An Approach to Automated Architectural Floor Layout Generation with Case-based Reasoning

by

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An Approach to Automated Architectural Floor Layout Generation with Case-based Reasoning

by

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1. Abstract

Research into automated floor layout generation has been a problem in which many
Architectural / Engineering / Construction (A/E/C) researchers have taken an interest since
the 1960s. These researchers have applied many approaches to solve this problem, however,
fee results which are considered acceptable by architectural designers have been achieved.
Since the approaches required quite a few restrictions for analysis, or were focused on a
narrow problem domains, the assumption has been that automated layout generation is still
not practical for designer’s purposes.

The previous approaches were based on mathematical methods dependent on the
processing ability of specific computers. In contrast, a recent approach to the layout
generation problem has evolved incorporating knowledge-based paradigms such as rules and
frames. Teicholz and Chinowsky (Chinowsky 90, Working Paper) have been studying this
problem in the “Knowledge-based System for Architectural Layout Generation” project at
the Center for Integrated Facility Engineering at Stanford University. In this project, they
developed a prototype automated layout generation program for the domain of university
facilities. They proposed the idea of storing space relationships and layout configurations in
slots within an instance of an applicable frame, and representing design principles with an IF-
THEN rule form.

Chinowsky pointed out the difficulty of representing layout case histories as one of
the major risks in his project (Chinowsky 90, Research Proposal). The objective of my
research is to study a case-based reasoning technique which has begun to attract notable
attention from AI researchers, and to examine the possibility of applying the technique to the
automated floor layout generation problem.

In this paper I will introduce the basic functions of case-based reasoning systems
including Memory Organizing Packages (MOPs) and Thematic Organization Points (TOPs),
and some case-based reasoning applications. In addition to this fundamental study of a
case-based reasoning system, I will introduce a Case-Based Reasoning Environment
(CBRE) developed for this research. CBRE is the development environment for the case-
based reasoning application written in Allegro Common Lisp Version 1.3.2 and FrameKit
Version 2.0. The reasoning functions of CBRE are based on Micro MOPs, introduced by
Riesbeck and Schank (Riesbeck and Schank 89). I translated the function of a frame in Micro
MOPs into FrameKit for the purpose of attaching a demon and other basic frame functions.
CBRE contains a color, interactive graphical display window to show MOPs hierarchy
networks and their slots, in addition to a tracing window to show MOPs created during the
reasoning process. Furthermore, I will propose the idea of applying a case-based reasoning
technique to the generation of a residential house layout. Since this is still a prototype version
developed in CBRE, only the room size and the building area are taken into account as design constraints.

Finally, I refer to the difficulty of extracting design knowledge from a designer, and the issue of applying a case-based reasoning technique to a generic automated floor layout generation problem.
2. Introduction

2.1. Objectives

The objective of the CIFE project, entitled "A Knowledge-based System for Architectural Layout Generation", is to develop a knowledge-based layout generation system which can work in cooperation with a designer at the conceptual stage of design. In this project, Teicholz and Chinowsky propose the idea of using a frame representation for space relationships and layout configurations, and an IF-THEN rule form for design principles. Chinowsky addresses several issues which could present risks to the project results (Chinowsky 90, Research Proposal). Specifically, he points out the potential difficulty of representing layout case histories within a computer representation, and obtaining a consensus concerning the requirements for case histories.

The objective of my research is to examine the above issues through the application of case-based reasoning techniques. Case-based reasoning provides advantages for this projects as follows:

- Case-based reasoning provides a reduction in the time needed to derive solutions in a search space, compared to rule-based reasoning.
- Case-based reasoning has the possibility to provide solutions in domains which a designer doesn't understand completely.
- Previous experiences provide insights into previous mistakes, and possibilities for eliminating these mistakes in similar situations and also abilities to recall good solutions for similar situations from history.
- Cases provide an understanding of what features are important in a problem domain.

Within my research period at CIFE*, I developed CBRE, a case-based reasoning environment, in Allegro Common Lisp. The case-based reasoning technique was then applied to the generation of residential layouts. Due to the limited development time, the prototype system contains only adapting and storing functions.

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* This research was investigated when the principle author, Yoshihiro Ichioka, studied as a Visiting Research Fellow from Obayashi Corporation in Center for Integrated Facility Engineering Stanford University from September 1989 to February 1991.
2.2. A Background of the Layout Generation Problem

Research into automated floor layout generation has been a problem in which many Architectural / Engineering / Construction (A/E/C) researchers have taken an interest since the 1960s. In this chapter, three classical methods: graph networks, shape grammars, and TCR (Total Closeness Rating), are introduced for the purpose of understanding the potential of automated floor layout generation.

2.2.1. Graph Networks

Several researchers including Mitchell etal. (Mitchell, Steadman, and Liggett 76), Rinsma (Rinsma 87), Flemming (Flemming 78), Gillear (Gillear 78), and Eastman (Baybars and Eastman 80), have used graph network theories to model room adjacencies. As shown in Figure 2.1.1, the simple illustrated layout (left) contains the adjacency graph (top right). The adjacency graph of a room layout is planar*, and has vertices corresponding to the rooms and edges corresponding to their connections. Given a connected planar graph, we can define its corresponding dual graph (bottom right). The dual graph represents the boundaries of the rooms.

The dual graph is the plausible method to transfer from the rooms and their adjacencies to rectangular dissections. However, the graph does not represent a unique dissection, because the alignment of dual edges produces alternative dissections.

2.2.2. Shape Grammars

Shape grammars were introduced as a useful method of generating designs about ten years ago (Stiny 80). Since then, researchers including Chase (Chase 88), Coyne, and Gero (Coyne and Gero 85), have proposed shape grammar methods based on their own design knowledge and experience. Shape grammars use rules related to the shape of rooms to generate layouts.

* A graph G is planar if it can be drawn in the plane in such a way that no two edges meet each other except at a vertex to which they are both incident.
Figure 2.2.2 shows a set of design rules for generating simple building forms from walls and columns (Coyne and Gero 85). A dot indicates the top of the room.

Rule(2) represents the following:

IF [ room a(1) and short wall(2)]


Figure 2.2.3 shows the representation of the shape, and Figure 2.2.4 shows a tree structure resulting from the application of the rules given in Figure 2.2.2.
Figure 2.2.2: Design Rule Examples in Shape Grammars

Figure 2.2.3: The Representation of The Room Shape
Figure 2.2.4: The Result Tree for The Rules in Figure 2.2.1
2.2.3. TCR (Total Closeness Rating)

Total Closeness Rating is a computational method based on a Computer-aided Facility Planning algorithm. In this chapter I will introduce CORELAP, an acronym for Computerized RElationship LAyout Planning (Tompkins and White 84).

In this method, the closeness relationships between a department and all the departments are represented in an activity relationship chart with six alphabetical values (shown in Figure 2.2.6). The TCR is the sum of the numerical values assigned to the closeness relationships (A=6, E=5, I=4, O=3, U=2, X=1). Table 2.2.7 shows the calculation of TCRs for the example problem in Figure 2.2.6. When we make a layout of these departments, the department that has the highest TCR is placed in the center of the layout. If an equal TCR exists, one of the following tie-breaking rules is applied: select the department having the largest area or select the department having the lowest department number. Next, the relationship chart is searched, and if a department is found with an "A" relationship to the selected department, it is added to the layout. If nothing is found, the relationship chart is searched for "E" relationships, "I" relationships, and so forth until a match is found. If there are two or more departments found, the department with the highest TCR is selected. If the department which has an "A" relationship to the first department is found among the unassigned departments, that department is selected as the third department. If there are still two or more candidates, TCR and the tie-breaking rule are utilized. If no unassigned department exists which has an "A" relationship to the second selected department, the searching procedure is repeated in order, for "E" relationships, "I" relationships, and so forth. Whenever a tie is found, TCR and the tie-breaking rule are applied. The searching procedure is continued until all departments are selected.

The location of the selected department in the layout is calculated with the placing rating score. The placing rating score is the sum of weighted closeness ratings between the department being put in the layout and its neighbors. Let's see the example shown in Figure 2.2.5. Now we have to put department 2 into the layout consisting of departments 1 and 7 (Figure (a)). We assumed that department 2 is the next to enter the layout and it has an "A" relationship with department 1 and an "E" relationship with department 7. If an "A" relationship is weighted 64 and an "E" relationship is 16, then the placing rating scores are shown in Figure (b), (c), and (d). If the same placing rating scores exist, the shared boundary lengths are compared. The boundary length is the number of unit square sides which are shared with the department to enter the layout and its neighbors. In Figure (B) and (C) have the boundary length 2 respectively, and (d) has 3.
CORELAP evaluates the result by calculating the layout score. The layout score is defined as follows:

\[
\text{Layout score} = \sum_{\text{all department}} \text{numerical closeness rating} \times \text{length of shortest path}
\]

Figure 2.2.6 shows the relation chart of the example. Table 2.2.7 shows the calculation of the TCRs for the example. Figure 2.2.8 shows one of the results of the example calculated by CORELAP, and finally, Table 2.2.9 shows its layout score.

![Figure 2.2.5: The Placing Rating Score (CORELAP)]

![Figure 2.2.6: Relationship Chart and Closeness Values]
<table>
<thead>
<tr>
<th>Room Name</th>
<th>Department No.</th>
<th>Relationships</th>
<th>TCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Room A</td>
<td>1</td>
<td>E, O, I, O, U, U</td>
<td>19</td>
</tr>
<tr>
<td>Room B</td>
<td>2</td>
<td>E, U, E, I, I, U</td>
<td>22</td>
</tr>
<tr>
<td>Room C</td>
<td>3</td>
<td>O, U, U, U, O, U</td>
<td>14</td>
</tr>
<tr>
<td>Room D</td>
<td>4</td>
<td>I, E, U, I, U, U</td>
<td>19</td>
</tr>
<tr>
<td>Room E</td>
<td>5</td>
<td>O, I, U, I, A, I</td>
<td>23</td>
</tr>
<tr>
<td>Room F</td>
<td>6</td>
<td>U, I, O, U, A, E</td>
<td>22</td>
</tr>
<tr>
<td>Room G</td>
<td>7</td>
<td>U, U, U, U, I, E</td>
<td>17</td>
</tr>
</tbody>
</table>

Table 2.2.7: Calculation of TCRs

\[
\begin{array}{cccccccccccc}
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 16 & 16 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 15 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
\end{array}
\]

(a) 

\[
\begin{array}{cccccccccccc}
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
\end{array}
\]

(b) 

\[
\begin{array}{cccccccccccc}
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
\end{array}
\]

(c) 

\[
\begin{array}{cccccccccccc}
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
\end{array}
\]

(d) 

Figure 2.2.8: The Layout Result for Example Figure 2.2.6

<table>
<thead>
<tr>
<th>Relationship</th>
<th>Preset Value</th>
<th>From</th>
<th>To</th>
<th>Distance</th>
<th>Product of Preset Value and Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6</td>
<td>E</td>
<td>F</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E</td>
<td>5</td>
<td>A</td>
<td>B</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E</td>
<td>5</td>
<td>B</td>
<td>D</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E</td>
<td>5</td>
<td>F</td>
<td>G</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>I</td>
<td>4</td>
<td>A</td>
<td>D</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>I</td>
<td>4</td>
<td>B</td>
<td>E</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>I</td>
<td>4</td>
<td>B</td>
<td>F</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>I</td>
<td>4</td>
<td>D</td>
<td>E</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>I</td>
<td>4</td>
<td>E</td>
<td>G</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>O</td>
<td>3</td>
<td>A</td>
<td>C</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>O</td>
<td>3</td>
<td>C</td>
<td>F</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>O</td>
<td>3</td>
<td>A</td>
<td>E</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>U</td>
<td>2</td>
<td>A</td>
<td>F</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>U</td>
<td>2</td>
<td>A</td>
<td>G</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>U</td>
<td>2</td>
<td>B</td>
<td>C</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>U</td>
<td>2</td>
<td>B</td>
<td>G</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>U</td>
<td>2</td>
<td>C</td>
<td>D</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>U</td>
<td>2</td>
<td>C</td>
<td>E</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>U</td>
<td>2</td>
<td>C</td>
<td>G</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>U</td>
<td>2</td>
<td>D</td>
<td>F</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>U</td>
<td>2</td>
<td>D</td>
<td>G</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Layout score 48

Table 2.2.9: Calculation of Layout Score
3. Case-based Reasoning System

3.1. Case-based Reasoning

If we examine our ordinary thinking, we use case-based reasoning to solve problems without noticing it. We remember the result and problem solving processes of old cases, and try to apply them to the new problem.

On this year’s Thanksgiving holiday, my wife decided to make a traditional pumpkin pie just like Americans do. Since before this, we ate a fabulous pumpkin pie which we bought at the farmer’s market, she tried to make one exactly like that.

First, she used some mashed pumpkin, several spoonfuls of granulated sugar and some cream as filling ingredients. However, the result of this case wasn’t good enough to satisfy us. The pumpkin filling was more yellowish than the one we got at the farmer’s market, and its flavor was less than we expected. This failure reminded my wife of previous cases involving an apple pie and a fruit cake. The apple pie case reminded her of using brown sugar to make the pie brown, and the case of the fruit cake reminded her that she used caramel sauce to make the cake more flavorful and brown. So, the second time she used brown sugar and caramel sauce instead of granulated sugar. These two memories brought us a good result. They worked effectively and successfully. Something about the first failure reminded her of the previous trials. As I mentioned above, case-based reasoning is used in the various kinds of everyday common-sense reasoning.

Generally, we can solve a problem easier the second time than the first, because we can adapt the previous experience to the new one.

A case-based system consists of four major parts (Figure 3.3.1).

These are as follows:

(1) Retrieve
(2) Adapt
(3) Evaluate
(4) Store
3.2. Retrieve

During the retrieving stage, the system finds the most appropriate case in its case-memory to adapt. Specifically, if when the system cannot find a solution which satisfies all of the requirements of a new case, then it tries to find the one which covers the most requirements.

The ability to understand the new problem in terms of old experiences has two parts: recalling old experiences and interpreting the new situation in terms of the recalled experiences. The first is called the **indexing problem**. An index is assigned when a case is stored in case memory for the purpose of retrieving the case under appropriate conditions. The second is the process of comparing the new problem to the previous experiences.

When we implement case-base reasoning systems on a computer, we have to think about the organization of its case memory and the retrieving algorithm. With regard to this issue, several methods have been implemented including flat memory, hierarchical memory, prioritized discrimination nets, and redundant discrimination nets (Kolodner and Riesbeck 90).
3.3. MOPs

In this chapter I will introduce MOPs; Memory Organization Packages, as an implementation of hierarchy memory. Shank described the basic MOP concept in his book titled "Dynamic Memory" (Shank 82).

According to his representation;

In order to account for reconstructive memory, and the ability to generalize and learn from past experience, I am proposing that a memory structure exists that I call a MOP. It follows from what I have said so far that a MOP is also a processing structure. As a memory structure, the role of a MOP is to provide a place to store new inputs. As a processing structure, the role of a MOP is to provide expectations that enable the prediction of future inputs or inference of implicit events on the basis of previously encountered, structurally similar, events. A MOP processes new inputs by taking the aspects of those inputs that relate to that MOP and interpreting those aspects in terms of the past experiences most closely related to them. Many different high-level memory structures can be relevant at any given time in processing an input, i.e., any of a number of different MOPs may applicable at one time.

He also defined the idea of scene and script which constitute MOPs.

A scene defines a setting, an instrumental goal, and actions that take place in that setting in service of that goal. These actions are defined in terms of specific and generalized memories relating to that setting and goal. For example, ordering in a restaurant or getting your baggage in an airport are scenes. As long as there is an identifiable physical setting and a goal being pursued with that setting, we have a scene. Two kinds of information are present in a scene. First, we have physical information about what the scene looks like. Information about what was in one's line of sight can be part of one's remembrance of a scene. Second, we have information about the activities that go on in a scene.

A script, in our new, narrower, scene, is a sequence of actions that take place within a scene. Many scripts can encode the various possibilities for the realization of a scene. That is a script instantiates or color a screen. Scenes contain general information; scripts provide the specifics.

Schank explained MOPs functions using the example of visiting a doctor’s office.

I went to the doctor’s yesterday. While I was reading a magazine I noticed that a patient who arrived after me was being taken ahead of me. The doctor will probably still overcharge me!
For this example he chose two kinds of MOPs, M-PROFESSIONAL OFFICE VISIT and M-CONTRACT (Figure 3.3.1). Each of these MOPs organizes scenes and scripts in terms of visiting a doctor's office. Waiting Room, for example, is one of the scenes in M-PROFESSIONAL OFFICE VISIT.

The primary function of M-PROFESSIONAL OFFICE VISIT is to provide the correct sequence of scenes when executing this action. Now let's see how this MOP works. The phrase "went to a doctor" refers to "doctor", which is something about which we have information. Doctor is a token in memory. For every token in memory, there exists information attached to that token which indicates where to look for further information.

M-PROFESSIONAL OFFICE VISIT has information attached to it concerning what other MOPs might also be active when it is active. When we imagine the scene of visiting a doctor, first we have to wait our turn in the waiting room, after our turn comes we see the doctor, and we pay some money for medical treatment before we get back home.
The MOP M-CONTRACT is invoked when M-PROFESSIONAL OFFICE VISIT is activated. This represents the unexpressed contract between a doctor and a patient. The doctor gives a bill to the patient for his or her medical examination. If the patient refuses to pay for it, the patient will be sued. All information about this should be in the MOP M-CONTRACT, not M-PROFESSIONAL OFFICE VISIT. Hence, a MOP has two sorts of information: One is a sequential set of scenes and the other is a relationship with the other MOPs.

A MOP organizes a set of scenes and scripts which lead to a goal in memory. Namely M-PROFESSIONAL OFFICE VISIT organizes a set of information about visiting a professional office, it would not be involved in any higher level MOPs. Generally, people go to see a doctor to take care of their health. However, this is not a scene or a script in M-PROFESSIONAL OFFICE VISIT, but a goal someone wants to achieve. Nevertheless, that information is not included in M-PROFESSIONAL OFFICE VISIT, that is also invoked by the phrase "went to a doctor". Thus we define the MOP M-HEALTH PROTECTION as a higher level MOP. As you can see in Figure 3.3.1 there are three activity MOPs: M-HEALTH PROTECTION, M-PROFESSIONAL OFFICE VISIT, and M-CONTRACT.

M-PROFESSIONAL OFFICE VISIT has information as follows:

[get there] + WAITING ROOM + GET SERVICE + PAY + [get back]

M-CONTRACT forms:

[get contract] + NEGOTIATE + AGREE + DELIVER + PAY

The following items are organized by MOPs:

<table>
<thead>
<tr>
<th>Items organized by MOPs</th>
<th>Denoted</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scripts</td>
<td>$XXX</td>
<td>$HERTZ-COUNTER</td>
</tr>
<tr>
<td>Scenes</td>
<td>XXX</td>
<td>RENT-A-CAR COUNTER</td>
</tr>
<tr>
<td>Place Holders</td>
<td>[xxx]</td>
<td>[get transportation]</td>
</tr>
</tbody>
</table>

Here, Place Holder is a parameter which comes from other knowledge. For example, M-PROFESSIONAL OFFICE VISIT has the Place Holder [get there]. Quite a few MOPs, scenes, or scripts can fill up that area. If someone takes a bus to visit a doctor, then the MOP M-BUS will fit that spot.
Schank explained the function of Place Holders:

The most important aspect of the structures organized by MOP is that they be general enough to be used by other MOPs. This is a key point. Scenes and scripts organized by one MOP can also be organized by others. For example, the PAY scene is used by a great many MOPs in addition to M-POV. If you lost your wallet you might attempt to figure out where you had it last. You might remember putting it down near a cash register while paying. The problem then would be differentiate one PAY event from another. The fact that this is difficult indicates that PAY is a shared structure.

As he pointed out, the first sentence, "I went to the doctor's yesterday," gets us to look at what we know about doctors. In this example, those are M-PROFESSIONAL OFFICE VISIT and M-CONTRACT. When the following sentence "While I was reading a magazine I noticed that a patient who arrived after me was being taken ahead of me" is matched, it can be interpreted as a WAITING ROOM in the MOP M-PROFESSIONAL OFFICE VISIT. What happened here, is the failure of the script, named "customer queueing" which is organized by WAITING ROOM. Thus, the actual situation is explained by way of M-PROFESSIONAL OFFICE VISIT, WAITING ROOM, and $CUSTOMER QUEUE. The last sentence "The doctor will probably still overcharge me!" brings up the scene PAY of M-CONTRACT.

We have three MOPs in a story of "doctor's visit", each MOP has a linked line to the many kinds of scenes which contain action information. Thus, a MOP is an organizer of scenes.

3.4. TOPs

In Dynamic Memory (Shank 82) Schank gave the idea of TOPs; Thematic Organization Points.

The key to remindings, memory organizing and generalization is the ability to create new structures that coordinate or emphasize the abstract significance of a combination of episodes. Structures that represent this abstract, domain-independent, information we call Thematic Organization Points or TOPs. Tops are responsible for our ability to:

1. Get reminded of a story that illustrates a point.
2. Come up with adages such as, "A stitch in time saves nine" or "Neither a borrower nor a lender be" at an appropriate point.
3. Recognize an old story in new trappings.
4. Notice co-occurrences of seemingly disparate events and draw conclusions from their co-occurrence.
5. Know how something will turn out because the steps leading to it have been seen before.
6. Learn information from one situation that will apply in another.
7. Predict an outcome for a newly encountered situation.

Schank addressed his idea in the example of the similarity between the stories Romeo and Juliet and West Side Story. In this example he pointed out that both stories are similar because of the following key factors:

1. young lovers
2. objections of parents
3. an attempt to get together surreptitiously
4. a false report of death
5. the false report causes a real death of one of the lovers

He categorized both stories as cases of young lovers with a mutual goal pursuit against outside opposition which correspond to the TOP MG; OO. Thus, a TOP has both a goal type and a condition on that goal. Figure 3.4.1 shows some TOPs that Schank proposed in his book: Dynamic Memory.
Figure 3.4.1: Schank's TOPs Example
In another example, Hammond used her own idea of TOPs in the case-based reasoning program called CHEF. She proposed the use of TOPs for planning problems in the book: Case-Based Planning (Hammond 89). CHEF stores its TOPs in a discrimination network, indexed by the features that describe the problem that they correspond to. In searching for a TOP, CHEF extracts these features from its explanation of the current problem and the TOP suggests strategies to solve that problem. CHEF’s TOPs have two components: the feature of the problem used to index to it and strategies that it suggests to deal with that problem.

CHEF uses sixteen TOPs as follows:

SIDE-EFFECT (SE)
TOPs in this group describe the problems with the side-effects of one step interfering with the overall plan in one way or another.
- SE: DISABLED-CONDITION: CONCURRENT
- SE: DISABLED-CONDITION: SERIAL
- SE: DISABLED-CONDITION: BALANCE
- SE: BLOCKED-PRECONDITION
- SE: GOAL-VIOLATION

DISIRED-EFFECT (DE)
TOPs in this group describe the situations in which the desired effect of a step, that is a state that either directly satisfies a goal or enables the satisfaction of a goal, causes problems later in the plan.
- DE: DISABLED-CONDITION: CONCURRENT
- DE: DISABLED-CONDITION: SERIAL
- DE: DISABLED-CONDITION: BALANCE
- DE: BLOCKED-PRECONDITION

SIDE-FEATURE (SF)
TOPs in this group relate to the situations in which the features of new items that have been added to plans interfere with the goal that the plans are trying to achieve.
- SF: ENABLEDS-BAD-CONDITION
- SF: BLOCKED-PRECONDITION
- SF: GOAL-VIOLATION

DESIREDE-FEATURE (DF)
TOPs in this group describe the situations in which a feature of an object that actually satisfies a goal causes trouble.
- DF: DISABLED-CONDITION
- DF: BLOCKED-PRECONDITION
STEP-PARAMETER (SP)
TOPs in this group relate to the problems involving the amount of time a step takes and the tools it uses.
- SP: TIME
- SP: TOOL

Figures 3.4.2-1 to 3.4.2-3 illustrate the use of the CHEF system.

Searching for plan that satisfies -
   Include beef in the dish.
   Include broccoli in the dish.
   Make a stir-fry dish.

Found recipe -> REC2 BEEF-WITH-GREEN-BEANS

Recipe exactly satisfies goals ->
   Make a stir-fry dish.
   Include beef in the dish.

Recipe partially matches ->
   Include broccoli in the dish.
   in that the recipe satisfies:
      Include vegetables in the dish.

Building new name for copy of BEEF-WITH-GREEN-BEANS
Calling recipe BEEF-AND-BROCCOLI

Modifying recipe: BEEF-AND-BROCCOLI
to satisfy: Include broccoli in the dish.

Placing some broccoli in recipe BEEF-AND-BROCCOLI

- Considering ingredient-critic:
   Before doing step: Stir fry the -Variable-
   do: Chop the broccoli into pieces the size of chunks.
   - ingredient-critic applied.

Checking goals of recipe -> BEEF-AND-BROCCOLI

Recipe -> BEEF-AND-BROCCOLI has failed goals.

The goal: The broccoli id now crisp.
   is not satisfied.
   It is instead the case that: The broccoli is now soggy.

Figure 3.4.2-1 : Hammond's CHEF TOPs Example
Unfortunately: The broccoli is now a bad texture. 
In that: The broccoli is now soggy.

Changing name of recipe BEEF-AND-BROCCOLI 
to BAD-BEEF-AND-BROCCOLI

Found TOP TOP1 -> SIDE-EFFECT: DISABLED-CONDITION: 
CONCURRENT
TOP -> SIDE-EFFECT: DISABLED-CONDITION: CONCURRENT has 3 strategies associated with it:
  SPLIT-AND-REFORM
  ALTER-PLAN: SIDE-EFFECT
  ADJUNCT-PLAN

Applying TOP -> SIDE-EFFECT: DISABLED-CONDITION: 
CONCURRENT
to failure it it not the case that: The broccoli is now crisp.
in recipe BAD-EFFECT-AND-BROCCOLI

Asking questions needed for evaluating strategy: 
SPLIT-AND-REFORM

ASKING -> Can plan 
  Stir fry the sugar, soy sauce, rice wine, garlic, 
corn starch, broccoli and beef for three minutes. 
or split and rejoined

Found plan: Instead of doing step: Stir fry the sugar, 
soy sauce, rice wine, garlic, corn starch, broccoli 
and beef for three minutes 
do:
S1 = Stir fry the broccoli for three minutes. 
S2 = Remove the broccoli from the result of action S1. 
S3 = Stir fry the sugar, soy sauce, rice wine, garlic, 
corn starch and beef for three minutes, 
S4 = Add the result of action S2 to the result of action S3. 
S5 = Stir fry the result of action S4 for a half minute.

Asking questions needed for evaluating strategy: 
ALTER-PLAN-SIDE-EFFECT

Figure 3.4.2-2 : Hammond's CHEF TOPs Example ( continued )
ASKING -> Is there an alternative to
stir fry the sugar, soy sauce, rice wine, garlic,
corn starch, broccoli and beef for three minutes.
that will enable
The dish now tastes savory.
which does not cause
There is thin liquid in the pan from the beef
equaling 4.8 teaspoons.

No alternative plan found

Asking questions needed for evaluating strategy: ADJUNCT-PLAN

ASKING -> Is there an adjunct plan that will disable
There is thin liquid in the pan from the beef
equaling 4.8 teaspoons,
that can be run with
Stir fry the sugar, soy sauce, rice wine, garlic,
corn starch, broccoli and beef for three minutes.

No alternative plan found

Deciding between modification plans suggested by strategies:
Only one modification can be implemented -> SPLIT-AND-REFORM

Implemented plan -> Instead of doing step: Stir fry the sugar,
soy sauce, rice wine, garlic, corn starch, broccoli
and beef for three minutes.
do:
S1 = Stir fry the broccoli for three minutes.
S2 = Remove the broccoli from the result of action S1.
S3 = Stir fry the sugar, soy sauce, rice wine, garlic,
corn starch and beef for three minutes,
S4 = Add the result of action S2 to the result of action S3.
S5 = Stir fry the result of action S4 for a half minute.
Suggested by strategy SPLIT-AND-REFORM.

Figure 3.4.2-3 : Hammond's CHEF TOPs Example (continued)
3.5. Adapt

In the adapting stage, the system modifies the retrieved case to fit the current requirements. When we looked at the previous applications using case-based reasoning, they used the following adaptations in their adapting process.

- Inserting values and structures
- Deleting values and structures
- Substituting values and structures for new ones
- Splitting a problem into a parts

Kolodner and Riesbeck introduced several adapting methods (Koldner and Riesbeck 90) as follows:

1. Reinstantiation
2. Parameter Adjustment
3. Local Search
4. Query Memory
5. Specialized Search
6. Transformation
7. Critic Application
8. Derivational Replay

(1) Reinstantiation
Reinstantiation is a method to substitute a slot’s values in the old case for the ones in a new case when using frame representations for organizing case memory.

(2) Parameter Adjustment
Parameter Adjustment is a method to change parameters in the old case to the new one by means of using adjustment heuristics which are derived from the relationship between problem features and solution parameters.

(3) Local Search
Local Search is a method to substitute other values by searching for a close relative in its abstract hierarchies.
(4) Query Memory
Query Memory is a method to search memory for the described element when Local Search is inapplicable or yields no answer. With this method a description of the needed element must be available after Local Search.

(5) Specialized Search
Specialized Search is a method to give memory instructions about how to look for an alternate.

(6) Transformation
Transformation is a method to transform the element of the old case to fit the new problem using one of the following heuristics:
- Delete a secondary feature
- Substitute a feature
- Add a feature
- Adjust the amount of a feature

(7) Critic Application
Critic Application uses critics which are indexed by the combinations of features that trigger them, and initiates the critics whose features are present in a problem or solution.

(8) Derivational Replay
Derivational Replay is a method to recall how the old value was computed and replay that computation to get the solution for the new case.

3.5. Evaluate
This stage is one of the most important for a case-based reasoner. In evaluation, the results of the adapted case are tested in the real world. If the results were as expected, it is accepted and no more analysis is done. On the other hand, if the results were different than expected, explanation would be needed.
3.6. Store

Finally, in the storing stage, the executed reasoning result is stored in case memory for future use. The most important process at this stage is indexing the new case in case memory. An index must be selected for recalling the case when it is needed at a later time.
4. CBRE (Case-Based Reasoning Environment)

4.1. CBRE Functional Overview

The case-based reasoning environment introduced in this chapter is implemented in Allegro Common Lisp and FRAMEKIT on a Macintosh. FRAMEKIT is a frame-based knowledge representation environment written in Common Lisp. It was first developed by Jamie Carbonell and enhanced by Eric Nyberg. FRAMEKIT provides the basic functions of frames, instances, inheritance, and demons.

Fundamentally, the case-based reasoning environment is based on Micro MOPs which was introduced in Riesbeck and Schank’s book “INSIDE CASE-BASED REASONING” (Schank and Riesbeck 89). Since the part of frame-based data handling in Micro MOPs is translated in FRAMEKIT, the case-based reasoning environment will be more flexible than Riesbeck and Schank’s.

Figure 4.1.1 shows the case-based reasoning environment main menu and submenus. “CBR-Menu”, shown at upper left, is the main menu and has five menu items, “MOP-File”, “MOP-Define”, “MOP-Utility”, “MOP-Edit”, and “Quit-CBR”. The following descriptions introduce the menu items and submenu items. “Micro MOPs CHEF” is used as the example in each description.

MOP-File When main menu “MOP-File” is clicked, the small submenu which has “New” and “Update” items pops up. The user can choose either a new file or a previous file. Both “New” and “Update” items invoke Macintosh’s “File Allocation” window.

MOP-Define Main menu item “MOP-Define” pops up “MOP Definition” window shown as Figure 4.1.2. The user can define easily MOP and instance with their slots.

MOP-Utility Main menu item “MOP-Utility” invokes submenu “Display” which has seven menu items, “MOPs-List”, “SLOTs-List”, “MOP-Hierarchy”, “SLOT-Hierarchy”, “Cases”, “New-MOPs”, and “Quit-Display” shown as Figure 4.1.1.
MOPs-List  Submenu item “MOPs-List” returns an abstract hierarchy list below a MOP keyed in after the prompt “enter MOP name ==>”. An abstract hierarchy is the context network structure in terms of the inheritance among MOPs and instances shown as Figure 4.1.3.

SLOTS-List  Submenu item “SLOTS-List” returns a slot hierarchy list below a MOP or an instance keyed in after the prompt “enter MOP name ==>”. A slot hierarchy list is the context network structure in terms of the relationship of slot roles and their fillers shown as Figure 4.1.4.

MOP-Hierarchy  Submenu item “MOP-Hierarchy” pops up “Hierarchy Window” window shown as Figure 4.1.5. This window shows an abstract hierarchy list below a MOP or an instance keyed in after the prompt “enter MOP name ==>” graphically. At this window the user can select several functions from submenu “MOPs”: submenu item “Scroll” scrolls the abstract hierarchy on the window up, down, right, and left easily, “Show-slots” pops up the slots window of MOPs or instances on “Hierarchy Window” window, “Zoom-in” and “Zoom-out” increases and shrinks the abstract hierarchy on the window respectively, “Quit” deletes “Hierarchy Window” window and returns the control to “Display” submenu.

SLOT-Hierarchy  Submenu item “SLOT-Hierarchy” pops up graphical window which shows the network of slot roles and their fillers below a MOP and an instance keyed in after the same prompt, “enter MOP name ==>”, as I mentioned above. As shown in Figure 4.1.6 this window supports the same functions as “MOP-Hierarchy” except “Show-slots” function. Figure 4.1.6 shows “i-m-recipe-steps.10”, the filler of role “steps” in “i-m-chicken-and peanuts” MOP.
Cases

Submenu item "Cases" shows "Cases in memory" radio-button window on the screen shown as Figure 4.1.7. The cases in memory, the same as the instances below "m-case" MOP, are displayed whenever he or she clicks "Cases" submenu item.

New-MOPs

Submenu item "New-MOPs" pops up the scroll window shown as Figure 4.1.8. This window shows all MOPs and instances which are created automatically during processing. When the user clicks the name on this window, its slot hierarchy list is returned.

Quit-Display

Submenu item "Quit-Display" returns the control to main menu "CBR-Menu".

MOP-Edit

Main menu item "MOP-Edit" pops up Macintosh's File Edit window of the file chosen at "MOP-File" menu item.

