data and titles are visible and aligned. Also, sort the data by room number (from smallest to largest, then alphabetically).
✓ Using Excel, determine and include the “NET SQ.FT.” value by summing the values from all of the rooms on the floor.

✓ Using Excel, determine and include the “STRUCTURAL” value by subtracting the net square footage from the gross. In the event that there is space defined as “OPEN TO BELOW,” subtract this area as well as the net square footage from the gross in order to determine the structural area.