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THE ESP-r COOKBOOK

Exercises for Deploying Virtual Representations

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Table of Contents

ABSTRACT

This *Cookbook* uses the general purpose simulation suite ESP-r as a platform to explore *strategies* for deploying virtual representations of the built environment to answer questions posed in the real world of design and research groups.

The *Cookbook Exercises* helps you increase you skills at translating client questions into virtual representations that are no more and no less complex than is required for the task. The exercises use the power of pencils and paper to complement the interface. And just like the main volume you might pick up some new definitions of the word QA.

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1 Introduction

The following practical exercises are intended as a complement to the strategy focus of the main body of the ESP-r cookbook. The exercises assume no particular proficiency with ESP-r or other dynamic simulation tools, only basic operating system skills in working in folders, managing files and running applications.

The exercises make reference to sections of the May 2008 ESP-r Cookbook to create a two zone model of a portion of a medical building. It includes a sequence of planning and keyboard tasks and the result will be a working model from which general building performance issues can be examined. To save time read each exercise in full before you do the tasks in the exercises. The tasks are given in a specific order and work best in that order.

Time required

In training workshops, participants tend to complete the first dozen exercises on the first day. In a self-paced environment 12 hours (including time to read the Cookbook) should suffice.

Preparation

Download the ESP-r Cookbook from the ESRU web site <http://www.esru.strath.ac.uk>. Work with a hard copy of the Cookbook and these exercises to facilitate note taking and to free up space on your screen. Have a notepad available to record assumptions and sketch paper for recording plans and dimensions. The exercises ask that you grab images at specific points so ensure you know how to grab a section of the screen and save it to an image file.

About files

Most ESP-r model files are ASCII text and can be viewed with a text editor. If you modify any of the files save as text rather than the native format of the word processor. On Windows use Word-Pad. On Linux/Unix nedit works well and on OSX bbedit works well. Transfer of text files between non-Windows to Windows computers can be automated by the use of scripts that come with the ESP-r source distribution.

Convention used

Commands that you type in are shown in bold courier text like this: **`cd`** Selections that you make in ESP-r menus are in italicized courier text like this: *`Model management ->Model management -> new mode`* where the first phrase is the menu title and the text after the **`->`** is the option to be selected. Note: the ESP-r interface is evolving so key phrases used in the exercises may not exactly match the interface.

1.1 Exercise one: Installing ESP-r

Read the Install Appendix and the Version Appendix of *The Cookbook* and review the requirements of ESP-r for your particular computer type and operating system.

Tasks:

- If ESP-r has already been installed on your computer you can test it out by following the instructions on the first page of Chapter 2
- If ESP-r has not been installed on your computer ask your instructor for specific instructions about installing ESP-r. If you are provided with one of the standard installers then follow the instructions which come with that installer.
- If you are installing from code then there are a number of steps required to checkout the current code from the source code repository in Canada and prepare your computer for the process. Ask your instructor for these instructions or look them up on the ESRU web pages <<http://www.esru.strath.ac.uk>>.

Additional reading:

Installation from source is based on a source code control environment called *subversion*. Subversion clients are available for all operating systems. The repository of ESP-r is maintained by a group in Natural Resources of Canada in Ottawa, Ontario. Assuming you have an svn client on your machine getting the code is a single command in the form of:

```
svn export https://esp-r.net/espr/esp-r/branches/development_branch
```

If you are going to be working with source code then you need to do a literature search for the terms *subversion* and *svn*.

Notes

1.2 Exercise two: Register an initial model

Read the first section of the chapter 2 'Building a model'. Models should be created in a folder which you have permission to manage and which is separate from the ESP-r modules and databases and training models. The path to the model folder should be short (ESP-r has a fixed limit to file names). Avoid spaces in folder names if possible.

Typical locations are:

- Unix/Linux/Cygwin in a folder named Models within your home folder (e.g. /home/ralph/Models)
- OSX in a folder named Models within your home folder (e.g. /Users/ralph/Models)
- Windows 2K/XP in C:\Esru\Models or C:\Models or D:\Models and if you have no other choice then use C:\Documents and Settings\user_x\Models

Task:

- Use your operating system to create the Models folder if it does not already exist.
  On Unix/Linux/OSX/Cygwin you should start up a graphic terminal (e.g. xterm) and go to the Model folder and issue the following command to start up the Project Manager:
  `esp-r`
  On Windows 2K/XP use Windows Explorer to focus on the Model folder. If it is C:\Esru\Models then there will already be an esp-r.cmd file which you can click on to start the Project Manager. If it is a folder you have created then copy the esp-r.cmd file into your Model folder and click on it (Not the prj.exe executable file).

