AUTODESK UNIVERSITY 2013

Advanced Techniques for Managing Building Data in Autodesk® Revit®

Mario Guttman – CASE

AB1796 The collection and management of building data, including the requirements for rooms, equipment, and other needs, as it evolves from early design through construction documentation and as a basis for facility management, can be enhanced through advanced techniques in Autodesk Revit software. This includes linking to an external data source, automating the creation of areas and rooms, creating room data sheets, and other graphic and non-graphic processes that complement BIM. This class covers basic database theory, the structure of objects and their relation to data management, and Revit techniques for implementing this general theory in actual projects. We will also discuss third-party software and customizations, and how they are used to further advance these processes. The class goes beyond learning Revit commands and looks at the underlying information requirements of emerging integration in project delivery.

Learning Objectives

At the end of this class, you will be able to:

- Understand how building data is represented in objects and databases.
- Evaluate computer system architectures and software options.
- Use Revit to study conceptual design and building massing.
- Create room data sheets in Revit and in an external database.

About the Speaker

Mario Guttman, AIA, LEED AP, is a Senior Design Technology Specialist with CASE, a consultancy that provides technology-driven process innovation to the AECO industry. In this role he is engaged in research and development of work processes and software, and their application to design practice.

Mario holds degrees in mathematics and architecture, and is a licensed architect who has practiced for over 30 years. He has also worked in software development, computer-aided facility management, and construction. He is an active participant in industry standards organizations, and a frequent speaker in support of Building Information Modeling and Integrated Project Delivery.

His recent work has focused on strategies for engaging users, overcoming their objections, and providing solutions to the difficulties they encounter. He is an avid computer programmer, using rapid prototyping strategies to promote best practice and advanced design capability, and to provide direct value to projects.

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Contents

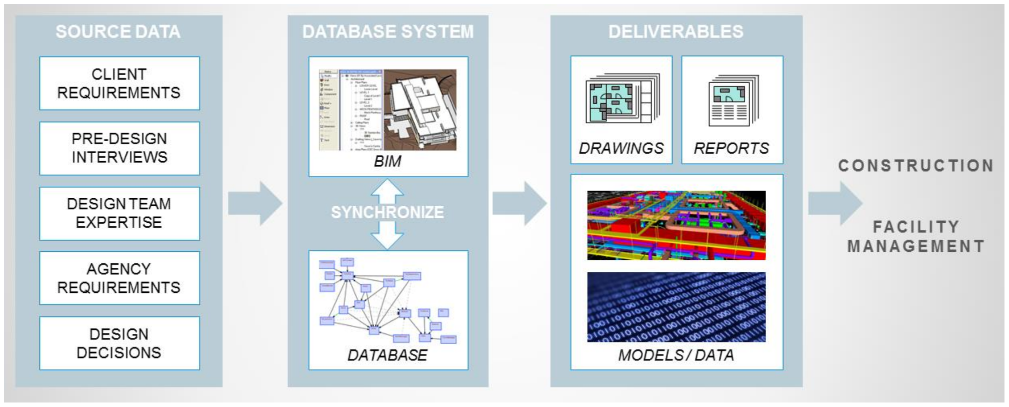
I. Introduction to Building Data

This class is about managing *Building Data*. This is the information about rooms, equipment, and so on that describes what goes into a building project. (It is differentiated from *Project Data*, information about the team, budget, schedule, etc., which we will not be talking about.)

A. The Problem

The design professions are experiencing a huge influx of data, and we are being asked to process it, share it and deliver it to others. It comes to us from a variety of sources: the architectural space program; user-group interviews; our own experience; and many others. We work with it in BIM and as data to produce drawings and other kinds of reports. Increasingly, we are also being asked to deliver the data itself, in both its BIM and database formats.

Between the source data and the deliverables, we work within a *Database System*, which includes both a BIM model grouping as well as a database of some kind. The need for a database, and the balance between it and the BIM component, are somewhat debatable: there are advocates for putting all of the data in the BIM model, while others try to put as much data as possible in the database. For the purposes of this discussion we will assume some kind of balance but stipulate that there must be a significant database component. How we manage the division of data between the two containers, and how we keep them synchronized and consistent, is the major focus of this class.



This discussion assumes that we will use both BIM and a separate database to manage data.

B. Information Flow

When we receive the owner’s space requirements, for example, they are often in paper or .PDF-file documents that are formatted for readability. In order to work with this data we need to transform it into a structured database, and then use it to develop rooms in the Revit model. Ultimately we want to be able to create reports that compare the spaces provided in the building with the original requirements. There are many information flows like this, for furniture and equipment, engineering requirements, and so on, all of which require special reports and other kinds of data deliverables.

Typically, project teams purchase software for this purpose. Unfortunately, using it is often problematic and the response is to provide additional training in the use of the software. While important, this overlooks a more fundamental issue: that the team does not understand its data. As a result, users need to memorize complex command sequences, and are unable to address unique requirements.

The core assertion of this class is that we are better served by first examining our data in terms of basic data principles. This understanding provides a conceptual framework that can be used to easily implement the software and improvise customized processes that it doesn’t provide “out-of-the-box”.

First, we want to understand our data, and define objectives for using it. Then, we can implement software to achieve those objectives

II. General Principles of Objects and Databases

This section describes some core principles of objects and databases, and how they are linked to one another.

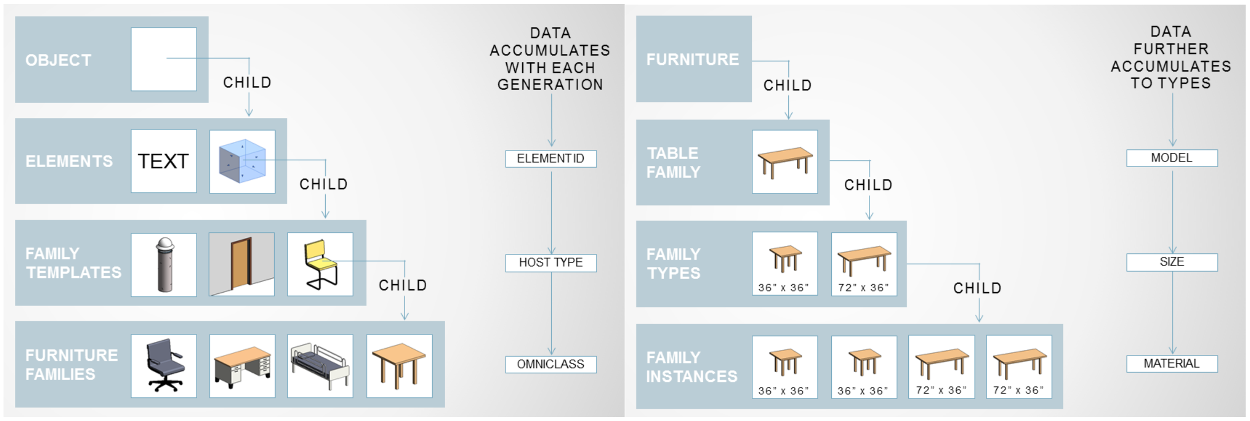
A. Objects and How Revit Uses Them

A *Model*, as used in the context of *Building Information Model*, is really an *Object Model*. It utilizes some theory, developed in computer science around the 1950's, for *Object-oriented Programming*. This includes important and very powerful concepts that, while fairly technical, really just codify ideas that have been understood intuitively within the design professions for a long time. To begin, we already understand what an *Object* is – a door, or a chair, for example; the theory simply formalizes this by being precise about *Methods* (what an object does) and *Properties* (the data attached to it.)

1. Object Inheritance

Of particular concern to the topic of data in Revit is the concept of *Object Inheritance*. Computer programmers don't just create objects in an ad hoc manner; they typically start with a base object and then derive other objects from it. This is analogous to saying that there is some "grandfather" object, and that the other objects are its children, grandchildren, and so on. This is important because each subsequent generation inherits all of the properties of its parent, and then adds properties of its own.

In Revit, we usually call objects *Families*, and their properties *Parameters*, but that is mostly semantics. The significance of inheritance is that it explains how a parameter behaves in terms of its position in the inheritance tree. Some properties, such as the *Element ID*, are very basic and every Revit entity has one. Others, such as their hosting type and OmniClass value, are picked up as more specific objects are derived. Eventually we get to the family *Types* and finally to the family *Instances*, where we track the most detailed information such as model-type, size, and material.



As objects are derived each generation accumulates all of the properties of its ancestors.

2. Issues with Revit

There are some aspects of Revit that make this a little confusing. *Shared* parameters and the distinction of *Project* from *Family* parameters, while important, are not significant to the current discussion. What is worth noting is that the term "Family", as used in the Revit term "Family Parameter", is something of a misnomer in terms of objects. While we can simply and clearly talk about "Type" and "Instance" parameters, using the same logic at the family level to refer to "family" parameters would be confusing, so we tend to use a term like "built-in" or "system" parameters.

The user-interface is also somewhat misleading in that it allows the editing of type values from the modeling environment, in which really only the instances values can be changed, and the editing of instance values in the family editor, where they are really default values, since editing an instance at the type level doesn't make sense.

3. Parameter Inheritance Levels

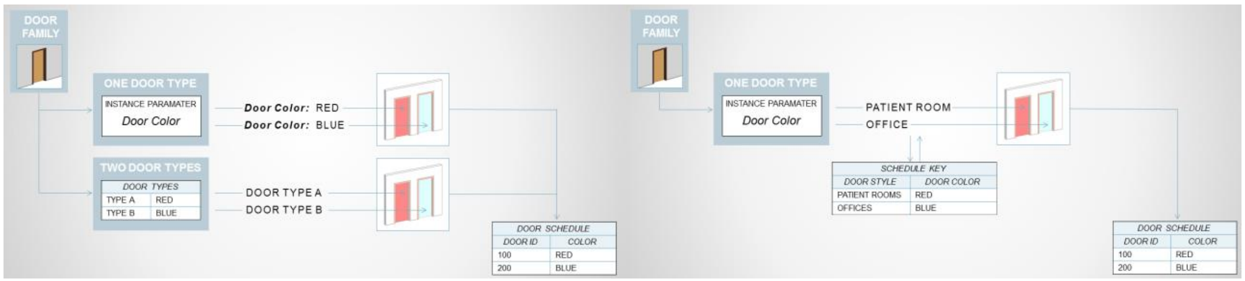
In project work, three levels of object inheritance are the most important:

Built-in: A limited number of very basic values that cannot be configured (even through the Revit API) and are edited only within the Family Editor in a section named "Family Parameters". (This adds to the naming confusion; "family" is the right term from a computer programming perspective, but conflicts with the use of the term in other parts of Revit.) From a data perspective, the *OmniClass Number* is significant, since its application at this level means that it is the same for all types. This suggests against using very general-purpose families that might represent different kinds of building components.

Type: Parameters that apply to a *Class* of objects, such as a particular model of a manufactured item. Defining logical types is an important aspect of structured thinking about data.

Instance: Parameters that apply to single placements of objects. These are used where it would be impractical to define the many types that would be necessary otherwise, such as a specific finish material.

The proper balance between defining more types or having more instance variation is very important, and sometimes difficult to resolve. Nevertheless, it is important to understand that the data expressed is essentially equivalent, and either approach can be used to achieve any given result, such as a schedule. Further, *Schedule Keys* can be used to make instance parameters behave more like type parameters.



Type or instance parameters, or instance parameters with schedule keys, store equivalent data.

B. Basics of Relational Databases

There are other kinds of databases but we will be talking about the most common ones called *Relational Databases*. They are beautifully simple and surprisingly powerful. For some reason the BIM user community has neglected learning about them, which is a huge shortcoming.

1. Tables and Relationships

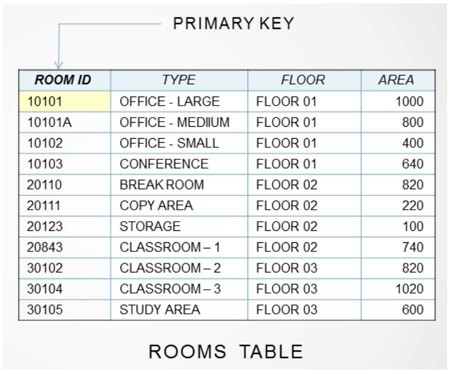
A database consists of *Tables* and *Relationships* between them. This simple construction can be used to represent a wide range of data, in a way that is very easy and efficient, but imposes restrictions on how data can be stored.

Each table is composed of *Rows* and *Columns* (which are sometimes called *records* and *fields*.) For example: The Room table contains a record for each room, with fields for Type, Area, and so on.

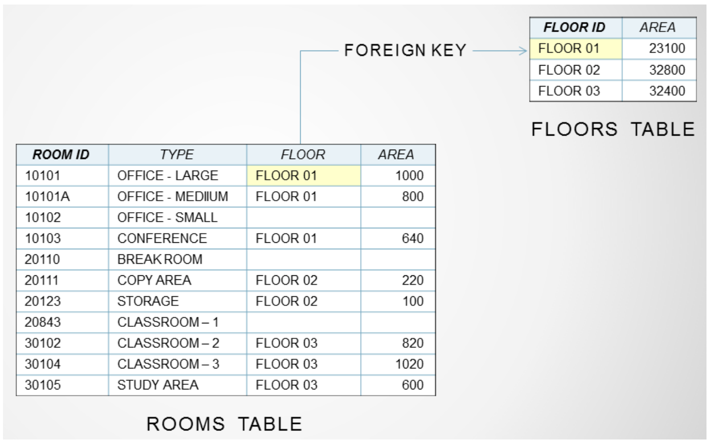
2. Primary and Foreign Keys

Every table has a *Primary Key* field, which is often called the *identifier*, and often has a name that includes "ID". Its value must be unique, and must not be missing, so that it can be used to uniquely identify each row. For example: The **RoomID** field could be the key field of the **Rooms** table. (Tables can also have multi-part keys.)

