

## **Introduction to Semantic Modeling Using EXPRESS**

### **PART 1: MODEL DEFINITION AND DESIGN**

#### **Model Description**

The descriptive task can be categorized in five domains, which are:

1. **Spatial Items:** Spatial items are items that do not obtain a physical form. There are abstract items that represent function, behavior and concept of physical items. For instance, items such as workstations, desktop usages, shelf usages or job descriptions are identified as spatial items in this model.
2. **Partition Items:** Partition items are items that obtain physical form in a design layout. Partition items such as panels, miscellaneous parts of a panel, attachments of a panel and connectors for connecting panels together.
3. **Located Items:** Located Items are instances of a specific Partition Item with an explicit location. It also provides special functionalities that allow several partitioning items to be grouped as an assembly and reuse a defined assembly for many times. In some cases, a located partitioning item may need an explicit modification or a non-descriptive insertion to a located item that has already been located, located items must successfully be able to serve those purposes. Each located item will have a location point to locate the corresponding partitioning item.
4. **Catalogue Type and Selective Type:** Materials, colors and patterns are selectable features to many partitioning items. To prevent frequent modification of the model in future, those selectable features and variables are defined as many catalogues that can be accessed as external references.
5. **Project Items:** Project Items are the highest-level entities in the model. A project item marries spatial items and portioning items together. The model is compatible with various design type, for instance, the model should be sufficient enough to solve either an advertisement company design or an accountant office. To avoid frequently modification to the model, the job description will also be given as an external reference so the content of a job description will be different in many types of design.

#### **Advantage of the Model**

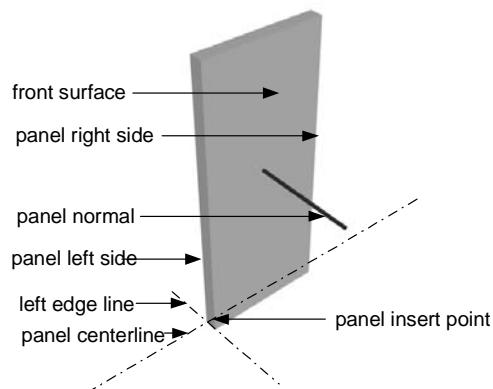
1. **External reference:** All materials, colors, patterns and surfacing are explicitly defined in many external catalogues. It allows design organization to replace their catalogues easily without modifying the model.
2. **Assembly and aggregation:** For both spatial items and physical partitioning items, the model allows user to aggregate many sub-divisions together to form a super assembly. This gives more flexibility to user to perform a complex design. For instance, sites of a project may fragmentally locate at multiple floors with irregular shapes. The model is capable to handle multiple sites for a single project and to define arbitrary shape of a site.

3. Unique identification number for instances: Each instance will obtain its own identification number among a project.
4. The model is also efficient enough to handle cases such as:
  - a. A workspace is assigned to a specific job type but the desktop and shelf is assigned individually to other job type with in a same space.
  - b. Arbitrary angle connection with panels.
  - c. Irregular site shape and irregular shape of workspace and corridor.

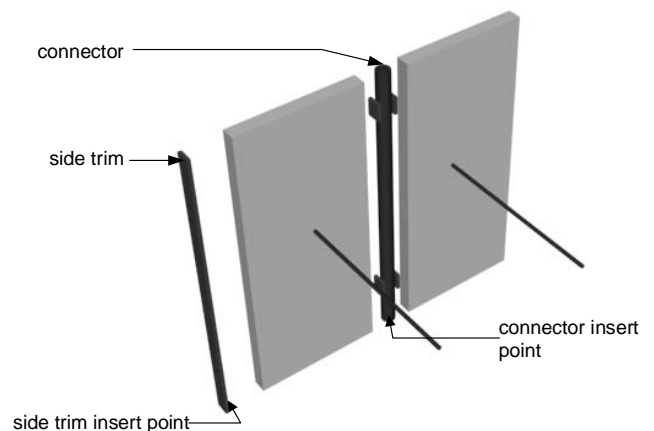
### Introduction of geometry and insert point

Each partitioning item will have one and only one insert point. For a more advanced system, it may require more flexible ways to locate a partitioning item. The following figures show how each partitioning items will be located:

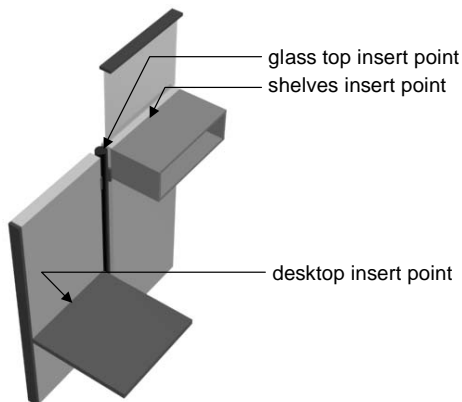
**Figure 1 Panel Insert Point**



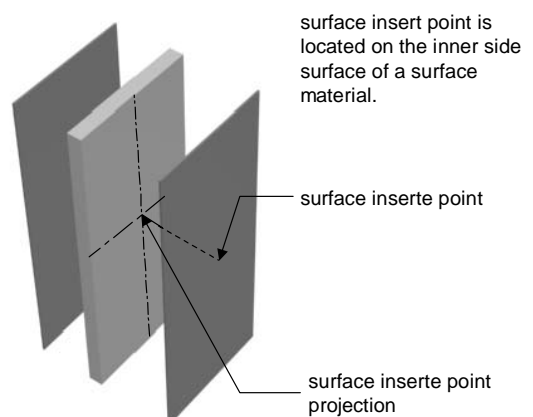
**Figure 2 Connector insert point and side trim insert point**



**Figure 3 Insert points of glass top, shelf and desktop**



**Figure 4 Insert point of surface**



## Data Dictionary

### 1.0 PROJECT

A project entity is the highest-level entity that marries both *spatial\_items* and *partition\_items* together. It carries a few general attributes that describe features of a project. Since a project is not addressed in the given task description, there are only few attributes included in a project entity that are an ID number, an optional project name and a project start date.

### 2.0 SPATIAL ITEMS

#### 2.1 SPATIAL\_ITEM

A *spatial\_item* is the high level instance that has three subtypes, a workstation space, a corridor space and a site space. A *spatial\_item* carries few descriptive attributes that includes a name field, an ID field and a description field. Each spatial item is bounded by an aggregated *LIST* of *coord\_points*. Each spatial item is assigned to a particular job description that is given from a external *job\_description* reference.

#### 2.2 SPATIAL\_SITE

A site is the periphery of a design. It is also a physical boundary of where all designed items must be located in. A project may have multiple sites and sites may not locate on a same elevation. A site can assemble with many other sites in a project. When a *spatial\_site* points to itself and defined as an aggregated *SET* of sites, it means that a site can be a composite site. Another attribute that defined in a site entity is the elevation of a site.

#### 2.3 SPATIAL\_COORIDOR

A spatial item can also be subscribed as a corridor. A corridor can be defined as a composite corridor, which means many corridors can assemble a super corridor.

#### 2.4 SPATIAL\_WORKSTATION

Similar to other spatial items, a *workstation\_child* is inherited from the workstation with using an aggregation *SET* type. Many *spatial\_workstation* can assemble another workstation. A workstation is assigned to a job type that can be selected from a given *job\_description* reference. All adjacent workstations to a workstation will be collected into another aggregation data type, a *LIST* data set, to indicate whether an adjacent workstation to is legally valid for some given constraints (from job description).

### 3.0 PARTITION ITEMS

#### 3.1 PARTITION\_ITEM

A partition item is a supertype of all partitioning entities. It carries the basic information of a partition entities hat includes an optional name field, an optional description field and an ID number.

### 3.2 PANEL

A *panel* is the most important partitioning item among others. A panel points to many entities to form an abstract design panel. The first attribute of a panel entity is a panel type that is selectable from a panel selection type. The second and third attributes are both pointing to a same entity that is a surface entity. The model assumed a panel has a front surface and a back surface. The distinction between a front surface and a back surface is based on another attribute called the *panel\_normal*, defined as a Part 42 – *direction* entity, which is a unit vector that identifies a front and back direction of a panel.

A panel optionally points to a trim entity when either a side end is not connected to any connector. A where rule is provided here, which is, a panel can place a side trim on its side edge only when the side edge is not connected to any connector. Another attribute of a panel is the type of insulation, which points to another partitioning entity, the *insulation* entity, to classify what type of insulation should be used. Another attribute of a panel is a Boolean type attribute that verifies whether the panel is a key panel or not. A key panel means that the panel is the main panel of an assembly. If a panel is a key panel, the value of this attribute will be *TRUE* otherwise it will be *FALSE*.

### 3.3 SURFACE

A panel may have two different types of surfaces so it is necessary to use a surface type entity to distinct the orientation of a panel. A surface will point to a selective surface type.

### 3.4 INSULATION

An *insulation* entity is to define what kind of insulation should be placed into the panel. The type of the insulation is selectable from an insulation catalogue. Except a selective insulation type, the *insulation* entity has a Logical attribute that tells whether an acoustic insulation is required. This requirement will determine by the location of its hosted panel and driven by a related job description that is assigned to a workspace.

### 3.5 CONNECTOR

A *connector* is a partitioning item that connects at least two panels together. A little invention has been made to solve many types of connection, which includes arbitrary angle intersections among multiple panels with multiple heights of panel. Assumed if the maximum connectivity for a connector is four (no more than four panels can intersect at one connector) and there are three different heights of panels, the total possible connectivity will be over thirty different connections. Therefore, the model will include all connection types within a selection type for a user to select (see *located\_connector* for more information).