Task:

- Once the Project Manager has started select `Model management -> new model` and provide a root name (with no blanks) for the model. The root name should be descriptive such as GP_offices or Bell_Str_Laboratory (see Figure 2.1).

Task:

- Provide a description of the model. This phrase will be displayed at the top of the graphic display and in reports so a phrase such as "Portion of doctor surgery and waiting room in Birmingham base case" is more helpful than "My first model".
  A text document/log file is also created as part of the initial setup and you can also edit it to include any notes and assumptions that are relevant to the project.

Figure 2.3 shows the model attribution steps that are required next.

Task:

- Reference photographs and images associated with the model. You will be asked if you have any images that you want to associate with the model (perhaps a site map and some site photos). Say no. In the future you can use this facility to add such images.

Task:

- Define the location of the simulation project. You will be asked for the site latitude and then the so-called longitude difference from the local Meridian for the time zone. For this exercise accept the default. Later when you select a climate file this information will be updated.

If you are in any doubt about one of the dialogues, click on the help button to find out more about the item. For example Birmingham is roughly at 52.4 North and -1.73 (West) from the Greenwich Meridian.

You will be asked for the year of the assessment. The help button provides some hints about year choices. For this exercise take the default.

Save what you have via Model management -> save model

Notes

1.3 Exercise 3: Select and explore climate data

Read the section 2.1 "Review of climate patterns and databases" in preparation for the exercise. There are several tasks involved in selecting a climate file and then reviewing the contents of the file to see if it is suitable for your needs.

Task:

- Identify a specific climate file and open it for investigation. The steps shown in Figures 2.5-2.8 identify the Birmingham climate file and start up the climate analysis module. When the climate module starts your first task is to confirm the file name (just click OK).

Task:

- Explore climate patterns via graphs. The options in the climate module support exploration via synoptic analysis, graphical analysis, psychrometric analysis and a one day table analysis. Use `Climate Analysis -> graphical analysis -> dry bulb temperature -> draw graph` to look at the temperatures over the year (as in Figure 2.11). Zoom in on the month of January via the graphical analysis -> set period option and redraw the graph. Add other items to the graph.

Task:

- Explore climate data via synoptic analysis. Choose the winter seasons and look for weekly average values of dry builb temperature as in Figure 2.9. Use `Synoptic analysis -> dry bulb temperature -> average values` to get the daily statistics for the month. Use `Synoptic analysis -> dry bulb temperature -> degree days -> weekly -> 17.0 heating base temperature -> 21.0 cooling base temperature` to report on the weekly heating and cooling degree days. Either look again selecting the daily option or use the set period option to choose a longer period and re-generate the report.

Task:

- Use a frequency analysis to explore climate data. Select January and look at the frequency of outside ambient temperatures via `Synoptic analysis -> dry bulb temperature -> frequency histogram -> fixed width -> 1.0 bin width -> default bins -> frequency bins`

Task:

- Use psychrometric analysis to explore temperature and humidity data. Another view of climate data is psychrometric analysis (Figure 2.12). Select the month of March and then `Climate Analysis -> psychrometric analysis -> plot data -> colour by temperature.` Task:
- Do the same again but choose `-> plot data -> colour by RH`

Exit from the climate module.

Notes

1.4 Exercise 4: Review materials database

This exercise explores materials used in buildings and creates a new material for use in your building. The following steps will open up the standard materials database so you can browse it and after you have a look around you will get a copy of that database for your model and then create a variant of a floor tile.

Remember that if your version of ESP-r is installed in a different location you may not see the same paths as shown in the *Cookbook* figures. If it has been installed correctly it will know the location of the standard databases.

Read sections 1.2 and 1.8 of the *Cookbook* to find out the model context that the databases will have to support. We will be using some existing database entities and we will also have to create some new materials and constructions prior to creating the zones of our model.

Task:

- View available materials in the concrete classification. To view all of the available concrete materials use: `Model management -> database management -> materials -> browse/edit -> Concrete`
- Question: What is the highest and lowest conductivity? Task:
- Look at the classification Insulation materials and check out the range of density.
- Question: What is a typical density for light-weight concretes?

Task:

- Identify a specific tile material and note its properties. Look at the classification `Tiles` and locate and write down the properties of Concrete tile.