Relationships between tables are established by a *Foreign Key*, i.e. a field in one table that is the key value in another table. Usually the foreign key field is allowed to be null, i.e. blank, which means that there is no association for that record.



ROOM ID	TYPE	FLOOR	AREA
10101	OFFICE - LARGE	FLOOR 01	1000
10101A	OFFICE - MEDIUM	FLOOR 01	800
10102	OFFICE - SMALL	FLOOR 01	400
10103	CONFERENCE	FLOOR 01	640
20110	BREAK ROOM	FLOOR 02	820
20111	COPY AREA	FLOOR 02	220
20123	STORAGE	FLOOR 02	100
20843	CLASSROOM – 1	FLOOR 02	740
30102	CLASSROOM – 2	FLOOR 03	820
30104	CLASSROOM – 3	FLOOR 03	1020
30105	STUDY AREA	FLOOR 03	600



FLOOR ID	AREA
FLOOR 01	23100
FLOOR 02	32800
FLOOR 03	32400

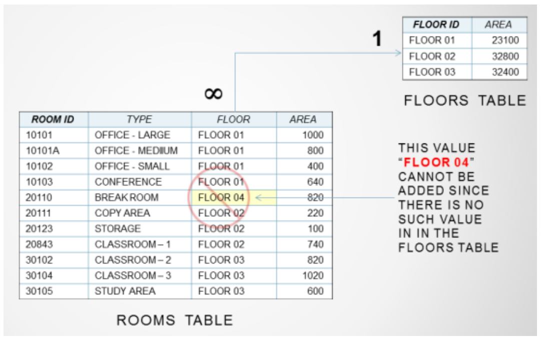
ROOM ID	TYPE	FLOOR	AREA
10101	OFFICE - LARGE	FLOOR 01	1000
10101A	OFFICE - MEDIUM	FLOOR 01	800
10102	OFFICE - SMALL		
10103	CONFERENCE	FLOOR 01	640
20110	BREAK ROOM		
20111	COPY AREA	FLOOR 02	220
20123	STORAGE	FLOOR 02	100
20843	CLASSROOM – 1		
30102	CLASSROOM – 2	FLOOR 03	820
30104	CLASSROOM – 3	FLOOR 03	1020
30105	STUDY AREA	FLOOR 03	600

Every table must have a Primary Key. *Relationships are defined by* Foreign Keys.

Generally these relationships are *One-To-Many*, which means that the “one” side must be unique but the “many” side may have many rows with the same value. For example: one **FloorID** value in the **Floors** table can be assigned to many room values in the **Rooms** table, but not vice-versa.

3. Referential Integrity, Normalization and Flattening Data

A database enforces *Referential Integrity* rules that ensure that you can’t corrupt the foreign keys. For example: a value cannot be added to the **FloorID** field of the **Rooms** table if a corresponding key value doesn’t already exist in the **Floors** table.



FLOOR ID	AREA
FLOOR 01	23100
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ROOM ID	TYPE	FLOOR	AREA
10101	OFFICE - LARGE	FLOOR 01	1000
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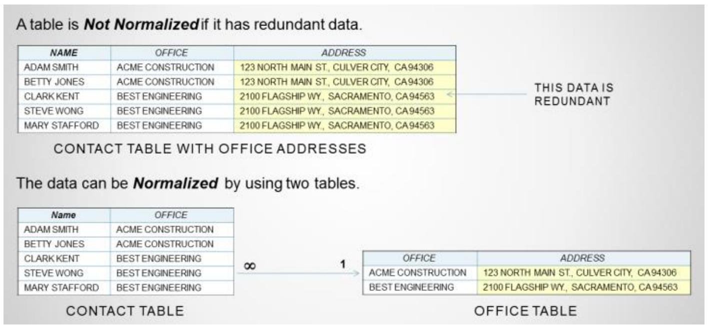
10103	CONFERENCE	FLOOR 01	640
20110	BREAK ROOM	FLOOR 04	820
20111	COPY AREA	FLOOR 02	220
20123	STORAGE	FLOOR 02	100
20843	CLASSROOM – 1	FLOOR 02	740
30102	CLASSROOM – 2	FLOOR 03	820
30104	CLASSROOM – 3	FLOOR 03	1020
30105	STUDY AREA	FLOOR 03	600

One-to-many relationships between tables are defined by foreign keys that enforce referential integrity

The database tables and their fields, and the relationships between them, should be well thought out so that information is stored once, and only once. This is done through a process called *Normalization* in which tables with redundant data are separated into related tables with unique values.

Generally it is better when data is normalized because it is easier to maintain and easier to understand. Unfortunately, there are many situations, particularly when working with Revit, where it is necessary to de-normalize the data, which is often called *Flattening* it. This is the opposite of normalizing: separate related tables are combined into a single table with some redundant data.


A table is ***Not Normalized*** if it has redundant data.

NAME	OFFICE	ADDRESS
ADAM SMITH	ACME CONSTRUCTION	123 NORTH MAIN ST., CULVER CITY, CA94306
BETTY JONES	ACME CONSTRUCTION	123 NORTH MAIN ST., CULVER CITY, CA94306
CLARK KENT	BEST ENGINEERING	2100 FLAGSHIP WY., SACRAMENTO, CA94563
STEVE WONG	BEST ENGINEERING	2100 FLAGSHIP WY., SACRAMENTO, CA94563
MARY STAFFORD	BEST ENGINEERING	2100 FLAGSHIP WY., SACRAMENTO, CA94563

The data can be ***Normalized*** by using two tables.

Name	OFFICE
ADAM SMITH	ACME CONSTRUCTION
BETTY JONES	ACME CONSTRUCTION
CLARK KENT	BEST ENGINEERING
STEVE WONG	BEST ENGINEERING
MARY STAFFORD	BEST ENGINEERING

OFFICE	ADDRESS
ACME CONSTRUCTION	123 NORTH MAIN ST., CULVER CITY, CA94306
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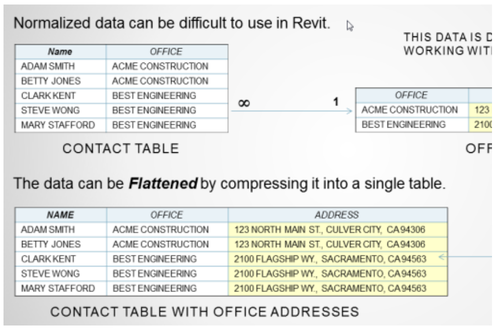

Normalized data can be difficult to use in Revit.

Name	OFFICE
ADAM SMITH	ACME CONSTRUCTION
BETTY JONES	ACME CONSTRUCTION
CLARK KENT	BEST ENGINEERING
STEVE WONG	BEST ENGINEERING
MARY STAFFORD	BEST ENGINEERING

OFFICE	
ACME CONSTRUCTION	123
BEST ENGINEERING	210

The data can be ***Flattened*** by compressing it into a single table.

NAME	OFFICE	ADDRESS
ADAM SMITH	ACME CONSTRUCTION	123 NORTH MAIN ST., CULVER CITY, CA94306
BETTY JONES	ACME CONSTRUCTION	123 NORTH MAIN ST., CULVER CITY, CA94306
CLARK KENT	BEST ENGINEERING	2100 FLAGSHIP WY., SACRAMENTO, CA94563
STEVE WONG	BEST ENGINEERING	2100 FLAGSHIP WY., SACRAMENTO, CA94563
MARY STAFFORD	BEST ENGINEERING	2100 FLAGSHIP WY., SACRAMENTO, CA94563

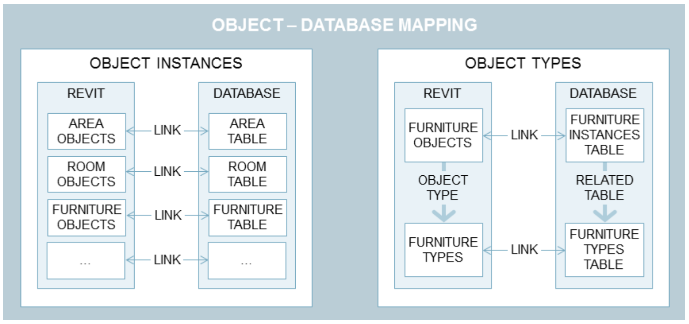
Normalized data is preferable but flattening data is often necessary with Revit.

C. Revit Objects and Relational Data

Using these fundamental principles of objects and databases we can define what it means to *Link* them.

1. Linking Families to Tables

The link can be somewhat mysterious since there is no actual, tangible "link" item. Rather, the link is defined by a convention: the values of specific family parameters are identified as corresponding to data items in the database. In other words, if we took the link away it would have no effect on either the Revit model or the database; the link only exists insofar as some software recognizes the patterns in the data as constituting a link.



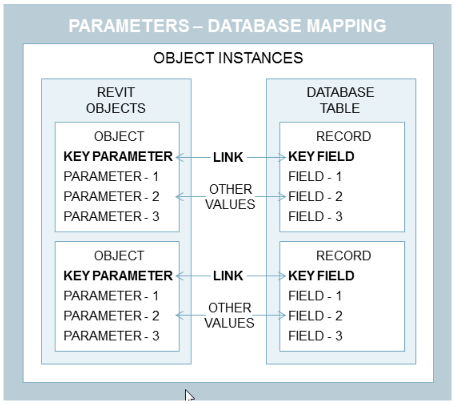
Object classes are associated with database tables. This can lead to ambiguities when working with types.

Generally, a class of family instances in Revit, such as a specific Revit *Category* like **Furniture,** corresponds to a table in the database. Likewise, the types of that family class may have a corresponding table in the database, often with a name like **FurnitureTypes**.

This is the first of many strategies that raise logical issues about redundant data. We are not going to solve these but it is important to acknowledge them and set expectations for how they will be managed. Ideally, well designed software will handle these issues but that is not always an adequate solution.

2. Linking Parameters to Fields

The parameters of the Revit families correspond to the fields of the database. One of these pairings must be between a *Key Parameter*, which can be any parameter designated for this purpose, and the *Key Field* of the table. This is the logical relationship that defines the link. Usually the parameters are something like "Room Number" or "Mark" and map to fields with the same name, but any choices are possible.



Object parameters are associated with database fields, one of which is a key that establishes the link.

What is essential is that both the parameter and the field are not missing and have unique values. Revit can be a little sloppy about this; it will warn you about duplicate room numbers but it will allow them and they can be blank. Either of those events will destroy the validity of the link, at which point the data relationship is useless.

Additional parameters, *Dependent Parameters,* can be paired with other fields in the database on a one-to-one basis. There is no limit on the number of these and their values can be null.

3. Synchronization

Of course the logical pitfalls exposed with the tables manifest at the parameter level as well. Many times this means that there is data duplicated between the model and the database. Some process of *Synchronization* is essential to resolve this. These discrepancies are not necessarily errors; they represent the decisions and changes that are a part of the work process. Doing them in this structured fashion is how we are able to replace a lot of manual, error-prone, drudgery with elegant, accurate, automation.

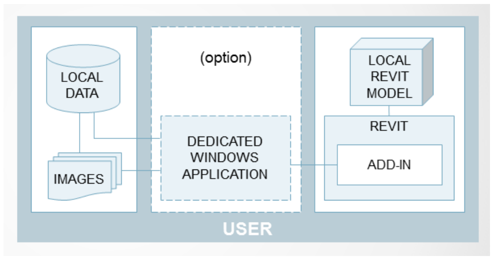
Key schedules in Revit pose a particular challenge. They are, in effect, a kind of related table construction in Revit, which doesn't support that level of database functionality in a true database sense. They can be very useful but coordinating their data with a true related table on the database side is complex.

III. System Architecture and Software Options

Using this theoretical framework of *Objects Linked to Data-Tables*, we can look at software strategies for doing the work. These can be categorized in terms of their *System Architecture*, which is a computer term for how the parts of a computer system fit together (not to be confused with “building architecture”, which is what we do in the AEC industry.)

A. System Architecture

These can be categorized by whether they are single or multiple-user, and the kind of multi-user technology they use.



A single-user architecture is simple to implement and can be very effective.

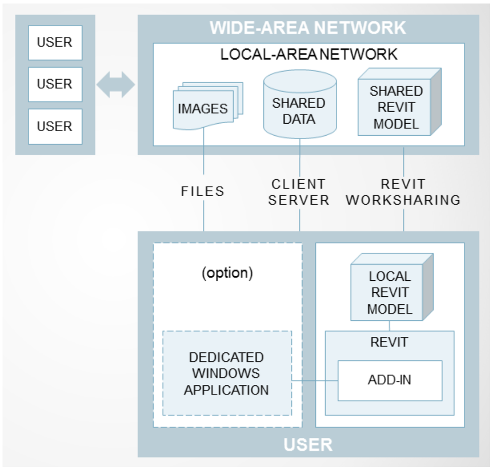
1. Single-User:

The simplest approach is to have the data, including a database and other files such as images, on the same local computer where Revit is running. The Revit session includes an *Add-In*, which is a custom program running inside Revit. The add-in may connect directly to the data sources, or there may be an additional Windows application that functions as an intermediary.