### 3.6 TRIM

A *trim* is added onto a panel when an edge side of a panel is not connected to a *connector*. The *trim* entity refers to a color selection type. The height or width of a *trim* will derived from the panel size and determines whether a connector already had taken an edge of a panel or not. If a top glass is installed on top of a panel, the *top\_trim* attribute must not be used.

### 3.7 ATTACHMENT

An *attachment* is an abstract entity and a super type of all attachments of a panel. The *attachment* has four subclasses that are *attachment\_glass*, *attachment\_desktop*, *attachment\_shelves* and *attachment\_outlet*.

#### 3.7.1 ATTACHMENT\_GLASS

An *attachment\_glass* is a glass panel that usually located on top of a panel. The location of a top glass is assumed to align with the centerline of a top edge of a panel. The width of a glass panel is derived from the width of the hosted panel plus an offset distance to the center of a connector. The height of the glass is selectable from a glass height selection type. Another geometrical attribute is the thickness of the glass that points to a *length\_measure\_with\_unit* measurement type.

Other feature of a top glass panel will be selectable from the glass type selection.

#### 3.7.2 ATTACHMENT\_DESKTOP

An *attachment\_desktop* points to a selective *desktop\_type* that specifies some features of a desktop. A *desktop* is an entity that will have an assigned *job\_description*. A *job\_description* labels the usage of the *attachment\_desktop* to a particular job type. The width of the desktop is derived from the width of its hosted surface. There are two cutting angles for trimming a desktop surface that are indirectly returned from angles between the *next* and *previous* connected panels (see *located\_panel* at 4.3).

#### 3.7.3 ATTACHMENT\_SHELVES

An *attachment\_shelves* is an entity that describes features of shelves storage. A storage shelf is assigned to a particular job type based on a given *job\_description*. A shelf optionally may have a shelf door that attaches to a shelf item.

##### 3.7.3.1 ATTACHMENT\_SHELVES\_DOOR

An *attachment\_shelves\_door* is an optional attribute for an *attachment\_shelves* item. Features of an *attachment\_shelves\_door* will be selectable form shelves selection type.

#### 3.7.4 ATTACHMENT\_OUTLET

Features of an *attachment\_outlet* are included in an outlet specification that goes to an outlet selection type.

## 4.0 LOACTED ITEMS

### 4.1 LOACTED\_ITEM

A *Located\_item* is the highest-level entity among all located items. It obtains few basic descriptive attributes that include an optional name, an optional description field and an identification number. These instances will inherit through all subclasses of a *located\_item* entities.

#### 4.2 LOCATED\_SITE

A *located\_site* has two attributes, a descriptive site that points to a site entity and a descriptive project that indicates its parent project.

#### 4.3 LOCATED\_PANEL

A *located\_panel* has an attribute, which points to a *panel* entity. Another attribute of a located panel is an adjacent panel. An adjacent panel allows a user to traverse through linear connected panels in a *next* and a *previous* direction. The *next* and *previous* direction is based on a counterclockwise orientation. If a *located\_panel* instance does not adjacent to another panel, which is a standalone panel, the “*next*” and “*previous*” attributes will point to the instance itself. If either a next or a previous panel is void, the instance will point to the instance itself whenever an edge of a panel is not connected to a connector. Meanwhile, there are two derived attributes that indicate angles between the subscribed panel and its next and previous panel. It allows a user to define any arbitrary angle between two adjacent panels.

#### 4.4 LOCATED\_ASSEMBLY

A *located\_assembly* points to a descriptive *assembly* which is assembled by several panels and connectors.

##### 4.4.1 ASSEMBLY

An *assembly* is a set of panels and connectors. An *assembly\_child* is an abstract subtype that allows a user to define a child assembly so multiple assemblies can group together to become a super assembly.

#### 4.5 LOCATED\_CONNECTOR

When a connector is located, it should derive the connected panels and proceed a constraint checking. A constraint rule is given to check if the connector type is valid or not. For instance, if a connector is connected to six panels, a connector for four panels is invalid. Nevertheless, heights of connected panels are a crucial issue. The constraint rule must also regulate if a connector is valid with all heights of all connected panels.

#### 4.6 LOCATED\_EXPLICIT\_COORD\_POINT

A *located\_explicit\_coord\_point* is used to define an arbitrary Cartesian coordinate point. If a physical partition only obtains two panels (connected as a L shape) but its assigned workstation requires to be defined as a rectangle shape, in this case, the *located\_explicit\_coord\_point* can identify the fourth corner to complete the rectangle shape for a spatial item.