Quit-CBR

Main menu item "Quit-CBR" quits Case-based reasoning environment and returns the control to general Allegro Common Lisp environment.
Figure 4.1.1: CBRE Main Menu and Submenu
Define abstract hierarchy

MOP Name : [ ]
© MOP
○ Instance

Abstract Name :

Define slots

<table>
<thead>
<tr>
<th>Slot-Role</th>
<th>Slot-Filler</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. nil</td>
<td>nil</td>
</tr>
<tr>
<td>2. nil</td>
<td>nil</td>
</tr>
<tr>
<td>3. nil</td>
<td>nil</td>
</tr>
<tr>
<td>4. nil</td>
<td>nil</td>
</tr>
<tr>
<td>5. nil</td>
<td>nil</td>
</tr>
</tbody>
</table>

Figure 4.1.2: MOP-Define Window

? enter MOP name ==> m-ingred

(M-INGRED  (M-SPICES  (I-M-SPICES ))
(M-SMALL-INGRED (I-M-Peanuts) (I-M-GREEN-BEANS )
(I-M-SNOW-PEAS ))
(M-LARGE-INGRED (I-M-GREEN-PEPPERS) (I-M-BROCCOLI )
(I-M-CHICKEN ) (I-M-BEEF ))
(M-VEGETABLE
(M-STURDY-VEGETABLE   (I-M-Peanuts) (I-M-GREEN-PEPPERS )
(I-M-GREEN-BEANS ))
(M-CRISP-VEGETABLE (I-M-SNOW-PEAS) (I-M-BROCCOLI )))
(M-MEAT   (M-BONY-MEAT   (I-M-CHICKEN ))
(M-BONELESS-MEAT (I-M-BEEF )))

Figure 4.1.3: MOPs-List Return Example

30
? enter MOP name ==> m-bone-step

(M-BONE-STEP (ACTION I-M-BONE)
  (OBJECT M-BONY-MEAT))

Figure 4.1.4: SLOTs-List Return Example

Figure 4.1.5: MOP-Hierarchy Window
Figure 4.1.6: SLOT-Hierarchy Window
### I-M-CHICKEN-AND-PEANUTS

<table>
<thead>
<tr>
<th>SLOT-ROLE</th>
<th>SLOT-FILLER</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEAT</td>
<td>I-M-CHICKEN</td>
</tr>
<tr>
<td>YEGE</td>
<td>I-M-GREEN-PEPPERS</td>
</tr>
<tr>
<td>YEGE2</td>
<td>I-M-PEANUTS</td>
</tr>
<tr>
<td>TASTE</td>
<td>I-M-HOT</td>
</tr>
<tr>
<td>STYLE</td>
<td>I-M-STIR-FRIED</td>
</tr>
<tr>
<td>STEPS</td>
<td>I-M-RECIPE-STEPS.10</td>
</tr>
</tbody>
</table>

**Cases in Memory**

- [ ] I-M-CHICKEN-AND-PEANUTS
- [x] I-M-BEEF-AND-GREEN-BEANS

---

Figure 4.1.7: Cases Return Example
Figure 4.1.8: New-MOPs Return Example
4.2. How to Define and Access the MOPs

Figure 4.2.1 shows a simple example of the MOP definitions and instances. The function "clear-memory" in the first statement creates the foundation MOP "m-root". In Micro MOPs, all MOPs should be defined under "m-root". Example 1 creates a world with three students and their characteristics.

```
( clear-memory )
(defmop m-nationality ( m-root ) mop )
(defmop i-m-American ( m-nationality ) instance )
(defmop i-m-Japanese ( m-nationality ) instance )
(defmop i-m-German ( m-nationality ) instance )
(defmop m-eye-color ( m-root ) mop )
(defmop i-m-blue ( m-eye-color ) instance )
(defmop i-m-grey ( m-eye-color ) instance )
(defmop i-m-brown ( m-eye-color ) instance )
(defmop i-m-green ( m-eye-color ) instance )
(defmop i-m-student ( m-root ) mop )
(defmop i-m-Bob ( m-student ) instance
    ( nationality i-m-American )
    ( age 26 )
    ( height 6.2 )
    ( eye-color i-m-grey ))
(defmop i-m-Mark ( m-student ) instance
    ( nationality i-m-German )
    ( age 24 )
    ( height 5.7 )
    ( eye-color i-m-green ))
(defmop i-m-Kazu ( m-student ) instance
    ( nationality i-m-Japanese )
    ( age 30 )
    ( height 5.6 )
    ( eye-color i-m-brown ))
```

Figure 4.2.1: MOPs Definition for Example 1
( defmop name mop-list type slot-form1 slot-form2 ... )

name : the name of new MOPs
mop-list : the name of immediate upper level abstraction MOPs
type : type of MOPs, it should be either "mop" or "instance"
slot-form : the form of slots

Defmop defines a MOP named name as type with slots specified as slot-form under the abstraction MOPs named mop-list.

In Micro MOPs, the words starting with "m-" are used as abstractions and the words starting with "i-m-" are used as instances. Furthermore, "slot" and "slot value" are referred to in a frame system as "role" and "role filler" respectively. A slot in Micro MOPs has the form "( role filler )".

( role-filler role slot-source )

role : the name of role
slot-source : the list of slots or the name of MOP

Role-filler returns the filler of role in slot-source. For example, if we want to get the filler of nationality-role in i-m-Bob and the filler of eye-color in i-m-Kazu.

? ( role-filler 'nationality 'i-m-Bob )
I-M-AMERICAN
? ( role-filler 'eye-color 'i-m-Kazu )
I-M-BROWN

( add-role-filler role mop filler )

role : the name of role
mop : the name of MOP
filler : the filler of role

Add-role-filler adds the slot (role filler) to the slots of mop. For example, if we want to add the slot (hair-color i-m-black) to i-m-Kazu, then

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Figure 4.2.2: Example 1
(new-mop name mop-list type slot-list)

name : the name of new MOP or instance
mop-list : the name of immediate abstraction MOPs which you want to link to
type : either mop or instance
slot-list : list of slots

New-mop makes a MOP named name as its type of type with slot of slots-list under immediate abstraction MOPs named mop-list. For example, if we make a new instance i-m-Jim with some new slots, then

? (new-mop 'i-m-Jim '(m-student) 'instance
  '((nationality i-m-American)
    (age 32)
    (height 6.2)
    (eye-color i-m-grey)))
I-M-JIM

In Figure 4.2.2, the words except a numerical number used as the filler of role should be defined as either MOP or instance before being referred. Figure 4.2.3 is an "m-root" abstraction hierarchy network graph which is displayed by sub-menu function "MOP-Hierarchy", in the case-based reasoning environment main menu "MOP-Utility".
Figure 4.2.3: MOPs Hierarchy Graph for Example 1
Figures 4.2.4-1 and 4.2.4-2 illustrate additional functions in Micro MOPs. In this example, three students' Math and English scores are added to the previous example.

```
(defmop m-nationality (m-root) mop)
(defmop i-m-American (m-nationality) instance)
(defmop i-m-Japanese (m-nationality) instance)
(defmop i-m-German (m-nationality) instance)
(defmop m-eye-color (m-root) mop)
(defmop i-m-blue (m-eye-color) instance)
(defmop i-m-grey (m-eye-color) instance)
(defmop i-m-brown (m-eye-color) instance)
(defmop i-m-green (m-eye-color) instance)
(defmop m-quarter (m-root) mop)
(defmop i-m-fall (m-quarter) instance)
(defmop i-m-winter (m-quarter) instance)
(defmop i-m-spring (m-quarter) instance)
(defmop i-m-summer (m-quarter) instance)
(defmop m-record (m-root) mop)
  (Math nil)
  (English nil)
  (year 1990)
  (quarter i-m-fall))
(defmop m-pattern (m-root) mop)
(defmop m-function (m-root) mop)
(defmop f-average (f-function))
(defmop i-m-student (m-root) mop)
  (nationality m-nationality)
  (age nil)
  (height nil)
  (eye-color m-eye-color)
  (record m-record)
  (average m-pattern
    (calc-fn f-average)))
(defmop i-m-Bob (m-student) instance)
  (nationality i-m-American)
  (age 26)
  (height 6.2)
  (eye-color i-m-grey)
  (record m-record
    (Math 70)
    (English 86)))
```

Figure 4.2.4-1: MOPs Definitions for Example 2
Figure 4.2.4-2: MOPs Definitions for Example 2 (continued)

In Figure 4.2.4, the slot whose role named “record” in every student’s MOP has the unique filler that has the form of “i-m-record.” In Figures 4.2.4-1 and 4.2.4-2, the slot “record” has the different filler from the other’s: this slot has the network structure which consists of MOP and its slots. In this case, the system automatically generates instances with the slots under MOP, attached unique number to the tail of their instance names to distinguish respectively.

(path-filler path mop)

path : the list of roles to search
mop : the name of MOP

Path-filler returns the filler for path in mop. For example, to retrieve Bob’s Math score, then

? (path-filler ‘(record Math) ‘i-m-Bob) 70
( inherit-filler role mop )

role : the name of role to get
mop : the name of MOP

Inherit-filler returns the first filler of role found in either mop or one of its abstraction MOP. For example, to retrieve the year of Bob's record, then

? ( inherit-filler 'year ( role-filler 'record 'i-m-Bob )) 1990

"( role-filler 'record 'i-m-Bob )" returns "i-m-record.0", despite the fact that "i-m-record.0" doesn't have role "year" and its filler. Otherwise, "1990" can be returned after inheriting "m-record" from its immediate abstraction MOP.

( get-filler role mop )

role : the name of role to get
mop : the name of MOP

Get-filler returns the filler of the role in mop. The filler is either an inherited instance or the value calculated by the function. The filler is calculated when a role inherits a pattern MOP with a slot "( calc-fn function )". For example, to retrieve Bob's average examination score, then

? ( get-filler 'average 'i-m-Bob )
I-M-BOB : AVERAGE <= 78.0
78.0
? ( get-filler 'average 'i-m-Mark )
I-M-MARK : AVERAGE <= 75.0
75.0
? ( get-filler 'average 'i-m-Kazu )
I-M-KAZU : AVERAGE <= 81.0
81.0
Figure 4.2.5 shows a case memory after the “get-filler” function is executed. Figure 4.2.6 shows a SLOT-Hierarchy graph network which is displayed by the “SLOT-Hierarchy” submenu function. The graph network shows slot “( average 78.0 )” is attached to i-m-Bob.
Figure 4.2.5: "get-filler" at Example 2
**Figure 4.2.6: SLOT-Hierarchy Graph for Example 2**
5. Case-based Reasoning Approach to A Residential House Design

5.1. System Architecture

As I introduced in chapter 2, researchers have applied case-based reasoning techniques to various domains. In this chapter, I will introduce an effort to apply this technique to the residential house design domain. Figure 5.1.1 shows the system architecture and its data flow. This prototype system consists of five parts: Layout CAD, Case-based Reasoning Platform, Function Library, Case Memory, and Design Knowledge Database.

- Layout CAD

Layout CAD has three major features. The first one is the Design Tool Box. The Design Tool Box has eleven designing functions as shown in Figure 5.1.2.

(a) is a tool for shrinking a room size.
(b) is a tool for extending a room size.
(c) is a tool for rotating a room location.
(d) is a tool for extending all rooms.
(e) is a tool for shrinking all rooms.
(f) is a tool for eliminating a room.
(g) is a tool for drawing an area plan bubble diagram.
(h) is a tool for rotating a house orientation.
(i) is a tool for changing a room adjacency.
(j) is a tool for drawing a building area.
(k) is a tool for attaching a new room.

The Design Tool Box is used when a designer inputs an area plan with bubble diagrams at the planning stage, and when the designer accumulates knowledge about using design techniques to fit the new case in Case Memory and Design Knowledge Database.

- Case-based Reasoning Platform

At Case-based Reasoning Platform Case-based Reasoner works as a supervisor. It watches the current situation in the system and decides which one of reasoning functions, Retriever, Adapter, Evaluator, Storer and Layout Output, should receive control corresponding to the situation.
Figure 5.1.1: System Architecture
• Function Library

Function Library is the library consisting of the functions necessary for checking design constraints such as a room size, sun light, noise, and privacy. It works in cooperation with the Case-based Reasoner to adapt stored design procedures and with the Design Tool Box to acquire case knowledge.

• Case Memory

Case Memory deals with two type of cases, the area plan bubble diagram and design procedure. The bubble diagram contains the area adjacency information, and is stored as an adjacency matrix. First, Retriever searches Case Memory with the area plan as a search index. Another is the design procedure. The design procedure is a set of methods which are applied when changing a room layout, e.g. shrinking all the rooms or eliminating unnecessary room. This kind of data is collected as a part of Design Data in Figure 5.1.1. Furthermore, Design Data contains room design attributes, e.g. room length, room width, and room name. Coordinate Data is a set of x-y coordinate values of rectangular room vertexes. Coordinate Data is necessary when Layout Output draws a rectangular dissection room layout on the screen.

• Design Knowledge Database

Design Knowledge Database consists of Geographical knowledge for Rectangular Dissection and Design Tool Adapting Knowledge. The former is the Euclidean relationship which comes from the rectangular room adjacencies. The latter is the knowledge about the adapting technique used in Design Tools. This is the information about when and how each tool was used, or which combination of tools was efficient to resolve this difficulty.

Figure 5.1.2 : Design Tool Box
Figure 5.1.2 shows a data flow of the first retrieving stage. At this stage, the user enters the area plan by means of a bubble diagram. After that, Retriever returns some alternatives corresponding to the entered area plan from Case Memory. Finally, Layout Output shows these alternatives graphically on the screen.

Figure 5.1.3 shows a data flow of the second retrieving stage. At this stage, the user chooses one of the alternatives, enters the building area by the Design Tool Box, answers some overall questionnaires and prioritizes the design requirements. First, all constraints are checked with the functions in the library. Next, the difference between the new case and the case picked from the alternatives is passed to Case-based Reasoner. Thus, at this stage, the case is indexed with a list of satisfied constraints and unsatisfied constraints. Retriever searches Case Memory and then returns the closest layout case. If Retriever finds a matching case, Adapter adapts the design process of the retrieved case to the new case. If Retriever finds an analogous case, then Case-based Reasoner searches the resolution which can repair the difference between the new and retrieved cases. In each case, evaluator evaluates the result. Finally, Layout Output draws the graphical layout which is customized by Adapter, and Storer stores it in Case Memory.

Figure 5.1.4 shows a data flow of acquiring knowledge about the case customization process. The user can accumulate the customizing process with the Design Tool Box.

Due to the limited development time, a part of the CBRE has not been developed. The example introduced in the next chapter illustrates the current system capabilities.
CM: Case Memory
CBR: Case-Based Reasoner
R: Retriever
DC: Data Classifier
DTB: Design Tool Box
LO: Layout Output

Figure 5.1.3: Data Flow Stage 1

GKRD: Geographical Knowledge for Rectangular dissection
DTAK: Design Tool Adapting Knowledge
LO: Layout Output
DTBFL: Design Tool Box Functions Library
CCFL: Constraint Check Functions Library

CBR: Case-Based Reasoner
A: Adapter
R: Retriever
E: Evaluator
DC: Data Classifier

Figure 5.1.4: Data Flow Stage 2
Figure 5.1.5 : Data Flow Stage 3
5.2. A Base Model Design

In this case, a designer’s learning process for residential house design is implemented with the case-based reasoning technique. People who want to build their own house often refer to previous examples. In this case, a typical example from “Home Planner’s Guide to Residential Design” (Talcott, Hepler and Wallach 86) is selected as a base model case (Figure 5.2.1).

Figure 5.2.1: A Base Model Residential House Design
A residence is divided into three major functional areas for planning purposes, i.e. the sleeping area, the living area, and the service area. In this base model case, these three major functional areas are located in the west side zone, the central zone, and the east side zone respectively.

From the designer's point of view, this base model case has several excellent points in terms of residential design. These are:

- The main entrance hall provides direct access to the sleeping area and the living area.

- The main entrance is readily identifiable and provides shelter to anyone awaiting entrance.

- Since the sleeping area is located on the north and west sides, it contains the greatest amount of darkness in the morning and provides the greatest degree of thermal comfort.

- The natural alignment of the living room, dining room, kitchen, family room, and entrance hall provides a circular living-area traffic pattern.

- Since the kitchen is directly adjacent to the family room, the layout provides visual access to children in the family room.

- The family room is not visible from the living area.
  (The family room is cluttered because of the normal accumulation of hobby materials.)

- The sleeping area is located far from the garage. The living area should shut out car noise from the garage.

To simplify the problem, only rectangular shaped rooms are dealt with in this case. Therefore, the sample layout becomes a simple rectangular dissection shown as Figure 5.2.2. Also, to simplify representation, the width and length of the rooms are represented as shown in Figure 5.2.2.
5.3. The Definitions for The Knowledge in the Design Domain

Figures 5.3.1-1 to 5.3.1-3 show the abstract hierarchy network graph of the base MOP “m-root” in this layout problem. The “M-root” consists of two major types of knowledge, i.e. reasoning knowledge and geographical knowledge. Figures 5.3.2-1 to 5.3.2-3 show the instance definition of MOP “i-m-layout001”. Instance “i-m-layout001” comprises the attributes and values of each room in the sample residential house shown in Figure 5.2.2. Figure 5.3.3 shows the abstract hierarchy network of MOP “m-space”. The MOP “m-space” has four specific MOPs: “m-sleeping-area”, “m-living-area”, “m-service-area”, and “m-traffic-area”. Furthermore, each MOP has its own instances. The MOP “m-space” represents the knowledge about the attributes of each room, the relationships between the functional zones and each room. E.g. “space109” is a bedroom with size 9.6’ x 11.5’ for one person and belongs to the sleeping area.

Figure 5.3.4 shows the abstract hierarchy network of MOP “m-orientation”. The MOP “m-orientation” has four specific MOPs: “m-north-orient”, “m-east-orient”, “m-south-orient”, and “m-west-orient”. This MOP represents the orientation knowledge of the house. E.g. the north side of the house consists of six rooms: “space101”, “space102”, “space104”, “space105”, “space106”, and “space107”.

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Figure 5.3.1-2: MOP "m--root" (continued)
Figure 5.3.1-3: MOP "m--root" (continued)
| (defmop i-m-layout001 (m-layout) |
|   (building-area m-building-area |
|     (width 76.0) |
|     (length 25.0)) |
|   (room m-space-organization |
|     (g1 m-sleeping-area |
|       (space-name i-m-space101) |
|       (width 15.0) |
|       (length 12.0) |
|       (no-of-people 2) |
|       (use i-m-main-bedroom)) |
|     (g2 m-sleeping-area |
|       (space-name i-m-space102) |
|       (width 8.0) |
|       (length 6.0) |
|       (no-of-people 1) |
|       (use i-m-bath-room)) |
|     (g3 m-sleeping-area |
|       (space-name i-m-space103) |
|       (width 8.0) |
|       (length 6.0) |
|       (no-of-people 1) |
|       (use i-m-bath-room)) |
|     (g4 m-living-area |
|       (space-name i-m-space104) |
|       (width 17.0) |
|       (length 12.0) |
|       (no-of-people 8) |
|       (use i-m-family-room)) |
|     (g5 m-service-area |
|       (space-name i-m-space105) |
|       (width 9.0) |
|       (length 12.0) |
|       (use i-m-kitchen)) |
|     (g6 m-service-area |
|       (space-name i-m-space106) |
|       (width 7.0) |
|       (length 12.0) |
|       (use i-m-laundry)) |
|     (g7 m-service-area |
|       (space-name i-m-space107) |
|       (width 20.0) |
|       (length 25.0) |
|       (use i-m-garage)) |

Figure 5.3.2-1: MOP "i-m-layout001"
( g8  m-sleeping-area
  ( space-name  i-m-space108 )
  ( width 11.5 )
  ( length 13.0 )
  ( no-of-people 1 )
  ( use  i-m-bed-room ))

(g9  m-sleeping-area
  ( space-name  i-m-space109 )
  ( width 11.5 )
  ( length 9.6 )
  ( no-of-people 1 )
  ( use  i-m-bed-room ))

(g10 m-trafic-area
  ( space-name  i-m-space110 )
  ( width 11.5 )
  ( length 3.4 )
  ( use  i-m-hall ) )

(g11 m-trafic-area
  ( space-name  i-m-space111 )
  ( width 6.5 )
  ( length 13.0 )
  ( use  i-m-entrance-hall ))

(g12 m-living-area
  ( space-name  i-m-space112 )
  ( width 16.0 )
  ( length 13.0 )
  ( no-of-people 6 )
  ( use  i-m-living-room ))

(g13 m-living-area
  ( space-name  i-m-space113 )
  ( width 10.5 )
  ( length 13.0 )
  ( no-of-people 6 )
  ( use  i-m-dining-room )))

( orientation  m-direction
  ( north  m-north-orient
    ( g1  i-m-space101 )
    ( g2  i-m-space102 )
    ( g3  i-m-space104 )
    ( g4  i-m-space105 )
    ( g5  i-m-space106 )
    ( g6  i-m-space107 )))

Figure 5.3.2-2 : MOP "i-m-layout001" (continued)
( east m-east-orient
  ( g1 i-m-space107 ))
( south m-south-orient
  ( g1 i-m-space108 )
  ( g2 i-m-space109 )
  ( g3 i-m-space111 )
  ( g4 i-m-space112 )
  ( g5 i-m-space113 )
  ( g6 i-m-space107 ))
( west m-west-orient
  ( g1 i-m-space101 )
  ( g2 i-m-space108 )))

Figure 5.3.2-3: MOP "i-m-layout001" (continued)
Figure 5.3.3: MOP "m-space"
<table>
<thead>
<tr>
<th>SLOT-ROLE</th>
<th>SLOT-FILLER</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1</td>
<td>i-M-SPACE101</td>
</tr>
<tr>
<td>G2</td>
<td>i-M-SPACE108</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SLOT-ROLE</th>
<th>SLOT-FILLER</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1</td>
<td>i-M-SPACE101</td>
</tr>
<tr>
<td>G2</td>
<td>i-M-SPACE102</td>
</tr>
<tr>
<td>G3</td>
<td>i-M-SPACE104</td>
</tr>
<tr>
<td>G4</td>
<td>i-M-SPACE105</td>
</tr>
<tr>
<td>G5</td>
<td>i-M-SPACE106</td>
</tr>
<tr>
<td>G6</td>
<td>i-M-SPACE107</td>
</tr>
</tbody>
</table>

Figure 5.3.4: MOP "m-orientation"
Even where no financial restriction exists, room sizes are limited by the area available for the building. Figure 5.3.5 shows the abstract hierarchy network of MOP "m-room-minimum". The MOP "m-room-minimum" contains knowledge about the minimum size of each room. The minimum size is calculated based on the requirement for the activity performed in each room (Chiara and Callender 90). E.g. the garage has two minimum size dimension, one for single car and the other for two cars.

Figure 5.3.6 shows the abstract hierarchy network of MOP "m-equal". MOP "m-equal" represents topological knowledge for graphical output. To keep traffic access from the entrance hall to the sleeping area and living area on the east walls of "space102", "space103", "space109", and "space110" (or the west wall of "space104" and "space111") are on a straight line. Moreover, because of the rectangular shape restriction for the garage, "space107", the east side of "space106" and "space113" are also on a straight line.

In terms of this model layout, some topological relationships, given as follows, should be taken into account.

\[
\begin{align*}
W_{101} + W_{102} &= W_{101} + W_{103} \\
&= W_{108} + W_{109} \\
&= W_{108} + W_{110} \\
W_{111} + W_{112} + W_{113} &= W_{104} + W_{105} + W_{105}
\end{align*}
\]

\[
\begin{align*}
L_{101} &= L_{102} + L_{103} = L_{104} = L_{105} = L_{106} \\
L_{108} &= L_{109} + L_{110} = L_{111} = L_{112} = L_{113} \\
L_{101} + L_{108} &= L_{107}
\end{align*}
\]
Figure 5.3.5: MOP "m-room-minimum"
Figure 5.3.6: MOP "m-equal"
5.4. Execution

Figure 5.4.1 illustrates the execution stages. Each stage has four steps. First, initial values for the building area, i.e. its width and length, are given. Next, the previously successful case is searched. Second, if there is a successful case in case memory, then the design method of that case is applied to the new case. On the other hand, if there isn't a case in memory, the design method "just-copy", which is defined as the first instance under MOP "m-design-tech", will be fired. All design methods defined in this program are shown in Figure 5.4.2. Third, all room size constraints are checked for compliance (Figure 5.4.3). Finally, if the constraints are compiled with, the case will be stored in case memory as a successful case. If not, it will be stored as a failed case with the failure reason. At step 4, the layout is displayed on the screen.

Figures 5.4.4-1 and 5.4.4-2 show how the case-based reasoning system works. The graphical output of the base residential house is shown in Figure 5.4.4. At stage 1, since there is not a successful case in case memory, the design method "just-copy" is applied to the new case. Consequently, the case succeeds, because the building area of the new case is the same as that of the base model. Therefore, this result is stored in case memory as a successful case. Figure 5.4.5 is the graphical result.

![Figure 5.4.1: Tasks of Each Step](image-url)
At stage 2, the new case, whose building area is 25.0' x 72.2', is given as the required size. At this stage, however, the design method "just-copy" is drawn from memory and applied, because "just-copy" is stored as a successful case in case memory. Otherwise, the case of the design method "just-copy" is stored as a failed case, since a couple of constraints are not satisfied. Following this failed result, other design methods are invoked to repair it. They are "shrink", "eliminate", and "partial shrink". Only the design method "partial shrink" satisfies the constraints in Figure 5.4.3. From Figure 5.4.7 to Figure 5.4.11 the graphical outputs of the above repaired design methods are illustrated.

At stage 3, the new building area, 24.0' x 65.0', is given. This results in the previous procedure not being applicable. At this stage, the design method "partial shrink" is applied immediately, because according to the previous stage’s result "partial shrink" is already stored as a successful case in case memory as a case where the new building area size is smaller than that of base model.

<table>
<thead>
<tr>
<th>Design Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Just Copy</td>
<td>Transfer all rooms of the base model house to the new required building area without changing the room size or other attributes.</td>
</tr>
<tr>
<td>Partial Shrink</td>
<td>Shrink some rooms of the base model to fit the new required building area.</td>
</tr>
<tr>
<td>Eliminate</td>
<td>Eliminate some rooms of the base model house to satisfy the required constraints.</td>
</tr>
<tr>
<td>Shrink</td>
<td>To shrink all rooms of base model house to fit new required building area.</td>
</tr>
<tr>
<td>Extend</td>
<td>Extend all rooms of the base model to fit new required building area (next version).</td>
</tr>
<tr>
<td>Rotate</td>
<td>Rotate some rooms to satisfy the required constraints (next version).</td>
</tr>
<tr>
<td>Change Adjacency</td>
<td>Change the adjacency of some rooms to satisfy the required constraints (next version).</td>
</tr>
</tbody>
</table>

Figure 5.4.2: The Design Methods
Required building gross area size
\[ \geq \text{Total gross area size of each room} \]

The side length of each direction of building area
\[ \geq \text{Total side length of each direction of each room} \]

Main bedroom size \( \geq \) The minimum size of main bedroom

Bathroom size \( \geq \) The minimum size of bathroom

Family room size \( \geq \) The minimum size of family room

Bedroom size \( \geq \) The minimum size of bedroom

Hall size \( \geq \) The minimum size of hall

Entrance hall size \( \geq \) The minimum size of entrance hall

Living room size \( \geq \) The minimum size of living room

Dining room size \( \geq \) The minimum size of dinning room

Garage size \( \geq \) The minimum size of garage

Figure 5.4.3: The Constraints about Room Size

<table>
<thead>
<tr>
<th>Base model</th>
<th>Building Area</th>
<th>25.0' x 76.0'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output</td>
<td></td>
<td>Figure 5.4.5</td>
</tr>
</tbody>
</table>

Stage 1

<table>
<thead>
<tr>
<th>Step1</th>
<th>Building Area</th>
<th>25.0' x 76.0'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case Memory Searched Result</td>
<td>No Succeeded Case</td>
<td></td>
</tr>
<tr>
<td>Step2</td>
<td>Applied Designing Method</td>
<td>Just Copy</td>
</tr>
<tr>
<td>Step3</td>
<td>Applied Result</td>
<td>Satisfied All Constraints</td>
</tr>
<tr>
<td>Step4</td>
<td>Stored</td>
<td>Succeeded Case</td>
</tr>
<tr>
<td>Output</td>
<td></td>
<td>Figure 5.4.6</td>
</tr>
</tbody>
</table>

Stage 2

<table>
<thead>
<tr>
<th>Step1</th>
<th>Building Area</th>
<th>25.0' x 72.2'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case Memory Searched Result</td>
<td>Just Copy</td>
<td></td>
</tr>
<tr>
<td>Step2</td>
<td>Applied Designing Method</td>
<td>Just Copy</td>
</tr>
<tr>
<td>Step3</td>
<td>Applied Result</td>
<td>Not Satisfied All Constraints</td>
</tr>
<tr>
<td>Step4</td>
<td>Stored</td>
<td>Failed Case</td>
</tr>
<tr>
<td>Output</td>
<td></td>
<td>Failed Explanation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Figure 5.4.7</td>
</tr>
</tbody>
</table>

Figure 5.4.4-1: The Result of Each Step
Repaired Method =>
  Step1  -  -
  Step2 Applied Design Method Shrink
  Step3 Applied Result Not Satisfied All Constraints
  Step4 Stored Failed Case
                  Failed Explanation
          Output Figure 5.4.8

Repaired Method =>
  Step1  -  -
  Step2 Applied Design Method Eliminate
  Step3 Applied Result Not Satisfied All Constraints
  Step4 Stored Failed Case
                  Failed Explanation
          Output Figure 5.4.9

Repaired Method =>
  Step1  -  -
  Step2 Applied Design Method Partial Shrink
  Step3 Applied Result Satisfied All Constraints
  Step4 Stored Succeeded Case
          Output Figure 5.4.10

Stage3  Step1 Building Area 24.0' x 65.0'
       Case Memory Searched Result Partial Shrink
  Step2 Applied Design Method Partial Shrink
  Step3 Applied Result Satisfied All Constraints
  Step4 Stored Succeeded Case
       Output Figure 5.4.11

Figure 5.4.4-2 : The Result of Each Step
Figure 5.4.5: Graphical Output Of A Base Model House
Figure 5.4.6: Graphical Output of Stage 1
Case Name: M-JUST-COPY
Result: I-M-FAILURE
Reason: I-M-NONE
Required Area:
Width: 72.2
Length: 25.0

Click the inside of the room!

Warning! : Total Area Size
Warning! : Side Length

Figure 5.4.7 : Graphical Output of Stage 2 no. 1
Figure 5.4.8: Graphical Output of Stage 2 no. 2
Figure 5.4.9: Graphical Output of Stage 2 no. 3
CASE NAME : M-PARTIAL-SHRINK
RESULT : I-M-SUCCESS
REASON : I-M-NONE
REQUIRED AREA
  WIDTH : 72.2
  LENGTH : 25.0

Click the inside of the room!  Shrinked!

Figure 5.4.10 : Graphical Output of Stage 2 no. 4
CASE NAME : M-PARTIAL-SHRINK
RESULT : I-M-SUCCESS
REASON : I-M-NONE

REQUIRED AREA
WIDTH : 65.0
LENGTH : 24.0

Click the inside of the room!  Shrinked!

Figure 5.4.11 : Graphical Output of Stage 3
6. Conclusions

When an expert system development shell, based on rule-based reasoning, was first introduced in public as the epochal problem-solving method several years ago, many people expected that it would provide innovative results in the near future. They, however, recognized that rule-based reasoning could not cover the whole process of a human being after examining it in many domains. Recently, case-based reasoning has begun to attract much attention from AI researchers as a method which can make up for rule-based reasoning’s deficiency. In this paper I introduced a case-based reasoning environment, named CBRE, and a simple prototype system for automated floor layout generation. CBRE’s functions are based on Schank and Riesbeck’s Micro MOPs and developed in Allegro Common Lisp and FrameKit. It provides not only case-based reasoning functions, but graphical windows which show abstract hierarchy networks and slot networks.

Due to time limits, the prototype system contains only adapting and storing functions. Nevertheless, through the development process, I noticed a few points that should be kept in mind to make a case-based reasoning model for automated floor generation system.

- MOPs must be a useful method for simulating a human being’s case-based reasoning process. Otherwise, when we use MOPs for our problem domains, we should define all words in advance, except numerical numbers, which are referred to in slot values.

- Using MOPs for the geographical knowledge for graphical output of rectangular dissections is not a good idea from the point of processing speed. Because it takes time to check the abstract hierarchy of geographical knowledge whenever we need the coordinates of vertexes for drawing a rectangular shaped room at new location.

Throughout the whole development process, the following two issues always concerned me.

- In the storing stage, the most important thing is indexing. So far as the prototype developed in my research is concerned, it needs only two indices, success or failure. However, if we attach the function of acquiring knowledge about using design techniques, we should find the indices to store these knowledge in memory for future use. How can I find them from a designer’s work and how can I generalize them for reasoning?
• When we use MOPs in a residential house design domain, we should define the characteristics of a house with texts. Are there some effective ways to distinguish cases with texts?

Case-based reasoning is one of the efficient methods which can provide reasoning intelligence like a human being. Retrieving and storing functions work like a human’s reminding ability, the adapting function works like a human’s partial matching and comprehending capabilities, and the evaluating explanation function works like a human’s explanation capability. When I started to struggle against my project, a case-based reasoning technique reminded me of computer scientists’ eternal theme: “Can machines think like a human?” At this time we can not answer in the affirmative. I, however, believe our honest efforts will bring the day when we can return “yes” as its answer in the future.
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(Mitchell 90)

(Montreuil 90)

(Oxman and Gero 88)

(Pile 78)

(Riesbeck and Shank 89)

83
(Rinsma 87)

(Saphier 68)

(Schank 82)

(Stiny 80)

(Stiny 81)

(Talcott, Hepler and Wallach 86)

(Tompkins and White 84)

(Webster 89)

(Wilson and Watkins 89)

(Winston and Horn 89)
Appendix : A

Reinstantiation : CHEF (Hammond)

New Problem: Stir-fried chicken and snow peas

Old Case: Beef & Broccoli
< Ingredients >
1/2 lb. beef, 1/2 lb. broccoli, 2 tbs. soy sauce, ...
< Method >
Chop garlic, shred beef, marinate beef in ..., chop broccoli into chunks, stir fry broccoli for 3 minutes, remove broccoli from pan, stir fry spices, wine, beef for 3 minutes, add broccoli, stir fry another 1/2 minute, add salt.

New Dish: Reinstantiate with chicken and snow peas
< Ingredients >
1/2 lb. chicken, 1/2 lb. snow peas, 2 tbs. soy sauce, ...
< Method >
Chop garlic, shred chicken, marinate chicken in ..., chop snow peas into chunks, stir fry snow peas for 3 minutes, remove snow peas from pan, stir fry spices, wine, chicken for 3 minutes, add snow peas, stir fry another 1/2 minute, add salt.

Appendix : B

Parameter Adjustment : JUDGE (Bain)

New Problem: Moe struck Ed several times.
Ed was slightly hurt. Ed struck Moe several times. Moe fell down.
Moe struck Ed several times, breaking Ed's nose.
Ed stabbed Moe with a knife one time, killing Moe. (CRIME4)

Old Case: Hal struck Gary several times.
Gary was slightly hurt. Gary struck Hall several times. Hal fell down.
Hal hit Gary very hard several times, breaking Gary's ribs.
Gary shot at Hal with a gun several times, killing Hal.
Gary's sentence, for murder, was a term of imprisonment of not less than 25 years. (CRIME3)

New Solution: The sentence for CRIME4 will be 15 years.