If our client wants to use a Concrete tile in the examination room which has a solar absoprtivity of 0.45 instead of 0.65 then we need a *new material*.

Task:

- Get a copy of the standard materials database. To avoid corrupting the standard database we want to get a COPY of the standard database into our model folder and then CREATE this variant tile. Use the following steps: `Model management -> database maintenance -> materials -> copy standard`
  `-> (accept suggested name)`

Task:

- Select the Tile category and the `copy material` option. Choose Concrete Tile (as the source) and a new item will be added to the end of the list. Select the NEW ITEM and alter its Name (e.g. White_conc_tile) and its note/description (e.g. White concrete glazed tile) and then alter its absorptivity to 0.45. When you exit confirm your changes.

Task:

- Save database. Choose the `save materials database` option so as not to lose the new tile.

On some computers, when you exit the materials database you will get a message to confirm creation of an ASCII version of the database and you should agree. The ASCII version acts as a backup and is useful when moving models between computers. Newer versions of ESP-r use an ASCII version of the materials database and you are not asked the additional question.

Notes

1.5 Exercise 5: Review constructions database

Read the sections 1.8 and 2.2 "Locating constructions for our model" before you browse the standard constructions database. Also study Figures 2.13 and 2.14. Many companies will have already created one or more constructions databases for use in their projects. For this exercise we will mostly use the existing entities.

The following general types of constructions will be required for the model:

- an exterior wall
- an internal lightweight partition
- double glazing for the windows
- a floor which includes some ground layers
- a ceiling for the sloped roof of the examination room which also acts as a roof
- a ceiling for the reception

Task:

- Based on the building standards in your region consider what typical constructions for low-rise institutional buildings. Write down a description of each required construction. If you have a standard form for recording the details of your constructions fill them in before you use the keyboard to enter the data.
  Include in your notes the order of layers and their approximate thickness and, if available, the type of building code standard that the construction must meet. This is an important QA step. The construction database does not yet hold this critical information - it is your task.

Task:

- Browse the standard constructions database. To browse the standard database: `Model management -> database maintenance -> constructions -> browse or edit db`
  To look at the details of a construction select the item from the menu and you will see a menu like Figure 16 along with a report in the text feedback area with more details of the layer composition.

Task:

- Understand layer ordering in the constructions database. From a vantage point within an ESP-r zone, the ordering of layers in a construction is from the other side (e.g. outside) to the inside face. The interface identifies construction layers as: SYMMETRIC or NONSYMMETRIC or LINKED WITH XX (where XX is the name of another construction).

A symmetric construction is the same composition of layers whether viewed from the outside face or the inside face. For example a partition made of 12mm plaster, 100mm block, 12mm plaster is symmetric. Such a construction can be specified in each of the rooms associated with the partition.

A NONSYMMETRIC construction is different when viewed from the outside face or the inside face. For example the structure between two floors (from below) might be plasterboard, air gap, plywood, carpet. From the room above the order needs to be reversed. ESP-r supports the concept of a pair of constructions, one with an inverted layer order, each referencing the other. Some NONSYMMETRIC constructions are not linked â for example an exterior wall construction is only referenced from within a zone.

- Question: If you were asked to add a large display board to one side of a solid concrete partition what would you have to change to update the model. Think about this. In what ways would a display board alter the thermophysical characteristics of this zone. What about the zone on the other side of the concrete partition?

When you understand these rules of ordering go to the next task.

Task:

- Identify existing constructions to use in your model. Within the list of constructions identify in your notes the names of the constructions which can be used 'as-is'.
  For example, the construction extern_wall could be used as it is for institutional low rise construction. You would not want to select intern_wall because it is NONSYMMETRIC. The construction partition is not really light weight but int_part is light weight.
  The sloped roof could use the construction named roof. It is a pre-built metal roof type.

Task:

- Identify constructions which require modification. Identify in your notes the names of the constructions which might be useful if they were altered (or copied and then modified).
  For example, the flat roof named roof_1 represents a very old construction type but it could be upgraded by the inclusion of some insulation between the roofing felt and the light mix concrete.
  The construction floor_1 could be copied and modified to include our new concrete tile to the inner layer.

Task:

- Make a project copy of the standard construction database. When you have your list return to the Project Manager to grab a copy of the standard database for your model: `Database Maintenance -> constructions -> copy the default database.` Confirm the suggested file name (based on the model root name) and you will be presented with the list of constructions.