#### 4.7 LOCATED\_ATTACHMENT

A *located\_attachment* is a supertype of a *located\_attachment\_panel* and *located\_attachment\_surface*. The reason to distinct a panel item with a surface item is because a panel has two surfaces and each surface may describe different material and usage. A *located\_attachment* will carries an attribute, a descriptive panel, which point to a partitioning panel type.

#### 4.7.1 LOCATED\_ATTACHMENT\_PANEL\_TOPGLASS

A *located\_attachment\_panel* entity only has one subtype, a subtype called *located\_attachment\_panel\_topglass*, which is an attachment to a panel. The *located\_attachment\_panel* has a selectable type of top glass and a Boolean attribute that indicates whether its normal is towards the same direction with its descriptive panel. If directions with both panel and top glass are the same, then the Boolean value should be setup as TRUE. If it is opposite, then should be setup to FALSE. The only insert point of a glass panel item will be located on the centerline of the upper left corner plus an offset distance between the center of a connector (only if a connector is there).

#### 4.7.2 LOACTED\_ATTACHMENT\_SURFACE

A *located\_attachment\_surface* will have two attributes, the first one is a Boolean type attribute called *front\_or\_back\_surface* that indicates whether this located surface is the front surface of a panel or not. It will setup to TRUE if the located surface is a front surface of a panel otherwise it will be set to FALSE. The second attribute is the descriptive surface, which refers to a surface item. A Boolean attribute, *spatial\_conflick\_chk*, is a computational attribute that calculates whether the attachment is physically overlapping with other partitioning items. There must have a B-rep type intelligent to proceed this checking.

##### 4.7.2.1 LOACTED\_ATTACHMENT\_SURFACE\_DESKTOP

A *located\_attachment\_surface\_desktop* is a subtype of a *located\_attachment\_surface* that uses for locating a desktop onto a panel surface. The only attribute it has is a descriptive desktop that points to a desktop item.

##### 4.7.2.2 LOACTED\_ATTACHMENT\_SURFACE\_OUTLET

A *located\_attachment\_surface\_outlet* is an entity that decides where an outlet must locate. It also determines where the associate knockout must be placed. Similar to use a slot hole interval when locating a shelf onto a surface, the total numbers of knockout holes are derived from the width of the panel divided by interval distance. A where-rule must check whether a knockout hole is knocked out or not. If it had been knocked out already, the same knockout hole no longer can be used by any other instances of a knockout hole.

##### 4.7.2.3 LOACTED\_ATTACHMENT\_SURFACE\_SHELVES

The logic of locating shelves to a surface is similar to the *located\_attachment\_surface\_desktop* entity. The height of where to locate the shelves is derived from a slot number and an interval distance between a pairs of slot holes. The interval of slot holes is fixed in the task description, which is one-inch interval between each slot hole. The model allows a user to define customize slot holes interval as a measurement distance.

### 5.0 TYPE

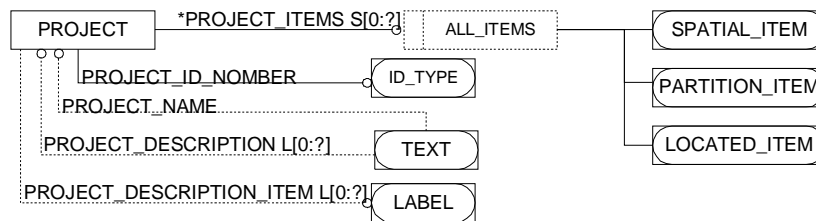
Few entities are defined in ISO 13030 Part -42. For example, a direction, a Cartesian point and a plane are all entity defined in Part 42.

### 6.0 EXTERNAL REFERENCE

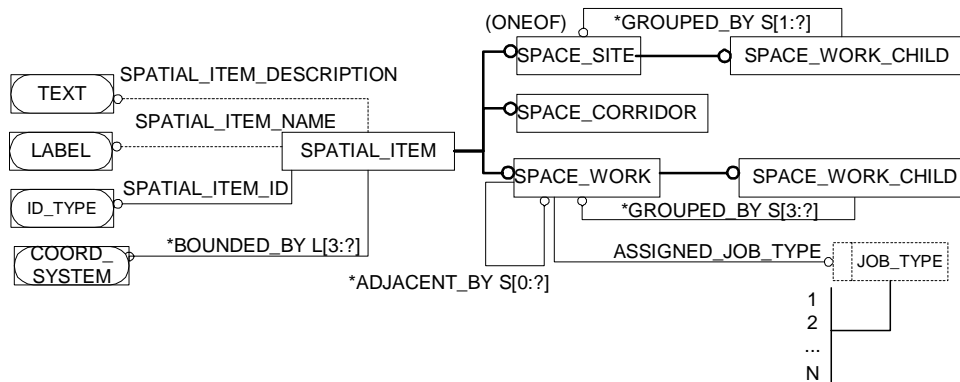
(See Diagram 5) All material and color selection will refer to external catalogues.