- Compare Problem Descriptions -

In both crimes, the victim was killed. Although results were the same in both situations, the outcome in the newer crime was accidental and involved a less severe intent. Ed's action did not demonstrate as extreme force as Gary's action. Gary's intent, shown by the repeated shooting, was more severe than that of Ed. ...
The old crime, CRIME3, was substantially worse.
Local Search: PLEXUS (Alterman)

New Problem: First trip on New York City subway.

Old Case: On BART, I buy a ticket from a machine that is used on entry and exit.

Problem: No ticket machines on New York City subway.

New Solution: Walk up to BUY TICKET, then down to buy theater ticket. This new step suggests looking for a person at a ticket window.
Appendix : D

Query Memory : JULIA (Hinrichs)

New Problem: Plan a meal, method of preparation should be stew.

Old Case: Main dish was bouillabaisse

New Information from Client:
Several meat and potatoes men will be attending. I need a stew with meat and potatoes.

Proposed Fix: Substitute a dish, prepared by stewing, with ingredients meat and potatoes.

Local search: Yields no appropriate dish.

Query Memory: Find a instance of “A dish, to be used as a main dish, prepared by stewing, with ingredients meat and potatoes”.
=> Irish Stew is found.

Proposed Solution: Serve Irish Stew as the main dish.

Appendix : E

Specialized Search : SWALE

New problem: Why did Len Bias, a healthy all-star college basketball player, die of a heart attack.

Old Case: Jim Fixx, an apparently healthy jogger, died of a heart attack after running, because of a hidden heart defect.

Proposed Solution: Len Bias had a hidden heart defect.

Problem: ACTOR-ACTION MISMATCH: STEREOTYPE VIOLATION
=> Len Bias is not a jogger.

Specialized Search: Heuristic => SUBSTITUTE ACTION: ACTOR THEME

Result of search: Bias, a basketball player, normally does practice shots and wind sprints (a kind of running).

Repaired Solution: Len Bias had a hidden heart defect, and doing wind sprints led to the heart attack.
Appendix : F

Transformation : JULIA (Hinrichs)

New Problem: Planning an Italian meal, want to serve pasta, some guests are vegetarians, attempting to derive main course.

Old Case: Italian meal, main course was lasagne.

Solution Based on Old Case:
Serve lasagne.

Problem: Violates vegetarian constraint.

Transformed Solution: Vegetarian lasagne.
< Solution 1 > delete secondary ingredient
  => delete meat
< Solution 2 > substitute feature, focusing on its function as a texture-adder
  => meat -> spinach
< Solution 3 > substitute feature, focusing on its function as a protein-food
  => meat -> tuna

Appendix : G

Critic Application : CHEF (Hammond)
Inserting a Step in a Plan

New Problem: Create a pasta dish that includes duck.

Old Case: Ants-climb-a-tree (ground pork and pasta)

Critic Solution: Recipe included a defatting step before cooking duck.

< Adaptation >
· Reinstantiation => Substitution the roles of the old case.
· Critic Application => When cooking duck, defat it before cooking.

- Note -
· This critic is attached to the concept duck, Whenever the concept duck is encountered during problem solving, its critics are checked for applicability.
· This critic is learned by CHEF after it fails to defat duck in a previous recipe.
Critic Application: JULIA (Hinrichs)
Divide & Conquer

New Problem: Guests include a vegetarian who is allergic to milk products and someone who only eats “normal” food.

Problem: Over-constraint feature => Main dish.

Critic Solution: Provide two main dishes.
• Vegetarian and others will eat tomato bake.
• Picky eater and others will eat barbecued chicken.

< Adaptation >
• IF a slot cannot be filled because of overconstraint, and overconstraint is due to constraints generated from individual members of a group,
THEN attempt to increase choice by splitting the overconstrained slot and partitioning the constraints.

Derivational Replay: JULIA (Hinrichs)

New Problem: Plan a school lunch, include chicken season is winter.

Old Case: A nursing home lunch in the summer, where chicken was served. The meal was melon, green salad, broiled chicken, mashed potatoes, milk.

Problem: Melon is unavailable.

Solution: Melon was chosen by a method of choosing a fruit appropriate to the season of the year. Using the same method, apple, orange, grapefruit, and pear are generated as plausible substitutes for melon.

< Derivational Replay >
Look at the reasons melon was chosen in the old meal. Using the same reasoning, choose an item for the new meal.
<table>
<thead>
<tr>
<th>Name</th>
<th>Developer</th>
<th>Domain</th>
<th>Case</th>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLAVIER</td>
<td>Lockheed AI Center 1989</td>
<td>autoclave layout and</td>
<td>previous good layout</td>
<td>list of parts and their priorities</td>
<td>schedule of loads and layouts for each load</td>
</tr>
<tr>
<td></td>
<td></td>
<td>scheduling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CEILA</td>
<td>Georgia Tech 1989</td>
<td>car mechanics</td>
<td>previous broken cars</td>
<td>list of symptoms</td>
<td>diagnostic and repair plan</td>
</tr>
<tr>
<td>Battle Planning</td>
<td>Cognitive Systems, Inc. 1988</td>
<td>battle planning</td>
<td>land warfare database from Data Memory Systems, Inc.</td>
<td>data about intelligence and operational information</td>
<td>similar prior battles with outcomes and analysis</td>
</tr>
<tr>
<td>Tactical</td>
<td>Texas Instruments 1982</td>
<td>scenario projection in</td>
<td>tactical episodes, pedagogically</td>
<td>set of goals for friendly forces, a tactical</td>
<td>possible courses of actions and outcomes</td>
</tr>
<tr>
<td>Assistant</td>
<td></td>
<td>battle planning</td>
<td>organized</td>
<td>situation</td>
<td></td>
</tr>
<tr>
<td>JUDGE</td>
<td>Yale 1986</td>
<td>criminal sentencing</td>
<td>previous crimes and sentences</td>
<td>description of crime and statute violated</td>
<td>a sentence</td>
</tr>
<tr>
<td>MEDIATOR</td>
<td>Georgia Tech 1985</td>
<td>political dispute</td>
<td>disputes and resolutions</td>
<td>description of goal conflicts, e.g. territorial dispute</td>
<td>possible resolution, e.g. split control of territory</td>
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<tr>
<td></td>
<td></td>
<td>mediation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PROTOS</td>
<td>Univ. of Texas 1988</td>
<td>clinical audiology</td>
<td>prior diagnoses</td>
<td>description of patient's symptoms</td>
<td>diagnostic classification</td>
</tr>
<tr>
<td>CASEY</td>
<td>MIT 1988</td>
<td>heart failure diagnosis</td>
<td>diagnoses for a variety of cases</td>
<td>description of patient's symptoms</td>
<td>causal network connecting symptoms with internal states suggested therapy</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>generated by Heart Failure Program</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PERSUADER</td>
<td>Georgia Tech 1987</td>
<td>labor contract</td>
<td>contracts, negotiation episodes, and</td>
<td>description of business plus management and labor goals</td>
<td>a contract</td>
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<tr>
<td></td>
<td></td>
<td>dispute resolution</td>
<td>management problems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CYCLOPS</td>
<td>CMU 1988</td>
<td>landscape design</td>
<td>layouts with results and explanations of</td>
<td>goal, e.g. house on firm ground, or possible</td>
<td>possible layout or evaluation of layout</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>results</td>
<td>layout, e.g. house on a hill</td>
<td></td>
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<tr>
<td>HYPO</td>
<td>Univ. of Mass 1987</td>
<td>patent law, particularly</td>
<td>trade secret cases and their outcomes</td>
<td>description of trade secret violation</td>
<td>a lattice of similar and contrasting precedents</td>
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<tr>
<td></td>
<td></td>
<td>trade secrets</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JULIA</td>
<td>Georgia Tech 1988</td>
<td>Catering</td>
<td>menus, planning episodes, menu failures</td>
<td>desired cuisine and constraints</td>
<td>a menu</td>
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<tr>
<td>PLEXUS</td>
<td>Univ. of Texas 1985</td>
<td>plan repair</td>
<td></td>
<td>execution-time failure, e.g. no BART cards in NY</td>
<td>modified plan, e.g. look for ticket seller</td>
</tr>
<tr>
<td>Name</td>
<td>Developer</td>
<td>Domain</td>
<td>Case</td>
<td>Input</td>
<td>Output</td>
</tr>
<tr>
<td>------------</td>
<td>--------------------------</td>
<td>-------------------------</td>
<td>-----------------------------------------------</td>
<td>-----------------------------------------------------------------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td>Runner</td>
<td>Univ. of Chicago 1989</td>
<td>everyday activities</td>
<td>standard activity sequences in memory hierarchy</td>
<td>goals, e.g. have breakfast and object-level visual features</td>
<td>actions, opportunistic optimization of conjunctive goals</td>
</tr>
<tr>
<td>TA</td>
<td>Univ. of Mass in progress</td>
<td>automatic program generation</td>
<td>programs, patches, and debugging episodes</td>
<td>program specification in logical form</td>
<td>lisp code</td>
</tr>
<tr>
<td>ROENTGEN</td>
<td>Univ. of Chicago 1989</td>
<td>radiation therapy</td>
<td>beam plan for lung cancer therapy</td>
<td>2D rep. of patient cross section, plus constraints and planned dosages</td>
<td>list of beams, strengths, orientations, etc.</td>
</tr>
<tr>
<td>CHEF</td>
<td>Yale 1986</td>
<td>cooking</td>
<td>recipes</td>
<td>desired ingredients and tastes</td>
<td>a recipe</td>
</tr>
<tr>
<td>BURN Sizer</td>
<td>DEC 1988</td>
<td>determining computer resource needs</td>
<td>organizing prototypes</td>
<td>description of origination (size, type of business, predicted computing user community, desired applications, etc.)</td>
<td>hardware/software recommendations</td>
</tr>
<tr>
<td>TRUCKER</td>
<td>Univ. of Chicago 1988</td>
<td>previous routes</td>
<td>UPS-like delivery</td>
<td>delivery requests, map of the area</td>
<td>schedule of truck deliveries, library of &quot;good&quot; routes</td>
</tr>
<tr>
<td>SUPERMOM</td>
<td>Georgia Tech in progress</td>
<td>scheduling household tasks</td>
<td>previous experiences achieving tasks individually and in tandem</td>
<td>set of tasks that need to be done, state of the world</td>
<td>schedule that achieves tasks</td>
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<td>SEPARATOR</td>
<td>Cognitive Systems, Inc. 1988</td>
<td>bank telex classification</td>
<td>telexes and their correct classifications</td>
<td>free-form unrestricted bank telexes</td>
<td>classification into one of 13 categories</td>
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</tbody>
</table>

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An Approach to Automated Architectural Floor Layout Generation with Case-based Reasoning
Part II

CBRE Lisp Code Lists

by

Yoshihiro Ichioka

TECHNICAL REPORT

Number 44 B

March, 1991

Stanford University
An Approach to Automated Architectural Floor Layout Generation with Case-based Reasoning

CBRE Lisp Code Lists

by

Yoshihiro Ichioka*

* Systems Engineer, Obayashi Corporation and Visiting Research Fellow, Center for Integrated Facility Engineering, Stanford University.
Welcome to CBRE: Case-based Reasoning Environment. The floppy disk, named CBRE, includes following three folders.

1. FRAMEKIT
2. CBRE.Lisp
3. CBR-Library

When you install CBRE in your Macintosh, there are some restrictions. Since CBRE uses some color functions, you should have Allegro Common Lisp Version 1.3.2 and a color monitor. CBRE needs more than 5 MB memories. So you should change Allegro Common Lisp memory size before running. You can easily change Allegro Common Lisp memory size with “Get Info” under “File” menu. I will recommend you to set more than 5 MB to reduce Garbage Collection.

FRAMEKIT is a frame-based knowledge representation, written in Common Lisp, that provides the basic mechanisms of frames, inheritance, demons, and views. Folder “FRAMEKIT” contains the functions that can provide above frame-based environment on Allegro Common Lisp. Folder “CBRE.Lisp” contains basic CBRE functions that can provide case-based reasoning environment. You can make your own case-based reasoning applications in Folder “CBR-Library”, when you key-in the new file name with “File” under “CBR-Menu”. Folder “CBR-Library” is referred by the function which is invoked by clicking “File” submenu item.

When you want to load CBRE into you Macintosh, Please follow next procedures.

1. Click Allegro Common Lisp icon double times to open Lisp environment.

2. Click “Eval” main menu item and draw your mouse below main menu and click “Load” submenu item. Then Macintosh File Allocation window will be popped up.

3. First click “Drive” radio-button and chose “CBRE” floppy disk. Second open Folder “CBRE.Lisp” and click File “CBRE.Load.Lisp” double times, then CBRE functions would be loaded from following twelve files just after FRAMEKIT environment are prepared.
(1) CBRE.Lisp.Framekit
(2) Expand.Lisp
(3) CBRE.Functions1
(4) CBRE.Functions2
(5) CBRE.Functions3
(6) CBRE.Functions4
(7) CBRE.Basic.MOPs
(8) CBRE.Floor.Defmop
(9) CBRE.Floor.Defun
(10) CBRE.Floor.Defun1
(11) CBRE.Floor.Output.Defmop
(12) CBRE.Floor.Output.Defun

If you want to contact the developer, please mail to

Yoshihiro Ichioka
CIFE, Civil Engineering,
Stanford University,
Terman Engineering Center
Mail Code: 4020
Stanford, CA 95305-4020
CBRE.Load.Lisp
;;; ****************************************************************************
;;; * When loading, you should change *CBRE-Directory* to refer to your *
;;; * current environment. *
;;; * Feb. 14, 1991 Y. ICHIOKA *
;;; ****************************************************************************
;;; * Requirements *
;;; * 1. Allegro Common Lisp Version 1.3.2 (more than 5.0 MB memory) *
;;; * 2. Framekit Version 2.0 *
;;; ****************************************************************************

(setq *CBRE-Directory* "ichioka:Languages:Allegro:CBRE:"
      (concatenate 'string *CBRE-Directory* "CBR-Library:"))

;;;; load quickdraw *****
(setq *CBR-Library* (concatenate 'string *CBRE-Directory* "CBR-Library:"))

;;;; load quickdraw *****
(require 'quickdraw)

;;;; load Framekit *****
(load (concatenate 'string *CBRE-Directory* "FRAMEKIT:framekit.system"))

;;;; compile Framekit *****
(compile-framekit)

;;;; load CBRE functions *****
(load (concatenate 'string *CBRE-Directory* "CBRE.Lisp:CBRE.Framekit"))

(load (concatenate 'string *CBRE-Directory* "CBRE.Lisp:CBRE.Expand.Lisp"))

(load (concatenate 'string *CBRE-Directory* "CBRE.Lisp:CBRE.Functions1"))

(load (concatenate 'string *CBRE-Directory* "CBRE.Lisp:CBRE.Functions2"))

(load (concatenate 'string *CBRE-Directory* "CBRE.Lisp:CBRE.Functions3"))

(load (concatenate 'string *CBRE-Directory* "CBRE.Lisp:CBRE.Functions4"))

(load (concatenate 'string *CBRE-Directory* "CBRE.Lisp:CBRE.Basic.MOPs"))

;;;; show CBR main menu *****
(m-cbrmenu-fun)

;;;; load retinail house example MOPs and functions *****
(load (concatenate 'string *CBRE-Directory* "CBRE.Lisp:CBRE.Floor.Defmop"))

(load (concatenate 'string *CBRE-Directory* "CBRE.Lisp:CBRE.Floor.Defmop"))
(concatenate 'string *CBRE-Directory*
"CBRE.Lisp:CBRE.Floor.Defun")

(load
(concatenate 'string *CBRE-Directory*
"CBRE.Lisp:CBRE.Floor.Defun1")

;***** load MOPs and functions for graphical output *****

(load
(concatenate 'string *CBRE-Directory*
"CBRE.Lisp:CBRE.Floor.Output.Defmop")

(load
(concatenate 'string *CBRE-Directory*
"CBRE.Lisp:CBRE.Floor.Output.Defun")

CBRE.Framekit
;; *** Listing 3.1: INSIST
;;
(defun make-insist-forms (fnnname exps)
  (cons `or , (car exps)
    (error "s failed in ", (car exps) "", fnnname)
    (make-insist-forms fnnname (cdr exps))))

(defun sum-squares (x y)
  (insist sum-squares (numberp x) (numberp y))
  (+ (* x x) (* y y)))

;; *** Listing 3.2: Definition of DEFINE-TABLE
;
(defun define-table (fn vars place)
  (let ((key (car vars))
    (set-fn (gentemp "set-fn."))
    (val (gentemp "val."))
    `progn (defun ,fn ,key
      (declare (object-variable ,place))
      (getf ,place ,key))
    (defun ,set-fn ,key ,val
      (declare (object-variable ,place))
      (setf (getf ,place ,key), val))
    (defsetsf ,fn ,set-fn
      ,fn))
)

(defun delete-key (table key)
  (remf table key) table)

(defun table-keys (table)
  (and table
    (cons (car table)
      (table-keys (cdr (cdr table))))))

;; *** Listing 3.3: Definition of FOR
;
(setf *for-keys* nil)
(define-table for-key (key) *for-keys*)

(defun for (var-clauses)
  (let ((when-part (member ':when var-clauses))
    (for-expander (for-var-forms var-clauses)
      (and when-part (car (cdr when-part))
        (for-body for-clauses)))))

(defun for-var-forms (l)
  (and l (listp (car l))
    (cons (car l) (for-var-forms (cdr l)))))

(defun for-body (l)
  (and l (or (and (for-key (car l)) l)
    (for-body (cdr l))))

(defun for-expander (var-forms when-form body-forms)
  (insist for
    (not (null var-forms))
    (not (null body-forms)))
  for-expander (var-forms when-form body-forms)
(let ((vars (mapcar #'car var-forms))
    (lists (mapcar #'(lambda (var-form)
                        (car (cdr (cadr var-form))))
             var-forms))
    (mapfn-body (funcall (for-key (car body-forms))
                       when-form
                       '((progn ,8(cdr body-forms)))))
  ',(car mapfn-body)
  #'(lambda ,vars ,(car (cdr mapfn-body)))
  ,@lists))
)

(defun define-for-key (key vars mapfn body)
  '(progn (setf {for-key ',key)
                #'(lambda ,vars (list ,mapfn ,body))
                ',key))
)

;;; Listing 3.4: Definition of FOR Keywords

(defun define-for-key :always (test body)
  'every
  (cond (test `'(or (not ,test) ,body)) (t body)))
)

(defun define-for-key :do (test body)
  'mapc (cond (test `'(and ,test ,body)) (t body)))
)

(defun define-for-key :filter (test body)
  'mapcan
  (let ((fbody `((let ((x ,body)) (and x (list x))))))
    (cond (test `'(and ,test ,fbody)) (t fbody))))
)

(defun define-for-key :first (test body)
  'some (cond (test `'(and ,test ,body)) (t body)))
)

(defun define-for-key :save (test body)
  (cond (test 'mapcan) (t 'mapcar))
    (cond (test `'(and ,test (list ,body)))
    (t body)))
)

(defun define-for-key :splice (test body)
  'mapcan
    `(copy-list
      ,(cond (test `'(and ,test ,body)) (t body)))))
)

 (;; Table definition

(defun mop-all-absts (mop)
  (let ((abst (get 'mop-all-absts mop)))
    (cond ((eql abst nil) (list mop))
      (t abst))))
)

(defun mop-type (mop)
  (get 'mop-type mop))
)

(defun mop-slots (mop)
  (let ((slotnames (skip-this 'is-a (%frame-slot-names mop))))
    (let ((slotnames (skip-this 'subclasses slotnames)))
      (let ((slotnames (skip-this 'instances slotnames)))
        (let ((slots (skip-this 'instance-of slotnames)))
          (for (slot :in (reverse slots))
            :save (list slot
car (%view-fillers mop slot 'value 'common))))))
)
(defun dah (mop)
  (pprint (tree->list mop #'specs->list nil)))
)

(defun tree->list (mop fn visited)
  (cond ((member mop visited) (list mop))
    (t (setf visited (cons mop visited))
      '(_,mop ,@(funcall fn mop visited))))))

(defun specs->list (mop visited)
  (cond ((member 'subclasses (%frame-slot-names mop))
    (for (spec :in (%view-fillers mop 'subclasses 'value 'common))
      :save (tree->list spec #'specs->list visited))
  ((member 'instances (%frame-slot-names mop))
    (for (spec :in (%view-fillers mop 'instances 'value 'common))
      :save (tree->list spec #'specs->list visited)))))

(defun dph (mop)
  (pprint (tree->list mop #'slots->forms nil)))

(defun slots->forms (mop visited)
  (cond ((eq (frame-p mop) nil) nil)
    (t (let ((slotnames (skip-this 'is-a (%frame-slot-names mop))))
      (let ((slotnames (skip-this 'subclasses slotnames))
        (let ((slotnames (skips-this 'instances slotnames)))
          (let ((slots (skip-this 'instance-of slotnames))
            (for (slot :in (reverse slots))
              :save (cons slot
                (mop->form (car (%view-fillers mop slot 'value
                    'common))
                  visited)))))))))

(defun mop->form (mop visited)
  (tree->list mop #'slots->forms visited))

(defun skip-this (atom l)
  (let ((result ())
        (dolist (element l result)
          (cond ((eq (frame-p element))
            (t (setf result (append result (list element)))))))))

;*******************************************************************************
; (mop-absts x) = (%view-fillers x 'instance-of ...) or (%view-fillers x 'is-a ...)
; (mop-specs x) = (%view-fillers x 'subclasses ...) or (%view-fillers x 'instances ...)
;*******************************************************************************
(defun mop-absts (mop)
  (cond ((eql (instance-p mop) t) (%view-fillers mop 'instance-of 'value 'common))
  (t (%view-fillers mop 'is-a 'value 'common))))

(defun mop-specs (mop)
  (cond ((eql (leaf-instance-p mop 'common) nil)
    (append (%view-fillers mop 'instances 'value 'common)
      (%view-fillers mop 'subclasses 'value 'common))
  (t nil)))

;;;; Listing 3.6

(defun mopp (x)
  (cond ((eql x nil) nil)
  (t (or (numberp x) (and (symbolp x) (mop-type x)))))))

(defun instance-mopp (x)
  (or (numberp x) (eql (instance-p x) t)))

(defun abst-mopp (x)
  (mopp x)
  (and (mopp x)
    (eql (mop-type x) 'mop)))

(defun abstp (abst spec)
  (or (eql abst spec)
    (member abst (mop-all-absts spec))))

(defun patternp (x) (abstp 'm-pattern x))

(defun groupp (x) (abstp 'm-group x))

;;;; Listing 3.7

(defun slot-role (slot) (car slot))
(defun slot-filler (slot) (cadr slot))

(defun make-slot (role mop) (list role mop))

(defun role-slot (role x)
  (insist role-slot
    (or (mopp x) (listp x)))
  (assoc role
    (cond ((mopp x) (mop-slots x)
      (t x)))))))

(defun role-filler (role x)
  (slot-filler (role-slot role x))

;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% add-role-filler %%%%%%%%%%%%%%%%%%%%

;* date    * June 20,1990
;* function * add slots (role filler) to frame
;* argument * role : slot name
;*          * mop : frame name
;*          * filler : facet value
;* var      * none
;* example  *
;            (add-role-filler 'price 'm-flower '$4.50)

;  (before) 
;  (m-flower 
;  (after) 
;  (m-flower
(defun add-role-filler (role mop filler)
  (insist add-role-filler
    (mopp mop) (null (role-filler role mop)))
  (format t "-&s::s <= ~s" mop role filler)
  (add-value mop role filler :demons t)
  (dph mop)
  (setf (get 'mop-slots mop)
    (cons (make-slot role filler) (mop-slots mop)))
  filler)

;;;; Listing 3.8

(defun link-abst (spec abst)
  (insist link-abst (abst-mopp abst) (mopp spec)
    (not (abstp spec abst)))
  (cond ((not (abstp abst spec))
    (setf (get 'mop-absts spec)
      (cons abst (mop-absts spec)))
    (setf (get 'mop-specs abst)
      (cons spec (mop-specs abst)))
    (let ((type (mop-type spec))
      (cond ((eql type 'mop) (add-view-filler abst 'subclasses 'value 'common)
      (add-view-filler spec 'is-a 'value 'common)
      (add-view-filler spec 'instances 'value 'common)
      (add-view-filler spec 'instance-of 'value 'common)
      (add-all-absts spec)))))
  spec)

(defun unlink-abst (spec abst)
  (cond ((abstp abst spec)
    (setf (get 'mop-absts spec)
      (remove abst (mop-absts spec)))
    (setf (get 'mop-specs abst)
      (remove spec (mop-specs abst)))
    (let ((type (mop-type spec))
      (cond ((eql type 'mop) (erase-filler abst 'subclasses 'value spec)
      (erase-filler spec 'is-a 'value abst)
      (erase-filler abst 'instances 'value spec)
      (erase-filler spec 'instance-of 'value abst)))
    (add-all-absts spec)))))

(defun redo-all-absts (mop)
  (setf (get 'mop-all-absts mop) (calc-all-absts mop))
  (for (spec :in (mop-specs mop))
    :do (redo-all-absts spec))

(defun calc-all-absts (mop)
  (remove-duplicates
    (cons mop (for (abst :in (mop-absts mop))
      :splice (mop-all-absts abst)))))

;;;; Listing 3.9


(setq *new-mop-stack* nil)
(defun new-mop (name absts type slots)
  (declare (special *new-mop-stack*
                  new-mop)
           (object-variable abst
                  slot))
  (insist new-mop
    (symbolp name)
    (for (abst :in absts) :always (mopp abst)))
  (or type (setq type (calc-type absts slots)))
  (or name (setq name (spec-name absts type)))
  (make-frame name)
  (setq (get 'mop-type name) type)
  ;; (and slots (setq (get 'mop-slots name) slots))
  (for (abst :in absts)
    :do (for (slot :in slots)
      :do (add-filler name (slot-role slot) 'value (slot-filler
           r slot))))
  (link-abst name abst)
  (setq *new-mop-stack* (append *new-mop-stack* (list name)))
  name)

(defun calc-type (absts slots)
  (or (for (abst :in absts)
        :when (patternp abst)
        :first 'mop)
    (and (null slots) 'mop)
    (for (slot :in slots)
      :when (not (instance-mopp (slot-filler slot)))
      :first 'mop)
    'instance))

(defun spec-name (absts type)
  (gentemp (format nil (cond ((eql type 'mop) "~s."
                                (t "i-~s."
                                (car absts)))))

;;;; Listing 3.10: Memory Management Functions

(defun clear-memory ()
  (new-mop 'm-root nil 'mop nil)
  (setf (get 'mop-all-absts 'm-root)
    (calc-all-absts 'm-root))
  'm-root)

(defun all-mops () (table-keys (mop-table 'type)))

(defun remove-mop (name)
  (for (abst :in (mop-absts name))
    :do (unlink-abst name abst)))
  (for (table-name :in (table-keys *mop-tables*))
    :do (setf (mop-table table-name)
      (delete-key (mop-table table-name)
      name))))

;;;; Listing 3.11: Extended Role Access Functions

(defun inherit-filler (role mop)
  (for (abst :in (mop-all-absts mop))
    :first (role-filler role abst)))

(defun get-filler (role mop)
  (or (role-filler role mop)
(let ((filler (inherit-filler role mop)))
  (and filler
    (or (and (instance-mopp filler) filler)
      (and (abstp 'm-function filler)
        (let ((fn (get-filler 'calc-fn filler)))
          (and fn (let ((new-filler (funcall fn filler mop))
            (and new-filler
              (add-role-filler role mop new-filler)))))
    )))
;
(defun path-filler (path mop)
  (and (for (role :in path)
      :always (setf mop (get-filler role mop)))
  mop)
;
;;;; Listing 3.12: Extended MOP Abstraction Predicates
;
(defun slots-abstp (mop slots)
  (and (abstp mop)
    (not (null (mop-slots mop)))
    (for (slot :in (mop-slots mop))
      :always (satisfiedp (slot-filler slot)
        (get-filler (slot-role slot) slots)))
  
;
(defun satisfiedp (constraint filler slots)
  (cond ((null constraint)
    ((patternp constraint)
      (funcall (inherit-filler 'abst-fn constraint) constraint filler slots))
      (abstp constraint filler))
    ((instance-mopp constraint) (null filler))
      (filler (slots-abstp constraint filler))
    (t nil))
;
;;;; Listing 3.13: MOP Equality Functions
;
(defun mop-includesp (mop1 mop2)
  (and (eql (mop-type mop1) (mop-type mop2))
    (for (slot :in (mop-slots mop2))
      :always (eql (slot-filler slot)
        (get-filler (slot-role slot) mop1)))
  
;
(defun mop-equalp (mop1 mop2)
  (and (mop-includesp mop2 mop1)
    (mop-includesp mop1 mop2)))
;
;%%%%%%%%%%%%%%%% get-twin %%%%%%%%%%%%%%%%%
;
;;;; * date   * June 26,1990
;;;; * function * returns the first MOP in memory it can find that is equal to mop
;;;; * argument  * mop : abstract frame name
;;;; * var      * none
;;;; * example  *
;
(defun get-twin (mop)
  (for (abst :in (mop-absts mop))
    :first (for (spec :in (mop-specs abst))
      :when (not (eql spec mop))
      :first (mop-equalp spec mop)))
;
;;;; Listing 3.14: Refining Functions
(defun refine-instance (instance)
  (for (abst :in (mop-absts instance))
    :when (mops-abstp (mop-specs abst) instance)
    :first (unlink-abst instance abst)
    (refine-instance instance)))

;(defun mops-abstp (mops instance)
  (not (null (for (mop :in mops)
                     :when (slots-abstp mop instance)
                     :save (link-abst instance mop))))))

;***** Listing 3.15: Instance Installation Functions
;
(defun install-instance (instance)
  (refine-instance instance)
  (let (((twin (get-twin instance)))
    ;; checks if any instance $
    (cond (twin (remove-mop instance) twin) ;; when includes, it is re
      ;; moved and returns old one
      (has-legal-absts-p instance) instance) ;; illegal abstractions ar
    ;; e unlinked and returns instance
    (t (remove-mop instance) nil)))))) ;; instance is removed and

(defun has-legal-absts-p (instance)
  (for (abst :in (mop-absts instance))
      :when (not (legal-abstp abst instance)) ;; if immediate abstraction
    ;; n is illegal
    :do (unlink-abst instance abst)) ;; then it is unlinked
  (mop-absts instance)) ;; return the list of illegal abstractions

(defun legal-abstp (abst instance)
  (declare (ignore instance)
    (object-variable spec))
  (and (mop-slots abst)
       (for (spec :in (mop-specs abst))
            :always (instance-mopp spec))))

;***** Listing 3.16: Abstraction Installation Functions
;
(defun install-abstraction (mop)
  (let (((twin (get-twin mop)))
        ((cond (twin (remove-mop mop) twin) ;; if identical MOP e
      ;; xsists, it is returned
      (t (reindex-siblings mop)))))

(defun reindex-siblings (mop)
  (for (abst :in (mop-absts mop)) ;; for all immediate
    ;; abstractions
    :do (for (spec :in (mop-specs abst)) ;; for all immediate
      ;; specifications
      :when (and (instance-mopp spec)
                 (slots-abstp mop spec)) ;; instances are unli
      :do (unlink-abst spec abst) ;; instances are link
      :nked from their abstractions
      (link-abst spec mop)))

(defun ed to mop
  mop)

;***** Listing 3.17: Top-Level Memory Update Functions
;
(defun slots->mop (slots absts must-work)
(insist slots->mop
 (not (null absts))
 (for (abst :in absts)
      :always (mopp abst))
 (or (and (null slots) (null (cdr absts)) (car absts))
    (let ((type (and slots (atom (car slots)) (car slots)))
           (and type (setf slots (cdr slots)))
           (let ((mop (new-mop nil absts type slots)))
           (let ((result (cond ((instance-mopp mop) (install-instance mop))
                             (t (install-abstraction mop))))
                (insist slots->mop
                      (or result (null must-work))
                result)))))))

;***** Listing 3.18: Form to MOP Functions
;
(defmacro defmop (name absts &rest args)
 (let ((type (and args (atom (car args)) (car args))))
  (let ((slot-forms (cond (type (cdr args))
                           (t args)))))
      `(new-mop ',name ',absts ',type
         (forms->slots ',slot-forms))))

(defun forms->slots (slot-forms)
  (for (slot-form :in slot-forms)
    :save (cond ((atom slot-form) slot-form)
                (t (make-slot (slot-role slot-form)
                   (let ((abst (car (cdr slot-form))))
                   (insist forms->slots (atom abst))
                   (and abst (slots->mop
                              (forms->slots (cdr s))
                              (list abst) t))))))))

;***** Listing 3.19: Group MOP Functions
;
;************* group-size *************
;
;; date    * July 1,1990
;; function * returns the size of the group
;; argument * x : abstract frame name
;; var      * none
;
(defun group-size (x)
  (and (groupp x) (length (mop-slots x))))

;************* group->list *************
;
;; date    * July 1,1990
;; function * returns a list of the members of the group
;; argument * group : name of the group
;; var      * none
;
(defun group->list (group)
  (and group
       (insist group->list (groupp group))
       (for (index :in (make-m-n 1 (group-size group))
              :filter (role-filler index group)))

;************* list->group *************
;
;; date    * July 1,1990
(* function * returns a group MOP with members from list
  * argument * list    :
  * var     * none

(defun list->group (l)
  (cond ((null l) 'i-m-empty-group)
    (t (slots->mop
        (for (x :in l)
            (i :in (make-m-n l (length l)))
            (m-group)
            :save (make-slot i x))
      t)))))

;;;;;;; make-m-n %%%%%%%%%%%%%%%%%

(* date    * July 1,1990
(* function * generates a list of integers from m to n
  * argument * m    : start integer
  * n        : end    integer
  * var      * none

(defun original-make-m-n (m n)
  (insist original-make-m-n (integerp m) (integerp n))
  (cond ((eql m n) (list n))
    ((< m n) (cons m (original-make-m-n (+ m 1) n)))
    (t (cons m (original-make-m-n (- m 1) n))))))

(setf *group-name* nil)
(setf (get *group-name* '1) 'g1)
(setf (get *group-name* '2) 'g2)
(setf (get *group-name* '3) 'g3)
(setf (get *group-name* '4) 'g4)
(setf (get *group-name* '5) 'g5)
(setf (get *group-name* '6) 'g6)
(setf (get *group-name* '7) 'g7)
(setf (get *group-name* '8) 'g8)
(setf (get *group-name* '9) 'g9)
(setf (get *group-name* '10) 'g10)
(setf (get *group-name* '11) 'g11)
(setf (get *group-name* '12) 'g12)
(setf (get *group-name* '13) 'g13)
(setf (get *group-name* '14) 'g14)
(setf (get *group-name* '15) 'g15)
(setf (get *group-name* '16) 'g16)
(setf (get *group-name* '17) 'g17)
(setf (get *group-name* '18) 'g18)
(setf (get *group-name* '19) 'g19)
(setf (get *group-name* '20) 'g20)
(setf (get *group-name* 'g1) '1)
(setf (get *group-name* 'g2) '2)
(setf (get *group-name* 'g3) '3)
(setf (get *group-name* 'g4) '4)
(setf (get *group-name* 'g5) '5)
(setf (get *group-name* 'g6) '6)
(setf (get *group-name* 'g7) '7)
(setf (get *group-name* 'g8) '8)
(setf (get *group-name* 'g9) '9)
(setf (get *group-name* 'g10) '10)
(setf (get *group-name* 'g11) '11)
(setf (get *group-name* 'g12) '12)
(setf (get *group-name* 'g13) '13)
(setf (get *group-name* 'g14) '14)
(setf (get *group-name* 'g15) '15)
(setf (get *group-name* 'g16) '16)
(setf (get *group-name* 'g17) '17)
(setf (get *group-name* 'g18) '18)
(setf (get *group-name* 'g19) '19)
(setf (get *group-name* 'g20) '20)