While this system architecture does not support multiple users accessing the data, it is actually widely used to get work done in large organizations. It is a common misconception to think that collaboration requires simultaneous access to the raw data; in fact, it is often more effective to have a single user who maintains the data and produces reports that are shared with a larger group.

2. Multi-User – LAN / WAN:

Within an organization’s *Firewall*, which is the network environment controlled by that company, the data may be made accessible on the *Local-Area Network* (LAN) of a single office or a *Wide-Area Network* (WAN) that includes multiple offices.



Traditionally LAN / WAN networks have been used for collaboration within a company firewall.

Revit is able to use a shared *Central Model* and with building data it is used in the conventional way. However, it is worth noting that it is really the local copy of the model that is being synchronized with the data, so the various users are actually accessing local copies of the BIM portion of the database system.

Unlike the Revit model, the database and other files can be truly shared on a network server. The database may be actually a single-user type, which means that it can only be accessed by one user at a time, but this is really just a variation on the single-user system architecture.

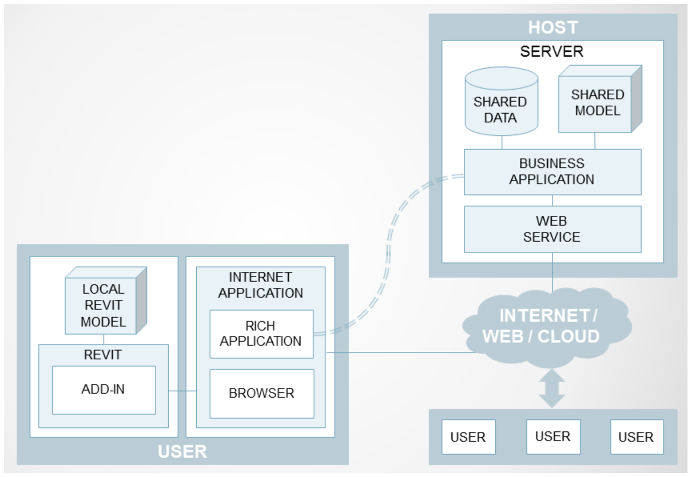
A truly *Multi-User Database*, which is designed to manage multiple, concurrent, user access, typically uses a technology called *Client-Server*. This is a very mature technology that is quite robust and relatively fast but requires significant IT support.

3. Multi-User – Internet:

The most truly shared, and most forward-looking technology is what is commonly called *The Internet*, *The Web*, or *The Cloud*. The meaning of these terms is evolving rapidly and there is debate about their proper usage. From a technical standpoint there is some overlap with the LAN / WAN solutions but in the marketplace the Internet products tend to be hosted externally and support collaboration outside of an organization's network and firewall.

Solutions of this kind typically include a remote *Host*, which is a computer complex that may be anywhere in the world. This host runs several software applications: a *Web Service*, which communicates with users; a *Business Application*, which is the program that does the work we are interested in; and, a local version of the database and other files that are utilized by the host application.

Historically, users communicated with this web host through a *Web Browser*, such as *Microsoft Internet Explorer* or *Google Chrome*, and this can be a good solution for working with building data. However, solutions are increasingly using a *Rich Internet Application,* which is similar except that the hosted application and the local Internet application are tightly integrated. This means that the program has the power of a local, Windows application, at the same time as it can do much of its work on the remote host.



Contemporary architectures are based on using the Internet to support a high level of collaboration between separate parties.

This approach supports very wide collaboration since users typically only need a browser to access the project. Consultant engineers, the contractor and sub-contractors, the client and the community can all participate easily. Moreover, it is easier to maintain the software since it is all delivered from a single location.

However, this system architecture difficult to setup and maintain, and is more restricted in the kinds of data processing activities that the primary users can do.

All of the solutions have inherent integrity weaknesses. The multi-user options, and especially the Internet-based approach, compound these. There are no simple solutions for this problem; it is a requirement of any solution that, using good software design and proper user behavior, the various data repositories are kept synchronized.

B. Software Solutions

The purpose of this section is to contrast software options in terms of their system architecture. It is fairly difficult to get this information and to diagram it accurately. The vendors are more focused on the features of their products and the workflows that they support, apparently believing that users don't need or want to know that much about what is going on in the background. While this assumption may be valid for the majority of end-users, this discussion is aimed at the more advanced users, technical support staff, and policy makers who need to care about the system architecture.

These applications are designed for very different purposes and have many complex features. In this discussion we are not evaluating those aspects, and potential users are encouraged to contact the developers to learn more about the products and services that are offered.

A selection of the many software solutions are described in the remainder of this section, ordered roughly from the simplest to the most collaborative.

1. Ideate – BIMLink

Fundamentally, *BIMLink* from Ideate is simply a tool for linking a Revit model to *Microsoft Excel*. As an inexpensive, and extremely easy to use, tool, it is seeing wide usage for many purposes. For users that want to use Excel (and this is very common) it provides an easy way to coordinate building data with Revit.

Excel is not really a true database, and BIMLink is not especially focused on supporting building data workflows, so this is a fairly limited solution. Nevertheless, it is easy to set up and keeps the team focused on their data, rather than engaging in a more complex software implementation.

http://www.ideatebimlink.com/

2. WhiteFeet Tools

Developed by a single programmer as a personal passion, *The WhiteFeet Tools for Revit* suite is not really a commercial application to same level as the other options. The suite also includes other commands, in addition to the database tool, which are used to illustrate the workflows in the next section of this document. (Full Disclosure: The creator of these tools is the author of this document.)

This solution is the simplest of the listed products that uses a true database. One option is to utilize *Microsoft Access*, which, in addition to being a good solution, will encourage wider understanding and use of databases. Alternatively, *Microsoft SQL Server* or the open-source *MySQL* databases can be used for a more enterprise-type solution.

http://www.whitefeettools.com/

3. Trelligence – Affinity

A product that is very appealing to architectural space programmers and early designers, *Affinity* from *Trelligence* is actually a stand-alone application with its own proprietary graphics system and database. It is focused on the architectural programming and early design stages so it is very useful during the initial building data workflows.

Affinity can link to various other BIM authoring products, including Revit, but its key strength is in its ability to standalone and remain independent of the subsequent BIM platform selections. Some projects use it during early design, and then switch to another product during the latter stages.

http://www.trelligence.com/

4. CodeBook

Probably the most mature of the options, *CodeBook* has achieved significant use in healthcare, particularly in the UK. Initially based on linking AutoCAD to Access, it now supports SQL Server with Revit and other BIM platforms. Projects can easily be scaled, from initial stand-alone exercises, to a multi-user production mode.

The basic design, using a client-server database in connection with a CAD/BIM graphics environment, is similar to the design of many products in use for Computer-aided Facility Management (CAFM). This is a well-established solution, with many production enhancements, especially in the management of furniture and equipment.

http://www.codebookinternational.com/

5. Nosyko dRofus

The *dRofus* product from *Nosyko* is a very contemporary solution, reflecting the current trend towards rich Internet applications, based on open, industry standards. Originally used primarily in Europe for healthcare, it is now being widely adopted in the US and for use with other market sectors.

The commitment to a true "Cloud" solution makes it slightly more formidable to launch a project, but results in a very robust collaboration environment. It includes features for tracking changes and accountability on large complex projects.

http://drofus.com/en/

6. Onuma Planning System

The *Onuma* organization is widely engaged with the AECO industry-wide discussion on open collaboration and has developed many products, often offered in connection with their other services. Their *Onuma Planning System* has been adopted particularly by public entities and university systems that require wide public involvement.

This product takes the "Cloud" philosophy, and the support of open standards, to an extreme. It has been used in a variety of public demonstrations of how large groups can collaborate publicly to tackle large-scale urban design problems.

http://www.onuma.com/

IV. Conceptual Design and Building Massing

Using the WhiteFeet software and Microsoft Access, we can demonstrate how a typical data framework is used in a Revit project.

A. Formalizing the Space Program

At the beginning of a project, designers and planners work with the client to establish architectural program requirements for rooms, equipment, and other needs. This *Architectural Program Data* is typically provided as text or in Excel and must be restructured so that it can be used with Revit.

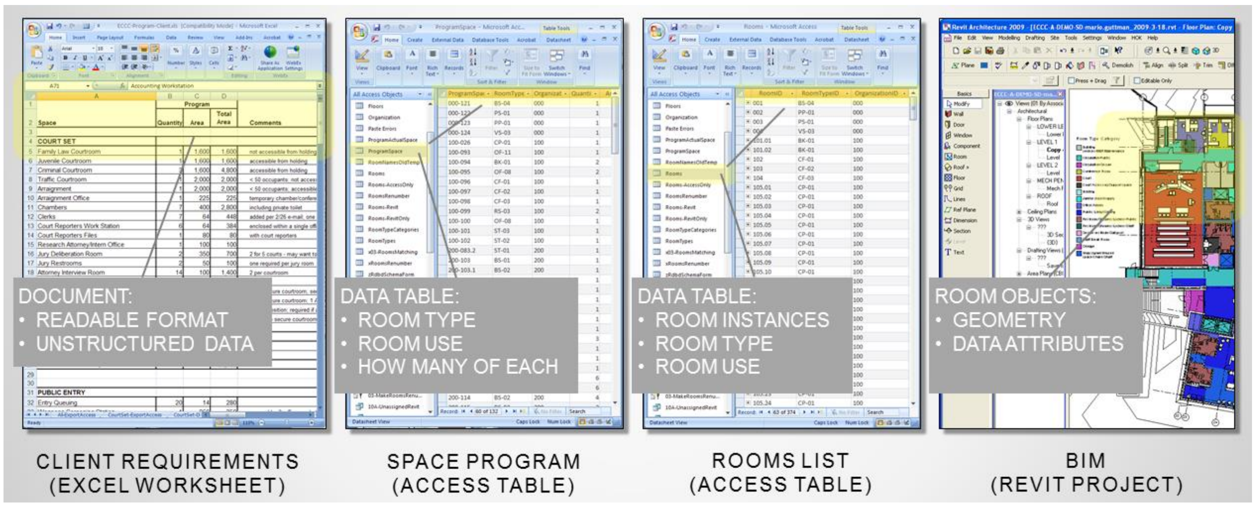
1. Overview

The core process occurs in three steps:

- The data is entered into an Access **Space Program** table.
- The **Space Program** table is processed to build a **Rooms** table.
- The **Rooms** table is used to create rooms in Revit.

In addition, intermediate steps make use of the data during the development of the overall building form, and ultimately the data will be used to validate the building design against the original program.

This is the most important stage in working with building data. Unfortunately, most projects hurry past it because they are rushing to meet a preliminary deadline; and as a result, they are not able to manage the data accurately or validate the design against the program later.



Program data from a client needs to be formalized in data tables before linking to Revit

2. Attributes

As we go through this process we want to be consistent with the kinds of attributes that we track with the spaces. A design team may elect to do this in various ways; however, the use of two attributes is recommended:

- **Organizational Use:** The activity, department, or cost centers that will use the space. For example: "Accounting" or "Sales".
- **Room Type:** The characteristics of the room or the functional use of the spaces. For example: "Office" or "Laboratory".

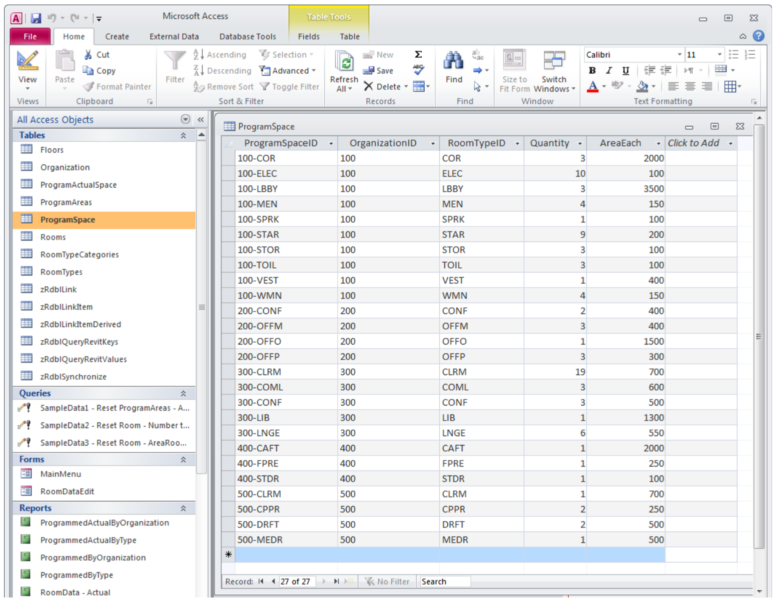
These attributes are each stored in their own separate tables, which have foreign-key relationships to the space program and room instance tables since their values are apply to many different kind of rooms.

3. The Space Program Table

The **Space Program** table lists the space requirements in the fields:

- **Space Program ID (key)**: A unique key value that will permanently identify the requirement.
- **Organization ID**: The foreign key to the **Organization** table.
- **Room Type ID**: The foreign key to the **Room Types** table.
- **Quantity**: The number of this organization-type combination required.
- **Area Each**: The area required for this organization-type combination.

Often the space program will not explicitly call for circulation and other kinds of common space, or they may be expressed as a factor of the specified spaces. In these cases additional program entities must be created to hold these values so that it will be possible to validate the areas later.