Task:

- Copy and modify an existing floor_1 construction. For this exercise take one of the existing constructions which is almost what you want and make a copy which you will give a new name and then adapt it to your requirements. Task:
- In your newly copied database select floor_1 and copy it and name the copy office_floor.

Task:

- Before you make further changes save the new local database. If you make an error you can recover easily if there is a backup of your initial local database.

Task:

- Take the new office_floor construction and `insert at inner layer` the new white concrete tile. You will be asked the thickness of the tile. 10mm is ok for this exercise.
  Save the constructions database.

Task:

- Insert insulation in the flat roof. Make a COPY of the construction roof_1 and call it flat_roof. The task is to insert a layer within the construction. If you select to add a layer and indicate the insertion point is at the light mix concrete. You will be asked for what to insert so browse the materials for Insulation materials and look for Roof insulation board. Again you will be asked for a thickness - 80mm is a good initial guess and it results in an ISO 6946 U value of 1.024.

Task:

- When you are done (most important) save the database and update your notes so that when it comes time to attribute the surfaces you can easily select the appropriate constructions.

Notes

1.6 Exercise 6 Review optical properties

Constructions are considered to be transparent if they include an optical properties attribute other than `OPAQUE.` Details are held in optical properties databases. The Cookbook does not have much to say (yet) about optical properties. This exercise is about browsing the optical properties database.

Task:

- Select the standard optical properties database. As you would other databases, select the `browse or edit this file` and a list of existing optical property sets are displayed.

Task:

- Look at a single glass item and a double glazed item. Notice the differences between these sets. Optical sets hold information about overall characteristics and layer characteristics.
- Question: What is the typical absorption of the outer and inner glass layers of the double glazed item in comparison with the absorption of the single layer of glass?

Task:

- Review how two optical sets represent a blind at different states. Look in the optical sets and find **Clear float 76/71 6mm open mid blnd** and **Clear float 76/71 mid blnd** in the list. Notice the differences in the optical properties, especially the higher absorption of the centre layer.

Task:

- Review how constructions database items point to optical sets. Go back to the constructions database and locate one of the transparent constructions. Notice that it has an optical set name attribute. Notice also that the number of layers in the construction and the number of layers in the optical set it references are the same.

The data within the optical database are based on calculations made outside ESP-r, for example data from the WIS application or the Window 5 application from LBL. The standard database is somewhat limited and it is up to you to fill in additional sets of optical properties. Creating a new optical set is the topic of a later exercise.

Notes

1.7.1 Exercise seven (first part): Model planning and initial sketches

Read the section 1.2 'The client specification' and review the layout of the two rooms in the wire-frame and the dimensions in the plan and section of Figure 1.1. Also read the section 1.4 'Model planning' and section 1.5 'Model coordinates'.

Tasks:

- convert the dimensions in Figure 1.1 into model X Y Z coordinates and add them to your sketch of the model.
- double check that your coordinates match those shown in Figure 1.8. If in doubt ask.

Additional reading:

Translating plans and sections into simulation models is discussed in section 1.5 so this is a good section to return to after you have some initial skills. Although not required for this exercise the information in sections 1.6 and 1.7 will be applied and if you read it now it might be clearer what you are being asked to do in later exercises.

Notes

1.7.2 Exercise 7 (second part): Preparation & creating a zone

Read the section 2.3 âZone composition tacticsâ. This exercise and the ones that follow are your chance to discover useful working practices. If possible, revisit the exercises to try alternative approaches and to increase proficiency.

The exercises are designed to show you how to re-use components as well as how to complete tasks by creating and discarding components.

Read the whole exercise before you start on the tasks. Find out how how to backup models using operating system commands. This will reduce the stress of this exercise. Experts make frequent backups as they evolve their models.

Task:

- Adding surface names to your sketch. On your sketch write down the names you are going to give your surfaces in both of the zones. This documentation forms a critical QA function. It will help others review your model and provide clarity while you are creating the zones. There is no excuse for skipping this step. Ever.

Read the section 'Defining the reception' (the L shaped room) and study Figures 2.16-2.20. Do the tasks in the order they are presented in the text.

Task:

- Create the reception. Take your time â some functions do not have an undo option. Look at what you have typed before you hit the ok button.

HINT: when creating a zone from a floor plan extrusion go anti-clockwise when looking at the plan of the zone. Compare the following coordinate pairs with those shown in Figure 2.17. What is the pattern?

```
0.0 4.0, 4.0 4.0, 4.0 0.0, 8.0 0.0, 8.0 7.0, 4.0 7.0, 0.0 7.0
```

When you are done the interface should look like Figure 2.19 and Figure 2.20.