## EXPRESS-G Diagrams of the MODEL

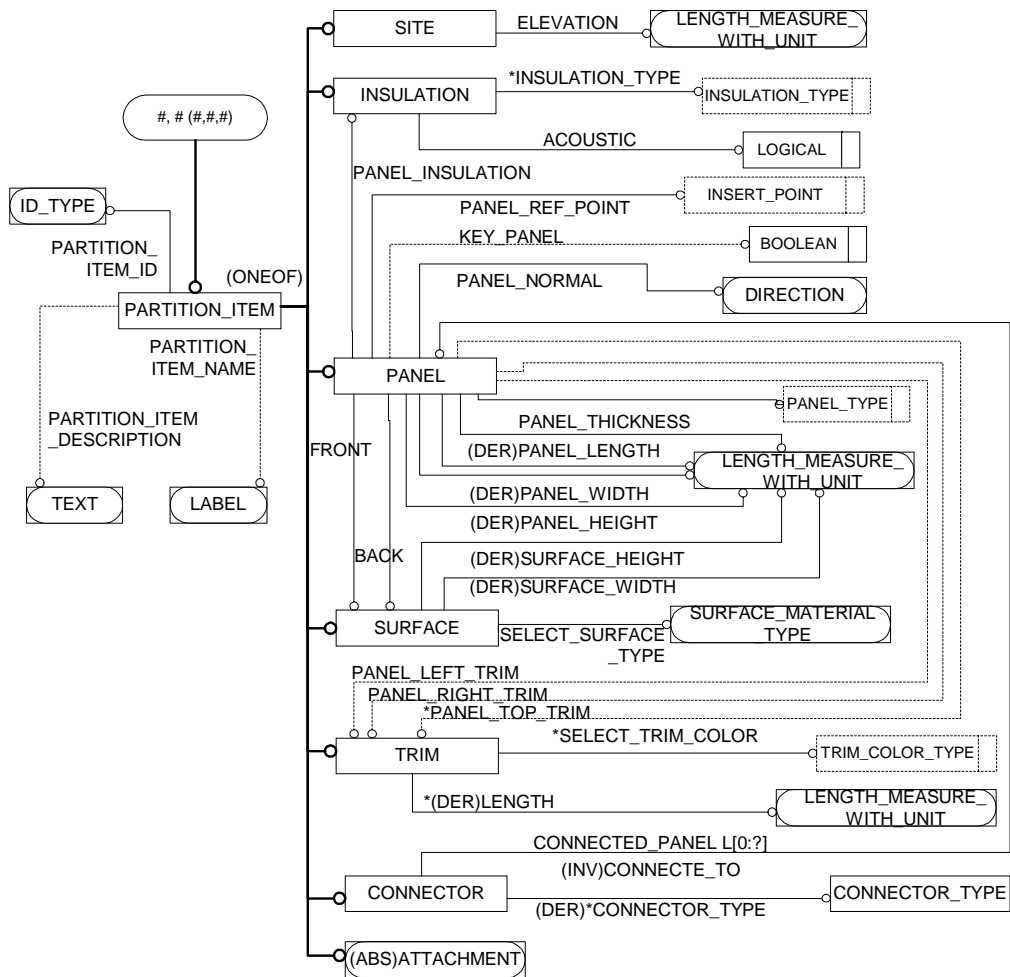
**Diagram 1 Project**



**Diagram 2 Spatial Items**



**Diagram 3 Partition Items (part 