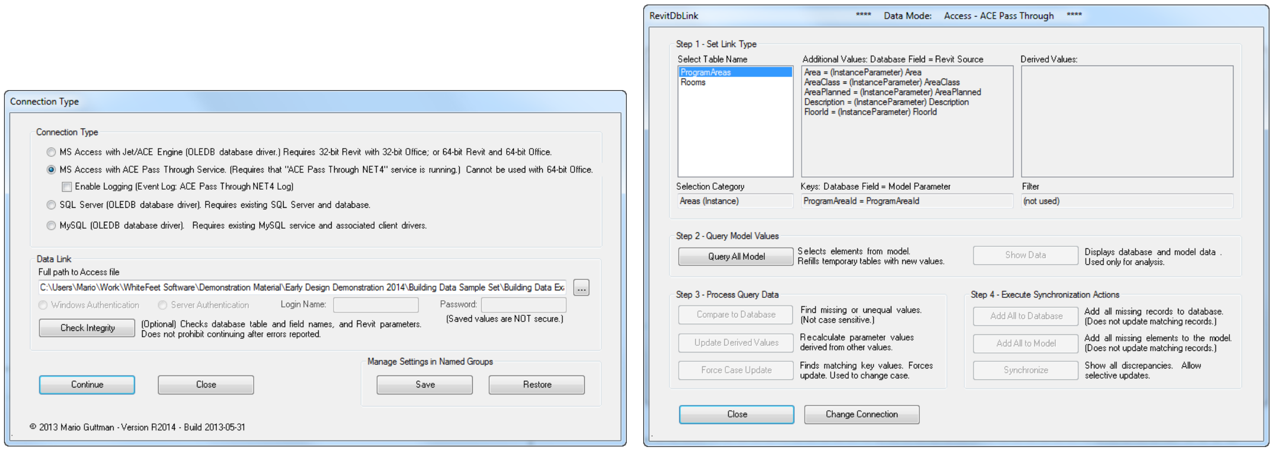
ProgramSpaceID	OrganizationID	RoomTypeID	Quantity	AreaEach	Click to Add
100-COR	100	COR	3	2000	
100-ELEC	100	ELEC	10	100	
100-LBBY	100	LBBY	3	3500	
100-MEN	100	MEN	4	150	
100-SPRK	100	SPRK	1	100	
100-STAR	100	STAR	9	200	
100-STOR	100	STOR	3	100	
100-TOIL	100	TOIL	3	100	
100-VEST	100	VEST	1	400	
100-WMN	100	WMN	4	150	
200-CONF	200	CONF	2	400	
200-OFFM	200	OFFM	3	400	
200-OFFO	200	OFFO	1	1500	
200-OFFP	200	OFFP	3	300	
300-CLRM	300	CLRM	19	700	
300-COML	300	COML	3	600	
300-CONF	300	CONF	3	500	
300-LIB	300	LIB	1	1300	
300-LNGE	300	LNGE	6	550	
400-CAFT	400	CAFT	1	2000	
400-FPRE	400	FPRE	1	250	
400-STDR	400	STDR	1	100	
500-CLRM	500	CLRM	1	700	
500-CPPR	500	CPPR	2	250	
500-DRFT	500	DRFT	2	500	
500-MEDR	500	MEDR	1	500	

The architectural space program is stored in a table with counts for each organization and room type combination.

B. Linking Revit to a Database

At this point we begin to establish the relationship between the database and the model. In this demonstration we are using the WhiteFeet Tools command **Revit-Database Link**. It uses special tables in the database to define the *Schema*, which is a list of the various tables, key fields, dependent fields, and Revit parameters that define the link. We will do this for *Areas*, which are used for general planning purposes, and for *Rooms*. Although not included in this example, a similar process would be used with furniture, equipment, and other elements.

Once the link is established, the tool is used to compare the Revit families with their respective data tables. A synchronization process is used to insure that the values are the same in both contexts.



Connection Type

Connection Type
- MS Access with Jet/ACE Engine (OLEDB database driver.) Requires 32-bit Revit with 32-bit Office; or 64-bit Revit and 64-bit Office.
- [✓ MS Access with ACE Pass Through Service. (Requires that "ACE Pass Through NET4" service is running.) Cannot be used with 64-bit Office.]
- ☐ Enable Logging (Event Log: ACE Pass Through NET4 Log)
- SQL Server (OLEDB database driver). Requires existing SQL Server and database.
- MySQL (OLEDB database driver). Requires existing MySQL service and associated client drivers.

Data Link
Full path to Access file: C:\Users\Mario\Work\WhiteFeet Software\Demonstration Material\Early Design Demonstration 2014\Building Data Sample Set\Building Data Ex
Windows Authentication · Server Authentication · Login Name: · Password: (Saved values are NOT secure.)
Check Integrity: (Optional) Checks database table and field names, and Revit parameters. Does not prohibit continuing after errors reported.

Manage Settings in Named Groups

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RevitDbLink **** Data Mode: Access - ACE Pass Through ****

Step 1 - Set Link Type
Select Table Name: ProgramAreas, Rooms
Additional Values: Database Field = Revit Source
Area = (InstanceParameter) Area
AreaClass = (InstanceParameter) AreaClass
AreaPlanned = (InstanceParameter) AreaPlanned
Description = (InstanceParameter) Description
FloorId = (InstanceParameter) FloorId
Derived Values:
Selection Category: Areas (Instance)
Keys: Database Field = Model Parameter: ProgramAreaId = ProgramAreaId
Filter: (not used)

Step 2 - Query Model Values
Query All Model: Selects elements from model. Refills temporary tables with new values.
Show Data: Displays database and model data. Used only for analysis.

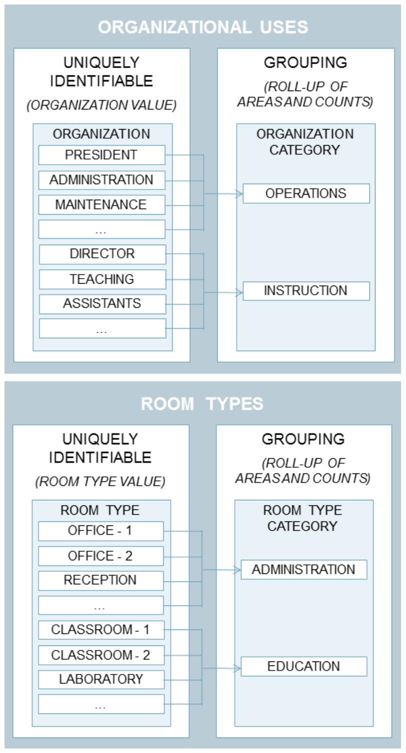
Step 3 - Process Query Data
Compare to Database: Find missing or unequal values. (Not case sensitive.)
Update Derived Values: Recalculate parameter values derived from other values.
Force Case Update: Finds matching key values. Forces update. Used to change case.

Step 4 - Execute Synchronization Actions
Add All to Database: Add all missing records to database. (Does not update matching records.)
Add All to Model: Add all missing elements to the model. (Does not update matching records.)
Synchronize: Show all discrepancies. Allow selective updates.

The WhiteFeet Revit-Database Link tool add-in command screens in Revit.

C. Aggregate Planning Areas

During the early stages of design, rooms are too granular to be used easily to develop a building form. Instead, we use composite *Aggregate Planning Areas.*



The organizational uses and room types are grouped into categories.

1. Planning Areas in the Database

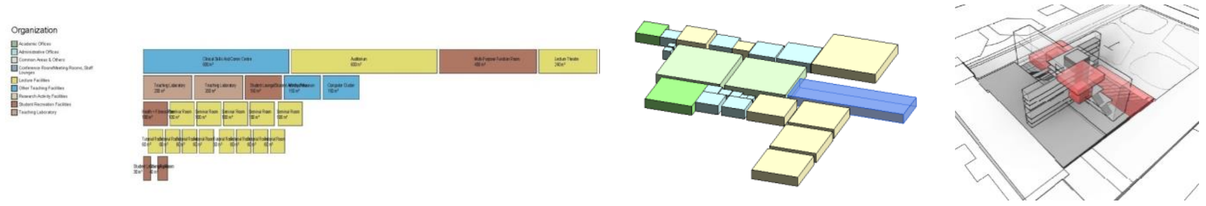
The planning areas are grouped by:

- **Organization Category**: Grouping of values from the **Organization** table.
- **Room Type Category**: Grouping of values from the **Room Types** values.

Note that we first define the more granular attributes, and insure that they have good identifiers, and then "roll-up" these values into categories, rather than the other way around. It is always much easier to group things by a characteristic than it is to try to divide an undifferentiated collection into groups after the fact.

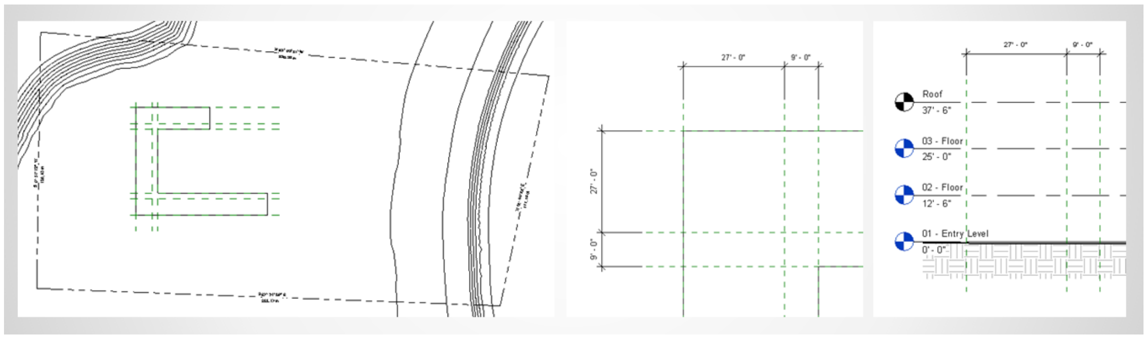
2. Working in Revit

Using the database link and the WhiteFeet **Area & Mass Tools → Place Unplaced Areas**, we import aggregate areas from the database and use them to create unplaced areas in Revit. Note that we include the category values and the required areas in the import process, using them to populate parameters of the area objects. This means that we can place the areas as squares, colored according to their function, and sized according to their required area. Sometimes the blocks are rectangular, based on a standard planning module. These can be manipulated to develop a building form.



Initial placement of areas, conversion to 3D solids, and manipulation of conceptual building mass.

However, in actual project work it is usually misleading to think that a building form can be generated from the space requirements alone. In our example we are going to assume that the designer has an architectural "Parti" for the building. It includes a site with some constraints, a "U" shaped building footprint, a typical floor dimension that is based on the width of a classroom and a corridor, and a standard floor-to-floor height.

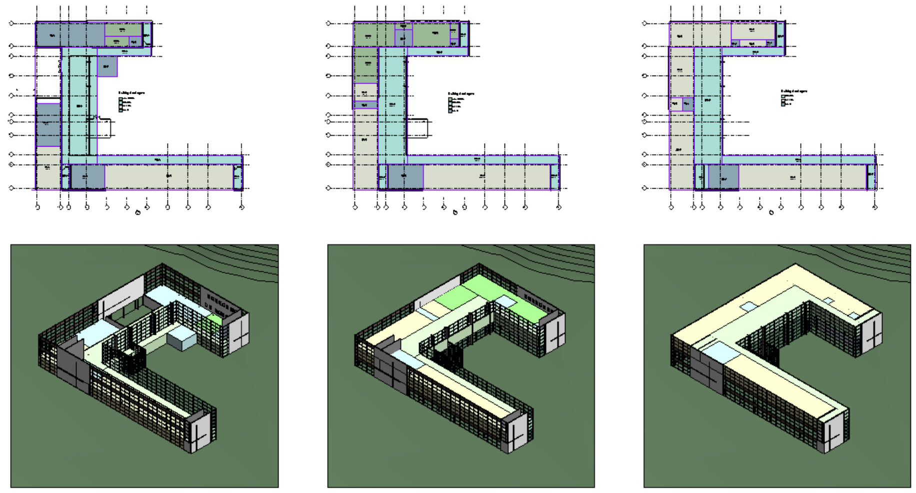


An architectural "parti" based on site constraints, planning modules, and floor heights.

Using the parti as a base, we can outline major planning areas with *Revit Area Boundary Lines*, and drag the areas into place. Once they are moved, the area objects adjust their sizes to meet the boundary lines.

At this point we can begin to develop the building massing by converting the areas into *Revit Mass* or *Revit Generic Solid* forms. The category attributes are transferred to the form so the blocks can be colored, which is used to create a 3D diagram of the design. The WhiteFeet **Area & Mass Tools → Create Solids From Areas** is used to do this.

Because of the way we constructed the database link we can synchronize the planning areas with the database and compare the actual areas with the design areas to validate the scheme.



Walls, floors and roofs are developed around the area-data-driven masses.

D. Creating Rooms

Based on the planning areas we can begin to develop the architecture, including creating walls, floors and roofs. These imply room spaces, but do not yet have Revit room objects in them.

1. Rooms in the Database

Before creating the room objects, we develop a rooms list in the database. As we do this, we need to insure that our organization and type values are structured correctly. Typically we give them a key value that is a short, capitalized string, such as “01”, “02” … or “OFF-1”, “CORR”, etc Then, we put the more descriptive name in a **Description** field in mixed case. That way we can use the key values in tags in Revit, and show the more descriptive name in Revit schedules and Access reports.