Task:

- Record your progress. Take a screen capture of the wireframe image for later reference.
- Find the save option on the menu and use it.

You might have found this exercise a bit of a challenge and took longer than you expected. It does get easier and much faster as you practice your techniques.

Notes

1.8 Exercise 8: Adding doors, windows and attributes

Read the section âInserting doors and windowsâ. It reviews the process of extracting useful information from the client brief and plans as well as selecting which architectural elements are useful to include in a thermal model.

Task:

- Confirm window sill and head heights. If not already included in your sketch, note the window sill and head height so you can check the model after you insert the windows.

Task:

- Insert windows into Wall-3Wall-3 and Wall-5Wall-5. The Cookbook text suggests beginning by inserting the window into Wall-3 and it suggests that you rotate the wireframe so that you are facing Wall-5 before you insert the second window.

Later you might find you can do without this step. A preview of the window to be punched into the surface will be given â if you have **any doubts just say no** and refine the dimensions you supply.

Task:

- Attribute the window construction. After you accept the position you will be asked to attribute the window construction as per the glazing that you identified in Exercise 5.

Task:

- Review the changes in the original Wall-3. Notice the diagonal line from the lower corner of the parent surface to the window. Where did that come from? Have a look at the list of vertices that make up the edges of Wall-3. There are no longer 4 vertices but 10. Wall-3 wraps around the polygon that forms the window.

Look at Figure 2.27 and imagine a pen-plotter that starts at vertex 3 and traces around the surface anti-clockwise looking from the outside until it gets back to vertex 3 a second time and then goes diagonally to vertex 15 and then clockwise around the window. The edge list for the new window go anti-clockwise and this demonstrates one of the geometric patterns used by ESP-r.

Surfaces which share a line always do so with their edges defined in opposing directions. Check out the other shared lines in the zone to confirm this. Also you should notice that the interface displays zone fully bounded rather than XX problem edges.

Task:

- Add the door. There is a door between the examination and reception. Following the dimensions in your sketch supply the offset from the lower left corner of the wall as well as the door width and height. A door is added by using the `insert at base` option rather than the insert within option. The insert at base option also updates the floor polygon to include the two points where the lower door edge is in contact with the floor. Of course, if your door starts above the floor then you can use the `insert within` option.

Task:

- Attribute surfaces with names. You next task is to give the surfaces names based on your earlier documenting of the sketch exercise. Follow the instructions in the text and use the attribute many function, first for the names and then for constructions.

As with Figure 2.29, as you add attributes to the surfaces the model becomes more and more self documenting. Making your client and colleagues work hard to understand your model is not a good business strategy.

Task:

- Record your progress and check your work. Take a screen shot of the zone when you have completed the surface name and construction attribution.
- Have someone else compare this with what is in your sketch.
- Question: Ask the person who looks at your sketch to also look at your model on the computer. Ask them to quickly locate the floor in one of the rooms.

Task:

- Save your work. At this point it is an especially good idea to save your model. If you are working on a Unix or Linux or Mac OSX machine or within the Cygwin environment of a Windows PC then you can ask the Project Manager to archive the model: `Project Manger -> archive current model.` If you are using the Native Windows version then create a zip file of the model folder hierarchy.

Notes

1.9 Exercise 9: Adding the examination room

Read the section âAdding the examination roomâ. The purpose of creating this second zone is to demonstrate starting with a simple shape and transforming it.

Task:

- Create an initial box-shaped zone

Look at your sketch and, step by step, follow the instructions for creating the initial box shape (Figure 2.31).

Task:

- Add a slope to the roof

As noted in the Cookbook in Figure 2.32, edit the Z coordinates to create a sloped roof.

Task:

- Identify where a surface has two boundary conditions

The second purpose of this exercise is to highlight the rule that 'every surface has one boundary condition'. The extension of the roof has transformed three of the surfaces in the room. Only one of them can conform with the rule without modification. Which two surfaces are problematic?

Task:

- Delete the two problem surfaces

Follow the instructions for deleting the two surfaces in the examination zone and look at Figures 2.32-2.34. Note that the menu now includes a warning that there are problem edges. This is a transient condition which will be resolved shortly. However, if you notice this warning at other times you should investigate.