; (defun make-m-n (m n)
  (declare (special group-name make-m-n)
    (object-variable num-list))
  (insist make-m-n (integerp m) (integerp n))
  (cond (> n 20) (format nil "**** error group name is more than 20 ****")
    (t
      (let ((num-list (original-make-m-n m n)))
        (for (num :in num-list)
          :save (get *group-name* num)))))))

; *** Listing 3.22: Basic Abstraction and Calculation Functions

; (defun constraint-fn (constraint filler slots)
  (declare (ignore constraint
    filler
  slots)) t)

; (defun not-constraint (constraint filler slots)
  (insist not-constraint (not (null filler)))
  (not (satisfiedp (get-filler 'object constraint)
    filler slots)))

; (defun get-sibling (pattern mop)
  (declare (ignore pattern)
    (object-variable abst
      spec))
  (for (abst :in (mop-absts mop))
    :first (for (spec :in (mop-specs abst))
      :when (and (instance-mopp spec)
        (not (eql spec mop))
        (not (abstp 'm-failed-solution spec)))
      :first spec)))
Expand.Lisp
;;; ** Listing A.1: Definition of BACKQUOTE
;;; (defun backquote (skel)
  (cond ((null skel) nil)
        ((atom skel) (list 'quote skel))
        ((eql (car skel) '$) (car (cdr skel)))
        ((and (listp (car skel))
           (eql (car (car skel)) '$$))
           (list 'append (car (cdr (car skel))))
           (backquote (cdr skel))))
        (t (combine-skels (backquote (car skel))
              (backquote (cdr skel))))))

;;; (defun combine-skels (left right)
  (cond ((and (constantp left) (constantp right))
         (list 'quote (cons (car (cdr left))
                         (car (cdr right))))))
  ((null right) (list 'list left))
  ((and (listp right)
        (eql (car right) 'list))
   (cons 'list (cons left (cdr right)))))
  (t (list 'cons left right))))

;;; ** Listing A.2: Definition for Backquote (') Readmacro
;;; (set-macro-character \\ #'(lambda (stream char)
    (backquote (read stream t nil t))))

;;; (set-macro-character \\ #'(lambda (stream char)
    (list (get-unquoter stream)
          (read stream t nil t))))

;;; (defun get-unquoter (stream)
; (let ((next-char (read-char stream t nil t)))
  (cond ((eql next-char #'\$)
         (t (unread-char next-char stream)
            '$))))

;;
(defobject *cbrmenu-function* *menu*)

(setq cbrmenu-fun (oneof *cbrmenu-function*
                   :menu-title "CBR-Menu"))

; MOP-File functions
(setq mop-file (oneof *cbrmenu-function*
                   :menu-title "MOP-File"))

(setq new (oneof *cbrmenu-function*
                   :menu-item-title "New"
                   :menu-item-title #:'(lambda ()
                   (file-alloc)
                   (ask mop-define menu-item-enab)
                   (ask mop-utility menu-item-enab)
                   (ask mop-edit menu-item-enab)
                   )))

(setq update (oneof *cbrmenu-function*
                   :menu-item-title "Update"
                   :menu-item-title #:'(lambda ()
                   (file-update)
                   (ask mop-define menu-item-enab)
                   (ask mop-utility menu-item-enab)
                   (ask mop-edit menu-item-enab)
                   )))

(setq cbrmenu-ll (oneof *cbrmenu-function*
                   :menu-item-title "-"))

; MOP definition
(setq mop-define (oneof *cbrmenu-function*
                   :menu-item-title "MOP-Define"
                   :menu-item-title #:'(lambda ()
}
(pop-up-input.l)
(input-dialog.l))

;; Blank line

(setq cbmenu-12 (oneof *menu-item* 
:menu-item-title "-"))

;; Blank line

(setq mop-utility (oneof *menu-item* 
:menu-item-title "MOP-Utility" 
:menu-item-action #'(lambda ()
(m-display-fun))
:disabled t))

;; Blank line

(setq cbmenu-13 (oneof *menu-item* 
:menu-item-title "-"))

;; Blank line

(setq mop-edit (oneof *menu-item* 
:menu-item-title "MOP-Edit" 
:menu-item-action #'(lambda ()
(setq cb-edit (oneof *fred-window*
:filename *cbr-defmop-file* 
:scratch-p nil))
:disabled t))

;; Blank line

(setq cbmenu-14 (oneof *menu-item* 
:menu-item-title "-"))

;; Blank line

(setq cbmenu-quit (oneof *menu-item* 
:menu-item-title "Quit-CBR" 
:menu-item-action #'(lambda ()
:disabled t)))
(ask cbrmenu-fun (remove-menu-items mo 2)
 (ask cbrmenu-fun (remove-menu-items cb 2)
 (ask cbrmenu-fun (remove-menu-items mo 2)
 (ask cbrmenu-fun (remove-menu-items cb 2)
 (ask cbrmenu-fun (remove-menu-items mo 2)
 (ask cbrmenu-fun (remove-menu-items cb 2)
 (ask cbrmenu-fun (remove-menu-items cb 2)
 (set-menubar *menu-no-cbrmenu*) )))

; ;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
; set CBR-Menu functions
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

;* date    : July 25,1990
;* function: sets CBR-Menu menu functions
;* argument: none
;* var     : none
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

(defun m-cbrmenu-fun ()
    (declare (special *menu-no-cbrmenu*
        cbrmenu-fun
        mop-file
        cbrmenu-11
        mop-define
        cbrmenu-12
        mop-utility
        cbrmenu-13
        mop-edit
        cbrmenu-14
        cbrmenu-quit
        new
        update))
    (setq *menu-no-cbrmenu* (menubar))

(ask cbrmenu-fun (menu-deinstall))
(ask cbrmenu-fun (menu-install))
(ask cbrmenu-fun (add-menu-items mop-file
cbrmenu-11
mop-define
cbrmenu-12
mop-utility
cbrmenu-13
mop-edit
cbrmenu-14
cbrmenu-quit))
(ask mop-file (add-menu-items new
update)))

; ;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
; Input dialog defenition no.1
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

;* date    * July 22,1990
;* function * define input dialog menu no.1
;* argument * none
;* var     * none
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
; (defun pop-up-input.1 ()
    (declare (special *mop-or-instance*
               *input-dialog.1*))
    (setf *mop-or-instance* 'mop)
    (setf *input-dialog.1* (oneof *dialog*
                      :window-type       :document-with-grow
                      :window-title      "MOP Definition"
                      :window-font       '("courie" 12)
                      :window-position   '([:top 40])
                      :window-size       #@(500 400))))

; (defun input-dialog.1 ()
    (declare (special *input-dialog.1*))
    (ask *input-dialog.1*
        (oneof *static-text-dialog-item*
            (add-dialog-items  (oneof *static-text-dialog-item*
                :dialog-item-position #@( 20 30)
                :dialog-item-font   '("courie" 12)
                :dialog-item-text   "Define abstract hierarchy"
                :dialog-item-action (lambda ()
                    (read-from-string (ask *input-dialog.1* (window-close))
                        (pop-up-input.1)
                        (input-dialog.1)))
                :default-button     t))
            (lambda ()
                (make-defmop.1)
                (ask *input-dialog.1* (window-close))
                (pop-up-input.1)
                (input-dialog.1))))

; (lambda ()
    (for each dialog or item)
    (lambda ()
        (read-from-string (ask *input-dialog.1* (window-close)))
        (pop-up-input.1)
        (input-dialog.1))

; ; MOP name and abstract name
; (oneof *static-text-dialog-item*
    :dialog-item-position #@( 30 70)
    :dialog-item-font   '("monaco" 12)
(have 'mop-name
  (oneof *editable-text-dialog-item*
    :dialog-item-position #@(150 70)
    :dialog-item-size #@(150 20)
    :dialog-item-font "("monaco" 12))
  (oneof *static-text-dialog-item*
    :dialog-item-position #@(30 110)
    :dialog-item-font "("monaco" 12)
    :dialog-item-text "Abstract Name :"
  (have 'abst-name
    (oneof *editable-text-dialog-item*
      :dialog-item-position #@(150 110)
      :dialog-item-size #@(150 20)
      :dialog-item-font "("monaco" 12))

; MOP or Instance (default : MOP)
;

(have 'mop
  (oneof *radio-button-dialog-item*
    :dialog-item-position #@(400 70)
    :dialog-item-text "MOP"
    :dialog-item-action #'(lambda ()
                        (setf *mop-or-instance* (radio-button-push)))
    :radio-button-cluster :mop-or-instatnce
    :radio-button-pushed-p t))

(%* 'mop)

(have 'instance
  (oneof *radio-button-dialog-item*
    :dialog-item-position #@(400 90)
    :dialog-item-text "Instance"
    :dialog-item-action #'(lambda ()
                        (setf *mop-or-instance* (radio-button-push)))
    :radio-button-cluster :mop-or-instatnce
    :radio-button-pushed-p nil))

; Define slots
;

(have 'rolel
  (oneof *static-text-dialog-item*
    :dialog-item-position #@( 20 150)
    :dialog-item-text "Define slots"
    :dialog-item-font "("courie" 12)
  (oneof *static-text-dialog-item*
    :dialog-item-position #@( 50 180)
    :dialog-item-text "Slot-Role"
    :dialog-item-font "("monaco" 12)
  (oneof *static-text-dialog-item*
    :dialog-item-position #@(250 180)
    :dialog-item-text "Slot-Filler"
    :dialog-item-font "("monaco" 12)

;
(defun pop-up-input.2 ()
  (declare (special *input-dialog.2*)
  (setf *input-dialog.2* (oneof *dialog*
:window-type   :document-with-grow
:window-title  "MOP Definition"
:window-font   '("courie" 12)
:window-position '(:top 40)
:window-size   #@(500 400))))

(defun input-dialog.2 ()
  (declare (special *input-dialog.2*
    mop-name
    abst-name))
  (ask *input-dialog.2*
  (add-dialog-items (oneof *static-text-dialog-item*
:dialog-item-position   #@(20 30)
:dialog-item-font        '("courie" 12)
:dialog-item-text        "Define abstract hierarchy")
""))}
(have 'save
  (oneof *button-dialog-item*
    :dialog-item-position #@(250 10)
    :dialog-item-text    " Save "
    :dialog-item-action  #'(lambda ()
                              (make-defmop.2)
                              (ask *input-dialog.1* (window-close)))
    :dialog-item-enabled-p nil
    :default-button     t))

(have 'more
  (oneof *button-dialog-item*
    :dialog-item-position #@(330 10)
    :dialog-item-text    " More "
    :dialog-item-enabled-p nil
    :default-button     t))

(have 'cancel
  (oneof *button-dialog-item*
    :dialog-item-position #@(410 10)
    :dialog-item-text    "Cancel"
    :dialog-item-action  #'(lambda ()
                              (ask *input-dialog.2* (window-close))
                              (pop-up-input.2)
                              (input-dialog.2) t)
    :default-button     nil))

; MOP name and abstract name

(have 'mop
  (oneof *static-text-dialog-item*
    :dialog-item-position #@(30 70)
    :dialog-item-font    "monaco" 12
    :dialog-item-text    "MOP: Name ":")

(have 'instance
  (oneof *static-text-dialog-item*
    :dialog-item-position #@(30 110)
    :dialog-item-font    "monaco" 12
    :dialog-item-text    "Abstract Name ":")

(have 'radio-button-dialog-item*
  :dialog-item-position #@(400 70)
  :dialog-item-text    "MOP"
  :dialog-item-enabled-p nil
  :radio-button-cluster :mop-or-instatnce
  :radio-button-pushed-p nil))
; Define slots

(oneof *static-text-dialog-item*
 :dialog-item-position #@( 20 150)
 :dialog-item-font '("courier" 12)
 :dialog-item-text "Define slots")

(oneof *static-text-dialog-item*
 :dialog-item-position #@( 50 180)
 :dialog-item-font '("monaco" 12)
 :dialog-item-text "Slot-Role")

(oneof *static-text-dialog-item*
 :dialog-item-position #@(250 180)
 :dialog-item-font '("monaco" 12)
 :dialog-item-text "Slot-Filler")

(oneof *static-text-dialog-item*
 :dialog-item-position #@( 30 200)
 :dialog-item-font '("monaco" 12)
 :dialog-item-text "6.")

(have 'role6
 (oneof *editable-text-dialog-item*
 :dialog-item-position #@( 50 200)
 :dialog-item-size #@(150 20)
 :dialog-item-text "nil"
 :dialog-item-font '("monaco" 12)))

(have 'filler6
 (oneof *editable-text-dialog-item*
 :dialog-item-position #@(220 200)
 :dialog-item-size #@(220 20)
 :dialog-item-text "nil"
 :dialog-item-font '("monaco" 12)))

(have 'role7
 (oneof *static-text-dialog-item*
 :dialog-item-position #@( 30 240)
 :dialog-item-font '("monaco" 12)
 :dialog-item-text "7.")

(have 'filler7
 (oneof *editable-text-dialog-item*
 :dialog-item-position #@(220 240)
 :dialog-item-size #@(220 20)
 :dialog-item-text "nil"
 :dialog-item-font '("monaco" 12)))
(have 'role8
  (oneof *editable-text-dialog-item*
    :dialog-item-position #@( 50 280)
    :dialog-item-size #@ (150 20)
    :dialog-item-text "nil"
    :dialog-item-font '("monaco" 12))
  (oneof *static-text-dialog-item*
    :dialog-item-position #@(220 280)
    :dialog-item-text ":")
  (have 'filler8
    (oneof *editable-text-dialog-item*
      :dialog-item-position #@(250 280)
      :dialog-item-size #@ (220 20)
      :dialog-item-text "nil"
      :dialog-item-font '("monaco" 12)))
  (have 'role9
    (oneof *editable-text-dialog-item*
      :dialog-item-position #@( 50 320)
      :dialog-item-size #@ (150 20)
      :dialog-item-text "nil"
      :dialog-item-font '("monaco" 12))
    (oneof *static-text-dialog-item*
      :dialog-item-position #@(220 320)
      :dialog-item-text ":")
  (have 'filler9
    (oneof *editable-text-dialog-item*
      :dialog-item-position #@(250 320)
      :dialog-item-size #@ (220 20)
      :dialog-item-text "nil"
      :dialog-item-font '("monaco" 12)))
  (oneof *static-text-dialog-item*
    :dialog-item-position #@( 22 360)
    :dialog-item-text "10.")
  (have 'role10
    (oneof *editable-text-dialog-item*
      :dialog-item-position #@( 50 360)
      :dialog-item-size #@ (150 20)
      :dialog-item-text "nil"
      :dialog-item-font '("monaco" 12))
    (oneof *static-text-dialog-item*
      :dialog-item-position #@(220 360)
      :dialog-item-text ":")
  (have 'filler10
    (oneof *editable-text-dialog-item*
      :dialog-item-position #@(250 360)
      :dialog-item-size #@ (220 20)
      :dialog-item-text "nil"
      :dialog-item-font '("monaco" 12))))
(defun make-defmop.l ()
  (declare (special
    *slot-set*
    *input-dialog.l*
    *cbr-defmop-file*
    *mop-or-instance*)
    (object-variable
      mop-name
      abst-name
      role1
      role2
      role3
      role4
      role5
      filler1
      filler2
      filler3
      filler4
      filler5))

  (setf *print-pretty* t)
  (setf *slot-set* nil)
  (let ((mop-name (read-from-string (ask (ask *input-dialog.l* mop-name) (dialog-i
    (stem-text)))))
    (abst-name (read-from-string (ask (ask *input-dialog.l* abst-name) (dialog-i
    (stem-text)))))
    (role1 (read-from-string (ask (ask *input-dialog.l* role1) (dialog-i
    (stem-text)))))
    (role2 (read-from-string (ask (ask *input-dialog.l* role2) (dialog-i
    (stem-text)))))
    (role3 (read-from-string (ask (ask *input-dialog.l* role3) (dialog-i
    (stem-text)))))
    (role4 (read-from-string (ask (ask *input-dialog.l* role4) (dialog-i
    (stem-text)))))
    (role5 (read-from-string (ask (ask *input-dialog.l* role5) (dialog-i
    (stem-text)))))
    (filler1 (read-from-string (ask (ask *input-dialog.l* filler1) (dialog-i
    (stem-text)))))
    (filler2 (read-from-string (ask (ask *input-dialog.l* filler2) (dialog-i
    (stem-text)))))
    (filler3 (read-from-string (ask (ask *input-dialog.l* filler3) (dialog-i
    (stem-text)))))
    (filler4 (read-from-string (ask (ask *input-dialog.l* filler4) (dialog-i
    (stem-text)))))
    (filler5 (read-from-string (ask (ask *input-dialog.l* filler5) (dialog-i
    (stem-text))))))
  (setf (get *slot-set* 'role1) filler1)
  (setf (get *slot-set* 'role2) filler2)
  (setf (get *slot-set* 'role3) filler3)
  (setf (get *slot-set* 'role4) filler4)
  (setf (get *slot-set* 'role5) filler5)
  (let ((role-list (list role1 role2 role3 role4 role5))
    (filler-list (list filler1 filler2 filler3 filler4 filler5))
    (slot-list nil))
    (let ((n (length role-list)) (result nil))
      (dotimes (count n result)
        (cond ((eql (car role-list) nil))
          (t
            (cond ((eql (string-equal (char (string (car fill
            (stem-text)) 0) "m") t)
          (let ((answer (read)))
            (cond ((eql answer 'n)
                ;; M

</n> ==> " (car filler-list)
%OP without a slot

\begin{verbatim}
(setf slot-list (append slot-list)
  (list
    (list (car role)
      (car filler-1)
    )
  )
)

%OP with a slot

(setf slot-list (append slot-list)
  (list
    (list (car role)
      (car filler-1)
    )
  )
)

(t (setf slot-list (append slot-list
  (list
    (list (car role)
      (car filler-1)
      (its-slot)))
  )
)
)

(with-open-file (defmop-stream *cbr-defmop-file*
  :direction :output
  :if-exists :append)
  (print `(defmop ,mop-name , (list abst-name) ,*mop-or-instance* ,@slot-list)
    defmop-stream))
)

; Make defmop lisp expression with 2 input-dialog menus
;
(defun make-defmop.2 ()
  (declare (special
    *slot-set*
    *input-dialog.1*
    *input-dialog.2*
    *cbr-defmop-file*
    *mop-or-instance*)
  (object-variable
    abst-name
    role1
    role2
    role3
    role4
    role5
    role6
    role7
    role8
    role9
    role10
    filler1
    filler2
    filler3
    filler4
)
)
(setq *print-pretty* t)
(setq *slot-set* nil)
(let ((role1 (read-from-string (ask (ast standard input-dialog.1) role1)))
    (role2 (read-from-string (ask (ast standard input-dialog.1) role2)))
    (role3 (read-from-string (ask (ast standard input-dialog.1) role3)))
    (role4 (read-from-string (ask (ast standard input-dialog.1) role4)))
    (role5 (read-from-string (ask (ast standard input-dialog.1) role5)))
    (role6 (read-from-string (ask (ast standard input-dialog.1) role6)))
    (role7 (read-from-string (ask (ast standard input-dialog.1) role7)))
    (role8 (read-from-string (ask (ast standard input-dialog.1) role8)))
    (role9 (read-from-string (ask (ast standard input-dialog.1) role9)))
    (role10 (read-from-string (ask (ast standard input-dialog.1) role10)))
    (filler1 (read-from-string (ask (ast standard input-dialog.1) filler1)))
    (filler2 (read-from-string (ask (ast standard input-dialog.1) filler2)))
    (filler3 (read-from-string (ask (ast standard input-dialog.1) filler3)))
    (filler4 (read-from-string (ask (ast standard input-dialog.1) filler4)))
    (filler5 (read-from-string (ask (ast standard input-dialog.1) filler5)))
    (filler6 (read-from-string (ask (ast standard input-dialog.1) filler6)))
    (filler7 (read-from-string (ask (ast standard input-dialog.1) filler7)))
    (filler8 (read-from-string (ask (ast standard input-dialog.1) filler8)))
    (filler9 (read-from-string (ask (ast standard input-dialog.1) filler9)))
    (filler10 (read-from-string (ask (ast standard input-dialog.1) filler10))))
(setf (ast standard slot-set 'role1) filler1)
(setf (ast standard slot-set 'role2) filler2)
(setf (ast standard slot-set 'role3) filler3)
(setf (ast standard slot-set 'role4) filler4)
(setf (ast standard slot-set 'role5) filler5)
(setf (ast standard slot-set 'role6) filler6)
(setf (ast standard slot-set 'role7) filler7)
(setf (ast standard slot-set 'role8) filler8)
(setf (get *slot-set* 'role9) filler9)
(setf (get *slot-set* 'role10) filler10)
(let ((role-list (list role1 role2 role3 role4 role5 role6 role7 role8 role9 role10))
     (filler-list (list filler1 filler2 filler3 filler4 filler5 filler6 filler7 filler8 filler9 filler10)))
  (slot-list nil)
(let ((n (length role-list)) (result nil))
  (doright (count n result)
    (cond ((eql (car role-list) nil))
      (t
        (cond ((eql (string-equal (char (string (car fill of the list)) 0) "m") t)
          (format t "~%Does MOP : ~s have a slot? <y
          (let ((answer (read)))
            (cond ((eql answer 'n) ;; M
              (setf slot-list (append slot-list
                            (list
                              (list (car role-list)
                                (car filler-1
                                    (eql answer 'y) ;; M
                                (format t "~%please input its sl
                                (let ((its-slot (read))
                                  (setf slot-list (append slot-list
                                    (list
                                      (list (car role-list)
                                        (car filler-1
                                            its-slot))))))))
    (t (setf slot-list (append slot-list
                            (list
                              (list (car role-list)
                                (car filler-1
                                  its-slot))))))))
  (with-open-file (defmop-stream *cbr-defmop-file*
      :direction :output
      :if-exists :append)
    (print `(defmop ,mop-name ,(list abst-name) ,*mop-or-i
           instance* ,@slot-list)
      defmop-stream))

; Get date & time
(defun get-datetime ()
  (declare (object-variable dtlist))
  (let ((dtlist (cdddr (reverse (multiple-value-list (get-decoded-time))))))
    (format nil "< ~d.-d.~d ~d:-d:-d >"
      (first dtlist)
(second dtlist)
(third dtlist)
(fourth dtlist)
(fifth dtlist)
(sixth dtlist)))

(defun file-alloc ()
  (declare (special *cbr-defmop-file*
                   *CBR-Library*))
  (setf *cbr-defmop-file* (choose-new-file-dialog :directory *CBR-Library*
                                               :prompt   "As CBR-name.Defmop.Lisp")
  (with-open-file (defmop-stream *cbr-defmop-file*
                                 :direction :output
                                 :if-exists :supersede)
      (princ ";**********************************************************************
      (princ "** defmop-stream)
      (princ ";\newline defmop-stream)
      (princ ";* CBR MOP Definition
      (princ ";** defmop-stream)
      (princ ";\newline defmop-stream)
      (princ ";\newline defmop-stream)
      (princ ";** defmop-stream)
      (princ ";**********************************************************************

(defun file-update ()
  (declare (special *cbr-defmop-file*
                   *CBR-Library*))
  (setf *cbr-defmop-file* (choose-file-dialog :directory *CBR-Library*))
  (with-open-file (defmop-stream *cbr-defmop-file*
                                :direction :output
                                :if-exists :append)
      (princ ";\newline defmop-stream)
      (princ ";\newline defmop-stream)
      (princ ";Updated " defmop-stream)
      (princ ";\newline defmop-stream)
      (princ ";\newline defmop-stream)
      (princ ";**********************************************************************

;
CBRE.Functions2
(defun set-initial ()
  (declare (special *initial-position*
                 *central-position*
                 *l-l-coord*
                 *pre-value*
                 *rect-position*
                 *mop-order*))
  (setf *initial-position* '(10 50))
  (setf *central-position* '(250 200))
  (setf *l-l-coord* nil) ;; list of start and end co
  (setf *pre-value* nil) ;; previous value of carri
  (setf *rect-position* nil) ;; list of x-y coordinates
  (setf *mop-order* nil) ;; list of the order of MO

; coordinates of line
; (setf *pre-value* nil)
; (setf *rect-position* nil)
; (setf *mop-order* nil))

;Ps shown on the screen;

; define display-function menu items

; date : July 7, 1990
; function : defines *display-function* subclass under *menu*
; argument : none
; var : none

; (defobject *display-function* *menu*)

(let (display-fun
  (oneof *display-function* :menu-title "Display"))

; display MOP-hierarchy

; date : July 7, 1990
; function : shows MOP hierarchy structure below the pointed mop
; argument : mop name
; var : none

; (setq display-mops (oneof *menu-item* :menu-item-title "MOPs-List"
  :menu-item-action '(eval-enqueue
                       (progn
                         (format t "enter MOP name ==> ")
                         (let ((mop (read)))
                           (dah mop))))))

; display slot-hierarchy

; date : July 7, 1990
; function : shows slots below the pointed mop
; argument : mop name
; var : none

; (setq display-slots (oneof *menu-item*}
(setq display-11 (oneof *menu-item*

  
  :menu-item-title "-")

  ;; Blank line

  ;; MOP-hierarchy graph (dah & dph)

  ;; date : July 16, 1990

  ;; function : shows hierarchy-graph below the pointed and calls hierarchy

  ;; arguments : none

  ;; var : none

  ;;

  (setq dah-hierarchy-graph (oneof *menu-item*

    
    :menu-item-title "MOP-Hierarchy"

    :menu-item-action '(eval-enqueue

      
      'progn

      (open-hierarchy-window)

      (set-initial)

      (define-redraw-window *hierarchy-graph* )

      (p-zoom-out)

      (format t "enter MOP name => ")

      (let ((mop (read)))

        (print-global-hierarchy *initia

        (l-position* mop))

        (draw-link-line *l-l-coord* )

        (draw-xy-axis)

        (store-hierarchy-graph)

        (ask dah-hierarchy-graph (menu-item-

        (setq *menu-no-hierarchy* (menubar))

        (m-hierarchy-fun))))))

  ;

  (setq dph-hierarchy-graph (oneof *menu-item*

    
    :menu-item-title "SLOT-Hierarchy"

    :menu-item-action '(eval-enqueue

      
      'progn

      (dph-set-initial)

      (format t "enter MOP name => ")

      (let ((mop (read)))

        (open-dph-window mop)

        (define-redraw-window *dph-graph* )

        (dph-zoom-out)

        (draw-dph mop)

        (setf *shown-dph* mop))

        (store-dph-hierarchy-graph)

        (setq *menu-no-dph* (menubar))

        (m-dph-fun))))))

  ;

  (setq display-12 (oneof *menu-item*

    
    :menu-item-title "-")

    ;; Blank line

    ;;

    ;;
; Display cases in memory

(* date : Aug 15, 1990
  * function: shows cases in memory
  * argument: none
  * var: none
;)
(setq cases-in-memory (oneof *menu-item*
  :menu-item-title "Cases"
  :menu-item-action #'(lambda ()
    (cond ((eql (show-instances 'm-c) (no-case-message))
      (t
        (setf *cases-dialog-case* (show-instances 'm-case))
        (calc-dialog-position)
        (pop-up-cases)
        (make-radio-button)))))
;)

; Display new-MOPs in memory

(* date : Sep 18, 1990
  * function: shows new-MOPs in memory
  * argument: none
  * var: none
;)
(setq newmops-in-memory (oneof *menu-item*
  :menu-item-title "New MOPs"
  :menu-item-action #'(lambda ()
    (show-new-mop-stack)))))

(setq display-l3 (oneof *menu-item* ;; Blank line
  :menu-item-title "-"))

; quit Display menu

(* date : July 20, 1990
  * function: remove Display menu items and returns previous menu
  * argument: none
  * var: none
;)
(setq display-quit (oneof *menu-item*
  :menu-item-title "Quit-Display"
  :menu-item-action #'(lambda ()
    (ask display-fun (remove-menu-items di )
    (splay-mops))
    (splay-slots))
    (splay-li))
    (h-hierarchy-graph))
    (h-hierarchy-graph)))
(setq display-fun (remove-menu-items di
(ask display-fun (remove-menu-items ca
(ask display-fun (remove-menu-items ne
(ask display-fun (remove-menu-items di
(ask display-fun (remove-menu-items di
(set-menubar *menu-no-display*)))))

; ;---------------------------------------------------------------------
; | set display functions
; ;---------------------------------------------------------------------

;* date : July 20,1990
;* function : sets Display menu functions
;* argument : none
;* var : none
;---------------------------------------------------------------------

(defun m-display-fun ()
   (declare (special *menu-no-display*
   display-fun
display-mops
display-slots
display-ll
dah-hierarchy-graph
dph-hierarchy-graph
display-l2
cases-in-memory
newmops-in-memory
display-l3
display-quit))
(setq *menu-no-display* (menubar))

(ask display-fun (menu-deinstall))
(ask display-fun (menu-install))
(ask display-fun (add-menu-items display-mops
display-slots
display-ll
dah-hierarchy-graph
dph-hierarchy-graph
display-l2
cases-in-memory
newmops-in-memory
display-l3
display-quit)))

; ;---------------------------------------------------------------------
; | define hierarchy-function menu items
; ;---------------------------------------------------------------------

;* date : July 20,1990
;* function : defines *hierarchy-functions* subclass below *menu*
;* argument : none
;* var : none
;---------------------------------------------------------------------

(defun object *hierarchy-function* *menu*)
(setq hierarchy-fun (oneof *hierarchy-function*
   :menu-title "MOPs"))
(setq scroll-window (oneof *menu-item*  
:menu-item-title "Scroll"  
:menu-item-action #'(lambda ()  
                     (scroll-window)))

  (setq hierarchy-11 (oneof *menu-item*  
                 :menu-item-title "-"))

  (setq show-slots (oneof *menu-item*  
                 :menu-item-title "Show-Slots"  
                 :menu-item-action #'(lambda ()  
                           (get-mop-slots)))

  (setq hierarchy-12 (oneof *menu-item*  
                 :menu-item-title "-"))

  (setq zoom-in (oneof *menu-item*  
               :menu-item-title "Zoom-in"  
               :menu-item-action #'(lambda ()  
                                 (erase-screen *rect-position* *l*  
                                 (p-zoom-in)  
                                 (draw-xy-axis)  
                                 (print-grobal-hierarchy *xy-star*)  
                                 (draw-link-line *l-l-coord*)  
                                 (store-hierarchy-graph)  
                                 (ask zoom-in (menu-item-disable)  
                                          (ask zoom-out (menu-item-enable)  
                                          :disabled nil)))))

  (zoom-out)
(setq zoom-out
  (oneof *menu-item*
    :menu-item-title "Zoom-out"
    :menu-item-action #'(lambda ()
      (erase-screen *rect-position* *l-
      (l-coord*)
      (p-zoom-out)
      (draw-xy-axis)
      (print-grobal-hierarchy *xy-star*)
    (draw-link-line *l-l-coord*)
    (store-hierarchy-graph)
    (ask zoom-in (menu-item-enable))
    (ask zoom-out (menu-item-disable))
  )))
(setq hierarchy-13
  (oneof *menu-item*
    :menu-item-title "-")
  ;; Blank line
)

; quit Hierarchy menu

; quit Hierarchy menu

; quit Hierarchy menu

::* function : sets hierarchy menu functions
::* argument : none
::* var     : none
;*****************************************************************************
;
(defun m-hierarchy-fun ()
  (declare (special hierarchy-fun
          scroll-window
          hierarchy-11
          show-slots
          hierarchy-12
          zoom-in
          zoom-out
          hierarchy-13
          hierarchy-quit))
  (ask hierarchy-fun (menu-deinstall))
  (ask hierarchy-fun (menu-install))
  (ask hierarchy-fun (add-menu-items scroll-window
          hierarchy-11
          show-slots
          hierarchy-12
          zoom-in
          zoom-out
          hierarchy-13
          hierarchy-quit)))
;
;*****************************************************************************
; define *hierarchy-graph* graphic window
;*****************************************************************************
::* date    : July 20,1990
::* function: defines *hierarchy-graph* window below *graphics-window*
::* argument: none
::* var     : none
;*****************************************************************************
;
(defobject *graphics-window* *window*)
;
(defun open-hierarchy-window ()
  (declare (special *hierarchy-graph*
           *graphics-window*))
  (setf *hierarchy-graph* (oneof *graphics-window*
          :window-position @(100 40)
          :window-size @(500 400)
          :window-font "courier" 10
          :window-type :tool
          :window-title "Hierarchy-Window"))
;
;*****************************************************************************
; define-redraw-window
;*****************************************************************************
::* date    : July 20,1990
::* function: redraws the stored picture when it exists
::* argument: window-name
::* var     : none
;*****************************************************************************
(defun define-redraw-window (window-name)
  (defobfun (view-draw-contents window-name) ()
    (declare (object-variable saved-pict))
    (when (ask self (ownp 'saved-pict))
      (ask self (draw-picture (ask self) saved-pict)))
    (usual-view-draw-contents)))
;
;*****************************************************************************
scroll-window

;**********************************************************************************************************

;; date : July 20, 1990
;; function : scroll the screen with the distance from the central point of screen
;; argument : none
;; var : x x-coordinate of clicked point
;; : y y-coordinate of clicked point
;; : x-dist the distance along x axis from the central point of screen
;; : y-dist the distance along y axis from the central point of screen
;**********************************************************************************************************

(defun scroll-window ()
  (declare (special *hierarchy-graph*))
  (defobfun (window-click-event-handler *hierarchy-graph*) (where)
    (declare (special
      *no-of-cr*
      *xy-start*
      *mop-shown*
      *pre-value*
      *x-inc*
      *y-inc*
      *rect-position*
      *l-l-coord*
      *central-position*)
    (object-variable x
      y
      x-dist
      y-dist))
    (erase-screen *rect-position* *l-l-coord*)
    (draw-xy-axis)
    (let ((x (point-h where)) (y (point-v where)))
      (let ((x-dist (- x (car *central-position*))) (y-dist (- y (cdr *central-position*))))
        (print-global-hierarchy (list (- (car *xy-start*) x-dist) (- (cdr *xy-start*) y-dist))
          *mop-shown*)
        (draw-link-line *l-l-coord*)
        (store-hierarchy-graph))))

;**********************************************************************************************************

store-hierarchy-graph

;**********************************************************************************************************