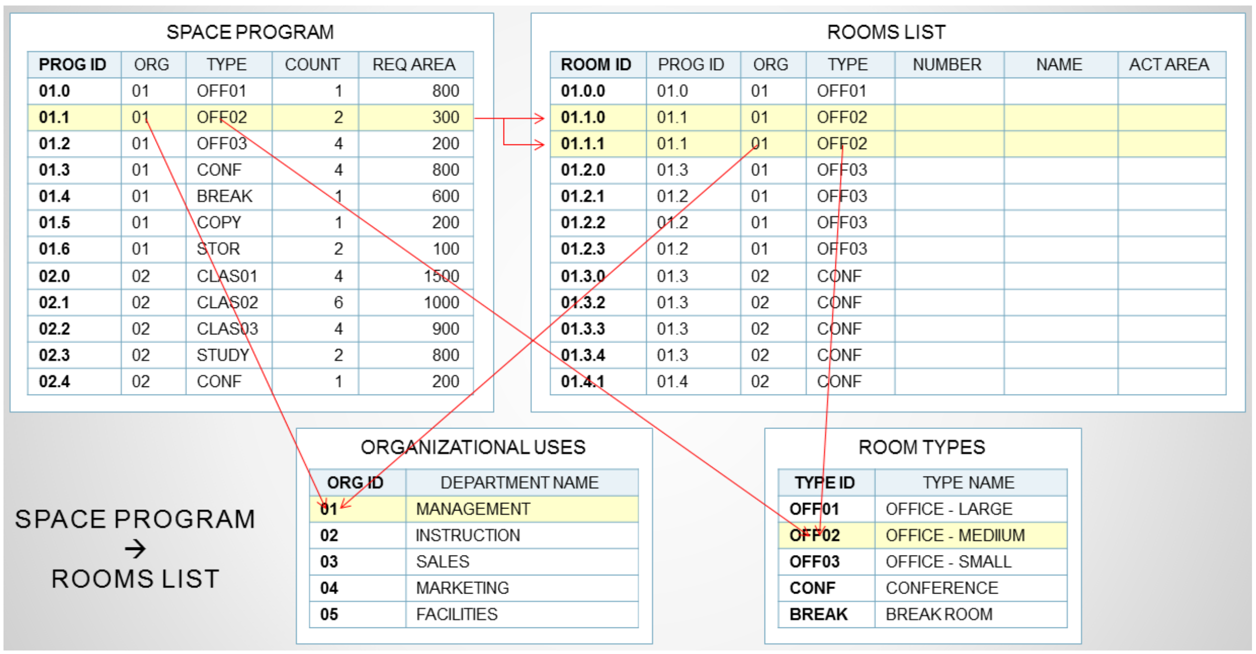
The example uses a VBA program in the Access database to generate the room records from the space program table. Being able to do this kind of simple programming is an important skill for an office to have because it means that it can automate a tedious task and customize the way it is done. This is another critical step where it is really important to plan the various ID values and relationships. As a minimum, from the **Space Program** table, we want to populate the following fields in the **Rooms** table:

- **Room ID (key)**: A unique key value that will permanently identify the room.
- **Space Program ID**: A permanent reference to the program item that the room came from.
- **Organization ID**: The foreign key to the **Organization** table.
- **Room Type ID**: The foreign key to the **Room Types** table.
- **Area Required**: The required area, transferred from the program.

The **Rooms** table does not have a *Quantity* value like the **Space Program** table. Instead, multiple rooms are created, according to the quantity specified. This means that there are many more room records than program entries, and that the VBA program has some strategy for generating unique ID values, such as appending a "**.01**", "**.02**", … suffix to the program ID values.

Ideally, the *Room ID* value should not be the same as the room's *Room Number* value, which will likely change as the planners make adjustments to the design. Unfortunately, owners often specify that they be the same, so it is important to maintain at least the *Space Program ID* value as a pointer back to the original program so that the history of where the room came from is preserved.

The related **Organization** and **Room Types** tables are the same tables that were used with the **Space Program** table. This discipline is important because it insures that the attributes of the rooms that we will be using to validate the design will align with the original program.



SPACE PROGRAM

PROG ID	ORG	TYPE	COUNT	REQ AREA
01.0	01	OFF01	1	800
01.1	01	OFF02	2	300
01.2	01	OFF03	4	200
01.3	01	CONF	4	800
01.4	01	BREAK	1	600
01.5	01	COPY	1	200
01.6	01	STOR	2	100
02.0	02	CLAS01	4	1500
02.1	02	CLAS02	6	1000
02.2	02	CLAS03	4	900
02.3	02	STUDY	2	800
02.4	02	CONF	1	200

ROOMS LIST

ROOM ID	PROG ID	ORG	TYPE	NUMBER	NAME	ACT AREA
01.0.0	01.0	01	OFF01			
01.1.0	01.1	01	OFF02			
01.1.1	01.1	01	OFF02			
01.2.0	01.3	01	OFF03			
01.2.1	01.2	01	OFF03			
01.2.2	01.2	01	OFF03			
01.2.3	01.2	01	OFF03			
01.3.0	01.3	02	CONF			
01.3.2	01.3	02	CONF			
01.3.3	01.3	02	CONF			
01.3.4	01.3	02	CONF			
01.4.1	01.4	02	CONF			

SPACE PROGRAM → ROOMS LIST

ORGANIZATIONAL USES

ORG ID	DEPARTMENT NAME
01	MANAGEMENT
02	INSTRUCTION
03	SALES
04	MARKETING
05	FACILITIES

ROOM TYPES

TYPE ID	TYPE NAME
OFF01	OFFICE - LARGE
OFF02	OFFICE - MEDIIUM
OFF03	OFFICE - SMALL
CONF	CONFERENCE
BREAK	BREAK ROOM

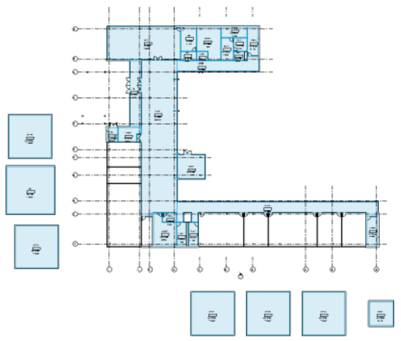
Rooms are developed from the space program, using the same organizational uses and room types.

2. Rooms in Revit

The rooms are created in Revit as unplaced rooms using the database link again. Using the WhiteFeet **Room Tools → Place Unplaced Rooms** command tool the rooms are arrayed as squares inside of *Revit Room Separation Lines* or temporary walls, sized according to their required area.

As with the areas, these rooms have brought their category, room type, and other attributes with them as parameter values. It is helpful if, during the database work, the rooms were classified by the floor they will be used on. That makes it easier to place them on the proper floor plan.

Finally, they are dragged to their final location in the plan.

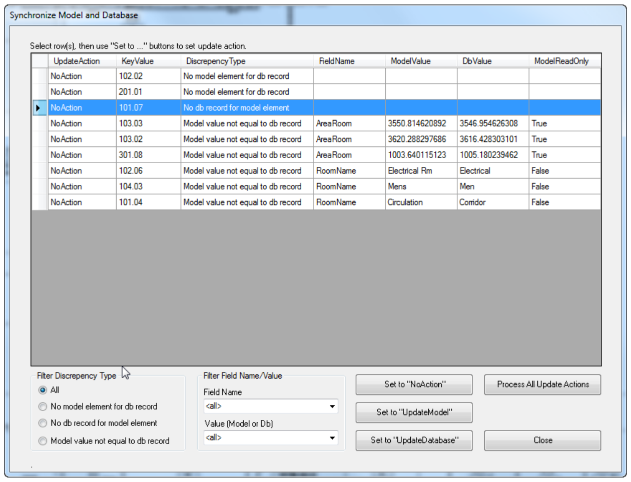


Rooms are placed as blocks of the required size and then dragged to the plan.

As the rooms are moved inside of the architectural walls of the building they assume the size of the space provided. This means that their **Area** parameter reflects the actual size of the room.

Using the database link again they can be synchronized back to a field such as **Area Actual**, and compared to the Area Required.

This can be used to develop a report showing the comparison of what was asked for to what is now in the design. Because of the internal consistency of the data, these reports can be grouped by the organization and room type attributes.


Synchronize Model and Database

Select row(s), then use "Set to ..." buttons to set update action.

UpdateAction	KeyValue	DiscrepencyType	FieldName	ModelValue	DbValue	ModelReadOnly
NoAction	102.02	No model element for db record				
NoAction	201.01	No model element for db record				
NoAction	101.07	No db record for model element				
NoAction	103.03	Model value not equal to db record	AreaRoom	3550.814620892	3546.954626308	True
NoAction	103.02	Model value not equal to db record	AreaRoom	3620.288297686	3616.428303101	True
NoAction	301.08	Model value not equal to db record	AreaRoom	1003.640115123	1005.180239462	True
NoAction	102.06	Model value not equal to db record	RoomName	Electrical Rm	Electrical	False
NoAction	104.03	Model value not equal to db record	RoomName	Mens	Men	False
NoAction	101.04	Model value not equal to db record	RoomName	Circulation	Corridor	False

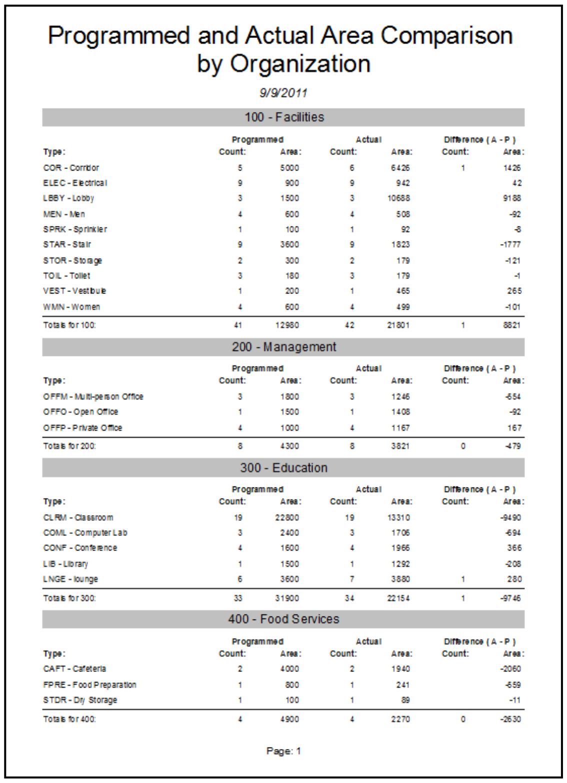
Filter Discrepency Type: [✓ All] No model element for db record / No db record for model element / Model value not equal to db record

Filter Field Name/Value

Field Name <all>

Value (Model or Db) <all>

The WhiteFeet Database Link Synchronize interface.


Programmed and Actual Area Comparison by Organization

9/9/2011

100 - Facilities

	Programmed		Actual		Difference (A - P)	
Type:	Count:	Area:	Count:	Area:	Count:	Area:
COR - Corridor	5	5000	6	6426	1	1426
ELEC - Electrical	9	900	9	942		42
LBBY - Lobby	3	1500	3	10688		9188
MEN - Men	4	600	4	508		-92
SPRK - Sprinkler	1	100	1	92		-8
STAR - Stair	9	3600	9	1823		-1777
STOR - Storage	2	300	2	179		-121
TOIL - Toilet	3	180	3	179		-1
VEST - Vestibule	1	200	1	465		265
WMN - Women	4	600	4	499		-101
Totals for 100:	41	12980	42	21801	1	8821

200 - Management

	Programmed		Actual		Difference (A - P)	
Type:	Count:	Area:	Count:	Area:	Count:	Area:
OFFM - Multi-person Office	3	1800	3	1246		-554
OFFO - Open Office	1	1500	1	1408		-92
OFFP - Private Office	4	1000	4	1167		167
Totals for 200:	8	4300	8	3821	0	-479

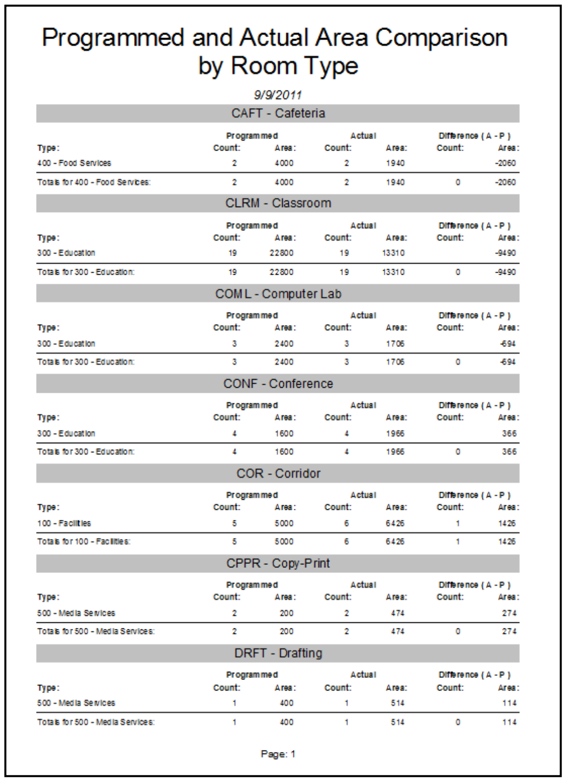
300 - Education

	Programmed		Actual		Difference (A - P)	
Type:	Count:	Area:	Count:	Area:	Count:	Area:
CLRM - Classroom	19	22800	19	13310		-9490
COML - Computer Lab	3	2400	3	1706		-694
CONF - Conference	4	1600	4	1966		366
LIB - Library	1	1500	1	1292		-208
LNGE - lounge	6	3600	7	3880	1	280
Totals for 300:	33	31900	34	22154	1	-9746