Task:

- Importing surfaces from another zone

The third purpose of this exercise is to demonstrate reuse of information from another zone. Following the instructions in the Cookbook, copy the three relevant surfaces from the reception zone (two partitions and the door as per Figure 2.36). Hopefully, the surface names used in the examination room made it easier to copy the correct surfaces. Notice that these surface names and construction attributes have been copied as well (saving you keystrokes). In a model with several dozen zones and a thousand surfaces â such keystroke savings add up.

Task:

- Creating surfaces with existing vertices

The fourth purpose of this exercise is to demonstrate how to use information within the zone to create surfaces from existing vertices. Rotate the wireframe if it helps you to correctly visualize how you are going to add in the remaining surfaces. Follow the steps in the Cookbook and look at Figure 2.37, remembering the rule that the order of the edges should be anticlockwise when viewing the zone from the outside. If possible the initial edge of a surface should be along a lower horizontal edge rather than a vertical edge (the shading analysis can be incorrect otherwise).

Task:

- Attribute the surfaces in the examination room.

The final step in creating the examination room is to attribute the surface names and their constructions (see Figure 2.37). Before you start typing, consider that some of the surfaces are already attributed â would it be quicker to select each of the incomplete surfaces and edit both the name and construction or use the attribute many approach?

At the end of this exercise the only UNKNOWN surface attributes should be for boundary conditions.

Task:

- Save the zone and archive the model

Usually the interface will have noticed that changes were made and will remind you. The key word is usually. Before you exit the zone geometry ensure that you have used the save option. Archive your model again using a technique appropriate for your computer type. This time give the archive file a slightly different name (use whatever naming strategy works for you).

Notes

1.10 Exercise 10: Defining boundary conditions

Read the 'Model topology' section. You might have noticed in the surface attributes an environment option (see Figure 2.39). In ESP-r surfaces have an attribute which stipulates what happens at the 'other face'.

Sometimes this is referred to as a boundary condition, sometimes as topology and sometimes as the other-face-environment. If two surfaces in separate zones reference each other as boundary conditions, heat can flow between the two zones during the simulation.

Task:

- Review supported types of boundary condition

What are the other boundary condition attributes are available in ESP-r? Where would you find this out within the interface? Discuss and write down a brief definition for each of the following:

```
Exterior _____________________________________________
Dynamic/similar ______________________________________
Static _______________________________________________
Surface in another zone ______________________________
Ground (standard profile) ____________________________
Ground (user defined) ________________________________
Adiabatic ____________________________________________
```

Task:

- Locate a surface which should use Dynamic/similar

Look at your notes and refer back to the information in Figures 1.1-1.2. The North wall of the reception was separated into two surfaces for a purpose â the portion of the wall with the window faces the outside while the other faces a room that has not been geometrically defined but which we are assuming has the same environmental conditions as the reception. This is a situation where the dynamic/similar attribute is useful.

Task:

- Automatic discovery of partitions

Use the topology facility as per the instructions in the Cookbook in Section 2.4 to help you attribute the boundary condition of each of the surfaces in the model.

Hint: the interface of steps quickly through the surfaces that it finds to match but pauses when it needs your confirmation.

As the topology facility checks surfaces in the model, some of the existing attributes of surfaces will be updated as well as the master 'connection' list. Once you finish with the topology tool you are asked if you want to use the revised information within your model (answer yes).

Task:

- Review changes in zone geometry

Return to the examination room geometry and look at the attributes of the surfaces and you should see that all of the attributes have been filled in and there are no UNKNOWN attributes.

Task:

- Archive your model

At this point it is a good idea to archive your model again. The habit of archiving your model as you progress allows you to recover your work if you have a problem or as a safety net if you are exploring a new facility. Experienced users rarely if ever lose more than a half-hours work. Consider also what might happen if your computer crashed. What you you have to do to carry on with your model? For many, the archive step would also insure against computer crashes.

Additional Task:

- In workshops this would be the point where the instructor would say "take a coffee break and when you come back try to recreate this model geometry and composition based on your notes and see how far you can get in 30 minutes. Don't bother attributing every surface, just do as many steps as possible in the 30 minutes".
  And most participants are able to get a lot done in 30 minutes. See what you can do!

Notes

1.11 Exercise 11: Alternative geometric input

If you are using the Native Windows version of ESP-r or the GTK graphics version you cannot do this exercise because the facility has not been ported.