1)**



**Diagram 4 External Reference**

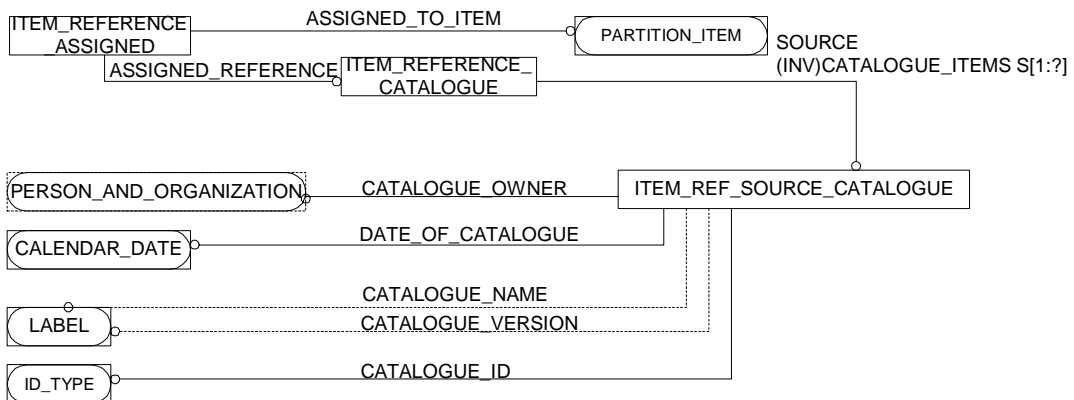
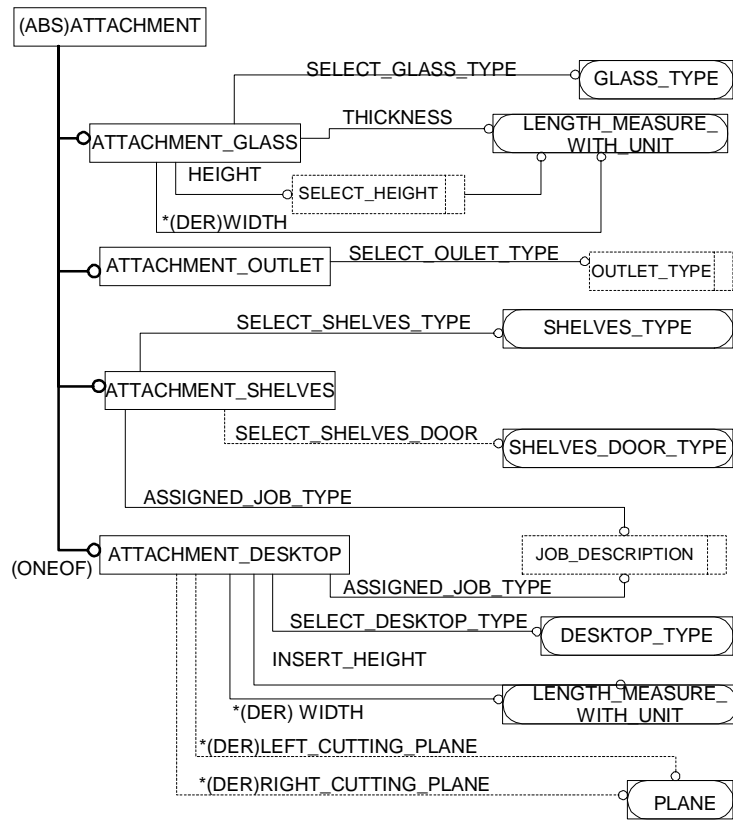
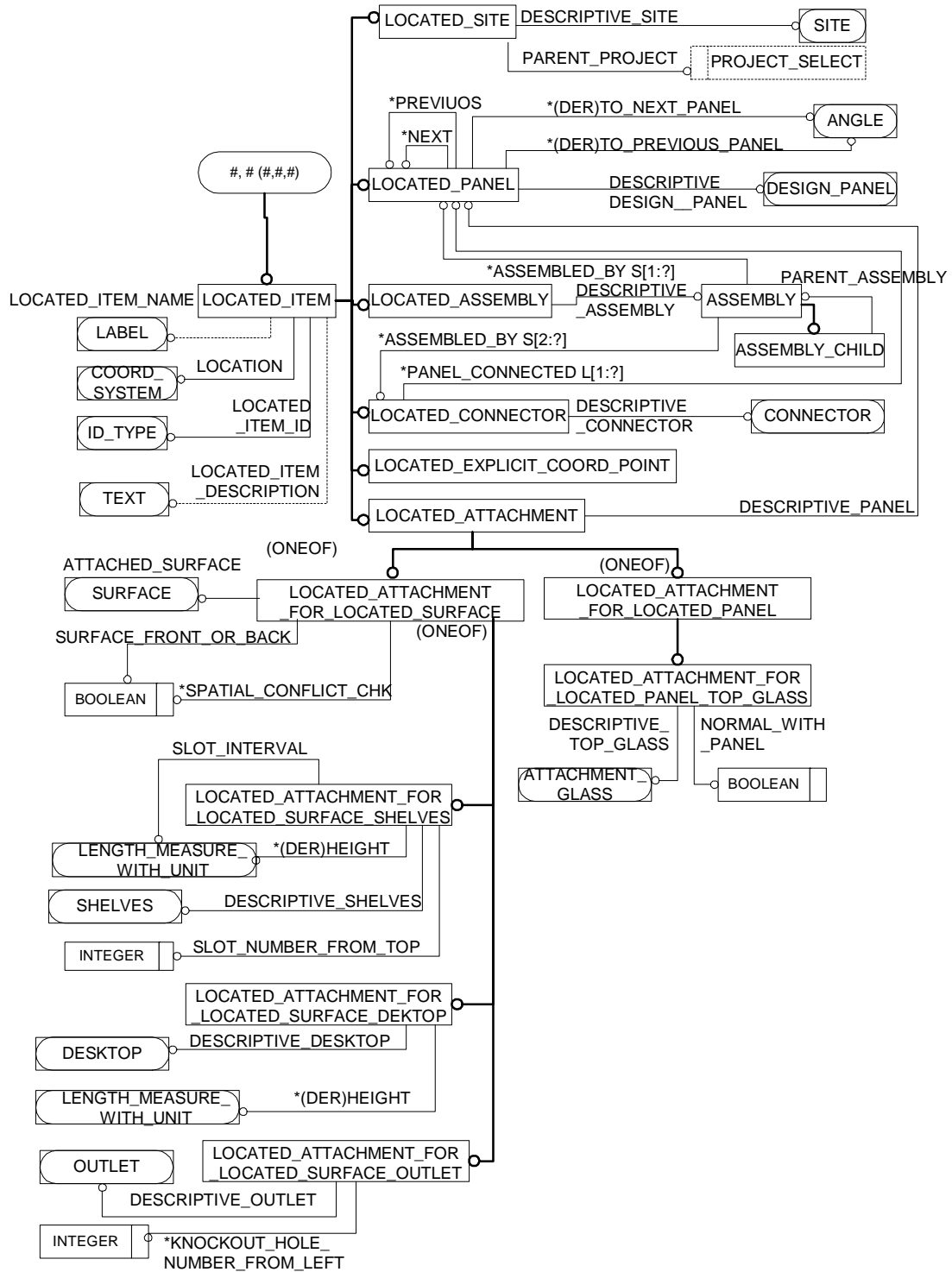