400 - Food Services

	Programmed		Actual		Difference (A - P)	
Type:	Count:	Area:	Count:	Area:	Count:	Area:
CAFT - Cafeteria	2	4000	2	1940		-2060
FPRE - Food Preparation	1	800	1	241		-559
STDR - Dry Storage	1	100	1	89		-11
Totals for 400:	4	4900	4	2270	0	-2630

Page: 1


Programmed and Actual Area Comparison by Room Type

9/9/2011

CAFT - Cafeteria

	Programmed		Actual		Difference (A - P)	
Type:	Count:	Area:	Count:	Area:	Count:	Area:
400 - Food Services	2	4000	2	1940		-2060
Totals for 400 - Food Services:	2	4000	2	1940	0	-2060

CLRM - Classroom

	Programmed		Actual		Difference (A - P)	
Type:	Count:	Area:	Count:	Area:	Count:	Area:
300 - Education	19	22800	19	13310		-9490
Totals for 300 - Education:	19	22800	19	13310	0	-9490

COM L - Computer Lab

	Programmed		Actual		Difference (A - P)	
Type:	Count:	Area:	Count:	Area:	Count:	Area:
300 - Education	3	2400	3	1706		-694
Totals for 300 - Education:	3	2400	3	1706	0	-694

CONF - Conference

	Programmed		Actual		Difference (A - P)	
Type:	Count:	Area:	Count:	Area:	Count:	Area:
300 - Education	4	1600	4	1966		366
Totals for 300 - Education:	4	1600	4	1966	0	366

COR - Corridor

	Programmed		Actual		Difference (A - P)	
Type:	Count:	Area:	Count:	Area:	Count:	Area:
100 - Facilities	5	5000	6	6426	1	1426
Totals for 100 - Facilities:	5	5000	6	6426	1	1426

CPPR - Copy-Print

	Programmed		Actual		Difference (A - P)	
Type:	Count:	Area:	Count:	Area:	Count:	Area:
500 - Media Services	2	200	2	474		274
Totals for 500 - Media Services:	2	200	2	474	0	274

DRFT - Drafting

	Programmed		Actual		Difference (A - P)	
Type:	Count:	Area:	Count:	Area:	Count:	Area:
500 - Media Services	1	400	1	514		114
Totals for 500 - Media Services:	1	400	1	514	0	114

Page: 1

Validation reports in Access with alternative groupings.

E. Supporting Construction Documentation

In this demonstration we are not developing the database further, but in actual projects it can be very useful to use similar processes manage other aspects of the project and documentation. These can include:

- **Room Requirements:** Utilities, finishes, and other detailed requirements. These may be defined initially in the room types so that they apply generally, but will often move to the rooms themselves as the project progresses and there are more exceptions than typical cases.
- **Doors and Hardware:** Although doors are scheduled in Revit it is often convenient to manage hardware and other detailed requirements as data.
- **Furniture and Equipment:** These may be managed as data initially and then used to develop furniture and equipment plans.

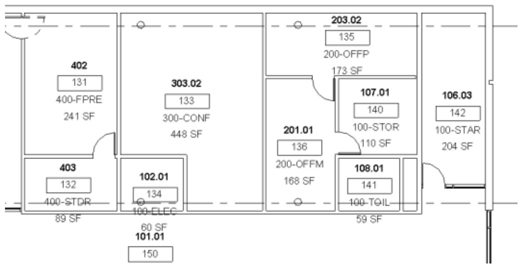
V. Room Data Sheets

The *Room Data Sheet* process involves working with client *User Groups*, which are made up of both experts and general users who know what is required in the building. This information must be gathered systematically and used to drive the design. In this example project the synchronization of this detail between the Revit model and the database is not developed, although such functionality is a major component of some of the commercial software options.

A. Numbering Rooms

Up to this point the rooms have been identified by a **Room ID** value that was assigned in the database. Once the rooms have been placed they are usually numbered in their **Room Number** parameter in a sequence that makes it easy to find them on a plan, such as sequentially along the corridors.

As noted earlier, it is preferable that the **Room ID** value and the **Room Number** value not be the same since the ID value is based on the program requirements and the number is based on its position on the floor. In addition, the rooms will likely have a **Room Signage Number** parameter that defines what text will be on the plaque placed by the door. Although it is tempting to try to make these numbers the same, actually doing so is very difficult, and keeping them separate will save work in the long run.



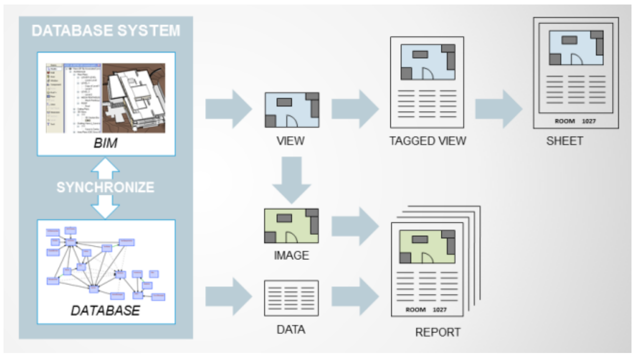
Rooms are numbered separately for program identification, construction documentation, and signage.

The actual method of numbering the rooms is not part of this discussion and many utilities are available for doing that. It is also a good idea to synchronize the room numbers back to the database so that the mapping of the numbers to the corresponding ID values can be included in reports.

B. Room Data Sheets Overview

There are two distinct strategies for the Room Data Sheet process:

- **Room Data Sheets in Revit**: The sheets are developed entirely within Revit.
- **Room Data Sheets in Access**: The sheets use images from Revit but are developed as Access reports.



Alternative workflows for making room data sheets.

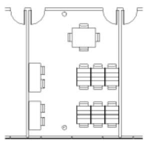
Both methods are valid and can be used simultaneously. The process in Revit lends itself to quicker adjustments while working in Revit and may be most useful to the design team. The Access reports can include more kinds of data and have more formatting options, so they may be more useful in working with user groups.

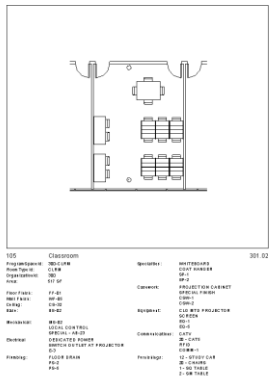
Both methods involve creating a separate view for each room. This is a small plan or 3D view that is cropped to a fixed distance around the room. The WhiteFeet command **View Tools → Create Views From Rooms** is used to create these in a batch process. The views are named systematically with a variant of the room number to enable the use of additional automation in the processes that follow.

C. Room Data Sheet in Revit

Each of the rooms is tagged, in the small room view, with a special tag that includes labels for all of the parameters that are going to be displayed. This is just a standard Revit Room Tag with many labels, which means that it will need to be repositioned if the walls around the room change. The WhiteFeet command **View Tools → Add Tags to Existing Rooms** is used to do this in a batch process.

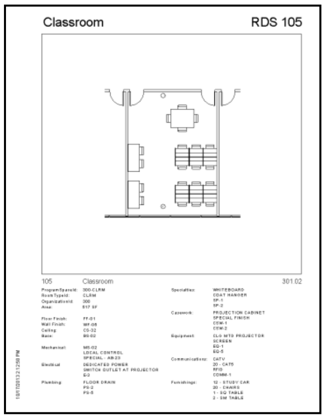
Each of these tagged views is then placed on its own sheet. The sheet uses a special Revit title block that is designed especially for this purpose, usually with a letter or tabloid paper size. The WhiteFeet command **View Tools → Create Sheets From Views** is used to do this in a batch process.





105 Classroom 301.02

ProgramSpaceId:	300-CLRM	Specialties:	WHITEBOARD COAT HANGER SP-1 SP-2
RoomTypeId:	CLRM		
OrganizationId:	300		
Area:	517 SF		
Floor Finish:	FF-01	Casework:	PROJECTION CABINET SPECIAL FINISH CSW-1 CSW-2
Wall Finish:	WF-05		
Ceiling:	CS-32		
Base:	BS-02	Equipment:	CLG MTD PROJECTOR SCREEN EQ-1 EQ-5
Mechanical:	MS-02 LOCAL CONTROL SPECIAL - AB-23	Communications:	CATV 20 - CAT5 RFID COMM-1
Electrical:	DEDICATED POWER SWITCH OUTLET AT PROJECTOR E-3		
Plumbing:	FLOOR DRAIN PS-2 PS-5	Furnishings:	12 - STUDY CAR 20 - CHAIRS 1 - SQ TABLE 2 - SM TABLE



Classroom RDS 105

105 Classroom 301.02

ProgramSpaceId:	300-CLRM	Specialties:	WHITEBOARD COAT HANGER SP-1 SP-2
RoomTypeId:	CLRM		
OrganizationId:	300		
Area:	517 SF		
Floor Finish:	FF-01	Casework:	PROJECTION CABINET SPECIAL FINISH CSW-1 CSW-2
Wall Finish:	WF-05		
Ceiling:	CS-32		
Base:	BS-02	Equipment:	CLG MTD PROJECTOR SCREEN EQ-1 EQ-5
Mechanical:	MS-02 LOCAL CONTROL SPECIAL - AB-23	Communications:	CATV 20 - CAT5 RFID COMM-1
Electrical:	DEDICATED POWER SWITCH OUTLET AT PROJECTOR E-3		
Plumbing:	FLOOR DRAIN PS-2 PS-5	Furnishings:	12 - STUDY CAR 20 - CHAIRS 1 - SQ TABLE 2 - SM TABLE

10/17/2013 2:12:58 PM

Room data sheets done in Revit require three steps: make a view; tag it; and place it on a sheet.

D. Room Data Sheet in Access

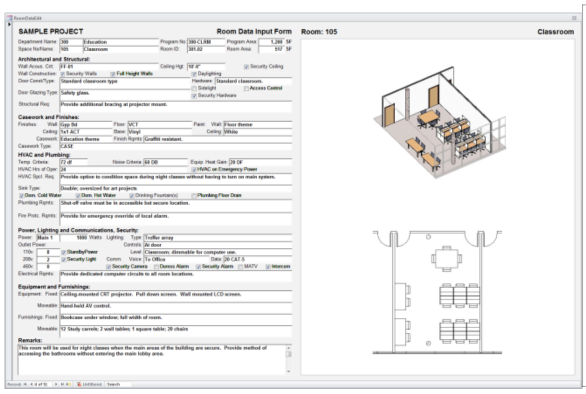
The views in Revit are exported to raster image files in a batch process using the WhiteFeet command **View Tools → Export Images From Views**. The images are named systematically so that they can be linked to the Access report based on a standard pattern. The images should be placed in a folder in the same location as the Access report.

A form in Access is used to input data, often live during user group meetings. A separate report is used to publish the same information in a read-only mode.

Creating the input form and the report in Access is a complex topic, outside of the scope of this discussion. They are based entirely on data from the Access tables so any data from Revit must be separately synchronized.

The exported images can be displayed in both the input form and the report. The syntax for the Access Control Source is of the form:

=[CurrentProject].[Path] & "\Images\Room" & [Number] & "-3DBC.jpg"



RoomDataEdit

SAMPLE PROJECT **Room Data Input Form** **Room: 105** **Classroom**

Department Name: 300 Education | Program No: 300-CLRM | Program Area: 1,200 SF
Space No/Name: 105 Classroom | Room ID: 301.02 | Room Area: 517 SF

Architectural and Structural:
Wall Acous. Crit: FF-01 | Ceiling Hgt: 10'-0" | ✓ Security Ceiling
Wall Construction: ✓ Security Walls ✓ Full Height Walls ✓ Daylighting
Door Const/Type: Standard classroom type | Hardware: Standard classroom.
☐ Sidelight ☐ Access Control
Door Glazing Type: Safety glass. | ✓ Security Hardware
Structural Req: Provide additional bracing at projector mount.

Casework and Finishes:
Finishes: Wall: Gyp Bd | Floor: VCT | Paint: Wall: Floor theme
Ceiling: 1x1 ACT | Base: Vinyl | Ceiling: White
Casework: Education theme | Finish Rqmts: Graffiti resistant.
Casework Type: CASE

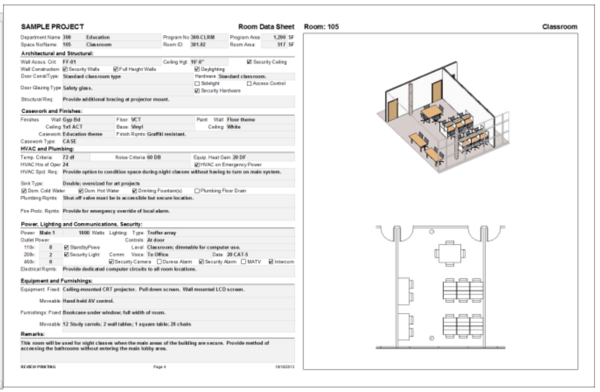
HVAC and Plumbing:
Temp. Criteria: 72 df | Noise Criteria: 60 DB | Equip. Heat Gain: 20 DF
HVAC Hrs of Oper: 24 | ✓ HVAC on Emergency Power
HVAC Spcl. Req: Provide option to condition space during night classes without having to turn on main system.
Sink Type: Double; oversized for art projects
✓ Dom. Cold Water ✓ Dom. Hot Water ✓ Drinking Fountain(s) ☐ Plumbing Floor Drain
Plumbing Rqmts: Shut-off valve must be in accessible but secure location.
Fire Protc. Rqmts: Provide for emergency override of local alarm.