;; date : July 20, 1990
;; function : stores the drawing procedure of hierarchy-graph as a picture
;; argument : none
;; var : none
;**********************************************************************************************************

(defun store-hierarchy-graph ()
  (declare (special *mop-order*
      *rect-position*
      *hierarchy-graph*
      *xy-start*
      *mop-shown*
      *l-l-coord*)
  (setf *mop-order* nil)
  (setf *rect-position* nil)
  (ask *hierarchy-graph* (start-picture))
  (print-global-hierarchy *xy-start* *mop-shown*)
  (draw-link-line *l-l-coord*)
  (draw-xy-axis)
  (ask *hierarchy-graph* (have 'saved-pict (ask *hierarchy-graph* (get-picture))))

;
;;; p-zoom-in

(* date : July 20, 1990
; * function : zooms in hierarchy-graph
; * argument : none
; * var : none

(defun p-zoom-in ()
  (declare (special *hierarchy-graph*
    *initial-position*
    *previous-position*
    *pen-size*
    *rect-x1*
    *rect-y1*
    *rect-x2*
    *rect-y2*
    *x-inc*
    *y-inc*))
  (ask *hierarchy-graph* (window-select))
  (ask *hierarchy-graph* (set-window-font '("helvetica" 12)))
  (setf *previous-position* *initial-position*)
  (setf *pen-size* '#@(2 2))
  (setf *rect-x1* 10)
  (setf *rect-y1* 15)
  (setf *rect-x2* 150)
  (setf *rect-y2* 10)
  (setf *x-inc* 200)
  (setf *y-inc* 40))

;;; p-zoom-out

(* date : July 20, 1990
; * function : zooms out hierarchy-graph
; * argument : none
; * var : none

(defun p-zoom-out ()
  (declare (special *hierarchy-graph*
    *initial-position*
    *previous-position*
    *pen-size*
    *rect-x1*
    *rect-y1*
    *rect-x2*
    *rect-y2*
    *x-inc*
    *y-inc*))
  (ask *hierarchy-graph* (window-select))
  (ask *hierarchy-graph* (set-window-font '("courier" 9)))
  (setf *previous-position* *initial-position*)
  (setf *pen-size* '#@(1 1))
  (setf *rect-x1* 5)
  (setf *rect-y1* 8)
  (setf *rect-x2* 100)
  (setf *rect-y2* 5)
  (setf *x-inc* 120)
  (setf *y-inc* 20))

;
; ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
; * date    : July 10,1990
; * function: draws x-y axis on the hierachy-graph
; * argument: none
; * var     : none
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;
(defun draw-xy-axis ()
  (declare (special *hierarchy-graph*))
  (ask *hierarchy-graph* (window-select))
  (ask *hierarchy-graph* (set-pen-pattern *gray-pattern*))
  (ask *hierarchy-graph* (set-pen-size #0(1 1)))
  (ask *hierarchy-graph* (move-to 250 0))
  (ask *hierarchy-graph* (line-to 250 400))
  (ask *hierarchy-graph* (pen-hide))
  (ask *hierarchy-graph* (move-to 0 200))
  (ask *hierarchy-graph* (pen-show))
  (ask *hierarchy-graph* (line-to 500 200))
)

;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

draw-mop-unit
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

; * date    : July 10,1990
; * function: draws the rectangle to represent MOP
; * argument: xy-list  x-y coordinates of the basic point of the rectangle
; *         : mop-name
; * var     : none
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;
(defun draw-mop-unit (xy-list mop-name)
  (declare (special 
              *rect-position*
              *mop-order*
              *hierarchy-graph*
              *pen-size*
              *rect-x1*
              *rect-y1*
              *rect-x2*
              *rect-y2*)

  (object-variable x
                   y))
  (let ((x (car xy-list)) (y (cadr xy-list)))
    (setq *rect-position* (append (list xy-list) *rect-position*))
    (setq *mop-order* (append (list mop-name) *mop-order*))
    (ask *hierarchy-graph* (window-select))
    (ask *hierarchy-graph* (set-pen-pattern *black-pattern*))
    (ask *hierarchy-graph* (set-pen-size *pen-size*))
    (ask *hierarchy-graph* (move-to x y))
    (ask *hierarchy-graph* (princ mop-name *hierarchy-graph*))
    (ask *hierarchy-graph* (frame-rect (- x *rect-x1*) (- y *rect-y1*)
                                         (+ x *rect-x2*) (+ y *rect-y2*))))
)

;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

erase-mop-unit
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

; * date    : July 20,1990
; * function: erases the rectangle of MOP
; * argument: xy-list  x-y coordinates of the basic point of the rectangle
; * var     : none
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;
(defun erase-mop-unit (xy-list)
  (declare (special *hierarchy-graph*
*pen-size*
*rect-x1*
*rect-y1*
*rect-x2*
*rect-y2*)

(object-variable x y))
(let ((x (car xy-list)) (y (cadr xy-list)))
  (ask *hierarchy-graph* (window-select))
  (ask *hierarchy-graph* (set-pen-pattern *white-pattern*))
  (ask *hierarchy-graph* (set-pen-size *pen-size*))
  (ask *hierarchy-graph* (move-to x y))
  (ask *hierarchy-graph* (paint-rect (- x *rect-x1*) (- y *rect-y1*)
    (+ x (+ 50 *rect-x2*)) (+ y *rect-y2*))))

; ;****************************************************************
; erase-screen
; ;****************************************************************

(defvar *date* :July 20,1990)
(defvar *function* :erases MOP rectangles and their liked lines)
(defvar *argument* :position-list list of the basic point of MOP rectangles
  :l-l-list list of start and end point of MOP rectangle linked line
  :var none)

(defun erase-screen (position-list l-l-list)
  (declare (special *rect-position*
                   *l-l-coord*
                   *mop-order*)
    (object-variable xy-list se-list))
  (for (xy-list :in position-list)
    :do (erase-mop-unit xy-list))
  (for (se-list :in l-l-list)
    :do (erase-link-line se-list))
  (setf *l-l-coord* nil)
  (setf *mop-order* nil))

; ;****************************************************************
; calc-line-pair.1
; ;****************************************************************

(defvar *date* :July 20,1990)
(defvar *function* :calculates start and end point of MOP linked line
  :var as a case that MOP has some instances
  :arg xy-list x-y coordinates of the basic point of MOP rectangles
  :var list of instances below the pointed MOP
  :y-position x coordinate of the basic point of MOP rectangle
  :x1 x coordinate of upper left corner of MOP rectangle
  :y1 y coordinate of upper left corner of MOP rectangle)

(defun calc-line-pair.1 (xy-list var-list)
  (declare (special *rect-x2*
                   *rect-y2*
                   *rect-x1*
                   *rect-y1*
                   *l-l-coord*
                   *x-inc*
                   *y-inc*)
    (object-variable x-position y-position)
n
result
x1
y1))
(let ((x-position (car xy-list))
      (y-position (cadr xy-list))
      (n (length var-list))
      (result 0))
  (let ((x1 (+ x-position *rect-x2*))
        (y1 (- (+ y-position *rect-y2*)
             (round (* 0.5 (+ *rect-yl* *rect-y2*))))
        (dotimes (count n result)
          (setf *1-1-coord*
                (append *1-1-coord*
                        (list (list x1 y1)
                               (list (- (+ x2
                                          *x-inc* *rect-x2*))
                                          *rect-x1*)
                               (+ y1 (* y-inc* result)))))))))
(setf result (+ 1 result)))))))

;*******************************************************************************
;
calc-line-pair.2
;*******************************************************************************

;* date : July 20, 1990
;* function : calculates start and end point of MOP linked line
;* : as a case that MOP has vertical hierarchy structure
;* argument : xy-list x-y coordinates of the basic point of MOP rectangles
;* var : x-position x coordinate of the basic point of MOP rectangle
;* : y-position y coordinate of the basic point of MOP rectangle
;* : x1 x coordinate of upper left corner of MOP rectangle
;* : y1 y coordinate of upper left corner of MOP rectangle
;* : x2 x coordinate of lower right corner of MOP rectangle
;* : y2 y coordinate of lower right corner of MOP rectangle
;*******************************************************************************
(defun calc-line-pair.2 (xy-list)
  (declare (special
             *rect-x2*
             *rect-y2*
             *rect-x1*
             *rect-yl*
             *1-1-coord*
             *x-inc*)
    (object-variable x-position
                     y-position
                     x1
                     y1
                     x2
                     y2))
  (let ((x-position (car xy-list))
        (y-position (cadr xy-list)))
    (let ((x1 (+ x-position *rect-x2*))
          (y1 (- (+ y-position *rect-y2*)
                 (round (* 0.5 (+ *rect-yl* *rect-y2*))))
          (dotimes (count n result)
            (setf *1-1-coord*
                  (append *1-1-coord*
                          (list (list x1 y1) (list x2
                                                  y2)))))))))

;*******************************************************************************
;
calc-line-pair.3
;*******************************************************************************

;* date : July 20, 1990
;* function : calculates start and end point of MOP linked line
;* : as a case that MOP has parallel hierarchy structure
;* argument : xy-list x-y coordinates of the basic point of MOP rectangles
;* : n the number of parallel MOP hierarchies
;* var : x-position x coordinate of the basic point of MOP rectangle
;* : y-position y coordinate of the basic point of MOP rectangle
;*******************************************************************************
(* x1 x coordinate of upper left corner of MOP rectangle
  *y1 y coordinate of upper left corner of MOP rectangle
  *x2 x coordinate of lower right corner of MOP rectangle
  *y2 y coordinate of lower right corner of MOP rectangle

(defun calc-line-pair.3 (xy-list n)
  (declare (special *rect-x2*
    *rect-y2*
    *rect-x1*
    *rect-y1*
    *l-1-coord*
    *x-inc*
    *y-inc*
    *xy-start*)

    (object-variable x-position
      y-position
      x1
      y1
      x2
      y2))

  (let ((x-position (car xy-list)) (y-position (cadr xy-list)))
      (let ((x1 (+ x-position *rect-x2*)
            (round (* 0.5 (+ *rect-y1* *rect-y2*))))
            (y2 (- (+ (cadr *xy-start*) (* *y-inc* n)) *rect-y2*)
            (round (* 0.5 (+ *rect-y1* *rect-y2*))))
              (setf *l-1-coord* (append *l-1-coord* (list (list (list x1
            y1) (list x2 y2)))))))
  )

(defun get-mop-slots ()
  (declare (special *hierarchy-graph*)
    (defobfun (window-click-event-handler *hierarchy-graph*) (where)
      (declare (special
        *rect-position*
        *beep-sound*
        *rect-x1*
        *rect-x2*
        *rect-y1*
        *rect-y2*
        *mop-order*
        *pop-up-slots*)