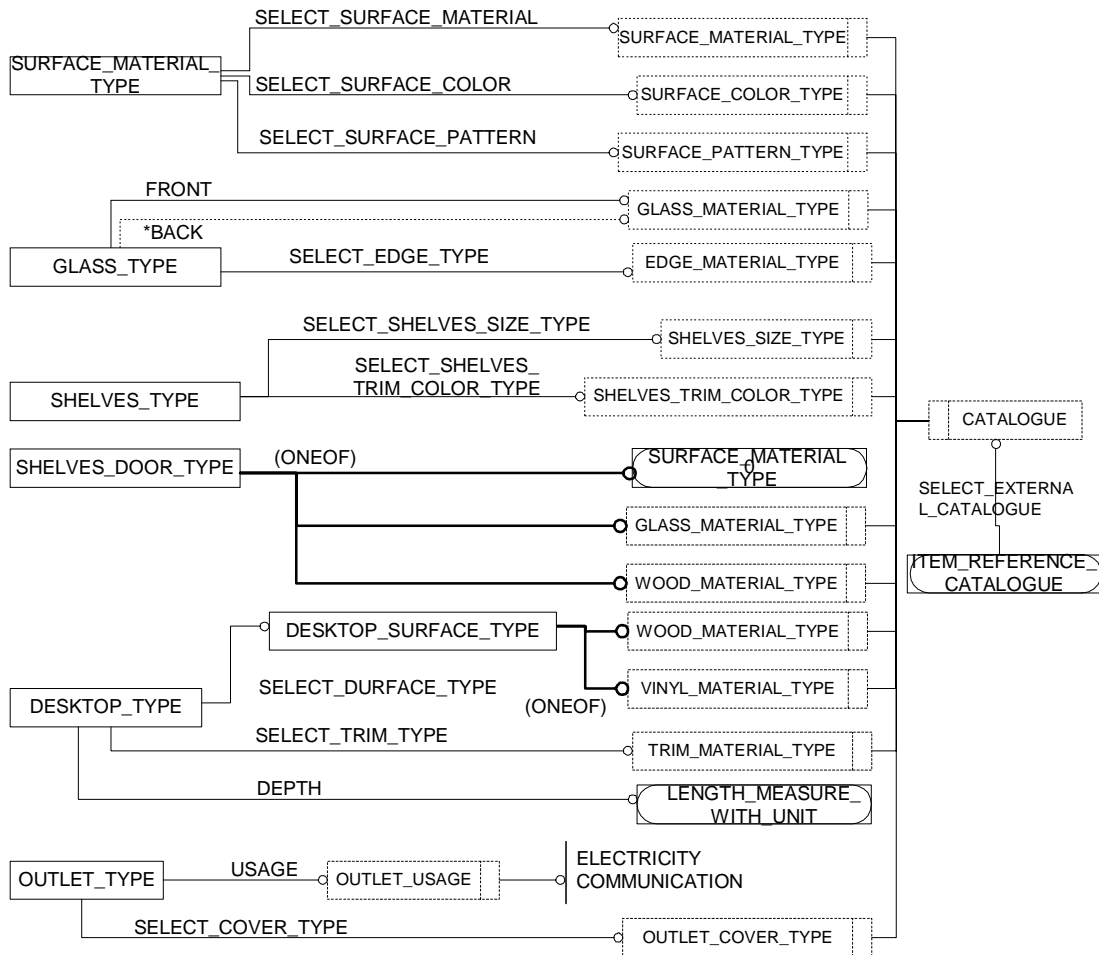
Diagram 5 Partition Items (part 2)