Read the whole of the 'Geometry revisited' Chapter. If possible get an experienced user to demonstrate how to create zones via the click-on-bitmap facility. This is one part of ESP-r where practice is required to gain proficiency in the steps needed to create a sequence of zones. It is also a facility where planning is especially important and where failure to plan can result in wasted effort. Once the techniques and planning required are mastered, a session with a dozen zones should be possible.

As the text notes, room layouts which are based on a fixed grid are well suited to the alternative approach. At the other extreme, non-orthogonal layouts which are especially tedious to define can be created rapidly (with some loss of accuracy).

Read this whole exercise before you start the tasks.

Task:

- Create three box shaped rooms and a corridor. The *Cookbook* does not mention this tasks, this is an additional exercise. Start your planning by sketching out three adjacent boxes, each 3.0m wide by 4.0m deep by 2.7m high with a passage running behind them which is 1.0m wide and the same height. Include on your sketch the major X Y co-ordinates. When it comes time to actually create the model you will be using one of the pre-defined bitmaps with a grid in the click-on-bitmap facility. To know which grid to use it helps to have already identified the critical co-ordinates. And for QA purposes the information on your sketch will make it easy to confirm that your point selection was correct.

Task:

- Exit from the Project Manager and begin a new model called test_boxes. Call the zones box_a, box_b, box_c, box_d. The point of the exercise is to master the sequence so (for this one time only) accept the default names for surfaces.

Task:

- Link the zones. Once you have the four zones use the topology tool to define the boundary conditions and when you return to the project manager look at the geometry of box_b to confirm that the left and right surfaces have been connected to the adjacent zones.

Task:

- Record your progress. Take a screen shot of your model.

Additional task:

- There is a lot of information about your zone that is not included in a single screen shot. Make a list of the types of information that are not included and for extra credit locate at least one place to look for such information. Is it a report or is it something that you can take a screen shot of?

The next exercise will show you additional ways of recording the state of a model.

Notes

1.12 Exercise 12: QA

There is no section in the Cookbook titled QA. Core strategies in the Cookbook; that intentional naming of model entities and documentation clarify the contents of a model, and working practices such as the frequent archiving of models will limit the risk of data loss are all a part of QA.

Task:

- Generating a QA report of the model

The first part of this exercise is to generate a QA report on the model: Model management -> browse/edit/simulate -> reporting and toggle to verbose the databases option as well as selecting all of the zones in the zone selection option. Next select the toggle report >> text feedback and finally select the generate report option.

Task:

- Review the report

Open up a text editor with the QA report. The report is intended to be read in conjunction with browsing the model in the Project Manager and your initial sketches.

Spend a few minutes looking at the report and then ask someone else to spend five minutes reviewing the report and model and your planning sketches. If possible, review another person's model to see if you can spot inconsistencies. Expert users get other people to check their models. Groups who use simulation professionally will have policies and procedures for model checking. This is done not only to reduce risk but to ensure that models are sufficiently clear and well documented to be easy for others in the design/research team to understand.

Notes

1.13 Exercise 13: Schedules

Read the section of the cookbook called 'Schedules'. In this exercise you will review and update your notes about what is happening within the rooms that you have created and attributed in terms of geometry and construction.

Task:

- Create graphs for daily occupancy lighting and small power

In your notebook create graphs of the weekday, Saturday and Sunday schedules for occupancy and lights and small power in a similar style to Figures 1.9-1.10. Planning pays. You will be asked for the number of periods on each day and the start time of each period and it takes a lot less time to type in the correct data. Follow the sequence of steps for filling in the remaining details of the casual gains in the reception.

Task:

- Define infiltration

The client brief had little to say about how tight the facade was and the Cookbook states that infiltration is assumed to be 0.5 ac/h all hours on all days as an initial approximation. Follow the steps in the *Cookbook* to define the simple infiltration schedule.

Task:

- Check your work

Create another QA report (give it a slightly different name) and compare it and the graph of schedules with that shown in Figure 5.4.

This exercise is intended to show how one might start from scratch to define what is happening in a room and to use the QA report to provide a record of changes.

Optional Task:

- Importing operational data. Those who use ESP-r on a regular basis will find ways to re-use existing operational schedules. As an option create an alternative operational file for the examination room and explore the option to import schedules from another zone or from a standard pattern.

Notes

1.14 Exercise 14: Zone constructions

There is no section (yet) in the Cookbook setting out strategies for creating the zone construction and optical property files. One attribute of each surface is the name of a construction (which is an entry in the construction database and which has further references to details in the materials and optical databases).