      (object-variable xx
        yy
        result

```
...
mop-position
x
y
x-min
x-max
y-min
y-max
mop-order
mopname))
(let ((xx (point-h where)) (yy (point-v where)))
  (let ((result 0) (mop-position 0))
    (setf *beep-sound* nil)
    (dolist (element *rect-position* result)
      (let ((x (car element)) (y (cadr element)))
        (let ((x-min (- x *rect-x1*)) (x-max (+ x *rect-x2)))
          (y-min (- y *rect-y1*)) (y-max (+ y *rect-y2)))
          (cond ((and (and (> xx x-min) (< xx x-max))
                          (and (> yy y-min) (< yy y-max)))
                        (setf *beep-sound* (or *beep-sound* ?
                           t))
                            (let ((result1 0) (mop-order *mop-ord?
                               $ult1)
                              (dotimes (count mop-position res
                                 (setf mop-order (cdr mo
                                    $p-order)))
                                  (let ((mopname (car mop-order)))
                                    (pop-up-slots mopname)
                                    (define-redraw-window *pop-
                                       $up-slots*)
                                       $))))
                                          (t (setf result (+ 1 result))
                                            (setf *beep-sound* (or *beep-sound* ?
                                               ? nil))
                                               (setf mop-position result))))))))

(defun last-out (l)
  (declare (object-variable l-reverse))
  (let ((l-reverse (reverse l)))
    (pop l-reverse)))

(defun last-out-list

(defun last-out-list
  (declare (object-variable l-reverse))
  (let ((l-reverse (reverse l)))
    (pop l-reverse))))
(defun last-out-list (l)
  (declare (object-variable l-reverse))
  (let ((l-reverse (reverse l)))
    (pop l-reverse)
    (reverse l-reverse)))

;*****************************************************************************
;  draw-link-line
;*****************************************************************************

;* date : July 15, 1990
;* function : draws MOP rectangles linked lines
;* argument : l-l-list  the list of start and end points of MOP rectangles liked line
;* var    : x-front  x coordinate of start point of line
;*         : y-front  y coordinate of start point of line
;*         : x-rear  x coordinate of end point of line
;*         : y-rear  y coordinate of end point of line
;*****************************************************************************

(defun draw-link-line (l-l-list)
  (declare (special *hierarchy-graph*)
    (object-variable result
      x-front
      y-front
      x-rear
      y-rear))
  (let ((result 0))
    (dolist (element l-l-list result)
      (let ((x-front (car (car element)))
            (y-front (cdr (car element)))
            (x-rear (car (cdr element)))
            (y-rear (cdr (cdr element))))
        (ask *hierarchy-graph* (window-select))
        (ask *hierarchy-graph* (set-pen-pattern *black-pattern*))
        (ask *hierarchy-graph* (move-to x-front y-front))
        (ask *hierarchy-graph* (line-to x-rear y-rear))))))

;*****************************************************************************
;  erase-link-line
;*****************************************************************************

;* date : July 15, 1990
;* function : erases MOP rectangles linked lines
;* argument : l-l-list  the list of start and end points of MOP rectangles liked line
;* var    : x-front  x coordinate of start point of line
;*         : y-front  y coordinate of start point of line
;*         : x-rear  x coordinate of end point of line
;*         : y-rear  y coordinate of end point of line
;*****************************************************************************

(defun erase-link-line (l-l-list)
  (declare (special *hierarchy-graph*)
    (object-variable x-front
      y-front
      x-rear
      y-rear))
  (let ((x-front (car (car l-l-list)))
        (y-front (cdr (car l-l-list)))
        (x-rear (car (cdr l-l-list)))
        (y-rear (cdr (cdr l-l-list))))
    (ask *hierarchy-graph* (window-select))
    (ask *hierarchy-graph* (set-pen-pattern *white-pattern*))
    (ask *hierarchy-graph* (move-to x-front y-front))
    (ask *hierarchy-graph* (line-to x-rear y-rear))))
(defun print-vertical (xy-list list-form)  
  (declare (special  
    *y-inc*)  
    (object-variable x-position  
      y-position  
      result  
      inc))  
  (let ((x-position (car xy-list)) (y-position (cadr xy-list)) (result 0) (inc *y-inc))  
    (dolist (element list-form result)  
      (draw-mop-unit (list x-position (+ y-position (* inc result))) elem)  
      (setf result (+ result 1)))))  

(defun print-partial-hierarchy (xy-list list-form)  
  (declare (special  
    *pre-value*  
    *no-of-cr*  
    *x-inc*  
    *y-inc*  
    *xy-start*)  
    (object-variable x-position  
      y-position))  
  (let ((x-position (car xy-list)) (y-position (cadr xy-list))  
    (var-list list-form) (item (car list-form)))  
    (cond ((eql (cdr list-form) nil)  
      (draw-mop-unit (list x-position y-position) item)  
      (setf *pre-value* (append *pre-value* (list *no-of-cr*)))  
      (setf *no-of-cr* (+ 1 *no-of-cr*))  
      (t  
        (cond ((eql (%view-fillers item 'instances 'value 'common) nil)  
          (cond ((eql (cadr var-list) nil)  
            (print-horizontal (list x-position y-position) (list item)  
            (calc-line-pair.2 (list x-position y-position))  
            (setf var-list (cadr var-list))  
            (print-partial-hierarchy (list (+ *x-inc* x-position) y-  
              position) var-list))  
            (t  
              (print-vertical (list x-position y-position) (list item)  
              (print-partial-hierarchy (list (+ *x-inc* x-position) y-  
                position) var-list))))))))))}
(setq var-list (cdr var-list))
(setq *pre-value* (append *pre-value* (list *no-of-cr*)))

(let ((result 0))
  (dolist (i var-list result)
    (print-partial-hierarchy
      (list (+ *x-inc* x-position)
            (+ (cdadr xy-start*) (* y-inc* *no-o-cr*))) i)
    (on (last-out *pre-value*))
    (setq *pre-value* (last-out-list *pre-value*))
    (calc-line-pair.3 (list x-position y-position)
          (setq *pre-value* (last-out-list *pre-value*)))
  )
)
(t
  (print-vertical (list x-position y-position) (list item))
  (setq var-list (for (item :in (cdr var-list))
                               :save (car item))
          (print-vertical (list (+ *x-inc* x-position) y-position) var-list))
)
(st
  (calc-line-pair.1 (list x-position y-position) var-list)
  (setq *pre-value* (append *pre-value* (list *no-of-cr*)))
  (setq *no-of-cr* (+ *no-of-cr* (length var-list))))))

; ;******************************************************************************
; ; print-grobal-hierarchy
; ;******************************************************************************
; *
; date : July 15,1990
; * function : draws the whole hierarchy structure of MOPs from the pointed point
; * argument : xy-list x-y coordinates of the start point of MOP hierarchy
; * : mop the parent MOP name of MOP hierarchy structure
; * : x-position x coordinate of start point of vertical hierarchy structure
; * : y-position y coordinate of start point of vertical hierarchy structure
; * : mop-list list of MOPs below the parent MOP
; ;******************************************************************************
;
(defun print-grobal-hierarchy (xy-list mop)
  (declare (special *no-of-cr* *xy-start* *mop-shown* *pre-value* *x-inc* *y-inc*)

    (object-variable x-position y-position))
  (setq *no-of-cr* 0)
  (setq *xy-start* xy-list)
  (setq *mop-shown* mop)
  (cond ((eql (%view-fillers mop 'instances 'value 'common) nil)
     (print-vertical xy-list (list mop))
     (setq *pre-value* (append *pre-value* (list *no-of-cr*)))
     (let ((x-position (car xy-list)) (y-position (position (car xy-list))
        (result 0) (mop-list (specs->list mop nil)))
        (dolist (element mop-list result)
          (print-partial-hierarchy (list (+ *x-inc* x-position) (+ (* y-inc* *n* o-of-cr*) y-position)) element)
          (setf result (+ 1 result))
          (calc-line-pair.3 (list x-position y-position) (last-out *pre-value*)
                (setq *pre-value* (last-out-list *pre-value*)))))
    (t
     (print-partial-hierarchy xy-list (append (list mop) (specs->list mop nil))))))

;
;;;;;;;;;;;;;;; pop-up-slots
;;;;;;;;;;;;;;;
(defvar *pop-up-slots* (mopname
  (declare (special *pop-up-slots*
    (window-type :tool
      (window-title (string mopname)
        (window-font "helvetica" 12)
        (window-position #@10 40)
        (close-box-p t)))))
  
  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
  ; print-no-slot
  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

(defvar *pop-up-slots* (none
  (declare (special *pop-up-slots*)
    (window-type :tool
      (window-title (string mopname)
        (window-font "helvetica" 12)
        (window-position #@10 40)
        (close-box-p t)))
  
  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
  ; print-slots
  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

(defvar *pop-up-slots* (none
  (declare (special *pop-up-slots*)
    (object-variable title
      column
      x-start
      y-start
      x-inc
      y-inc
      sr
      sf))
    (let ((title (list 'slot-role 'slot-filler)) (column (length print-buffer)))
    (let ((window-size (make-point 320 (+ 50 (* column 20))))
      (ask *pop-up-slots* (window-select))
      (ask *pop-up-slots* (set-window-font "chicago" 12))
      (ask *pop-up-slots* (set-window-size window-size))))
(ask *pop-up-slots* (move-to 20 25))
(ask *pop-up-slots* (princ (car title) *pop-up-slots*))
(ask *pop-up-slots* (move-to (+ 10 135) 25))
(ask *pop-up-slots* (princ (cadr title) *pop-up-slots*))
(ask *pop-up-slots* (set-window-font '{"helvetica" 10}))
(let ((x-start 20) (y-start 45) (x-inc 125) (y-inc 20) (result 0))
  (dolist (element print-buffer result)
    (let ((sr (slot-role element)) (sf (slot-filler element)))
      (ask *pop-up-slots* (move-to x-start (+ y-start (* y-inc 2))
        result)))
    (ask *pop-up-slots* (princ sr *pop-up-slots*))
    (ask *pop-up-slots* (move-to (+ x-start x-inc) (+ y-star 2))
      ($ result)))))
  (ask *pop-up-slots* (princ sf *pop-up-slots*))
  (setf result (+ 1 result)))))
(ask *pop-up-slots* (move-to 10 10))
(ask *pop-up-slots* (frame-rect 10 10 302 (round (+ 42 (* column 20))))))
(ask *pop-up-slots* (move-to 135 10))
(ask *pop-up-slots* (line-to 135 (round (+ 40 (* column 20))))))
(ask *pop-up-slots* (move-to 10 30))
(ask *pop-up-slots* (line-to 300 30)))))

; ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
; ; print-pop-up-slots
; ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

; * date : July 20,1990
; * function : draws slots table
; * argument : mopname MOP name
; * var : print-buffer list of slots below pointed MOP
; ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

(defun print-pop-up-slots (mopname)
  (declare (special *pop-up-slots*)
    (object-variable print-buffer))
  (let ((print-buffer (mop-slots mopname)))
    (cond ((eql print-buffer nil)
      (print-no-slot)
      (without-interrupts
        (ask *pop-up-slots* (start-picture))
        (print-no-slot)
        (ask *pop-up-slots* (have 'saved-pict (ask *pop-up-slots* (get-picture) $))))))
    (t
      (print-slots print-buffer)
      (without-interrupts
        (ask *pop-up-slots* (start-picture))
        (print-slots print-buffer)
        (ask *pop-up-slots* (have 'saved-pict (ask *pop-up-slots* (get-picture) $)))))
    ($))))))

; ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
; ; show-instances
; ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

; * date : Aug 13,1990
; * function : returns instances of pointed mop
; * argument : mop mop name
; * var : none
; ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

(defun show-instances (mop)
  (declare (special *work-instances*))
  (setf *work-instances* nil)
  (get-instances mop))

;
(defun get-instances (mop)
  (declare (special
               *work-instances*)
            (object-variable
               speclist
               element
               inst))
  (cond ((eql (get-fillers mop 'instances 'value) nil)
        (let ((speclist (mop-specs mop)))
            (for (element :in speclist)
                :do (let ((inst (get-fillers element 'instances 'value))
                          (cond ((eql inst nil)
                              (get-instances element))
                                (t (setf *work-instances* (append *work-instances* (get-instances inst))))))))
        (setf *work-instances* (remove-duplicates *work-instances*))))
)

(defun pop-up-cases ()
  (declare (special *work-instances* *cases-dialog*)
   (setf *cases-dialog* (oneof *dialog*
                 :window-type :tool
                 :window-title "Cases in Memory"
                 :window-font '("helvetica" 12)
                 :window-size (make-point 250 (* 25 (length *work-instances*)))
                 :window-position #(380 40)
                 :default-button t)))

(defun calc-dialog-item-position ()
  (object-variable x-init y-init result))
  (let ((x-init 20) (y-init 10) (result 0)))
(dolist (mop *work-instances* result)
  (setf (get *cases-dialog-item-position* mop) (make-point x-init (+ y-2
  (init result)))))
  (setf result (+ result 20))))

;******************************************************************************
; make-radio-button
;******************************************************************************
:* date  * Aug 14,1990
:* function * defines dialog-items to *cases-dialog*
:* argument * none
:* var    * none
;******************************************************************************

(defun make-radio-button ()
  (declare (special
                *work-instances*
                *cases-dialog*
                *cases-radio-button-dialog-item*
                *cases-dialog-item-position*)

    (object-variable i
      mop))

  (let ((i 0))
    (declare (ignore i))
    (for (mop :in *work-instances*)
      :do
        (ask *cases-dialog*
          (add-dialog-items (oneof *cases-radio-button-dialog-item*
              :dialog-item-position (get *cases-dialog-item-position* mop))
            :dialog-item-text (string mop)
            :dialog-item-action (progn (radio-button-push)
               (princ "Hello"))
            :radio-button-cluster 0
            :radio-button-pushed-p nil)))))

(defun no-case-message ()
  (declare (special *no-case-dialog*))
  (setf *no-case-dialog* (oneof *dialog*
      :window-type  :tool
      :window-title "Cases in Memory"
      :window-font  "("helvetica" 12)
      :window-size  #@(250 100)
      :window-position #@(380 40)
      :default-button  t))

    (ask *no-case-dialog*
      (add-dialog-items (oneof *static-text-dialog-item*
          :dialog-item-position #@(30 40)
          :dialog-item-text "There is no case in memory!")))

(defun dialog-item-click-event-handler *cases-radio-button-dialog-item*) (where)
  (declare (ignore where)
    (special
        *work-instances*
        *cases-dialog-item-position*
        *pop-up-slots*)

    (object-variable click
      result
      pos))

  (radio-button-push)
  (let ((click (dialog-item-position)) (result 0))
    (dolist (mop *work-instances* result)
      (let ((pos (get *cases-dialog-item-position* mop)))
        (cond ((eql click pos)
          ...
(pop-up-slots mop)
(define-redraw-window *pop-up-slots*)
(print-pop-up-slots mop))
(t)))))
;
;;;******************************************************************************************
;;; Set dph initial values
;;;******************************************************************************************
(defun dph-set-initial ()
  (declare (special *dph-central-position*
                   *dph-element-order*
                   *dph-element-position*))
  (setf *dph-central-position* '(150 200))
  (setf *dph-element-order* nil)
  (setf *dph-element-position* nil))

;;;******************************************************************************************
;;; define dph-function menu items
;;;******************************************************************************************
(defun dph-hierarchy-function* *menu*)
(setq dph-hierarchy-fun (oneof *dph-hierarchy-function*
                     :menu-title "SLOTS")

;; scroll dph-hierarchy-graph
;;******************************************************************************************
(defun dph-scroller-window (oneof *menu-item*
                     :menu-item-title "Scroll"
                     :menu-item-action #'(lambda ()
                                           (dph-scroller-window))
                     :disabled nil))

(setq dph-hierarchy-ll (oneof *menu-item*
                     :menu-item-title "-")
               ;; Blank line
)

;; dph-zoom-in
;;******************************************************************************************
(defun dph-zoom-in (oneof *menu-item*
                     :menu-item-title "Zoom-in"
                     :menu-item-action #'(lambda ()
                                           (dph-erase-screen)
                                           (dph-zoom-in)
                                           (draw-dph-xy-axis)
                                           (draw-dph *shown-dph*)
                                           (store-dph-hierarchy-graph)
                                           (ask dph-zoom-in (menu-item-dis...
(ask dph-zoom-out (menu-item-ena 
 :disabled t))

(setq dph-hierarchy-12 (oneof *menu-item* 
 :menu-item-title "-"))

(ask dph-zoom-in (menu-item-ena 
 :disabled nil))

(setq dph-hierarchy-quit (oneof *menu-item* 
 :menu-item-title "Quit" 
 :menu-item-action #'(lambda () 
 (dph-hierarchy-fun (remove-menu-it 
 (ems dph-scroll-window)) 
 (ems dph-hierarchy-11)) 
 (ems dph-zoom-in)) 
 (ems dph-zoom-out)) 
 (ems dph-hierarchy-12)) 
 (ems dph-hierarchy-quit))

(set-menubar *menu-no-dph*)))

; set dph hierarchy functions
;***********************************************************************

;***********************************************************************
:* var : none
;******************************
;
(defun m-dph-fun ()
  (declare (special dph-hierarchy-fun
                   dph-scroll-window
                   dph-hierarchy-l1
                   dph-zoom-in
                   dph-zoom-out
                   dph-hierarchy-l2
                   dph-hierarchy-quit))

(ask dph-hierarchy-fun (menu-deinstall))
(ask dph-hierarchy-fun (menu-install))
(ask dph-hierarchy-fun (add-menu-items dph-scroll-window
                                       dph-hierarchy-l1
                                       dph-zoom-in
                                       dph-zoom-out
                                       dph-hierarchy-l2
                                       dph-hierarchy-quit)))
;
;******************************
;
;open-dph-graph
;******************************
:* date : Aug 19,1990
:* function : defines *dph-graph* window under *graphics-window*
:* argument : mopname  MOP name
:* var : none
;******************************
;
(defun open-dph-window (mop)
  (declare (special *dph-graph*
                   *graphics-window*))
  (setf *dph-graph* (oneof *graphics-window*
               :window-type  :tool
               :window-title (string mop)
               :window-size  @(300 400)
               :window-font '("helvetica" 12)
               :window-position  @(10 40)
               :close-box-p  t))
;
;******************************
;
;draw-dph
;******************************
:* date : Aug 19,1990
:* function : draws dph hierarchy graph
:* argument : mop  mopname
:* var : none
;******************************
(defun draw-dph (mop)
  (declare (special *dph-initial-position* *dph-first-position*)
   (setf *dph-first-position* *dph-initial-position*)
   (calc-element-position (cdr (tree->list mop #'slots->forms nil)))
   (draw-element-procedure))
;
;******************************
;
; dph-zoom-in
;******************************
:* date : Aug 20,1990
:* function : zooms in dph-graph
:* argument : none
:* var : none
;******************************
(defun dph-zoom-in ()
  (declare (special *dph-initial-position*
                *dph-graph* 
                *dph-pen-size*
                *dph-rect-x1* 
                *dph-rect-y1* 
                *dph-rect-x2* 
                *dph-rect-y2* 
                *dph-x-inc*
                *dph-y-inc*))
  (setf *dph-initial-position* '(-280 20))
  (ask *dph-graph* (window-select))
  (ask *dph-graph* (set-window-font "helvetica" 12))
  (setf *dph-pen-size* '#(2 2))
  (setf *dph-rect-x1* 10)
  (setf *dph-rect-y1* 15)
  (setf *dph-rect-x2* 145)
  (setf *dph-rect-y2* 10)
  (setf *dph-x-inc* 150)
  (setf *dph-y-inc* 30))

;;****************************
;; dph-zoom-out
;;****************************
;; * date : Aug 20,1990
;; * function : zooms out dph-graph
;; * argument : none
;; * var : none
;;****************************
(defun dph-zoom-out ()
  (declare (special *dph-initial-position*
                *dph-graph* 
                *dph-pen-size*
                *dph-rect-x1* 
                *dph-rect-y1* 
                *dph-rect-x2* 
                *dph-rect-y2* 
                *dph-x-inc*
                *dph-y-inc*))
  (setf *dph-initial-position* '(-226 20))
  (ask *dph-graph* (window-select))
  (ask *dph-graph* (set-window-font "courier" 9))
  (setf *dph-pen-size* '#(1 1))
  (setf *dph-rect-x1* 5)
  (setf *dph-rect-y1* 10)
  (setf *dph-rect-x2* 118)
  (setf *dph-rect-y2* 5)
  (setf *dph-x-inc* 120)
  (setf *dph-y-inc* 17))

;;****************************
;; draw-dph-xy-axis
;;****************************
;; * date : Aug 20,1990
;; * function : draws x-y axis on dph-graph
;; * argument : none
;; * var : none
;;****************************
(defun draw-dph-xy-axis ()
  (declare (special *dph-graph*)))
(ask *dph-graph* (window-select))
(ask *dph-graph* (set-pen-pattern *gray-pattern*))
(ask *dph-graph* (set-pen-size #\(1 1\)))
(ask *dph-graph* (move-to 150 0))
(ask *dph-graph* (line-to 150 400))
(ask *dph-graph* (pen-hide))
(ask *dph-graph* (move-to 0 200))
(ask *dph-graph* (pen-show))
(ask *dph-graph* (line-to 300 200))

; ;******************************************************************
; ; calc-element-position
; ;******************************************************************

; * date : Aug 20, 1990
; * function : calculates every element's start position
; * argument : element-list slotname lists
; * var : none
; ;******************************************************************

(defun calc-element-position (element-list)
  (declare (special *dph-first-position*
        *dph-start-position*
        *dph-x-inc*
        *dph-y-inc*
        *dph-element-order*
        *dph-element-position*)
    (object-variable x-start
        x-position
        y-position
        result
        y-newline
        x-inc
        y-inc)
    (setf *dph-start-position* *dph-first-position*)
    (let ((x-position (car *dph-start-position*))
          (y-position (cdr *dph-start-position*))
          (x-inc *dph-x-inc*)
          (y-inc *dph-y-inc*))
      (result 0)
      (dolist (element element-list result)
        (let ((x-start (+ x-inc x-position)))
          (cond ((eql (listp element) nil)
                 (setf *dph-element-order* (append *dph-element-order* (list element)))
                 (setf *dph-element-position* (append *dph-element-position* (list list x-start (+ x-inc result) y-inc))
                 (setf *dph-start-position* (list (+ x-start (* result x-inc)) y-inc))
                 (setf result (+ 1 result)))
              (t
               (let ((y-newline (+ y-inc (cdr *dph-start-position*)))
                 (setf *dph-first-position* (list x-start y-newline))
                 (calc-element-position element))))))))

; ;******************************************************************
; ; draw-element-procedure
; ;******************************************************************

; * date : Aug 20, 1990
; * function : draws slot's rolls and lts roll-fillers
; * argument : none
; * var : none
; ;******************************************************************

(defun draw-element-procedure ()
  (declare (special *dph-graph*
*dph-pen-size*
*dph-element-order*
*dph-element-position*
*dph-rect-x1*
*dph-rect-y1*
*dph-rect-x2*
*dph-rect-y2*)

(object-variable result
  n
  element-order
  element-position
  element
  x-pos
  y-pos)

(ask *dph-graph* (window-select))
(ask *dph-graph* (set-pen-pattern *black-pattern*))
(ask *dph-graph* (set-pen-size *dph-pen-size*))
(let ((result 0)
  (n (length *dph-element-order*))
  (element-order *dph-element-order*)
  (element-position *dph-element-position*))
  (dottimes (count n result)
    (let ((element (car element-order))
      (x-pos (car (car element-position)))
      (y-pos (cdr (car element-position)))
      (ask *dph-graph* (move-to x-pos y-pos))
      (ask *dph-graph* (princ element *dph-graph*)
      (ask *dph-graph* (frame-rect (- x-pos *dph-rect-x1*) (- y-pos ?
        + x-pos *dph-rect-x2*) (+ y-pos ?
        *dph-rect-y1*)
        *dph-rect-y2*)))
      (setf element-order (cdr element-order))
      (setf element-position (cdr element-position))))
    (draw-dph-xy-axis)))

(defun dph-erase-screen ()
  (declare (special *dph-graph*
    *dph-pen-size*
    *dph-element-order*
    *dph-element-position*
    *dph-rect-x1*
    *dph-rect-y1*
    *dph-rect-x2*
    *dph-rect-y2*)
  (object-variable result
    n
    element-position
    x-pos
    y-pos))
  (ask *dph-graph* (set-pen-pattern *white-pattern*))
  (ask *dph-graph* (set-pen-size *dph-pen-size*))
  (let ((result 0)
    (n (length *dph-element-order*))
    (element-position *dph-element-position*)))
(dotimes (count n result)
  (let ((x-pos (car (car element-position)))
        (y-pos (cdr (car element-position))))
   (ask *dph-graph* (move-to x-pos y-pos))
   (ask *dph-graph* (paint-rect (- x-pos *dph-rect-x1*) (- y-pos 2)
         (*dph-rect-y1*))
   (+ x-pos (+ 25 *dph-rect-x2*)) (+ 2
         (*y-pos *dph-rect-y2*)))))
 (setf element-position (cdr element-position)))
 (setf *dph-element-order* nil)
 (setf *dph-element-position* nil))
)

;********************************************************************
; dph-scroll-window
;********************************************************************

;* date : Aug 20,1990
;* function : scroll the screen with the distance from the central point of screen
;* argument : none
;* var : x x-coordinate of clicked point
;       : y y-coordinate of clicked point
;       : x-dist the distance along x axis from the central point of screen
;       : y-dist the distance along y axis from the central point of screen
;********************************************************************

(defun dph-scroll-window ()
  (declare (special *dph-graph*))
  (defobject (window-click-event-handler *dph-graph*) (where)
    (declare (special *dph-initial-position* *shown-dph*
        *dph-central-position*)
      (object-variable x
      y
      x-dist
      y-dist))
  (dph-erase-screen)
  (draw-dph-xy-axis)
  (let ((x (point-h where))
        (y (point-v where)))
    (let ((x-dist (- x (car *dph-central-position*))
               (y-dist (- y (cad
         (*r *dph-central-position*)
               )))
      (setf *dph-initial-position* (list
         (- (car *dph-initial-position*)
         x-dist
         (- (cadr *dph-initial-position*)
         y-dist)))
    (draw-dph *shown-dph*)
    (store-dph-hierarchy-graph)))
)

;********************************************************************
; store-dph-hierarchy-graph
;********************************************************************

;* date : Aug 20,1990
;* function : stores the drawing procedure of dph-graph as a picture
;* argument : none
;* var : none
;********************************************************************

(defun store-dph-hierarchy-graph ()
  (declare (special *dph-graph*))
  (ask *dph-graph* (start-picture))
  (draw-element-procedure)
  (ask *dph-graph* (have 'saved-pict (ask *dph-graph* (get-picture))))
)}
(defun draw-dph-hierarchy ()
  (dph-set-initial)
  (format t "enter MOP name ==> ")
  (let ((mop (read)))
    (open-dph-window mop)
    (define-redraw-window *dph-graph*)
    (dph-zoom-out)
    (draw-dph mop)
    (setf *shown-dph* mop))
  (store-dph-hierarchy-graph)
  (setq *menu-no-dph* (menubar))
  (m-dph-fun))
CBRE.Functions4
(defun pick-up (n list)
  (declare (object-variable result))
  (let ((result 1))
    (dolist (element list result)
      (if (eql result n) (return element))
      (setf result (+ result 1))))
)

(defun pop-up-new-mop-stack ()
  (declare (special *new-mop-dialog*)
    (setf *new-mop-dialog* (oneof *dialog*
        :window-type :tool
        :window-title "New MOPs"
        :window-font '("helvetica" 12)
        :window-size @(215 350)
        :window-position @(410 40)
        :default-button t)))
)

(defun make-sequence-dialog ()
  (declare (special *new-mop-stack* *new-mop-dialog*)
    (object-variable table-sq))
  (let ((table-sq (mapcar #'string *new-mop-stack*))
        (ask *new-mop-dialog*
          (add-dialog-items (oneof *new-mop-sequence-dialog-item*
              :dialog-item-action
              #'(lambda ()
                 (let ((n (+ 1 (point-v (car (selected-cells)))))
                   (dph (pick-up n *new-mop-stack*))))))
          :table-vscrollp t
          :table-hscrollp nil
          :table-dimensions @(1 50)
          :visible-dimensions @(1 20)
          :table-sequence table-sq))))
)
(defun show-new-mop-stack ()
  (pop-up-new-mop-stack)
  (make-sequence-dialog))
CBRE.Basic.MOPs
;;; Clear Memory
;;; (clear-memory)
;;; *** Listing 3.21: Basic MOPs
;;; (defmop m-event (m-root))
;;; (defmop m-state (m-root))
;;; (defmop m-act (m-root))
;;; (defmop m-actor (m-root))
;;; (defmop m-group (m-root))
;;; (defmop m-empty-group (m-group))
;;; (defmop i-m-empty-group (m-empty-group) instance)
;;; (defmop m-function (m-root))
;;; (defmop constraint-fn (m-function))
;;; (defmop m-pattern (m-root) (abst-fn constraint-fn))
;;; (defmop get-sibling (m-function))
;;; (defmop m-case (m-root)
;;;   (old m-pattern (calc-fn get-sibling)))
;;; (defmop m-role (m-root))
;;; (defmop not-constraint (constraint-fn))
;;; (defmop m-not (m-pattern) (abst-fn not-constraint))
;;; (defmop m-failed-solution (m-root))
;;; Clear Memory

;;; Basic MOPs

(defun m-space-name (m-root) mop)
(defun i-m-space101 (m-space-name) instance)
(defun i-m-space102 (m-space-name) instance)
(defun i-m-space103 (m-space-name) instance)
(defun i-m-space104 (m-space-name) instance)
(defun i-m-space105 (m-space-name) instance)
(defun i-m-space106 (m-space-name) instance)
(defun i-m-space107 (m-space-name) instance)
(defun i-m-space108 (m-space-name) instance)
(defun i-m-space109 (m-space-name) instance)
(defun i-m-space110 (m-space-name) instance)
(defun i-m-space111 (m-space-name) instance)
(defun i-m-space112 (m-space-name) instance)
(defun i-m-space113 (m-space-name) instance)

(defun m-compass (m-root))
(defun north (m-compass) instance)
(defun east (m-compass) instance)
(defun south (m-compass) instance)
(defun west (m-compass) instance)

(defun m-cooperate (m-root)
  (space-name m-space-name)
  (direction m-compass))

(defun m-size-minimum (m-root)
  (value1 nil)
  (value2 nil))

(defun m-room-minimum (m-root)
  (minimum nil))
(defun i-m-main-bed-room (m-room-minimum)
  (minimum m-size-minimum
    (value1 12.0)
    (value2 12.0)))
(defun i-m-bath-room (m-room-minimum)
  (minimum m-size-minimum
    (value1 8.0)
    (value2 5.0)))

(defun i-m-family-room (m-room-minimum)
  (minimum m-size-minimum
    (value1 12.0)
    (value2 10.0)))
(defun i-m-kitchen (m-room-minimum)
  (minimum m-size-minimum
    (value1 11.0)
    (value2 7.0)))
(defun i-m-laundry (m-room-minimum)
  (minimum m-size-minimum
    (value1 10.0)
    (value2 7.0)))
(defun i-m-bed-room (m-room-minimum)
  (minimum m-size-minimum
    (value1 11.0)
    (value2 8.7)))
(defmop i-m-hall (m-room-minimum)
  (minimum m-size-minimum
    (value1 m-cooperate
      (space-name i-m-space109)
      (direction north))
    (value2 3.0)))

(defmop i-m-entrance-hall (m-room-minimum)
  (minimum m-size-minimum
    (value1 m-cooperate
      (space-name i-m-space112)
      (direction west))
    (value2 3.0)))

(defmop i-m-living-room (m-room-minimum)
  (minimum m-size-minimum
    (value1 16.0)
    (value2 12.0)))

(defmop i-m-dining-room (m-room-minimum)
  (minimum m-size-minimum
    (value1 10.5)))

(defmop i-m-garage (m-room-minimum)
  (single m-size-minimum
    (value1 22.0)
    (value2 12.0))
  (double m-size-minimum
    (value1 22.0)
    (value2 22.0)))

; (defmop m-space-use (m-root))
(defmop m-space-need (m-root))
(defmop i-m-main-bed-room (m-space-use m-space-need) instance)
(defmop i-m-bath-room (m-space-use m-space-need) instance)
(defmop i-m-family-room (m-space-use) instance)
(defmop i-m-kitchen (m-space-use m-space-need) instance)
(defmop i-m-laundry (m-space-use) instance)
(defmop i-m-bed-room (m-space-use m-space-need) instance)
(defmop i-m-hall (m-space-use) instance)
(defmop i-m-entrance-hall (m-space-use m-space-need) instance)
(defmop i-m-living-room (m-space-use m-space-need) instance)
(defmop i-m-dining-room (m-space-use m-space-need) instance)
(defmop i-m-garage (m-space-use m-space-need) instance)

; (defmop m-space-minimum (m-root)
  (space-name m-space-name)
  (north nil)
  (east nil)
  (south nil)
  (west nil))

; (defmop m-space (m-root)
  (space-name m-space-name)
  (width nil)
  (length nil)
  (use nil)
  (requirement nil))

; (defmop m-sleeping-area (m-space)
  (space-name m-space-name)
  (width nil)
  (length nil)
  (no-of-peple nil)
  (use nil)
  (requirement nil))
(defmop m-living-area (m-space)
  (space-name m-space-name)
  (width nil)
  (length nil)
  (no-of-peple nil)
  (use nil)
  (requirement nil))

(defmop m-service-area (m-space)
  (space-name m-space-name)
  (width nil)
  (length nil)
  (use nil)
  (requirement nil))

(defmop m-traffic-area (m-space)
  (space-name m-space-name)
  (width nil)
  (length nil)
  (use nil)
  (requirement nil))

(defmop m-orientation (m-root)
  (gl nil))

(defmop m-north-orient (m-orientation)
  (gl nil))
(defmop m-east-orient (m-orientation)
  (gl nil))
(defmop m-south-orient (m-orientation)
  (gl nil))
(defmop m-west-orient (m-orientation)
  (gl nil))

(defmop m-direction (m-root)
  (north nil)
  (east nil)
  (south nil)
  (west nil))

(defmop m-land (m-root)
  (width nil)
  (length nil)
  (orientation m-orientation))

(defmop m-building-area (m-land)
  (width nil)
  (length nil))

(defmop m-building-area (m-land)
  (requirement m-requirement))
(defmop m-adjacency-req (m-requirement))
(defmop m-sunlight-req (m-requirement))
(defmop m-noise-req (m-requirement))
(defmop m-privacy-req (m-requirement))

(defmop m-function (m-root))
(defmop m-cite/c-fn (m-function))
(defmop m-design/c-fn (m-function))
(defmop m-constraint/c-fn (m-function))

(defmop select-repair-tech (m-design/c-fn))
(defmop get-rooms (m-design/c-fn))
(defop i-m-get-rooms (get-rooms) instance)
(defop get-orientations (m-design/c-fn))
(defop i-m-get-orientations (get-orientations) instance)
(defop compare-cite (m-cite/c-fn))
(defop i-m-compare-cite (compare-cite) instance)
(defop get-before-land (m-cite/c-fn))
(defop i-m-get-before-land (get-before-land) instance)
(defop get-after-land (m-cite/c-fn))
(defop i-m-get-after-land (get-after-land) instance)
(defop partial-shrink-rooms (m-design/c-fn))
(defop i-m-partial-shrink-rooms (partial-shrink-rooms) instance)
(defop eliminate-room (m-design/c-fn))
(defop i-m-eliminate-room (eliminate-room) instance)
(defop eliminate-orientation (m-design/c-fn))
(defop i-m-eliminate-orientation (eliminate-orientation) instance)
(defop shrink-rooms (m-design/c-fn))
(defop i-m-shrink-rooms (shrink-rooms) instance)
(defop extend-rooms (m-design/c-fn))
(defop i-m-shrink-rooms (shrink-rooms) instance)
;; (defop rotate (m-design/c-fn))
;; (defop change-adj (m-design/c-fn))
(defop total-space (m-constraint/c-fn))
(defop i-m-total-space (total-space) instance)
(defop news-length (m-constraint/c-fn))
(defop i-m-north-length (news-length) instance)
(defop i-m-east-length (news-length) instance)
(defop i-m-south-length (news-length) instance)
(defop i-m-west-length (news-length) instance)
(defop main-bed-room-space (m-constraint/c-fn))
(defop i-m-main-bed-room-space (main-bed-room-space) instance)
(defop bath-room-space (m-constraint/c-fn))
(defop i-m-bath-room-space (bath-room-space) instance)
(defop family-room-space (m-constraint/c-fn))
(defop i-m-family-room-space (family-room-space) instance)
(defop kitchen-space (m-constraint/c-fn))
(defop i-m-kitchen-space (kitchen-space) instance)
(defop laundry-space (m-constraint/c-fn))
(defop i-m-laundry-space (laundry-space) instance)
(defop bed-room-space (m-constraint/c-fn))
(defop i-m-bed-room-space (bed-room-space) instance)
(defop hall-space (m-constraint/c-fn))
(defop i-m-hall-space (hall-space) instance)
(defop entrance-hall-space (m-constraint/c-fn))
(defop i-m-entrance-hall-space (entrance-hall-space) instance)
(defop living-room-space (m-constraint/c-fn))
(defop i-m-living-room-space (living-room-space) instance)
(defop dining-room-space (m-constraint/c-fn))
(defop i-m-dining-room-space (dining-room-space) instance)
(defop garage-space (m-constraint/c-fn))
(defop i-m-garage-space (garage-space) instance)
(defop main-bed-room-space (m-constraint/c-fn))

;; (defop m-map (m-root)
  (abst m-root)
  (spec m-root))

;; (defop m-group (m-root))

;; (defop m-space-organization (m-group)
  (gl m-space))

;; (defop m-cite/c-group (m-group)
  (gl m-cite/c-fn))
(defmop m-design/c-group (m-group)
 (gl m-design/c-fn))
(defmop m-constraint/c-group (m-group)
 (gl m-constraint/c-fn))
(defmop i-m-empty-group (m-cite/c-group m-design/c-group m-constraint/c-group)
 instance)
(defmop m-map-group (m-group)
 (gl m-map))
(defmop m-pattern (m-root)
 (abst-fn m-function))
(defmop m-condition (m-root))
(defmop i-m-none (m-condition) instance)
(defmop i-m-smaller/BA (m-condition) instance)
(defmop i-m-same/BA (m-condition) instance)
(defmop i-m-bigger/BA (m-condition) instance)
(defmop i-m-different/OR (m-condition) instance)
(defmop i-m-same/OR (m-condition) instance)
(defmop i-m-different/AR (m-condition) instance)
(defmop i-m-same/AR (m-condition) instance)
(defmop m-design-knowledge (m-root))
(defmop m-cite-tech (m-design-knowledge))
(defmop m-design-tech (m-design-knowledge))
(defmop m-constraint-tech (m-design-knowledge))
(defmop m-cite-check (m-cite-tech)
 (difference m-pattern (calc-fn compare-cite))
 (before m-pattern (calc-fn get-before-land))
 (after m-pattern (calc-fn get-after-land)))
(defmop i-m-cite-difference (m-cite-check) instance)
(defmop m-just-copy (m-design-tech)
 (reason i-m-same/BA)
 (room m-pattern (calc-fn get-rooms))
 (orientation m-pattern (calc-fn get-orientations)))
(defmop i-m-just-copy (m-just-copy) instance)
(defmop m-partial-shrink (m-design-tech)
 (reason i-m-smaller/BA)
 (room m-pattern (calc-fn partial-shrink-rooms))
 (orientation m-pattern (calc-fn get-orientations)))
(defmop i-m-partial-shrink (m-partial-shrink) instance)
(defmop m-eliminate (m-design-tech)
 (reason i-m-smaller/BA)
 (room m-pattern (calc-fn eliminate-room))
 (orientation m-pattern (calc-fn eliminate-orientation)))
(defmop i-m-eliminate (m-eliminate) instance)
(defmop m-shrink (m-design-tech)
 (reason i-m-smaller/BA)
 (room m-pattern (calc-fn shrink-rooms))
 (orientation m-pattern (calc-fn get-orientations)))
(defmop i-m-shrink (m-shrink) instance)
(defmop m-extend (m-design-tech)
(reason i-m-bigger/BA)
(room m-space-organization)
(orientation m-direction))
;
(defmop i-m-extend (m-extend) instance)
;
(defmop m-rotate (m-design-tech)
(reason i-m-different/OR)
(room m-space-organization)
(orientation m-direction))
;
(defmop i-m-rotate (m-rotate) instance)
;
(defmop m-change-adj (m-design-tech)
(reason i-m-different/AR)
(room m-space-organization)
(orientation m-direction))
;
(defmop m-constraint-check (m-constraint-tech))
;
(defmop m-space-check (m-constraint-check))
(defmop m-main-bed-room-space (m-space-check)
(check m-pattern (calc-fn main-bed-room-space)))
(defmop m-bath-room-space (m-space-check)
(check m-pattern (calc-fn bath-room-space)))
(defmop m-family-room-space (m-space-check)
(check m-pattern (calc-fn family-room-space)))
(defmop m-kitchen-space (m-space-check)
(check m-pattern (calc-fn kitchen-space)))
(defmop m-laundry-space (m-space-check)
(check m-pattern (calc-fn laundry-space)))
(defmop m-bed-room-space (m-space-check)
(check m-pattern (calc-fn bed-room-space)))
(defmop m-hall-space (m-space-check)
(check m-pattern (calc-fn hall-space)))
(defmop m-entrance-hall-space (m-space-check)
(check m-pattern (calc-fn entrance-hall-space)))
(defmop m-living-room-space (m-space-check)
(check m-pattern (calc-fn living-room-space)))
(defmop m-dining-room-space (m-space-check)
(check m-pattern (calc-fn dining-room-space)))
(defmop m-garage-space (m-space-check)
(check m-pattern (calc-fn garage-space)))
(defmop m-news-length (m-space-check)
(check m-pattern (calc-fn news-length)))
(defmop m-total-space (m-space-check)
(check m-pattern (calc-fn total-space)))
;
(defmop m-sunlight-check (m-constraint-check) mop)
(defmop i-m-sunlight (m-sunlight-check) instance)
(defmop m-noise-check (m-constraint-check) mop)
(defmop i-m-noise (m-noise-check) instance)
(defmop m-privacy-check (m-constraint-check) mop)
(defmop i-m-privacy (m-privacy-check) instance)
;
(defmop m-design-steps (m-root)
(cite-check m-cite/c-group)
(design-change m-design/c-group)
(constraint-check m-constraint/c-group))
;
(defmop m-layout (m-root)
(building-area m-building-area)
(room m-space)
(orientation m-orientation))

; (defmop m-example  (m-root)
(building-area m-building-area)
(room m-space)
(orientation m-orientation))

; (defmop m-failure  (m-root)
(constraint m-constraint/c-fn))

; (defmop m-explanation  (m-root)
(failure m-failure))

; (defmop m-result (m-root))
(defmop i-m-success (m-result) instance)
(defmop i-m-failure (m-result) instance)

; (defmop m-repair  (m-root)
(repaired-solution m-pattern
  (calc-fn select-repair-tech)))

; (defmop m-case  (m-root)
(case-name m-design-tech)
(result m-result)
(condition m-condition)
(before m-layout)
(after m-example)
(step m-design-steps))

; (defmop i-m-layout001 (m-layout)
  (building-area m-building-area
    (width 76.0)
    (length 25.0))
  (room m-space-organization
    (g1 m-sleeping-area
      (space-name i-m-space101)
      (width 15.0)
      (length 12.0)