Power, Lighting and Communications, Security:
Power: Main 1 1000 Watts | Lighting: Type: Troffer array
Outlet Power: | Controls: At door
110v: 8 ✓ StandbyPower | Level: Classroom; dimmable for computer use.
208v: 2 ✓ Security Light | Comm: Voice: To Office | Data: 20 CAT-5
460v: 0 | ✓ Security Camera ☐ Duress Alarm ✓ Security Alarm ☐ MATV ✓ Intercom
Electrical Rqmts: Provide dedicated computer circuits to all room locations.

Equipment and Furnishings:
Equipment: Fixed: Ceiling-mounted CRT projector. Pull down screen. Wall mounted LCD screen.
Moveable: Hand-held AV control.
Furnishings: Fixed: Bookcase under window; full width of room.
Moveable: 12 Study carrels; 2 wall tables; 1 square table; 20 chairs

Remarks:
This room will be used for night classes when the main areas of the building are secure. Provide method of accessing the bathrooms without entering the main lobby area.

Record: 4 of 10 | Unfiltered | Search



SAMPLE PROJECT **Room Data Sheet** **Room: 105** **Classroom**

Department Name: 300 Education | Program No: 300-CLRM | Program Area: 1,200 SF
Space No/Name: 105 Classroom | Room ID: 301.02 | Room Area: 517 SF

Architectural and Structural:
Wall Acous. Crit: FF-01 | Ceiling Hgt: 10'-0" | ☑ Security Ceiling
Wall Construction: ☑ Security Walls ☑ Full Height Walls ☑ Daylighting
Door Const/Type: Standard classroom type | Hardware: Standard classroom.
☐ Sidelight ☐ Access Control
Door Glazing Type: Safety glass. | ☑ Security Hardware
Structural Req: Provide additional bracing at projector mount.

Casework and Finishes:
Finishes: Wall: Gyp Bd | Floor: VCT | Paint: Wall: Floor theme
Ceiling: 1x1 ACT | Base: Vinyl | Ceiling: White
Casework: Education theme | Finish Rqmts: Graffiti resistant.
Casework Type: CASE

HVAC and Plumbing:
Temp. Criteria: 72 df | Noise Criteria: 60 DB | Equip. Heat Gain: 20 DF
HVAC Hrs of Oper: 24 | ☑ HVAC on Emergency Power
HVAC Spcl. Req: Provide option to condition space during night classes without having to turn on main system.
Sink Type: Double; oversized for art projects
☑ Dom. Cold Water ☑ Dom. Hot Water ☑ Drinking Fountain(s) ☐ Plumbing Floor Drain
Plumbing Rqmts: Shut-off valve must be in accessible but secure location.
Fire Protc. Rqmts: Provide for emergency override of local alarm.

Power, Lighting and Communications, Security:
Power: Main 1 1000 Watts | Lighting: Type: Troffer array
Outlet Power: | Controls: At door
110v: 8 ☑ StandbyPowe | Level: Classroom; dimmable for computer use.
208v: 2 ☑ Security Light | Comm: Voice: To Office | Data: 20 CAT-5
460v: 0 | ☑ Security Camera ☐ Duress Alarm ☑ Security Alarm ☐ MATV ☑ Intercom
Electrical Rqmts: Provide dedicated computer circuits to all room locations.

Equipment and Furnishings:
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Moveable: 12 Study carrels; 2 wall tables; 1 square table; 20 chairs

Remarks:
This room will be used for night classes when the main areas of the building are secure. Provide method of accessing the bathrooms without entering the main lobby area.

REVIEW PRINTING Page 4 10/18/2013

In Access, a form used to input room data, and a report used to create a booklet, have a similar format.

VI. Supplemental Topics

A. Parent-Child Family Relationships – Site FAR Example

In many cases, it is useful to define "ownership" relationships between different kinds of families. These occur when there is a logical *one-to-many* type relationship. They are commonly expressed as one family "owning" the other, or that one is the "parent" and the other is the "child".

For example, in site planning it is often necessary to calculate a *Floor Area Ratio* (FAR) that expresses the ratio of the total floor area of all of the buildings on a parcel to the area of the parcel. This kind of calculation only makes sense if each building "belongs" to one, and only one, parcel.

$$FAR = \frac{\sum Areas\ of\ All\ Floors}{Area\ of\ Parcel}$$

Although Revit includes a *Property Line* object this class has limited functionality so it is typical to use *Area* objects for this purpose. (Custom values for the *Area Schemes* and *Area Types* are limited; so arbitrary values are typically used and then parameters added to store any site characteristics.)

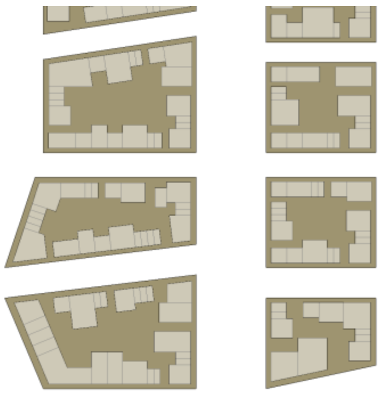
To represent buildings, mass objects can be used, either modeled in-place or as separate families. A system of Revit Levels is developed for the entire site. For each mass object, when the appropriate floors are activated, Revit *Mass Floor* objects are created, and the total area of all of these for that building is calculated automatically.

1. Establishing a Parent-Child Relationship

The ownership, or parent-child relationship is represented by the child storing an identifier of the parent that it belongs to as a parameter. (Note that we do not do the opposite – have the parent store the ID values of its children – since we don't know how many children there might be and it is hard to work with value lists of varying length.)

In the example, each parcel (Revit Area object) has a parameter named **AreaId**. These are populated with unique values to identify the parcels. Each building (Mass family) includes a parameter named **ParentAreaId** establishing which parcel it belongs to.

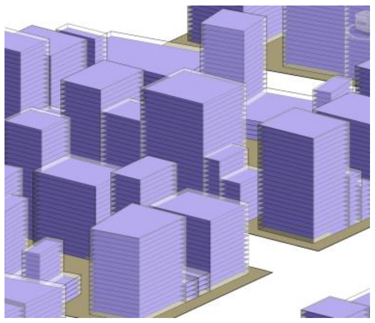
In this example we have used the WhiteFeet **Parameter Tools → Parent-Child Relationship** command to find which buildings are located on which parcels and assign the appropriate ID values.


The buildings (masses) belong to the parcels (areas).

2. Rolling-up a Value to the Parent

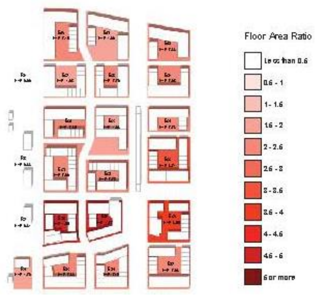
A numerical value such as area is said to be *rolled-up* when the values of the children are summed and the total is stored with the parent.

By default, Revit stores the total floor area of each building in a parameter called **Gross Floor Area**. In the example, a parameter called **AreaSumOfChildFloorAreas** has been added to the parcels. The total floor area of all of the buildings on a given parcel is assigned to this parameter. This is fairly tedious to do manually, so the WhiteFeet Tools command **Parameter Tools → Roll-Up Value to Parent** has been used to do the arithmetic and assign the values.


Floor areas are totaled from mass floors in each building.

3. Calculating a Ratio

Although Revit can do calculations in schedules, these values are difficult to use with tags and color fill plans, so it is often convenient to pre-calculate a value and store it in a parameter. In the example we have the **AreaSumOfChildFloorAreas** values calculated in the previous step, and Revit automatically reports the area of the Revit Area object in its **Area** parameter. We need to take the ratio of these and store it another parameter called **FloorAreaRatio**. The WhiteFeet **Parameter Tools → Math Calculation** tool has been used to do the arithmetic and assign the values.



A view filter is used to show the FAR values as a gradient.

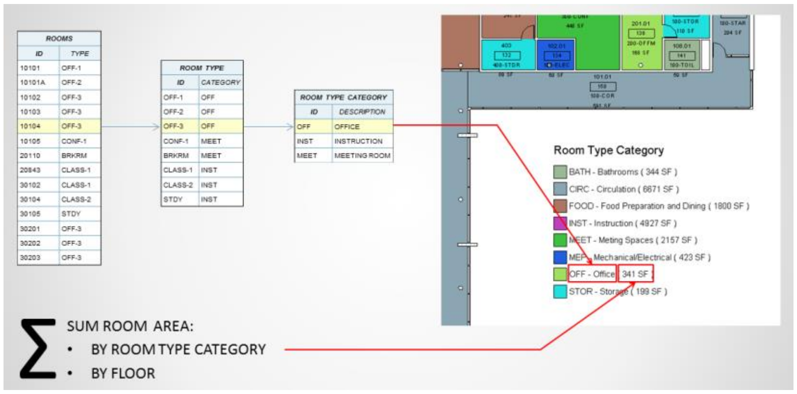
4. Creating a View Filter

In the example, floors have been added to represent the parcels in plan views since the areas are not visible. A Revit *View Filter*, utilizing the **FloorAreaRatio** parameter, is used to shade the parcels on a scale. All of these processes use standard Revit commands.

B. Related Database Tables in Revit Color Fill Plans

Because Revit tends to flatten data it can be difficult to display data that is based on relationships and aggregations. This example uses several tools to illustrate various techniques for getting around this.

The goal of the example is to create a *Revit Color Fill Plan* that shows the rooms colored by their **Room Type Category** value in the Access database with a legend that shows:



ROOMS	
ID	TYPE
10101	OFF-1
10101A	OFF-2
10102	OFF-3
10103	OFF-3
10104	OFF-3
10105	CONF-1
20110	BRKRM
20843	CLASS-1
30102	CLASS-1
30104	CLASS-2
30105	STDY
30201	OFF-3
30202	OFF-3
30203	OFF-3

ROOM TYPE	
ID	CATEGORY
OFF-1	OFF
OFF-2	OFF
OFF-3	OFF
CONF-1	MEET
BRKRM	MEET
CLASS-1	INST
CLASS-2	INST
STDY	INST

ROOM TYPE CATEGORY	
ID	DESCRIPTION
OFF	OFFICE
INST	INSTRUCTION
MEET	MEETING ROOM

Room Type Category
BATH - Bathrooms (344 SF)
CIRC - Circulation (6671 SF)
FOOD - Food Preparation and Dining (1800 SF)
INST - Instruction (4927 SF)
MEET - Meting Spaces (2157 SF)
MEP - Mechanical/Electrical (423 SF)
OFF - Office (341 SF)
STOR - Storage (199 SF)
∑ SUM ROOM AREA:
• BY ROOM TYPE CATEGORY
• BY FLOOR

Data must be flattened and aggregated to a single parameter in order to display it in a color fill plan.

- Each category value.
- Its descriptive name.
- The total room area of that category on the current floor.

To do this, the example illustrates several techniques:

- Indirect values: Values that must be retrieved from a related table.
- Rolled-up values: Summing up a value across a selected grouping.
- Concatenation: Combining text into a single parameter value.

1. Importing *Room Type Category* Values to *Rooms*

In the database table *Rooms*, each room is assigned a *Room Type*. In a related *Room Types* table each such room type is associated with a *Room Type Category*. In order to work with this data in Revit we need to “flatten” it into a single parameter of the room called **RoomTypeCategoryId**. We also want to bring along a more descriptive title, from the *Room Type Categories* table, and assign it to a parameter called **RoomTypeCategoryDescription**. The **Update Derived Values** option of the WhiteFeet **Revit Database Link** tool is used to do this.

2. Separating Rooms by *Room Type Category* and *Floor*

In order to perform aggregate functions on the rooms we need to be able to group them properly. We do this by creating a new parameter called **RoomTypeCategoryFloor** and using the WhiteFeet **Parameter Tools → String Calculation and Concatenation** command to combine the **RoomTypeCategoryId** value from the previous step with the Revit Level number. The resulting values associate each room with a distinct floor and room type category combination.

3. Summing the Room Areas

Using the **RoomTypeCategoryFloor** parameter from the previous step to group the rooms, the total area is calculated and stored in the **RoomTypeCategoryFloorArea** parameter. Note that this value is the same for all rooms with the same category-floor combination. In the example, the WhiteFeet **Parameter Tools → Math Calculation** tool has been used to do the arithmetic and assign the values.

4. Converting the Number to a String

In the following steps we will be creating a legend that incorporates the **RoomTypeCategoryFloorArea** parameter value calculated in the last step. In order to use it this way it needs to be converted to a string value and stored in the **RoomTypeCategoryFloorString** parameter. The WhiteFeet **Parameter Tools → Math Calculation** command tool can be used to do this.