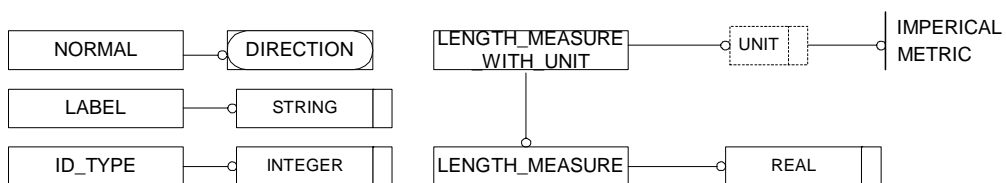
**Diagram 6 Located Items**



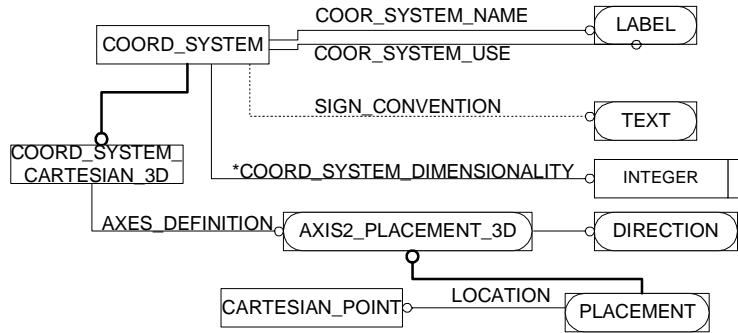
**Diagram 7 Catalogue Type and Material Specification**



**Diagram 8 Generic Type and Unit Type**



**Diagram 9 Coord\_System Definition**



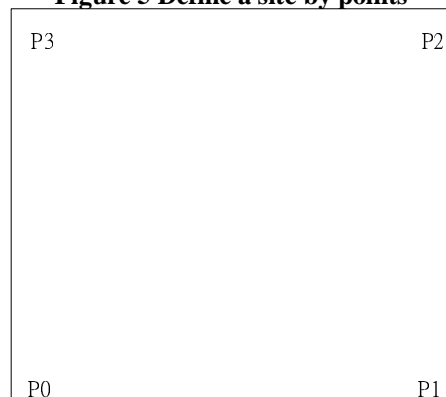
## PART 2: A DESIGN LAYOUT AND TESTING

### A General Case

Assumed an accountant office needs to renew their office. The basic requirement of the design is given as follow:

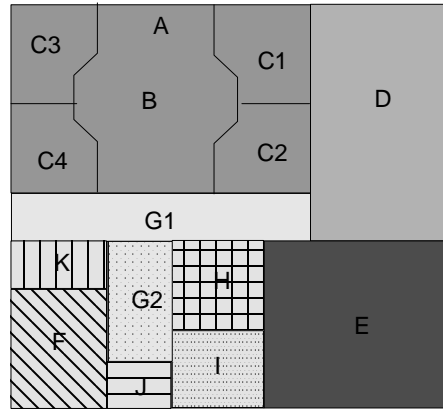
1. One common meeting area use as a conference room and are able to accommodate 10 persons.
2. Ten staffs include an accountant, a secretary of the accountant, an IT, four assistants, one general administrator, one reception employee and two consultants. The two consultants come to the office and shared working space with others. The four assistant employees shared a small public meeting space. The accountant needs to have a more private cubic that includes features of acoustic absorption. The four assistants need to have a small meeting area between their individual workspaces.

**Figure 5 Define a site by points**



Site: {P0, P1, P2, P3}

**Figure 6 Identify Workspace with job**



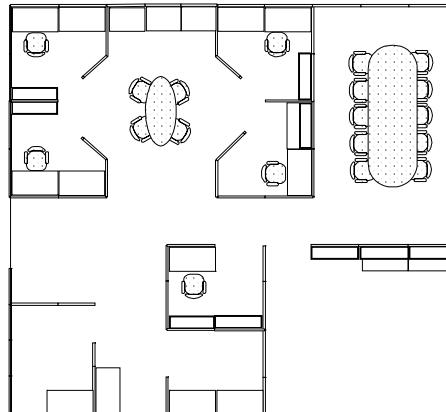
**Job Description**


- A: Consultants working area
- B: Assistants meeting area
- C1: Assistant's workspace
- C2: Assistant's workspace
- C3: Assistant's workspace
- C4: Assistant's workspace
- D: Conference Room
- E: Accountant's Room
- F: Office administrator 1
- G1: Primary Corridor
- G2: Secondary Corridor
- H: Secretary
- I: IT
- J: Office administrator 2
- K: Reception

**Job type:**

1. General Working Space: {C1, C2, C3, C4, E, F, J, I, H}
2. Shared Space: {A, B, D, K}
3. Corridor Access: {G1, G2}

**Figure 7 Placing partition units based on the workspace layout**



 Items not include in the model