      (no-of-people 2)
      (use i-m-main-bed-room))
    (g2 m-sleeping-area
      (space-name i-m-space102)
      (width 8.0)
      (length 6.0)
      (no-of-people 1)
      (use i-m-bath-room))
    (g3 m-sleeping-area
      (space-name i-m-space103)
      (width 8.0)
      (length 6.0)
      (no-of-people 1)
      (use i-m-bath-room))
    (g4 m-living-area
      (space-name i-m-space104)
      (width 12.0)
      (length 10.0)
      (no-of-people 8)
      (use i-m-family-room))
    (g5 m-service-area
      (space-name i-m-space105)
      (width 9.0)
      (length 12.0)
(use i-m-kitchen))

(g6 m-service-area
  (space-name i-m-space106)
  (width 7.0)
  (length 12.0)
  (use i-m-laundry))

(g7 m-service-area
  (space-name i-m-space107)
  (width 20.0)
  (length 25.0)
  (use i-m-garage))

(g8 m-sleeping-area
  (space-name i-m-space108)
  (width 11.5)
  (length 13.0)
  (no-of-people 1)
  (use i-m-bedroom))

(g9 m-sleeping-area
  (space-name i-m-space109)
  (width 11.5)
  (length 9.6)
  (no-of-people 1)
  (use i-m-bedroom))

(g10 m-traffic-area
  (space-name i-m-space110)
  (width 11.5)
  (length 3.4)
  (use i-m-hall))

(g11 m-traffic-area
  (space-name i-m-space111)
  (width 6.5)
  (length 13.0)
  (use i-m-entrance-hall))

(g12 m-living-area
  (space-name i-m-space112)
  (width 16.0)
  (length 13.0)
  (no-of-people 6)
  (use i-m-living-room))

(g13 m-living-area
  (space-name i-m-space113)
  (width 10.5)
  (length 13.0)
  (no-of-people 6)
  (use i-m-dining-room))

(orientation m-direction
  (north m-north-orient
    (g1 i-m-space101)
    (g2 i-m-space102)
    (g3 i-m-space104)
    (g4 i-m-space105)
    (g5 i-m-space106)
    (g6 i-m-space107))

  (east m-east-orient
    (g1 i-m-space107))

  (south m-south-orient
    (g1 i-m-space108)
    (g2 i-m-space109)
    (g3 i-m-space111)
    (g4 i-m-space112)
    (g5 i-m-space113)
    (g6 i-m-space107))

  (west m-west-orient
    (g6 i-m-space107))
(g1 i-m-space101)
(g2 i-m-space108))

(defun m-space-define (m-root))
(defun width (m-space-define) instance)
(defun length (m-space-define) instance)

(defun m-space-group (m-group)
  (g1 m-space-name))

(defun m-equal (m-root)
  (equal nil))

(defun m-equal-width (m-equal)
  (equal width)
  (argument1 nil)
  (argument2 nil))

(defun m-equal-width-g1 (m-equal-width)
  (equal width)
  (argument1 nil)
  (argument2 nil))

(defun i-m-equal-width.1 (m-equal-width-g1)
  (argument1 m-space-group
    (g1 i-m-space101)
    (g2 i-m-space102))
  (argument2 m-space-group
    (g1 i-m-space101)
    (g2 i-m-space103))
  (argument3 m-space-group
    (g1 i-m-space108)
    (g2 i-m-space110))
  (argument4 m-space-group
    (g1 i-m-space108)
    (g2 i-m-space109)))

(defun i-m-equal-width.2 (m-equal-width-g1)
  (argument1 m-space-group
    (g1 i-m-space104)
    (g2 i-m-space105)
    (g3 i-m-space106))
  (argument2 m-space-group
    (g1 i-m-space111)
    (g2 i-m-space112)
    (g3 i-m-space113))

(defun i-m-equal-width.3 (m-equal-width-g1)
  (argument1 m-space-group
    (g1 i-m-space107))
  (argument2 m-space-group
    (g1 i-m-space107)))

(defun m-equal-length (m-equal)
  (equal length)
  (argument1 nil)
  (argument2 nil))

(defun m-equal-length-g1 (m-equal-length)
  (equal length)
  (argument1 nil)
  (argument2 nil))
(defmop m-equal-length-g2 (m-equal-length)
  (equal      length)
  (argument1 nil)
  (argument2 nil))

(defunop i-m-equal-length.1 (m-equal-length-g1)
  (argument1 m-space-group
    (g1  i-m-space101)
    (g2  i-m-space108))
  (argument2 m-space-group
    (g1  i-m-space107)))

(defunop i-m-equal-length.2 (m-equal-length-g2)
  (argument1 m-space-group
    (g1  i-m-space101))
  (argument2 m-space-group
    (g1  i-m-space102)
    (g2  i-m-space103))
  (argument3 m-space-group
    (g1  i-m-space104))
  (argument4 m-space-group
    (g1  i-m-space105))
  (argument5 m-space-group
    (g1  i-m-space106)))

(defunop i-m-equal-length.3 (m-equal-length-g2)
  (argument1 m-space-group
    (g1  i-m-space108))
  (argument2 m-space-group
    (g1  i-m-space110)
    (g2  i-m-space109))
  (argument3 m-space-group
    (g1  i-m-space111))
  (argument4 m-space-group
    (g1  i-m-space112))
  (argument5 m-space-group
    (g1  i-m-space113)))
CBRE.Floor.Defun
;;; Set Initial Values

(defun initial-values ()
  (declare (special *example-mop*
    *cite-method*
    *design-tech*
    *design-method*
    *constraint-method*
    *design-steps*
    *reason*
    *explanation*
    *eliminate-room*
    *measure-width*
    *measure-length*
    *distance-queue*
    *warning-msg*
    *shrunked-room-list*))
  (setf *example-mop* nil) ;; example mop
  (setf *cite-method* nil) ;; cite-check method
  (setf *design-tech* nil) ;; design-change technique
  (setf *design-method* nil) ;; design-change method
  (setf *constraint-method* nil) ;; constraint-check method
  (setf *design-steps* nil) ;; design steps
  (setf *reason* nil) ;; the reason chose
  (setf *explanation* nil) ;; explanation
  (setf *eliminate-room* nil) ;; eliminate rooms' group number
  (setf *measure-width* nil) ;; measure value of width for
  (setf *measure-length* nil) ;; measure value of length for
  (setf *distance-queue* nil) ;; queue of *distance*
  (setf *warning-msg* nil) ;; queue of warning messages
  (setf *shrunked-room-list* nil)) ;; list of shrinked-room

(setq *space-check-table* nil)
(setq (get *space-check-table* 'i-m-main-bed-room) 'main-bed-room-space)
(setq (get *space-check-table* 'i-m-bath-room) 'bath-room-space)
(setq (get *space-check-table* 'i-m-family-room) 'family-room-space)
(setq (get *space-check-table* 'i-m-kitchen) 'kitchen-space)
(setq (get *space-check-table* 'i-m-laundry) 'laundry-space)
(setq (get *space-check-table* 'i-m-bed-room) 'bed-room-space)
(setq (get *space-check-table* 'i-m-hall) 'hall-space)
(setq (get *space-check-table* 'i-m-entrance-hall) 'entrance-hall-space)
(setq (get *space-check-table* 'i-m-living-room) 'living-room-space)
(setq (get *space-check-table* 'i-m-dining-room) 'dining-room-space)
(setq (get *space-check-table* 'i-m-garage) 'garage-space)
(setq (get *space-check-table* 'i-m-main-bed-room-space) 'i-m-main-bed-room)
(setq (get *space-check-table* 'i-m-bath-room-space) 'i-m-bath-room)
(setq (get *space-check-table* 'i-m-family-room-space) 'i-m-family-room)
(setq (get *space-check-table* 'i-m-kitchen-space) 'i-m-kitchen)
(setq (get *space-check-table* 'i-m-laundry-space) 'i-m-laundry)
(setq (get *space-check-table* 'i-m-bed-room-space) 'i-m-bed-room)
(setq (get *space-check-table* 'i-m-hall-space) 'i-m-hall)
(setq (get *space-check-table* 'i-m-entrance-hall-space) 'i-m-entrance-hall)
(setq (get *space-check-table* 'i-m-living-room-space) 'i-m-living-room)
(setq (get *space-check-table* 'i-m-dining-room-space) 'i-m-dining-room)
(setq (get *space-check-table* 'i-m-garage-space) 'i-m-garage)

(setq *news-direction* nil)
(setq (get *news-direction* 'north) 'm-north-orient)
(setq (get *news-direction* 'east) 'm-east-orient)
(setq (get *news-direction* 'west) 'm-west-orient)
(setq (get *news-direction* 'south) 'm-south-orient)

(setq *compass* nil)
(setq (get *compass* 'i-m-north-length) 'north)
(setq (get *compass* 'i-m-east-length) 'east)
(setq (get *compass* 'i-m-south-length) 'south)
(setq (get *compass* 'i-m-west-length) 'west)

(defun get-rooms (pattern mop)
  (declare (special *design-method*)
  (ignore pattern
      mop))
  (format t "~%*** Hello there! get-rooms ***")
  ; #DEBUG# => (print pattern)
  ; #DEBUG# => (print mop)
  (setq *design-method* (append *design-method* (mop-specs 'get-rooms)))
  (get-filler 'room (car (mop-specs 'm-layout))))

(defun get-orientations (pattern mop)
  (declare (special *design-method*)
  (ignore pattern
      mop))
  (format t "~%*** Hello there! get-orientations ***")
  ; #DEBUG# => (print pattern)
  ; #DEBUG# => (print mop)
  (setq *design-method* (append *design-method* (mop-specs 'get-orientations)))
  (get-filler 'orientation (car (mop-specs 'm-layout))))

(defun compare-cite (pattern mop)
  (declare (special *cite-method* 
    *reason*)
  (ignore pattern
      mop))
  (format t "~%*** Hello there! compare-step ***")
  ; #DEBUG# => (print pattern)
  ; #DEBUG# => (print mop)
  (setq *cite-method* (append *cite-method* (mop-specs 'compare-cite)))
  (let ((compl1 (role-filler 'building-area (car (mop-specs 'm-layout))))
        (compl2 (role-filler 'building-area (car (mop-specs 'm-example))))
        (ans1 'i-m-same/BA) (ans2 'i-m-different/BA))
    (setf *reason*
      (cond ((= compl1 compl2)
        (format t "~%>>> Hey! it's same >>>>>")
        ans1)
        (t (format t "~%>>> I'm sorry. It's different. >>>>>")
        (print compl1)
        (print compl2)
        (print ans2)))))

(defun get-before-land (pattern mop)
  (declare (special *cite-method*)
  (ignore pattern
      mop))
  (format t "~%*** Hello there! get-before-land ***")
  ; #DEBUG# => (print pattern)
  ; #DEBUG# => (print mop)
  (setq *cite-method* (append *cite-method* (mop-specs 'get-before-land)))
  (role-filler 'building-area (car (mop-specs 'm-layout))))

(defun get-after-land (pattern mop)
  (declare (special *cite-method*)
  (ignore pattern
mop))
 (format t "-8** Hello there! get-after-land **")
 ; #DEBUG# => (print pattern)
 ; #DEBUG# => (print mop)
 (setq *cite-method* (append *cite-method* (mop-specs 'get-after-land))
 (role-filler 'building-area (car (mop-specs 'm-example)))
)

*** apply-design-tech

(defun apply-design-tech (mop)
   (add-filler mop 'room 'if-added
   '(transport-rooms !filler))
   (add-filler mop 'orientation 'if-added
   '(transport-orient !filler))
   (get-filler 'room mop)
   (get-filler 'orientation mop))

*** get-space-constraint

(defun get-space-constraint ()
   (declare (special *example-mop*))
   (format t "-%++++ Hey! get-space-constraint +++")
   (let ((mop-list (mop-specs 'm-space-check))
         (for (mop :in mop-list)
           :do (let ((constraint-check (eval `(slots->mop '((example-name ,*example-mop*)))
                                      ',(mop) nil)))
                 (get-filler 'check constraint-check)))))

*** select-design-tech

(defun select-design-tech (size)
   (declare (special *design-tech*
                   *example-mop*))
   (format t "-%?????? select-design-tech ?????")
   (let ((specs (mop-specs 'm-design-tech))
         (setf *design-tech* (for (spec :in specs)
                                 :when (eq size (role-filler 'reason spec))
                                 :save spec)))
     (cond ((eq 1 (length *design-tech*))
            (let ((design-tech (eval `(slots->mop '((example-name ,*example-mop*)
                                             ,*design-tech* nil))))
                  (apply-design-tech design-tech)))
           (t (format t "-%#### more design technique **"))))

(defun transport-rooms (rooms)
   (declare (special *example-mop*))
   (add-role-filler 'room *example-mop* rooms))

(defun transport-orient (orient)
   (declare (special *example-mop*))
   (add-role-filler 'orientation *example-mop* orient))

*** calc-area

(defun calc-area (space-mop)
   (* 0.1 (round (* (role-filler 'width space-mop)
                   (role-filler 'length space-mop)) 0.1)))

*** list-plus
(defun list-plus (list)
  (let ((result 0))
    (dolist (element list result)
      (setq result (+ result element)))
    )
)

;;; calc-total-space

(defun calc-total ()
  (declare (special *example-mop*)
    (let ((room-list (mop-slots (role-filler 'room *example-mop*)))
      (result 0))
      (dolist (room room-list result)
        (let ((width (role-filler 'width (cadr room)))
           (length (role-filler 'length (cadr room))))
          (setq result (+ result (* width length))))
        (* 0.1 (round result 0.1))))
)

;;; remove-duplicate-room

(defun remove-duplicate-room (zone)
  (let ((space-list (mop-specs zone))
    (result nil))
    (let ((identifier (role-filler 'space-name (car space-list)))
      (result result)
      (setq space-list (cdr space-list))
      (loop
        (when (or (endp space-list)
                  (eq identifier (role-filler 'space-name (car space-list)))
                  (return result))
        (setq result (append result (list (car space-list))))
        (setq space-list (cdr space-list))))
      (setq result result))
)

;;; total-space

(defun total-space (pattern mop)
  (declare (special *example-mop*
                   *constraint-method*)
    (ignore pattern
      mop))
  (format t "~% calculate total space +++")
  (let ((build-area (calc-area (role-filler 'building-area *example-mop*)))
    (total (calc-total))
    (passed 'passed) (not-passed 'not-passed))
  (format t "~% build-area => ~s" build-area)
  (format t "~% total-space => ~s" total)
  (cond (> total build-area)
    (setq *constraint-method* (append *constraint-method* (mop-specs 'total-space))
      not-passed)
    (t passed)))

;;; shrink-rooms

(defun shrink-rooms (pattern mop)
  (declare (ignore pattern
    mop))
  (special *example-mop*
    *design-method*)
  (let ((old-space-org (get-filler 'room 'i-m-layout001))
    (before-width (path-filler 'building-area width) 'i-m-layout001))
    (before-length (path-filler 'building-area length) 'i-m-layout001)))
(after-width (path-filler '(building-area width) *example-mop*))
(after-length (path-filler '(building-area length) *example-mop*))
(let ((rate1 (/ after-width before-width))
      (rate2 (/ after-length before-length))
      (room-list (mapcar #'(cadr (mop-slots old-space-org)))
      (setq *design-method* (append *design-method* (mop-specs 'shrink-rooms)

;)))(new-space-org (for (room :in room-list)
              :save (shrink-room room rate1 rate2))))
(format t "%-new-space-org => ~s new-space-org")
(eval `(list->group ',new-space-org)))))

(defun shrink-room (room rate1 rate2)
  (let ((space-name (get-filler 'space-name room))
        (width (* rate1 (get-filler 'width room)))
        (length (* rate2 (get-filler 'length room)))
        (use (get-filler 'use room))
        (mop (mop-absts room)))
    (eval `(slots->mop '((space-name ,space-name)
                          (width ,width)
                          (length ,length)
                          (use ,use)) ',mop t))))

(defun get-group-number (role filler mop)
  (let ((space-organization (role-filler 'room mop)))
    (let ((number-list (make-m-n (length (mop-slots space-organization)) 1))
          (result nil))
      (dolist (number number-list result)
            (cond ((eq (eval `(path-filler ',(number ,role) ',space-organization)
                            (setq result (append result
                                          (list number)))))))))

(defun garage-space (pattern mop)
  (declare (ignore pattern mop)
            (special *example-mop*
                     *constraint-method*)
    (let ((group-name1 (car (get-group-number 'use 'i-m-garage 'i-m-layout001)))
          (group-name2 (car (get-group-number 'use 'i-m-garage *example-mop*))
          (space-org1 (role-filler 'room 'i-m-layout001))
          (space-org2 (role-filler 'room *example-mop*))
          (passed 'passed)
          (not-passed 'not-passed))
      (let ((width1 (eval `(path-filler ,((group-name1 width) ',space-org1)))
              (length1 (eval `(path-filler ,((group-name1 length) ',space-org1)))
              (width2 (eval `(path-filler ,((group-name2 width) ',space-org2))))
(length2 (eval `(path-filler ',(group-name2 length) ',space-org2)))
(value1 nil)
(value2 nil)
(d-value1 (path-filler ',(double value1) 'i-m-garage))
(d-value2 (path-filler ',(double value2) 'i-m-garage))
(s-value1 (path-filler ',(single value1) 'i-m-garage))
(s-value2 (path-filler ',(single value2) 'i-m-garage)))
(cond ((and (>= width1 d-value1) (>= width1 d-value2)
(>= length1 d-value1) (>= length1 d-value2))
(setq value1 d-value1) (setq value2 d-value2))
(t (setq value1 s-value1) (setq value2 s-value2)))
(format t "~%-garage minimum 1 => ~s" value1)
(format t "~%-garage minimum 2 => ~s" value2)
(format t "~%-garage width => ~s" width2)
(format t "~%-garage length => ~s" length2)
(cond ((> width2 length2)
(format t "~%-width > length")
(cond ((and (>= width2 value2) (>= length2 value2)) passed)
(t (setq *constraint-method* (append *constraint-method*
(mop-specs 'garage-space)) ))
(not-passed)))))
(t (format t "~%-width <= length")
(cond ((and (>= length2 value2) (>= width2 value2)) passed)
(t (setq *constraint-method* (append *constraint-method*
(mop-specs 'garage-space)) ))
(not-passed))))))))
;;*** dining-room-space
;;
(defun dining-room-space (pattern mop)
 (declare (ignore pattern mop)
 (special *example-mop*
 *constraint-method*))
(let ((group-name1 (car (get-group-number 'use 'i-m-dining-room 'i-m-layout001)))
 (group-name2 (car (get-group-number 'use 'i-m-dining-room *example-mop*)))
 (space-org1 (role-filler 'room 'i-m-layout001))
 (space-org2 (role-filler 'room *example-mop*)))
(let ((value1 (path-filler ',(minimum value1) 'i-m-dining-room))
 (value2 (+ 4.0 (eval `(path-filler ',(group-name1 no-of-people) ',space )))
 -org11)))
(work nil)
(passed 'passed)
(not-passed 'not-passed))
(cond ((< value1 value2) (setq work value1)
 (setq value1 value2)
 (setq value2 work )))
(let ((width (eval `(path-filler ',(group-name2 width) ',space-org2)))
 (length (eval `(path-filler ',(group-name2 length) ',space-org2)))
 (format t "~%-dining-room minimum 1 => ~s" value1)
 (format t "~%-dining-room minimum 2 => ~s" value2)
 (format t "~%-dining-room width => ~s" width)
 (format t "~%-dining-room length => ~s" length)
 (cond ((> width length)
(format t "~%-width > length")
(cond (and (>= width value1) (>= length value2)) passed)
(t (setq *constraint-method* (append *constraint-method*
(mop-specs 'dining-room-space))
(not-passed)))))
(t
  (format t "-~s width <= length")
  (cond ((and (> width value1) (> width value2)) passed)
      (t (setq *constraint-method* (append *constraint-method* (mop-specs 'dining-room-space)) not-passed)))

;*** ordinary-check
;
(defun ordinary-check (space-for-use)
  (declare (special *example-mop*
                  *constraint-method*
                  *space-check-table*))
  (let ((result nil))
      (dolist (group-name (get-group-number 'use space-for-use *example-mop*) result)
        (let ((space-org (role-filler 'room *example-mop*))
               (value1 (path-filler 'minimum value1) space-for-use)
               (value2 (path-filler 'minimum value2) space-for-use)
               (work nil)
               (passed 'passed)
               (not-passed 'not-passed))
          (cond ((< value1 value2) (setq work value1)
                 (setq value1 value2)
                 (setq value2 work))
                 (t (setq result not-passed))))
      (let ((width (eval (path-filler ',group-name width) ',space-org)
                 (length (eval (path-filler ',group-name length) ',space-org)
                 (format t "-~s minimum 1 => ~s" space-for-use value1)
                 (format t "-~s minimum 2 => ~s" space-for-use value2)
                 (format t "-~s width => ~s" space-for-use width)
                 (format t "-~s space-for-use length" space-for-use length)
                 (cond ((> width length)
                          (format t "-~s width > length")
                          (cond ((and (>= width value1) (>= width value2))
                                 (setq result passed))
                                 (t (setq *constraint-method* (append *constraint-method* (mop-specs (get *space-check-table*)
                                 (*space-for-use))))
                                 (setq result not-passed))))
      (t (format t "-~s width <= length")
      (cond ((and (> width value1) (> width value2))
               (setq result not-passed))
               (t (setq *constraint-method* (append *constraint-method* (mop-specs (get *space-check-table*
                                (*space-for-use))))
                                (setq result not-passed))))

;*** hall-check
;
(defun hall-check (space-for-use)
  (declare (special *example-mop*
                  *constraint-method*))
  (let ((group-name (car (get-group-number 'use space-for-use *example-mop*)))
         (space-org (role-filler 'room *example-mop*))
         (value2 (path-filler 'minimum value2) space-for-use))
    (passed 'passed))
(defun main-bed-room-space (pattern mop)
  (declare (ignore pattern mop))
  (ordinary-check 'i-m-main-bed-room))

(defun bathroom-space (pattern mop)
  (declare (ignore pattern mop))
  (ordinary-check 'i-m-bathroom))

(defun family-room-space (pattern mop)
  (declare (ignore pattern mop))
  (ordinary-check 'i-m-family-room))

(defun kitchen-space (pattern mop)
  (declare (ignore pattern mop))
  (ordinary-check 'i-m-kitchen))

(defun laundry-space (pattern mop)
  (declare (ignore pattern mop))
  (ordinary-check 'i-m-laundry))

(defun bed-room-space (pattern mop)
  (declare (ignore pattern mop))
  (ordinary-check 'i-m-bed-room))
;;; living-room-space
;;;
(defun living-room-space (pattern mop)
  (declare (ignore pattern mop))
  (ordinary-check 'i-m-living-room))

;;; hall-space
;;;
(defun hall-space (pattern mop)
  (declare (ignore pattern mop))
  (hall-check 'i-m-hall))

;;; entrance-hall-check
;;;
(defun entrance-hall-space (pattern mop)
  (declare (ignore pattern mop))
  (hall-check 'i-m-entrance-hall))

;;; eliminate-room
;;;
(defun eliminate-room (pattern mop)
  (declare (ignore pattern mop)
    (special *eliminate-room*
      *design-method* ))
  (setq *eliminate-room* (get-remove-gnum))
  (let ((room-list (mop-slots (role-filler 'room 'i-m-layout001)))
      (remove-gnum (car *eliminate-room*))
      (result nil))
    (setq *design-method* (append *design-method* (mop-specs 'eliminate-room)))
    (let ((new-room-list (dolist (room room-list result)
        (cond ((eq remove-gnum (car room)))
          (t (setq result (append result (cdr room))))))))
      (list->group new-room-list))))

;;; get-remove-gnum
;;;
(defun get-remove-gnum ()
  (declare (special *example-mop*))
  (let ((width1 (path-filler 'building-area width) 'i-m-layout001))
    (length1 (path-filler 'building-area length) 'i-m-layout001))
    (width2 (path-filler 'building-area width) *example-mop*)
    (length2 (path-filler 'building-area length) *example-mop*))
  (let ((areal (* width1 length1))
      (area2 (* width2 length2)))
    (let ((difference (~ areal area2))
      (result nil))
      (format t "~%layout area => ~s " areal)
      (format t "~%example area => ~s " area2)
      (format t "~%difference => ~s " difference)
    (dolist (room (get-space-no-need) result)
      (let ((gnum (car (get-group-number 'use room 'i-m-layout001))))
        (let ((width3 (eval `(path-filler '(room ,gnum width) 'i ~m-layout001))))
          (length3 (eval `(path-filler '(room ,gnum length) 'i ~m-layout001))))))
      (format t "~%room area => ~s" (* width3 length3))
      (cond ((> (* width3 length3) difference)
        (setq result (append result (list gnum))))))
(format t "~%Hey! Remove this => ~s" room)))

;;; get-space-no-need
;
(defun get-space-no-need ()
  (let ((space-organization (role-filler 'room 'i-m-layout001)))
    (let ((slot-list (mop-slots space-organization)))
      (let ((room-list (for (slot :in slot-list)
              :save (role-filler 'use (cadr slot)))))
        (result nil))
        (dolist (room room-list result)
         (cond ((eq (find room (mop-specs 'm-space-need)) nil)
                (setq result (append result (list room)))))))
  )))

;;; eliminate-orientation
;
(defun eliminate-orientation (pattern mop)
  (declare (ignore pattern mop)
    (special *eliminate-room*
     *design-method*)
    (let ((result nil))
      (setq *design-method* (append *design-method* (mop-specs 'eliminate-
         orientation)))
      (let ((space-name-list (dolist (room *eliminate-room* result)
          (let ((space-name (eval `'(path-filler `(room 
            ,room space-name) 'i-m-layout001))))
            (format t "~%Eliminate : ~s from orient
                ation" space-name)
            (setq result (append result (list space 
              ,-name))))))
        (let ((north (eliminate-news 'north space-name-list))
              (east (eliminate-news 'east space-name-list))
              (west (eliminate-news 'west space-name-list))
              (south (eliminate-news 'south space-name-list)))
          (eval `(slots->mop `((north ,north)
               (east ,east)
               (west ,west)
               (south ,south)) 'm-direction) t))
    )))

(defun eliminate-news (direction space-name-list)
  (declare (special *news-direction*)
    (let ((room-list (eval `(mop-slots (path-filler `(orientation ,direction) 'i-m-layout001))))
        (result1 nil)
        (news (get *news-direction* direction)))
      (dolist (space-name space-name-list result1)
        (let ((result2 nil))
          (dolist (room room-list result2)
            (cond ((eq space-name (cadr room)))
              (t (setq result2 (append result2 (cadr room))))))))
        (setq room-list result2)
        (setq result1 room-list))))

; #DEBUG# => (format t "~%~s" room-list)
  (cond ((null room-list) 'i-m-empty-group)
    (t (eval `(slots->mop ',(for (x :in room-list)
           (i :in (make-m-n 1 (length room-list))))
(defun width-length-check (direction worl)
  (declare (special *example-mop*
               *measure-width*
               *measure-length*))
  (let ((value (eval `(path-filler '(building-area ,worl) *example-mop*)))))
    (slots (mop-slots (eval `(path-filler '(orientation ,direction) *example-mop*)))))
  (passed 'passed)
  (not-passed 'not-passed)
  (result 0))
  (format t "~%Check => ~s of ~s" direction worl)
  (format t "~%~s" value)
  ; #DEBUG# => (format t "~%~s slots")
  (dolist (slot slots result)
    (let ((space-name (cadr slot)))
      (let ((gnum (car (get-group-number 'space-name space-name *example-mop*))))
        (setq result (+ result (eval `(path-filler '(room ,gnum ,worl)
               (l1) *example-mop*)))))))
    (format t "~%~s result")
    (cond ((eq worl 'width)
           (setq *measure-width* (append *measure-width* (list result)))
           (format t "~%~s" *measure-width*))
          (t
           (setq *measure-length* (append *measure-length* (list result)))
           (format t "~%~s" *measure-length*))
           (cond (> result value) not-passed)
          (t passed))))))
  (passed 'passed)
  (not-passed 'not-passed)
  (switch nil))
  (cond ((eq (width-length-check 'north 'width ) not-passed)
         (setq *constraint-method* (append *constraint-method* '(i-m-north-length)))
         (setq switch t)))
  (cond ((eq (width-length-check 'east 'length) not-passed)
         (setq *constraint-method* (append *constraint-method* '(i-m-east-length)))
         (setq switch t)))
  (cond ((eq (width-length-check 'south 'width ) not-passed)
         (setq *constraint-method* (append *constraint-method* '(i-m-south-length)))
         (setq switch t)))
  (cond ((eq (width-length-check 'west 'length) not-passed)
         (setq *constraint-method* (append *constraint-method* '(i-m-west-length)))
         (setq switch t)))
  (cond ((eq switch t) not-passed)
         (t passed)))))

;*** news-length
;
(defun news-length (pattern mop)
  (declare (ignore pattern mop)
            (special *constraint-method*
               *news-length*))
  (let ((passed 'passed)
        (not-passed 'not-passed)
        (switch nil))
    (cond ((eq (width-length-check 'north 'width ) not-passed)
           (setq *constraint-method* (append *constraint-method* '(i-m-north-length)))
           (setq switch t)))
    (cond ((eq (width-length-check 'east 'length) not-passed)
           (setq *constraint-method* (append *constraint-method* '(i-m-east-length)))
           (setq switch t)))
    (cond ((eq (width-length-check 'south 'width ) not-passed)
           (setq *constraint-method* (append *constraint-method* '(i-m-south-length)))
           (setq switch t)))
    (cond ((eq (width-length-check 'west 'length) not-passed)
           (setq *constraint-method* (append *constraint-method* '(i-m-west-length)))
           (setq switch t)))
    (cond ((eq switch t) not-passed)
           (t passed)))))

;*** demon : select-design-tech
;
(add-filler 'i-m-cite-difference 'difference 'if-added
'(select-design-tech !filler)

;*** give-land
;
(defun give-land (slot)
  (declare (special *example-mop*)
    (let ((building-area (slots->mop slot '(m-building-area) nil)))
      (let ((width (role-filler 'width building-area))
            (length (role-filler 'length building-area)))
        (format t "~%# < Building Area > #")
        (format t "~%# width => ~s #" width)
        (format t "~%# length => ~s #" length)
        (format t "~%# ~s")))
    (setf *example-mop* (eval `(slots->mop `((building-area ,building-area))
                              '(m-example)
                              nil)))))))

;****
;start-design
;***********************************************************************
;* date       * Oct. 25,1990
;* function   * starts from cite check step or gets previous design technology from case memory
;* argument   * none
;* design-tech : instance of design technology
;***********************************************************************
;
(defun start-design ()
  (declare (special *example-mop*  
                    *design-tech*)
    (setq *design-tech* (mop-absts (role-filler 'case-name (car (mop-specs 'm-case)))))
    (cond ((eq *design-tech* nil)
      (format t "~%# Now we gonna start designing from cite check step. +++")
            (get-filler 'before  (car (mop-specs 'm-cite-check)))
            (get-filler 'after   (car (mop-specs 'm-cite-check)))
            (get-filler 'difference (car (mop-specs 'm-cite-check)))
            (t
             (format t "~%# Now we gonna get previous design technique from case-memory
             Y. +++")
             (let ((design-tech (eval `(slots->mop `((example-name ,*example-mop*) ,*design-tech* nil))))
               (apply-design-tech design-tech))))))

;*** store-case
;
(defun store-case ()
  (declare (special *design-tech*
                    *cite-method*
                    *reason*
                    *example-mop*
                    *design-method*
                    *constraint-method*
                    *design-steps*)
    (format t "~%# Now we gonna store this case. +++")
    (let ((before (car (mop-specs 'm-layout)))
          (after  (car (mop-specs 'm-example)))
          (none  'i-m-none)
          (case-name (car (mop-specs (car *design-tech*)))))
      (result (which-case *example-mop*)
              (cite-method (list->group *cite-method*))
              (design-method (list->group *design-method*)))
(constraint-check (list->group *constraint-method*))
(print cite-method)
(print design-method)
(print constraint-check)
(setq *design-steps* (eval `(slots->mop ((cite-check ,cite-method)
          (design-change ,design-method)
          (constraint-check ,constraint-check)
          (m-design-steps) nil))))
(let ((reason (cond ((eq *reason* nil) 'none)
                   (t *reason*)))))
(print *design-steps*)
(print result)
(print reason)
(eval `(slots->mop ((case-name ,case-name)
          (result ,result)
          (reason ,reason)
          (before ,before)
          (after ,after)
          (steps ,*design-steps*)) (m-case) nil)))
(draw-layout) ;; draw layout output
(break "+++ after store case to memory +++")

;; which-case

(defun which-case (example)
  (let ((space-mop-list (mop-specs 'm-space-check)))
    (let ((space-list (for (mop :in space-mop-list)
                  :save (mop-specs mop)))
          (result nil)
          (not-passed nil)
          (success 'i-m-success)
          (failure 'i-m-failure))
      (let ((space-check-result (for (instance-list :in space-list)
                   :save (dolist (instance instance-list result)
                   (cond ((eq example (role-filler
                   (example-name instance))
                   (setq result (role-filler
                   (check instance))))
          (print space-check-result)
          (let ((result1 nil))
            (dolist (element space-check-result result1)
              (cond ((eq element 'not-passed)
                  (setq not-passed 't))
              (t)))))
      (cond ((eq not-passed nil)
        (format t "~%+++ This case stored as a good-case. +++")
        (t
          (format t "~%+++ This case stored as a bad-case. +++")
          failure)))))))

;******************************************************************************
; list-compress
;******************************************************************************

;* date   * Oct. 20,1990
;* function * returns the list without nil
;* argument * list
;* var     * result
;* input   => (nil nil a nil b nil c nil nil)
;* return  => (a b c)
;******************************************************************************
(defun list-compress (list)
  (let ((result nil))
    (dolist (element list result)
      (cond ((eq element nil)
               (t (setq result (append result (list element)))))))))

(defun remove-slot (slot mop)
  (erase-slot mop slot))

(defun select-repair-tech (pattern mop)
  (declare (ignore pattern mop))
  (special *explanation*)
  (format t "~%++ Let's get another technique. +++")
  (let ((condition (role-filler 'condition *explanation*)))
    (design-tech-list (mop-specs 'm-design-tech)
      (result1 nil))
    (dolist (design-tech design-tech-list result1)
      (let ((instance-list (mop-specs design-tech)
             (result2 nil))
        (dolist (instance instance-list result2)
          (cond ((eq condition (get-filler 'reason instance))
                 (setq result2 (append result2 (list instance))))
            (t)))))
    (setq result1 (append result1 result2)))
  result1))

(defvar *explanation* "")

(defun set-explanation ()
  (declare (special *constraint-method*
                   *design-tech* *explanation*)
    (cond ((eq *constraint-method* nil)
           (format t "~%++ no need to set explanation mop +++")
           (t (format t "~%++ explanation mop will be set +++")
                (let ((constraint (list->group *constraint-method*)))
     (let ((failure (slots->mop `(constraint ,constraint)
                      '(m-failure) t))
       (condition 'i-m-smaller/BA)
       (design-tech (car (mop-specs (car *design-tech*))))
       (let ((abst1 (car (mop-absts condition)))
            (abst2 (car (mop-absts design-tech)))
            (spec1 condition)
            (spec2 (car (reverse (mop-specs (car (mop-absts design-tech)))))))))))
  (cond ((eq *constraint-method* nil)
         (format t "~%++ no need to set explanation mop +++")
         (t (format t "~%++ explanation mop will be set +++")
              (let ((constraint (list->group *constraint-method*)))
             (let ((failure (slots->mop `(constraint ,constraint)
                              '(m-failure) t))
         (condition 'i-m-smaller/BA)
         (design-tech (car (mop-specs (car *design-tech*))))
         (let ((abst1 (car (mop-absts condition)))
              (abst2 (car (mop-absts design-tech)))
              (spec1 condition)
              (spec2 (car (reverse (mop-specs (car (mop-absts design-tech))))))))))))

(defvar *constraint-method* nil)

(defvar *explanation* "")

(defun set-explanation ()
  (declare (special *constraint-method*
                   *design-tech* *explanation*)
    (cond ((eq *constraint-method* nil)
           (format t "~%++ no need to set explanation mop +++")
           (t (format t "~%++ explanation mop will be set +++")
                (let ((constraint (list->group *constraint-method*)))
     (let ((failure (slots->mop `(constraint ,constraint)
                      '(m-failure) t))
       (condition 'i-m-smaller/BA)
       (design-tech (car (mop-specs (car *design-tech*))))
       (let ((abst1 (car (mop-absts condition)))
            (abst2 (car (mop-absts design-tech)))
            (spec1 condition)
            (spec2 (car (reverse (mop-specs (car (mop-absts design-tech)))))))))))))

(defvar *constraint-method* nil)

(defvar *explanation* "")

(defun set-explanation ()
  (declare (special *constraint-method*
                   *design-tech* *explanation*)
    (cond ((eq *constraint-method* nil)
           (format t "~%++ no need to set explanation mop +++")
           (t (format t "~%++ explanation mop will be set +++")
                (let ((constraint (list->group *constraint-method*)))
     (let ((failure (slots->mop `(constraint ,constraint)
                      '(m-failure) t))
       (condition 'i-m-smaller/BA)
       (design-tech (car (mop-specs (car *design-tech*))))
       (let ((abst1 (car (mop-absts condition)))
            (abst2 (car (mop-absts design-tech)))
            (spec1 condition)
            (spec2 (car (reverse (mop-specs (car (mop-absts design-tech)))))))))))))

(defvar *constraint-method* nil)
(let ((mapping (slots->mop (eval `(forms->slots '((g1 m- Parents

(map instance
$m,abst1) (spec ,spec1))

(map instance
$m,abst2) (spec ,spec2)))))

(group) t))

(print mapping)
(setq *explanation*
  (slots->mop `(failure ,failure)
  (condition ,condition)
  (design-tech ,design-tech)
  (mapping ,mapping)
  ,(m-explanation) t)))))

;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

applyRepair
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

;* date  * Oct. 25,1990
;* function * apply repair technology
;* argument * tech : repair technology name
;*     * building-area : example's building area value
;*     * mop-tech : abstract mop name of repair technology
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

(defun apply-repair (tech)
  (declare (special *example-mop*
    *design-tech*
    *design-method*))
  (let ((building-area (get-filler 'building-area *example-mop*)))
    (initial-values)
    (setq *design-tech* (mop-absts tech))
    (setq *example-mop* (eval `(slots->mop '((building-area ,building-area)
        (repair-tech ,tech))
        ,(m-example) nil)))
    (let ((mop-tech (mop-absts tech)))
      (let ((design-tech (eval `(slots->mop '((example-name ,*example-mop*)
        ',mop-tech t))))
        (print design-tech)
        (apply-design-tech design-tech))))

;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

get-repaired-solution
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

;* date  * Oct. 25,1990
;* function * searches repaired solution
;* argument * none
;*     * instance : instance of repair mop
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

(defun get-repaired-solution ()
  (declare (special *explanation*
    *repaired-instance*))
  (let ((instance (eval `(slots->mop '((explanation ,*explanation*) ' (m-repair) t))

(setq *repaired-instance* nil)
(setq *repaired-instance* instance)
(format t "~%*repaired-instance* => ~s" *repaired-instance*)
(and (get-filler 'repaired-solution instance) instance)))
(defun repaired-steps (repaired-tech)
  (apply-repair repaired-tech)
  (get-space-constraint)
  (store-case)
  (set-explanation))
(defun get-space-minimum (space-for-use)
  (let ((result nil))
    (dolist (gnum (get-group-number 'use space-for-use 'i-m-layout001) result)
      ; #DEBUG# => (format t "~-%s" gnum)
      (let ((value1 (path-filler '(minimum value1) space-for-use))
            (value2 (path-filler '(minimum value2) space-for-use))
            (space-name (eval `(path-filler '(room ,gnum space-name) 'i-m-layout001))))
        (work 0))
      (cond ((< value1 value2) (setq work value1)
                (setq value1 value2)
                (setq value2 work))))
    (format t "~-%s minimum 1 => ~s" space-for-use value1)
    (format t "~-%s minimum 2 => ~s" space-for-use value2)
    (let ((width (eval `(path-filler '(room ,gnum width) 'i-m-layout001))
              (length (eval `(path-filler '(room ,gnum length) 'i-m-layout001))
              (cond ((> width length)
                      (format t "~-%width > length")
                      (eval `(slots->mop '((space-name ,space-name)
                                           (north ,value1)
                                           (east ,value2)
                                           (south ,value1)
                                           (west ,value2)) (m-space-minimum) t))
                      (t (format t "~-%width <= length")
                         (eval `(slots->mop '((space-name ,space-name)
                                              (north ,value2)
                                              (east ,value1)
                                              (south ,value2)
                                              (west ,value1)) (m-space-minimum) t))
              (t))))))))
  (defun get-garage-minimum ()
    (let ((gnum (car (get-group-number 'use 'i-m-garage 'i-m-layout001))))
      (let ((width (eval `(path-filler '(room ,gnum width) 'i-m-layout001))
                (length (eval `(path-filler '(room ,gnum length) 'i-m-layout001))
                (space-name (eval `(path-filler '(room ,gnum space-name) 'i-m-layout001))
                (value1 nil)
                (value2 nil)
                (d-value1 (path-filler '(double value1) 'i-m-garage))
                (d-value2 (path-filler '(double value2) 'i-m-garage))
                (s-value1 (path-filler '(single value1) 'i-m-garage))
                (s-value2 (path-filler '(single value2) 'i-m-garage))
                (cond ((and (> width d-value1) (> width d-value2)
                            (> length d-value1) (> length d-value2))
                       (setq value1 d-value1) (setq value2 d-value2))
                       (t (setq value1 s-value1) (setq value2 s-value2))))
      (format t "~-%garage minimum 1 => ~s" value1)
      (format t "~-%garage minimum 2 => ~s" value2)
      (cond ((> width length)
              (format t "~-%width > length")
              (eval `(slots->mop '((space-name ,space-name)
                                   (north ,value1)
                                   (east ,value2)
                                   (south ,value1)
                                   (west ,value2)) (m-space-minimum) t))
              (t (format t "~-%width <= length")
                 (eval `(slots->mop '((space-name ,space-name)
                           (north ,value2)
                           (east ,value1)
                           (south ,value2)
                           (west ,value1)) (m-space-minimum) t))))
(north ,value2)
(east ,value1)
(south ,value2)
(west ,value1) ' (m-space-minimum) t))))  

();
(defun get-dining-minimum ()
  (let ((gnum (car (get-group-number 'use 'i-m-dining-room 'i-m-layout001))))
    (let ((value1 (path-filler '(minimum value1) 'i-m-dining-room))
        (value2 (+ 4.0 (eval `(path-filler `(room ,gnum no-of-people) 'i-m-layout001))))