5. Creating a Title Parameter with a Concatenated String

In order to create the final legend, all of the assembled data must be combined into a single parameter. In this case it combines three parameter values and three literal strings:

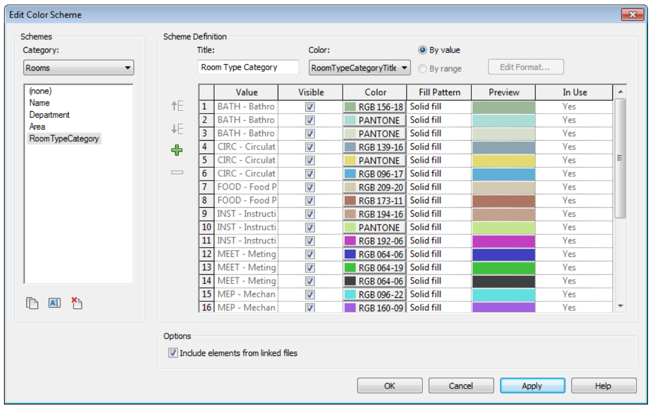
- **RoomTypeCategoryId**.
- Literal " **–** ".
- **RoomTypeCategoryDescription**
- Literal "**(** ".
- **RoomTypeCategoryFloorString**.
- Literal " **SF)**"

The combined string has the form: **CIRC – Circulation (6671 SF)**

Its value is stored in the parameter **RoomTypeCategoryTitle**. As an illustration, the **Update Derived Values** option of the WhiteFeet **Revit Database Link** tool is used to do this; however, the concatenation tool could be used in the same way.

6. Creating a Color Fill Legend with a Title Parameter

Now that we have the values in the **RoomTypeCategoryTitle** parameter, conventional Revit commands are used to create the *Color Fill Plan* and *Color Fill Legend*.


Edit Color Scheme

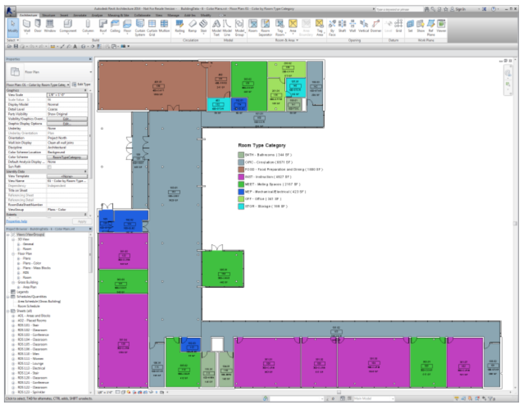
Schemes
Category: Rooms

(none)
Name
Department
Area
RoomTypeCategory

Scheme Definition
Title: Room Type Category
Color: RoomTypeCategoryTitle
[✓ By value] By range
Edit Format...

	Value	Visible	Color	Fill Pattern	Preview	In Use
1	BATH - Bathro	✓	RGB 156-18	Solid fill	🟩	Yes
2	BATH - Bathro	✓	PANTONE	Solid fill	🟦	Yes
3	BATH - Bathro	✓	PANTONE	Solid fill	⬜	Yes
4	CIRC - Circulat	✓	RGB 139-16	Solid fill	🟦	Yes
5	CIRC - Circulat	✓	PANTONE	Solid fill	🟨	Yes
6	CIRC - Circulat	✓	RGB 096-17	Solid fill	🟦	Yes
7	FOOD - Food P	✓	RGB 209-20	Solid fill	⬜	Yes
8	FOOD - Food P	✓	RGB 173-11	Solid fill	🟫	Yes
9	INST - Instructi	✓	RGB 194-16	Solid fill	🟫	Yes
10	INST - Instructi	✓	PANTONE	Solid fill	🟩	Yes
11	INST - Instructi	✓	RGB 192-06	Solid fill	🟪	Yes
12	MEET - Meting	✓	RGB 064-06	Solid fill	🟦	Yes
13	MEET - Meting	✓	RGB 064-19	Solid fill	🟩	Yes
14	MEET - Meting	✓	RGB 064-06	Solid fill	⬛	Yes
15	MEP - Mechan	✓	RGB 096-22	Solid fill	🟦	Yes
16	MEP - Mechan	✓	RGB 160-09	Solid fill	🟪	Yes

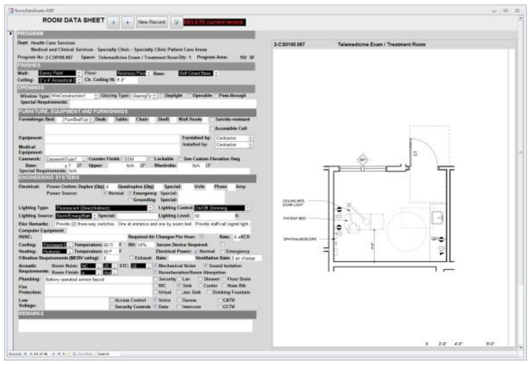
Options
[✓] Include elements from linked files

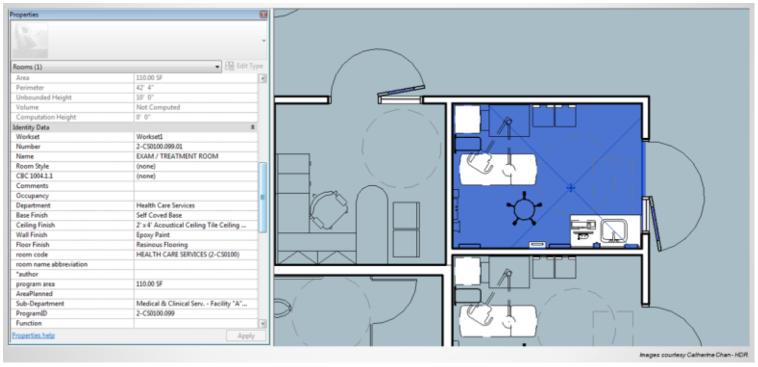

Room Type Category
BATH - Bathrooms (344 SF)
CIRC - Circulation (6671 SF)
FOOD - Food Preparation and Dining (1080 SF)
INST - Instruction (6827 SF)
MEET - Meting Spaces (2167 SF)
MEP - Mechanical/Electrical (423 SF)
OFF - Office (341 SF)
STOR - Storage (198 SF)

*The final color fill plan based on the **RoomTypeCategoryTitle** parameter.*

VII. Example Project

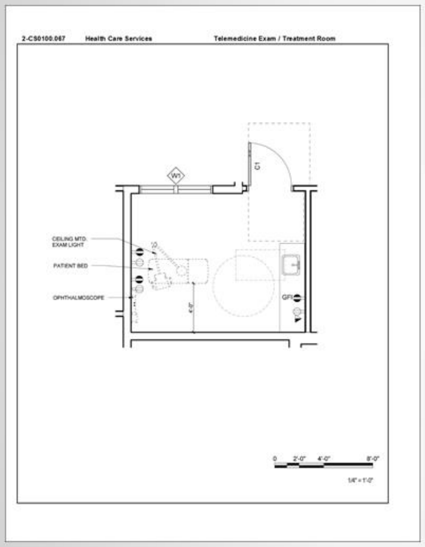
The images used in this presentation have been based on sample data, which is easy to work with and convenient for illustrating techniques, but is not truly realistic in terms of what occurs in actual projects. The images on this page, which are from a real project provided courtesy of Catherine Chan at HDR, illustrate what building data looks like when it is scaled up to hundreds of records. They also illustrate how flexible Revit and Access can be in creating special-purpose forms and reports for inputting and distributing data.

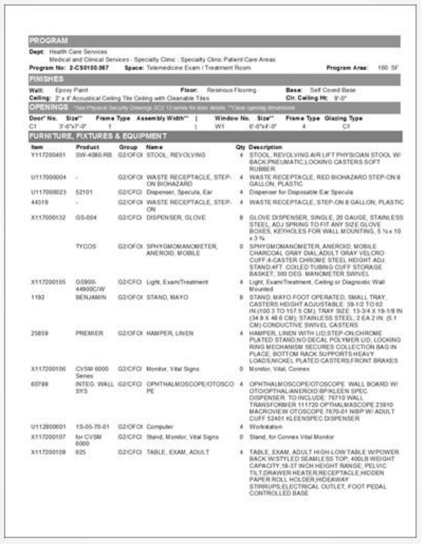


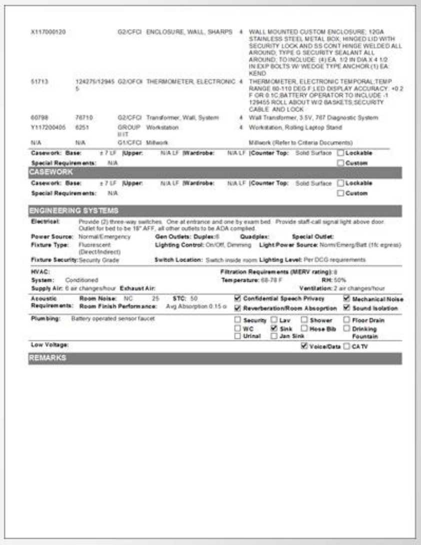


Area 110.00 SF
Perimeter 42' 4"
Unbounded Height 10' 0"
Volume Not Computed
Computation Height 0' 0"
Identity Data
Workset Workset1
Number 2-CS0100.099.01
Name EXAM / TREATMENT ROOM
Room Style (none)
CBC 1004.1.1 (none)
Department Health Care Services
Base Finish Self Coved Base
Ceiling Finish 2' x 4' Acoustical Ceiling Tile Ceiling ...
Wall Finish Epoxy Paint
Floor Finish Resinous Flooring
room code HEALTH CARE SERVICES (2-CS0100)
program area 110.00 SF
Sub-Department Medical & Clinical Serv. - Facility "A"...
ProgramID 2-CS0100.099

Images courtesy Catherine Chan - HDR

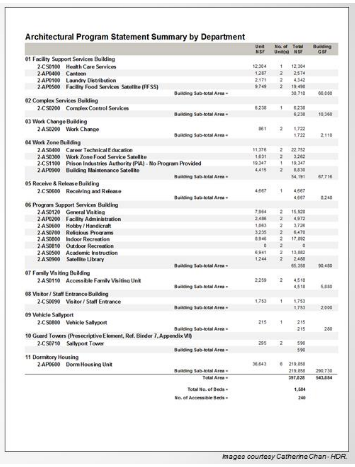

2-CS0100.067 Health Care Services Telemedicine Exam / Treatment Room
CEILING MTD. EXAM LIGHT
PATIENT BED
OPHTHALMOSCOPE
1/4" = 1'-0"



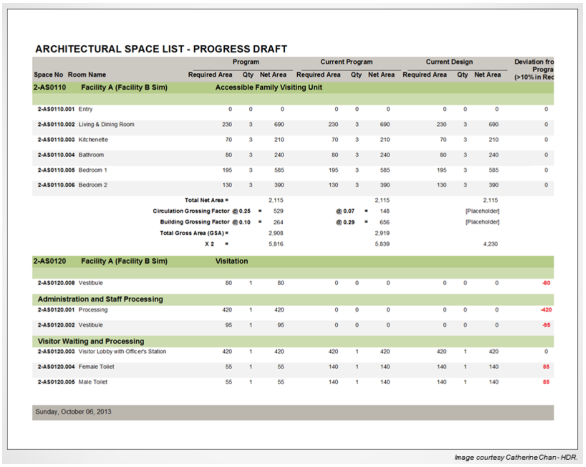


Images courtesy Catherine Chan - HDR.

Architectural Program Statement
01 Facility Support Services Building
2-CS0100 Health Care Services



Images courtesy Catherine Chan - HDR.



ARCHITECTURAL SPACE LIST - PROGRESS DRAFT

		Program			Current Program			Current Design			Deviation fro Progra (>10% in Rec
Space No	Room Name	Required Area	Qty	Net Area	Required Area	Qty	Net Area	Required Area	Qty	Net Area	
2-AS0110	Facility A (Facility B Sim)	Accessible Family Visiting Unit									
2-AS0110.001	Entry	0	0	0	0	0	0	0	0	0	0
2-AS0110.002	Living & Dining Room	230	3	690	230	3	690	230	3	690	0
2-AS0110.003	Kitchenette	70	3	210	70	3	210	70	3	210	0
2-AS0110.004	Bathroom	80	3	240	80	3	240	80	3	240	0
2-AS0110.005	Bedroom 1	195	3	585	195	3	585	195	3	585	0
2-AS0110.006	Bedroom 2	130	3	390	130	3	390	130	3	390	0
	Total Net Area =			2,115			2,115			2,115	
	Circulation Grossing Factor @ 0.25 =			529	@ 0.07 =		148			[Placeholder]	
	Building Grossing Factor @ 0.10 =			264	@ 0.29 =		656			[Placeholder]	
	Total Gross Area (GSA) =			2,908			2,919				
	X 2 =			5,816			5,839			4,230	
2-AS0120	Facility A (Facility B Sim)	Visitation									
2-AS0120.008	Vestibule	80	1	80	0	0	0	0	0	0	-80
Administration and Staff Processing											
2-AS0120.001	Processing	420	1	420	0	0	0	0	0	0	-420
2-AS0120.002	Vestibule	95	1	95	0	0	0	0	0	0	-95
Visitor Waiting and Processing											
2-AS0120.003	Visitor Lobby with Officer's Station	420	1	420	420	1	420	420	1	420	0
2-AS0120.004	Female Toilet	55	1	55	140	1	140	140	1	140	85
2-AS0120.005	Male Toilet	55	1	55	140	1	140	140	1	140	85

Sunday, October 06, 2013

Image courtesy Catherine Chan - HDR.