The simulator requires access to the raw thermophysical properties for each layer of each surface. Rather than repeatedly scanning the databases for such data at the start of the simulation, it gets these from zone construction and so-called tmc files for each zone in the model. You are in charge of the initial definition of these files. Assuming all of the surfaces have a construction attribute the process is straightforward. Subsequent changes in the model are taken care of automatically.

Task:

- Initial creation of zone construction files The initial creation of zone construction files is as follows: `Model management -> browse/edit/simulate -> zone composition -> constructions.` You will be presented with a list of zones. Each zone is annotated as not found, not defined or defined. A 'not found' annotation indicates that the file name has been set but has yet to be created. A 'not defined' annotation indicates we haven't even started. A defined annotation says the zone files have been defined and are probably up to date.

Pick a zone that is annotated as 'not defined' and select it. A dialog will be presented asking if you want to create a file and will suggest a name based on the name of the zone. Ask to create the file. If there are any transparent surfaces you will be asked to confirm the name of the so-called zone tmc (transparent construction) file which holds the optical properties. The materials and construction databases will be scanned for the named surface construction attributes and the data will be extracted. All you have to do is to select the save construction details option.

Do the same for the examination room.

Task:

- Discover the total area of exterior wall construction used

Having attributed the model it is possible to find out useful information which can be passed on to others in the design process. Create a new QA report for the model and open up the QA report in a text editor and look at the bottom of the report for the section about constructions. Add to your notes the area of each construction type used in the model.

Task:

- Check for UNKNOWN in the QA report

Before the next exercise can be undertaken scan (or use the text editor's search facility) to confirm that there is no occurrence of the work UNKNOWN in the QA report. If you find one return to the Project Manager and attempt to resolve it. If in doubt ask.

Task:

- Save and archive the model

For all the usual reasons.....

Notes

1.15 Exercise 15: Running a simulation

At this point you will have a model with full zone and operations and construction attribution. Assuming your model is syntactically correct is is possible to run a simulation.

Task:

- Define simulation parameters

Prior to running an assessment define the assessment period via Model definition -> simulation -> simulation presets. Name the simulation set 'March'. Set the simulation period for the month of March and the timesteps to one per hour. The name of the simulation results file shown in this menu is based on your model name. Accept the suggested startup days.

Task:

- Run an interactive simulation

Assuming there were no errors in your model, run an integrated simulation. The simulator will be passed the simulation parameters you just defined so accept them. In order to track the progress of the simulation find and use the monitor simulation option for the two zones and request zone temperatures. Because there is no environmental control in your model you will probably find that the predicted temperatures are somewhat uncomfortable.

Task:

- Record your progress. Capture a screen shot of a graph of ambient and zone dry bulb temperatures to include in your submission.

Notes

1.16 Exercise 16: Defining an environmental control

This exercise is to implement an environmental control in the model as ideal zone controls.

Task:

- Planning

The client specification is to maintain heating to 20C from 8h00 to 18h00 on weekdays and 10C (frost protection) at all hours on weekends and after hours on weekdays. For weekdays there will be three control periods: starting at midnight heating to 10C, starting at 8h00 heating to 20C and starting at 18h00 heating to 10C. On Saturday and Sunday there is one period starting at midnight and heating to 10C. Since both rooms have the same environmental controls you can define one control loop and use it for both rooms. No capacity was specified so use an initial guess of 2000W of heating capacity for each room.

Task:

- Begin control definition

Use the `Model definition -> zone control` facility to define the heating regime. Start by documenting the regime (use phrases such as those in the preceding paragraph).

Task:

- Create a control loop

Create a new loop and when asked about the day types choose Weekday/ Saturday/ Sunday. For this exercise we start with convective heating based on the room air temperature. The sensor is at the air in the room (the sensor index is 0 0 0) and the actuator is at the air in the room (index 0 0 0). For the week day there will be three periods of data to be filled in. Select the first period and the first task is to change the control law from free floating to basic control for heating and cooling and the interface data items will be updated. Revise the setpoint and the capacity and then select the second and third periods.

Task:

- Associate control loop with zones

A control loop is only used if it is linked with one or more zones. Find the option link zones and controls and for each zone type in the index of the control loop. Next link the zones in the model to the control loop (if you do not do this there will be no control applied to the zones). Save the control file and generate a new QA report and run another simulation to see if it is more comfortable in your model. Capture a screen shot of the temperatures in the zone as well as the heating used.

Notes