        (space-name (eval `(path-filler `(room ,gnum space-name) 'i-m-layout001))))

      (work nil)
    (cond (< value1 value2)
          (setq work value1)
          (setq value1 value2)
          (setq value2 work ))

    (let ((width (eval `(path-filler `(room ,gnum width) 'i-m-layout001)))
        (length (eval `(path-filler `(room ,gnum length) 'i-m-layout001)))
        (format t `"%-dining-room minimum 1 => ~s" value1)
        (format t `"%-dining-room minimum 2 => ~s" value2)
        (cond (> width length)
              (format t `"%-width > length")
              (eval `(slots->mop '((space-name ,space-name)
                                   (north ,value1)
                                   (east ,value2)
                                   (south ,value1)
                                   (west ,value2)) ' (m-space-minimum) t))))

    (t
     (format t `"%-width <= length")
     (eval `(slots->mop '((space-name ,space-name)
                          (north ,value2)
                          (east ,value1)
                          (south ,value2)
                          (west ,value1)) ' (m-space-minimum) t)))))

();
(defun hall-minimum (space-for-use)
  (let ((gnum (car (get-group-number 'use space-for-use 'i-m-layout001))))
    (let ((space-name1 (eval `(path-filler `(room ,gnum space-name) 'i-m-layout001))
                    (space-name2 (path-filler `(minimum value1 space-name) space-for-use))
                    (direction (path-filler `(minimum value1 direction) space-for-use)))

      (let ((value1 (car (for (instance :in (mop-specs 'm-space-minimum)
                               :when (eq (role-filler 'space-name instance)
                                            space-name2)
                               :save (role-filler direction instance))))
            (value2 (path-filler `(minimum value2) space-for-use)))

        (let ((width (eval `(path-filler `(room ,gnum width) 'i-m-layout001)))
              (length (eval `(path-filler `(room ,gnum length) 'i-m-layout001))))

          (format t `"%-s minimum 1 => ~s" space-for-use value1)
          (format t `"%-s minimum 2 => ~s" space-for-use value2)
          (cond (> width length)
                (format t `"%-width > length")
                (eval `(slots->mop '((space-name ,space-name1)
                                     (north ,value1)
                                     (east ,value2)
                                     (south ,value1)
                                     (west ,value2)) ' (m-space-minimum) t))))

    (t)
(format t "~width <= length")
(eval `(slots->mop `((space-name ,space-name1)
 (north ,value2)
 (east ,value1)
 (south ,value2)
 (west ,value1))` )

(imum) t)))))))))))
(defun check-room-minimum ()
 (get-space-minimum 'i-m-main-bedroom)
 (get-space-minimum 'i-m-bath-room)
 (get-space-minimum 'i-m-family-room)
 (get-space-minimum 'i-m-kitchen)
 (get-space-minimum 'i-m-laundry)
 (get-space-minimum 'i-m-bed-room)
 (get-space-minimum 'i-m-living-room)
 (get-dining-minimum)
 (get-garage-minimum)
 (hall-minimum 'i-m-entrance-hall)
 (hall-minimum 'i-m-hall))

(defun calc-minimum-length (direction)
 (let ((room-list (eval `(mop-slots (path-filler `(orientation ,direction) 'i-m-lay
 $out001)))))
  (result nil))
 (dolist (room room-list result)
   (let ((space-name (cdr room)))
     (setq result
       (append result (for (instance :in (mop-specs 'm-space-minimu
 $m))
                     :when (eq (role-filler 'space-name
 $instance) space-name)
                     :save (role-filler direction instan
 $ce)))))
   result)))

(defun length-limit ()
 (declare (special *example-mop*
 *width-limit*
 *length-limit*))
 (let ((north-list (calc-minimum-length 'north))
   (east-list (calc-minimum-length 'east ))
   (south-list (calc-minimum-length 'south))
   (west-list (calc-minimum-length 'west )))
 (let ((north-length (list-plus north-list))
   (east-length (list-plus east-list))
   (south-length (list-plus south-list))
   (west-length (list-plus west-list))
   (format t "~%north-length => ~s" north-length)
   (format t "~%east-length => ~s" east-length)
   (format t "~%south-length => ~s" south-length)
   (format t "~%west-length => ~s" west-length)
   (let ((width1 (max north-length south-length))
     (length1 (max east-length west-length ))
     (width2 (path-filler `(building-area width) *example-mop*))
     (length2 (path-filler `(building-area length) *example-mop*))
     (format t "~%width -limit => ~s" width1)
     (format t "~%length-limit => ~s" length1)
     (cond ((< width2 width1)
       (format t "-%s" width1)
       (format t "-%s Stop! This Exceeds width minimum @")
       (format t "-%s Stop! This Exceeds length minimum @")
     )
     (cond ((< length2 length1)
       (format t "-%s" length1)
       (format t "-%s Stop! This Exceeds length minimum @")
       (format t "-%s Stop! This Exceeds width minimum @")
     ))
   ))
   (result nil))
 (dolist (room room-list result)
   (let ((space-name (cdr room)))
     (setq result
       (append result (for (instance :in (mop-specs 'm-space-minimu
 $m))
                     :when (eq (role-filler 'space-name
 $instance) space-name)
                     :save (role-filler direction instan
 $ce)))))
   result)))

(defun length-limit ()
 (declare (special *example-mop*
 *width-limit*
 *length-limit*))
 (let ((north-list (calc-minimum-length 'north))
   (east-list (calc-minimum-length 'east ))
   (south-list (calc-minimum-length 'south))
   (west-list (calc-minimum-length 'west )))
 (let ((north-length (list-plus north-list))
   (east-length (list-plus east-list))
   (south-length (list-plus south-list))
   (west-length (list-plus west-list))
   (format t "~%north-length => ~s" north-length)
   (format t "~%east-length => ~s" east-length)
   (format t "~%south-length => ~s" south-length)
   (format t "~%west-length => ~s" west-length)
   (let ((width1 (max north-length south-length))
     (length1 (max east-length west-length ))
     (width2 (path-filler `(building-area width) *example-mop*))
     (length2 (path-filler `(building-area length) *example-mop*))
     (format t "~%width -limit => ~s" width1)
     (format t "~%length-limit => ~s" length1)
     (cond ((< width2 width1)
       (format t "-%s" width1)
       (format t "-%s Stop! This Exceeds width minimum @")
       (format t "-%s Stop! This Exceeds length minimum @")
     )
     (cond ((< length2 length1)
       (format t "-%s" length1)
       (format t "-%s Stop! This Exceeds length minimum @")
       (format t "-%s Stop! This Exceeds width minimum @")
     ))
   ))
   (result nil))
 (dolist (room room-list result)
   (let ((space-name (cdr room)))
     (setq result
       (append result (for (instance :in (mop-specs 'm-space-minimu
 $m))
                     :when (eq (role-filler 'space-name
 $instance) space-name)
                     :save (role-filler direction instan
 $ce)))))
   result)))
(format t "%!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!!!!!!!!!\%!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(defun return-room-length (space-name direction)
  (declare (special *distance*))
  (let ((length (get-space-length space-name (return-worl direction)))
      (mini (car (get-minimum-length space-name direction)))
      (let ((differ (- length *distance*))
            (format t "~*S~s of ~S <minimum : ~S => ~S" direction space-name len2
gth mini differ)
         (cond ((>= differ mini)
                 (setq *distance* 0) differ)
               (t (setq *distance* (- *distance* (- length mini)) mini))))

(let ((space-name-list (for (element :in group-list)
                          :save (cdr element)))
      (result 0))
   (dolist (space-name space-name-list result)
    (setq result (+ result (car (get-minimum-length space-name (return-ne
gs worl)))))))

(let ((worl (role-filler 'equal (car (mop-absts mop))))
      (result 0))
   (space-name-list (for (element :in (mop-slots (role-filler 'argument1 mop)))
                     :save (cdr element)))
   (dolist (space-name space-name-list result)
    (setq result (+ result (get-space-length space-name worl)))))))

(let ((slots (mop-slots mop)))
  (let ((minimum (role-slot 'minimum slots))
        (current (role-slot 'current slots))
        (let ((argument-list (remove minimum slots))
              (setq argument-list (remove current argument-list)))
         (DEBUG# => (format t "~S" argument-list))
           (let ((mini-list (for (argument :in argument-list)
                               :save (calc-group-minimum (mop-slots (cadr argu
tent) worl))))
                  (format t "~*group-minimum => ~S" mini-list)
                (eval (append '(max) mini-list)))_weather
t

(let ((mini (get-group-minimum mop (role-filler 'equal (car (mop-absts mop))))))
  (add-filler mop 'minimum 'value mini)))

(let ((length (get-group-length mop)))
  (add-filler mop 'current 'value length)))

(let ((result1 nil))
  (let ((equal-worl (dolist (specs (mop-specs 'm-equal) result1)
                   (setq result1 (append result1 (mop-specs specs))))
         (result2 nil))
    (format t "~*group-current&minimum => ~S" equal-worl)
    (dolist (worl equal-worl result2)
     (let ((result3 nil))
      (dolist (mop (mop-specs worl) result3)
        (set-group-minimum mop)
        (set-group-length mop)))))))

;************************************************************************************
equal-group

;****************************************************************************
;* date             * Nov 6, 1990
;* function         * returns mop-name under m-equal which has space-name
;* argument         * space-name : name of space (ex. i-m-space101)
;*                 * mop : name of mop under m-equal (ex. i-m-equal-width.1)
;*****************************************************************************

(defun equal-group (space-name mop)
  (let ((argument-list (cdr (mop-slots mop))))
    (let ((result (for (argument :in argument-list)
                       :save (let ((group-list (mop-slots (cadr argument))))
                           (let ((space-name-list (for (element :in group-li
                                             :save (cadr  
                                             \$element)))))
                           (format t "~%equal-group => ~s" space-name- \$list)
                           (cond ((eq (member space-name space-name-li \$st) nil) nil)
                                 (t t))))))))
    (cond ((eq (member 't result) nil) nil)
          (t mop))))

;*****************************************************************************
; get-equal-group
;*****************************************************************************

(defun get-equal-group (space-name direction)
  (let ((worl (return-worl direction))
        (result nil))
    (format t "~%worl => ~s" worl)
    (cond ((eq worl 'width)
            (list-compress
             (dolist (mop (mop-specs 'm-equal-width) result)
               (setq result (append result (list (equal-group space-name mop \$p)))))))
         (t
          (list-compress
           (dolist (mop (mop-specs 'm-equal-length) result)
             (setq result (append result (list (equal-group space-name mop \$p))))))))))

;*****************************************************************************
;*** check-perimeter
;*****************************************************************************

(defun check-perimeter ()
  (let ((not-passed 'not-passed)
        (result nil))
    (cond ((eq (check-perimeter-fn 'north 'width ) not-passed)
           (setq result (append result ((i-m-north-length)))))
         (cond ((eq (check-perimeter-fn 'east 'length) not-passed)
                (setq result (append result ((i-m-east-length)))))
         (cond ((eq (check-perimeter-fn 'south 'width ) not-passed)
                (setq result (append result ((i-m-south-length)))))
         (cond ((eq (check-perimeter-fn 'west 'length) not-passed)
                (setq result (append result ((i-m-west-length)))))
             (result))
;;; check-perimeter-fn

(defun check-perimeter-fn (direction worl)
  (declare (special *example-mop*))
  (let ((value (eval `(path-filler `(building-area ,worl) *example-mop*)))))
    (slots (mop-slots (eval `(path-filler `(orientation ,direction) 'i-m-layout001) ))
    ))
      (passed 'passed)
    (not-passed 'not-passed)
  (result 0))
  (format t "~%Check => ~s of ~s" direction worl)
  (format t "~%~s" value)

; #DEBUG# => (format t "~%~s slots")
(dolist (slot slots result)

  (let ((space-name (cadr slot)))

    (let ((gnum (car (get-group-number 'space-name space-name 'i-m-layout001))))

      (setq result (+ result (eval `(path-filler `(room ,gnum ,worl)

          '(i-m-layout001))))))
    (format t "~%~s" result)
    (cond ((> result value) not-passed)

    (t passed))))

(defun get-conflict-direction ()
  (declare (special *compass*

    *direction*))
  (setq *direction* nil)
  (let ((constraints (check-perimeter)))
    (format t "~%get-conflict-direction : ~s" constraints)
    (for (constraint :in constraints)

      :save (let ((direction (get *compass* constraint)))

      (setq *direction* (append *direction* (list dir

        section)))

    (format t "~%Conflict direction => ~s" direction

  n))

  (cond ((or (eq direction 'north) (eq direction 

  'south))

    (set-distance direction 'width)

    (mapcar #'mop-specs (mop-specs 'm-equal-

          width))))

    (t

    (set-distance direction 'length)

    (mapcar #'mop-specs (mop-specs 'm-equal-

          length)))))

(defun set-distance (direction worl)
  (declare (special *example-mop*

    *distance*

    *distance-queue*))
  (let ((value (eval `(path-filler `(building-area ,worl) *example-mop*)))))
    (slots (mop-slots (eval `(path-filler `(orientation ,direction) 'i-m-layout001) ))

    ))
      (result 0))
    (format t "~%Check => ~s of ~s" direction worl)
    (format t "~%~s" value)

; #DEBUG# => (format t "~%~s slots")
(dolist (slot slots result)

  (let ((space-name (cadr slot)))

    (let ((gnum (car (get-group-number 'space-name space-name 'i-m-layout001))))

      (setq result (+ result (eval `(path-filler `(room ,gnum ,worl)

          '(i-m-layout001))))))

    (setq result (+ result (eval `(path-filler `(room ,gnum ,worl)

          '(i-m-layout001))))))
(let ((dist (- result value)))
  (setq *distance* dist)
  (setq *distance-queue* (append *distance-queue* (list dist)))))

(defun partial-shrink-rooms (pattern mop)
  (declare (ignore pattern mop)
    (special *direction*
      *design-method*
      *distance*
      *distance-queue*
      *new-room-list*)
  (setq *design-method* (append *design-method* (mop-specs 'partial-shrink-rooms)))
  (check-room-minimum)
  (length-limit)
  (group-current&minimum)
  (setq *new-room-list* (mop-slots (role-filler 'room 'i-m-layout001)))
  (let ((conflict-direction (get-conflict-direction))
    (result1 *direction*)
    (dolist (conflict-list conflict-direction result1)
      (format t "~%*distance-queue* => ~s" *distance-queue*)
      (format t "~%conflict-list => ~s" conflict-list)
    (let ((result2 nil))
      (dolist (mop-list conflict-list result2)
        (let ((direction (car result1)))
          (setq *distance* (car *distance-queue*)
            (format t "~%partial-shrink direction => ~s" direction))
        (on)
          (cond ((or (eq direction 'north) (eq direction 'south))
            (shrink-equal-group mop-list 'width))
          (t (shrink-equal-group mop-list 'length)))))
      (setq result1 (cdr result1))
      (setq *distance-queue* (cdr *distance-queue*)))
    (let ((room-list (for (element :in *new-room-list*)
          :save (cdr element)))
      (format t "~%new-room-list => ~s" room-list)
      (list->group room-list)))
  )

(defun shrink-equal-group (mop-list worl)
  (declare (special *distance*
    *alpha*))
  (format t "~%mop-list => ~s" mop-list)
  (for (mop :in mop-list)
    :when (> *distance* 0)
    :do (let ((value (- (role-filler 'current mop) (role-filler 'minimum mop)))
      (cond ((>= value -1) (setq *alpha* *distance*)
        (t (setq *alpha* value))))
      (format t "~%distance* => ~s" *distance*)
      (format t "~%value => ~s" value)
      (format t "~%alpha* => ~s" *alpha*)
      (setq *distance* (- *distance* *alpha*)
      (result nil)
      (slots (mop-slots mop)))
    (let ((minimum (role-slot 'minimum slots))
      (current (role-slot 'current slots)))
      (let ((argument-list (remove minimum slots)))
        ))))
(format t "-%argument-list => ~s" argument-list)
(setq argument-list (remove current argument-list))
(dolist (argument argument-list result)
  (format t "-%s ~s       => ~s"
    (space-name-list (mop-slots (car argument-list)) (cdr argument-list))))
(let ((space-name-list (mop-slots (car argument-list)) (cdr argument-list))))
(format t "-%s" space-name-list)
(shrink-partial-room space-name-list)

(defun shrink-partial-room (space-name-list shrink-value worl)
  (declare (special *shrinked-room-list*))
  (let ((alpha shrink-value))
    (for (slot :in space-name-list)
      :when (> alpha 0)
      :do (let ((space-name (cadr slot)))
        (let ((mini (cond ((eq worl 'width)
            (car (get-minimum-length space-name))
              (t (car (get-minimum-length space-name))))
            (beta 0)
            (length (get-space-length space-name worl))
            (let ((value (- length mini)))
              (cond ((> value alpha)
                (setq beta alpha))
                (t
                (setq beta value))))
            (format t "-%s shrink-partial-room ~s beta = ~s" space-name beta)
            (cond ((eq beta 0))
              (t (setq *shrinked-room-list* (append *new-room-list* (cdr element))))
              (let ((new-length (- length beta)))
                (create-shrinked-room-space-name worl)
                (format t "-%s shrinked-room-list => ~s" *shrinked-room-list*
                  (setq alpha (- alpha beta))
                  (let ((new-length (- length beta)))
                    (create-shrinked-room-space-name worl)
                    (format t "-%s shrinked-room-list => ~s" *shrinked-room-list* result)
                    (cond ((eq space-name (role-filler 'space-name (cadr element)))
                      (setq result (car element))))))))))))
(defun create-shrinked-room (space-name worl new-length)
  (declare (special *example-mop* *new-room-list*)
    (let ((result nil))
      (let ((gnum (dolist (element *new-room-list* result)
        (cond ((eq space-name (role-filler 'space-name (cadr element)))
          (setq result (car element))))))))
    (format t "-%gnum => ~s" gnum)
    (let ((width (role-slot gnum *new-room-list*)))
      (format t "-%old width => ~s" width)
      (format t "-%old length => ~s" length)
      (setq gnum width gnum length)
      (setq alpha (- alpha beta))
      (let ((new-length (- length beta)))
        (create-shrinked-room-space-name worl)
        (format t "-%s shrinked-room-list => ~s" *shrinked-room-list* result)
        (cond ((eq space-name (role-filler 'space-name (cadr element)))
          (setq result (car element))))))))
; #DEBUG# => (format t "-%gnum => ~s" gnum)
(let ((width (role-slot gnum *new-room-list*))
      (length (role-slot gnum *new-room-list*))
      (use (role-slot gnum *new-room-list*))
      (mop (role-slot gnum *new-room-list*))
      (format t "-%old width => ~s" width)
      (format t "-%old length => ~s" length)
      (setq gnum width gnum length)
      (setq alpha (- alpha beta))
      (let ((new-length (- length beta)))
        (create-shrinked-room-space-name worl)
        (format t "-%s shrinked-room-list => ~s" *shrinked-room-list* result)
        (cond ((eq space-name (role-filler 'space-name (cadr element)))
          (setq result (car element))))))
(if (eq worl 'width)
  (setq width new-length)
  (setq length new-length))
(format t "~%new width => ~s" width)
(format t "~%new length => ~s" length)
(let ((new-room (eval `(,(space-name ,space-name ,)
  width ,width)
(length ,length)
(use ,use))
',mop t)))
(result nil))
(format t "~%new-room => ~s" new-room)
(setq *new-room-list*
  (dolist (room *new-room-list* result)
    (cond ((eq gnum (car room))
      (setq result (append result (list (list gn ,
  t
  (setq result (append result (list room))))))
(format t "~%new-room)))))

(/))

(defun example-layout001 ()
  (declare (special *example-mop*
  *repaired-instance*))

;; stage 1
;;
;; (format t "~%step 1> sets building-area example 1 << width and length >>")
;;
;; (initial-values)
;;
;; (setq *example-mop* 'i-m-layout001)
;;
;; (news-length 'dummy-argument1 'dummy-argument2)
;;
;; ;; This function is necessary for
;; ;; *measure-length* and *measure-length*
;; ;;
;; (draw-layout)
;;
;; ;; Draws i-m-lyout001 layout gra
;;
;; (give-land '((width 76.0) (length 25.0)))
;;
;; (format t "~%step 2> starts design procedures")
;;
;; (start-design)
;;
;; (format t "~%step 3> checks space constraints")
;;
;; (get-space-constraint)
;;
;; (format t "~%step 4> stores this case to case memory")
;;
;; (store-case)
;;; stage 2

(format t "~%*** <step 5> sets building-area example 2 << width and length >>")
(initial-values)
(give-land '((width 72.2) (length 25.0)))
(format t "~%*** <step 6> gets previous design technique from case memory")
(start-design)
(format t "~%*** <step 7> checks space constraints")
(get-space-constraint)
(format t "~%*** <step 8> stores this case to case memory")
(store-case)
(format t "~%*** <step 9> sets explanation mop instance")
(set-explanation)
(format t "~%*** <step 10> searches repaired solutions")
(get-repaired-solution)

==> return (i-m-shrink i-m-eliminate) under m-repair
(format t "~%***<step 11> applies repair procedures")
(mapcar #'repaired-steps (role-filler 'repaired-solution *repaired-instance*))

;;; stage 3

(format t "~%*** <step 12> sets building-area example 3 << width and length >>")
(initial-values)
(give-land '((width 65.0) (length 24.0)))
(format t "~%*** <step 13> gets previous design technique from case memory")
(start-design)
(format t "~%*** <step 14> checks space constraints")
(get-space-constraint)
(format t "~%*** <step 15> stores this case to case memory")
(store-case)

CBRE.Floor.Output.Defmop
(defmop rect107 (m-room-rectangle) ;; rect107 - data for graphics -
  (top-lx nil)
  (top-ly nil)
  (btm-rx nil)
  (btm-ry nil)
  (width nil)
  (length nil))

(defmop rect108 (m-room-rectangle) ;; rect108 - data for graphics -
  (top-lx nil)
  (top-ly nil)
  (btm-rx nil)
  (btm-ry nil)
  (width nil)
  (length nil))

(defmop rect109 (m-room-rectangle) ;; rect109 - data for graphics -
  (top-lx nil)
  (top-ly nil)
  (btm-rx nil)
  (btm-ry nil)
  (width nil)
  (length nil))

(defmop rect110 (m-room-rectangle) ;; rect110 - data for graphics -
  (top-lx nil)
  (top-ly nil)
  (btm-rx nil)
  (btm-ry nil)
  (width nil)
  (length nil))

(defmop rect111 (m-room-rectangle) ;; rect111 - data for graphics -
  (top-lx nil)
  (top-ly nil)
  (btm-rx nil)
  (btm-ry nil)
  (width nil)
  (length nil))

(defmop rect112 (m-room-rectangle) ;; rect112 - data for graphics -
  (top-lx nil)
  (top-ly nil)
  (btm-rx nil)
  (btm-ry nil)
  (width nil)
  (length nil))

(defmop rect113 (m-room-rectangle) ;; rect113 - data for graphics -
  (top-lx nil)
  (top-ly nil)
  (btm-rx nil)
  (btm-ry nil)
  (width nil)
  (length nil))

(defmop m-rectangle (m-root) mop)
(defmop top-lx (m-rectangle) instance) ;; x coordinate for top left corner
(defmop top-ly (m-rectangle) instance) ;; y coordinate for top right corner
(defmop btm-rx (m-rectangle) instance) ;; x coordinate for top left corner
(defmop btm-ry (m-rectangle) instance) ;; y coordinate for top right corner

; (defmop m-coordinate (m-root) (space-name nil) (coordinate nil)) ;; name of space
; one of top-lx, top-ly, top-rx, an...

(defvar top-ry)
;(defmop m-coord-equal (m-root) (argument1 nil) (length 0)) ;; MOPs for equal coordinate value
; names of space and coordinate
; length of side

;(defmop i-m-coord-equal.1 (m-coord-equal) (argument1 m-coordinate (space-name i-m-space101) (coordinate top-lx)) (argument2 m-coordinate (space-name i-m-space108) (coordinate top-lx)) (length 0)) ;; = top-lx of i-m-space101

;(defmop i-m-coord-equal.2 (m-coord-equal) (argument1 m-coordinate (space-name i-m-space102) (coordinate top-lx)) (argument2 m-coordinate (space-name i-m-space103) (coordinate top-lx)) (argument3 m-coordinate (space-name i-m-space101) (coordinate btm-rx)) (length 0)) ;; = top-lx of i-m-space102

;(defmop i-m-coord-equal.3 (m-coord-equal) (argument1 m-coordinate (space-name i-m-space104) (coordinate top-lx)) (argument2 m-coordinate (space-name i-m-space102) (coordinate btm-rx)) (argument3 m-coordinate (space-name i-m-space103) (coordinate btm-rx)) (argument4 m-coordinate (space-name i-m-space111) (coordinate top-lx)) (argument5 m-coordinate (space-name i-m-space109) (coordinate btm-rx)) (argument6 m-coordinate (space-name i-m-space110) (coordinate btm-rx)) (length 0)) ;; = btm-rx of i-m-space104

;(defmop i-m-coord-equal.4 (m-coord-equal) (argument1 m-coordinate (space-name i-m-space105) (coordinate top-lx)) (argument2 m-coordinate (space-name i-m-space104) (coordinate btm-rx)) (length 0)) ;; = top-lx of i-m-space105
; = btm-rx of i-m-space104
(defmop i-m-coord-equal.5 (m-coord-equal)
  (argument1 m-coordinate
    (space-name i-m-space106)
    (coordinate top-lx))
  (argument2 m-coordinate
    (space-name i-m-space105)
    (coordinate btm-rx)))

; (defmop i-m-coord-equal.6 (m-coord-equal)
  (argument1 m-coordinate
    (space-name i-m-space107)
    (coordinate top-lx))
  (argument2 m-coordinate
    (space-name i-m-space106)
    (coordinate btm-rx))
  (argument3 m-coordinate
    (space-name i-m-space113)
    (coordinate btm-rx)))

; (defmop i-m-coord-equal.7 (m-coord-equal)
  (argument1 m-coordinate
    (space-name i-m-space109)
    (coordinate top-lx))
  (argument2 m-coordinate
    (space-name i-m-space110)
    (coordinate top-lx))
  (argument3 m-coordinate
    (space-name i-m-space108)
    (coordinate btm-rx)))

; (defmop i-m-coord-equal.8 (m-coord-equal)
  (argument1 m-coordinate
    (space-name i-m-space112)
    (coordinate top-lx))
  (argument2 m-coordinate
    (space-name i-m-space111)
    (coordinate btm-rx)))

; (defmop i-m-coord-equal.9 (m-coord-equal)
  (argument1 m-coordinate
    (space-name i-m-space113)
    (coordinate top-lx))
  (argument2 m-coordinate
    (space-name i-m-space12)
    (coordinate btm-rx)))

; (defmop i-m-coord-equal.10 (m-coord-equal)
  (argument1 m-coordinate
    (space-name i-m-space101)
    (coordinate top-ly))
  (argument2 m-coordinate
    (space-name i-m-space102)
    (coordinate top-ly))
  (argument3 m-coordinate
    (space-name i-m-space104)
    (coordinate top-ly))
  (argument4 m-coordinate
    (space-name i-m-space105)
    (coordinate top-ly))

;; = top-ly of i-m-space101
;; = top-ly of i-m-space102
;; = top-ly of i-m-space104
;; = top-ly of i-m-space105

(coordinate top-ly))
  (argument5 m-coordinate
   (space-name i-m-space106)
   (coordinate top-ly))
;; = top-ly of i-m-space106

;; = top-ly of i-m-space107

;; = top-ly of i-m-space103

;; = btm-ry of i-m-space102

;; = top-ly of i-m-space110

;; = top-ly of i-m-space103

;; = btm-ry of i-m-space103

;; = top-ly of i-m-space111

;; = top-ly of i-m-space112

;; = btm-ry of i-m-space104

;; = btm-ry of i-m-space104

;; = top-ly of i-m-space113

;; = btm-ry of i-m-space105

;; = btm-ry of i-m-space106

;; = btm-ry of i-m-space106

;; = top-ly of i-m-space109

;; = btm-ry of i-m-space110

;; = btm-ry of i-m-space108
(coordinate btm-ry))
(argument2 m-coordinate
  (space-name i-m-space109)
  (coordinate btm-ry)) ;; = btm-ry of i-m-space109
(argument3 m-coordinate
  (space-name i-m-space111)
  (coordinate btm-ry)) ;; = btm-ry of i-m-space111
(argument4 m-coordinate
  (space-name i-m-space112)
  (coordinate btm-ry)) ;; = btm-ry of i-m-space112
(argument5 m-coordinate
  (space-name i-m-space113)
  (coordinate btm-ry)) ;; = btm-ry of i-m-space113
(argument6 m-coordinate
  (space-name i-m-space107)
  (coordinate btm-ry)) ;; = btm-ry of i-m-space107
(length 0))
CBRE.Floor.Output.Defun
(defrecord RGBColor
  (red :integer)
  (green :integer)
  (blue :integer))

(defrecord ColorSpec
  (value :integer)
  (rgb :RGBColor))

(defrecord (ColorTable :handle)
  (ctSeed :longint)
  (transIndex :integer)
  (ctSize :integer)
  (ctTable :colorSpec))

(defrecord (Pixmap :handle)
  (baseAddr :pointer)
  (rowBytes :integer)
  (bounds :rect)
  (kerVersion :integer)
  (packType :integer)
  (packSize :longint)
  (hRes :longint)
  (vRes :longint)
  (pixelType :integer)
  (pixelSize :integer)
  (cmpCount :integer)
  (cmpSize :integer)
  (planeBytes :longint)
  (Table :handle)
  (Reserved :longint))

(defrecord (PixPat :handle)
  (patType :integer)
  (patMap :handle)
  (patData :handle)
  (patXData :handle)
  (patXValid :integer)
  (patXMap :handle)
  (pat1Data :pattern))

(defrecord CGrafPort
  (device :integer)
  (portPixmap :handle)
  (portVersion :integer)
  (grafVars :handle)
  (chExtra :integer)
  (plLocHFrac :integer)
  (portRect :rect)
  (visRgn (region :handle))
  (clipRgn (region :handle))
  (bkPixPat :handle)
  (rgbFgColor :RGBColor)
  (rgbBkColor :RGBColor)
(defrecord (GrafDevice :handle)
  (RefNum :integer)
  (ID :integer)
  (Type :integer)
  (ITable :handle)
  (ResPref :integer)
  (SearchProc :pointer)
  (CompProc :pointer)
  (Flags :integer)
  (PMap :handle)
  (RefCon :longint)
  (NextGD :handle)
  (Rect :rect)
  (Mode :longint)
  (CCBytes :integer)
  (CCDepth :integer)
  (CCXData :handle)
  (CCXMask :handle)
  (Reserved :longint))

(defrecord (CCrsr :handle)
  (Type :integer)
  (Map (:PixMap :handle))
  (Data :handle)
  (XData :handle)
  (XValid :integer)
  (XHandle :handle)
  (IData :bits16)
  (Mask :bits16)
  (HotSpot :point)
  (XTable :longint)
  (ID :longint))

(defrecord (CIcon :handle)
  (PMap :PixMap)
  (Mask :BitMap)
  (BMap :BitMap)
  (Data :handle)
  (MaskData :integer))

(defobject *color-window* *window*)

(defobfun (color-window-p *window*) ()
(setf (get *room-rectangle* 'i-m-spacell2) 'rect112)
(setf (get *room-rectangle* 'i-m-spacell3) 'rect113)

(setf (get *room-rectangle* 'rect101) 'i-m-space101) ;; rectxxx => i-m-spacexxx
(setf (get *room-rectangle* 'rect102) 'i-m-space102)
(setf (get *room-rectangle* 'rect103) 'i-m-space103)
(setf (get *room-rectangle* 'rect104) 'i-m-space104)
(setf (get *room-rectangle* 'rect105) 'i-m-space105)
(setf (get *room-rectangle* 'rect106) 'i-m-space106)
(setf (get *room-rectangle* 'rect107) 'i-m-space107)
(setf (get *room-rectangle* 'rect108) 'i-m-space108)
(setf (get *room-rectangle* 'rect109) 'i-m-space109)
(setf (get *room-rectangle* 'rect110) 'i-m-space110)
(setf (get *room-rectangle* 'rect111) 'i-m-space111)
(setf (get *room-rectangle* 'rect112) 'i-m-space112)
(setf (get *room-rectangle* 'rect113) 'i-m-space113)

;****************************************************************************************
; open-output-window
;****************************************************************************************
(* date   * Nov 10,1990
(* function * define output graphic window parameters
(* argument * none
(* var     * none
;****************************************************************************************

(defun open-output-window ()
  (declare (special *output-graph*))
  (setf *output-graph* (oneof *color-window*
    :window-position #(200 40)
    :window-size  #(400 400)
    :window-font  "courier"
    :window-type  :tool
    :window-title "Output Window"))

;****************************************************************************************
; get-coord-equal
;****************************************************************************************
(* date   * Nov 10,1990
(* function * return the name of the space < ex. i-m-space101 >
(* argument * space-name  : the name of the space < ex. i-m-space101 >
(* argument * lx-ly  : one of top-lx, top-ly, btm-rx, and btm-ry
;****************************************************************************************

(defun get-coord-equal (space-name lx-ly)
  (let (((coord-equal-list (mop-specs 'm-coord-equal))
        (result1 nil))
        (dolist (coord-equal coord-equal-list result1)
          (let ((argument-list (reverse (cdr (reverse (mop-slots coord-equal)))))
            (result2 nil))
            (dolist (argument-list result2)
              (let ((arg (car argument)))
                (cond ((eq (eval `(path-filler '(*arg space-name)
                      `(coordinate) '(coord-equal)) lx-ly)
                  (cond ((eq (eval `(path-filler '(*arg coord-equal)) lx-ly)
                      (setq result1 coord-equal))))))))
          )
        (cond ((eq (eval `(path-filler '(*arg coord-equal)) lx-ly)
            (setq result1 coord-equal)))))
        )
      )))

;****************************************************************************************

; calc-btm-rx
;*****************************************************************************
;* date    Nov 10, 1990
;* function calculates x-coordinate of bottom right corner of the rectangle
;* argument rect-name  : the name of the rectangle < ex. rect101 >
;*        top-lx  : x-coordinate of the top left corner of the rectangle
;*****************************************************************************
(defun calc-btm-rx (rect-name top-lx)
  (declare (special *room-rectangle* *multiplier*))
  ; #DEBUG# => (format t "~%---- calc-btm-rx ----")
  ; #DEBUG# => (format t "~% ~s top-lx : ~s width : ~s" rect-name top-lx (car (get-values $rect-name 'width)))
  (let ((space-name (get *room-rectangle* rect-name)))
    (let ((coord-equal (get-coord-equal space-name 'btm-rx))
          (width (car (get-values rect-name 'width))))
      ; #DEBUG# => (format t "~%coord-equal : ~s " coord-equal)
      (cond ((eq coord-equal nil)
               (replace-value rect-name 'btm-rx
                (round (+ top-lx (* *multiplier* width))))
             (t
              (cond ((eq (role-filler 'length coord-equal) 0)
                     (cond ((eq width nil)
                                (replace-value rect-name 'btm-rx nil))
                           (t
                            (replace-value rect-name 'btm-rx
                             (round (+ top-lx (* *multiplier* width))))
                             :demons t))))
             (t
              (replace-value rect-name 'btm-rx
               (round (role-filler 'length coord-equal)))))))
  )
;*****************************************************************************
;  calc-btm-ry
;*****************************************************************************
(defun calc-btm-ry (rect-name top-ly)
  (declare (special *room-rectangle* *multiplier*))
  ; #DEBUG# => (format t "~%---- calc-btm-ry ----")
  ; #DEBUG# => (format t "~% ~s top-ly : ~s length : ~s" rect-name top-ly (car (get-values $rect-name 'length)))
  (let ((space-name (get *room-rectangle* rect-name)))
    (let ((coord-equal (get-coord-equal space-name 'btm-ry))
          (length (car (get-values rect-name 'length))))
      ; #DEBUG# => (format t "~%coord-equal : ~s " coord-equal)
      (cond ((eq coord-equal nil)
               (replace-value rect-name 'btm-ry
                (round (+ top-ly (* *multiplier* length))))
             (t
              (cond ((eq (role-filler 'length coord-equal) 0)
                     (cond ((eq length nil)
                                (replace-value rect-name 'btm-ry nil))
                           (t
                            (replace-value rect-name 'btm-ry
                             (round (+ top-ly (* *multiplier* length))))
                             :demons t))))
             (t
              (replace-value rect-name 'btm-ry
               (round (role-filler 'length coord-equal))))))
  )
(replace-value rect-name 'btm-ry
  (round (role-filler 'length coord-equal)))))
)

;*********************************************************************************************************************************
; set-coord-equal
;*********************************************************************************************************************************

;* date * Nov 10,1990
;* function * sets the coordinate value of bottom right corner of the rectangle
;* argument * rect-name : the name of the rectangle < ex. rect101 >
;* * rx-ry : one of btm-rx or btm-ry
;* * value : the value of the coordinate
;*********************************************************************************************************************************

(defun set-coord-equal (rect-name rx-ry value)
  (declare (special *room-rectangle* *multiplier*))
  "#
  ;DEBUG# => (format t "~S--- set-coord-equal ---"
  ;DEBUG# => (format t "~S ~S : ~S : ~S" rect-name rx-ry value)
  (let ((space-name (get *room-rectangle* rect-name)))
    (let ((coord-equal (get-coord-equal space-name rx-ry)))
      (cond ((eq (car (get-values coord-equal 'length)) 0)
             (replace-value coord-equal 'length value :demonst t)))
      (cond ((eq rx-ry 'btm-ry)
             (cond ((eq (car (get-values rect-name 'top-ly)) nil)
                    (let ((coord-equal1 (get-coord-equal space-name 'top-lx))
                         (width (car (get-values rect-name 'width)))
                         (cond ((eq width nil)
                                (t
                                 (cond ((eq (car (get-values coord-equal1 'le
                        (length (car (get-values rect-name 'length)))
                        (cond ((eq length nil)
                            (t
                             (cond ((eq (car (get-values coord-equal2 'le
                               (ngth)) 0)
                            ; DEBUG# => (format t "~S replace : ~S coord-equal1"
                               (replace-value coord-equal1 'length
                                (round (~ value (* multiplier* width
g                               (dth))))
                              (cond ((eq rx-ry 'btm-ry)
                                      (cond ((eq (car (get-values rect-name 'top-ly)) nil)
                                             (let ((coord-equal2 (get-coord-equal space-name 'top-ly))
                                                      (length (car (get-values rect-name 'length)))
                                                            (cond ((eq length nil)
                                                  (t
                                                      (cond ((eq (car (get-values coord-equal2 'le
                                                                             (ngth)) 0)
                                                  ; DEBUG# => (format t "~S replace : ~S coord-equal2"
                                                    (replace-value coord-equal2 'length
                                                     (round (~ value (* multiplier* length
g                                                   (ngth))))
                           
)

;**********************************************************************************************************************************
; demons
;**********************************************************************************************************************************

;* date * Nov 10,1990
;* function * sets x-coordinate value of bottom right corner of the rectangle
;* * when x-coordinate value of top left corner was set
;* argument * !frame : current frame name = the name of the rectangle
;* * !filler : current filler = x-coordinate value of
top left corner
;**********************************************************************************************************************************

(add-filler 'rect101 'top-lx 'if-added ;; for rect101
'(calc-btm-rx !frame !filler))
(add-filler 'rect101 'top-ly 'if-added
  '(calc-btm-ry !frame !filler))
(add-filler 'rect101 'btm-ry 'if-added
  '(set-coord-equal !frame !slot !filler))
(add-filler 'rect101 'btm-ry 'if-added
  '(set-coord-equal !frame !slot !filler))

; (add-filler 'rect102 'top-lx 'if-added
  '(calc-btm-rx !frame !filler))
(add-filler 'rect102 'top-ly 'if-added
  '(calc-btm-ry !frame !filler))
(add-filler 'rect102 'btm-ry 'if-added
  '(set-coord-equal !frame !slot !filler))
(add-filler 'rect102 'btm-ry 'if-added
  '(set-coord-equal !frame !slot !filler))

; (add-filler 'rect103 'top-lx 'if-added
  '(calc-btm-rx !frame !filler))
(add-filler 'rect103 'top-ly 'if-added
  '(calc-btm-ry !frame !filler))
(add-filler 'rect103 'btm-ry 'if-added
  '(set-coord-equal !frame !slot !filler))
(add-filler 'rect103 'btm-ry 'if-added
  '(set-coord-equal !frame !slot !filler))

; (add-filler 'rect104 'top-lx 'if-added
  '(calc-btm-rx !frame !filler))
(add-filler 'rect104 'top-ly 'if-added
  '(calc-btm-ry !frame !filler))
(add-filler 'rect104 'btm-ry 'if-added
  '(set-coord-equal !frame !slot !filler))
(add-filler 'rect104 'btm-ry 'if-added
  '(set-coord-equal !frame !slot !filler))

; (add-filler 'rect105 'top-lx 'if-added
  '(calc-btm-rx !frame !filler))
(add-filler 'rect105 'top-ly 'if-added
  '(calc-btm-ry !frame !filler))
(add-filler 'rect105 'btm-ry 'if-added
  '(set-coord-equal !frame !slot !filler))
(add-filler 'rect105 'btm-ry 'if-added
  '(set-coord-equal !frame !slot !filler))

; (add-filler 'rect106 'top-lx 'if-added
  '(calc-btm-rx !frame !filler))
(add-filler 'rect106 'top-ly 'if-added
  '(calc-btm-ry !frame !filler))
(add-filler 'rect106 'btm-ry 'if-added
  '(set-coord-equal !frame !slot !filler))
(add-filler 'rect106 'btm-ry 'if-added
  '(set-coord-equal !frame !slot !filler))

; (add-filler 'rect107 'top-lx 'if-added
  '(calc-btm-rx !frame !filler))
(add-filler 'rect107 'top-ly 'if-added
  '(calc-btm-ry !frame !filler))
(add-filler 'rect107 'btm-ry 'if-added
  '(set-coord-equal !frame !slot !filler))
(add-filler 'rect107 'btm-ry 'if-added
  '(set-coord-equal !frame !slot !filler))

; (add-filler 'rect108 'top-lx 'if-added
  '(calc-btm-rx !frame !filler))
(add-filler 'rect108 'top-ly 'if-added
  '(calc-btm-ry !frame !filler))
(add-filler 'rect108 'btm-ry 'if-added
  '(set-coord-equal !frame !slot !filler))
(add-filler 'rect108 'btm-ry 'if-added
  '(set-coord-equal !frame !slot !filler))

; for rect103

; for rect104

; for rect105

; for rect106

; for rect107

; for rect108
'(calc-btm-rx !frame !filler))
(add-filler 'rect108 'top-ly 'if-added
  '(calc-btm-ry !frame !filler))
(add-filler 'rect108 'btm-rx 'if-added
  '(set-coord-equal !frame !slot !filler))
(add-filler 'rect108 'btm-ry 'if-added
  '(set-coord-equal !frame !slot !filler))

; ; for rect109
(add-filler 'rect110 'top-lx 'if-added
  '(calc-btm-rx !frame !filler))
(add-filler 'rect110 'top-ly 'if-added
  '(calc-btm-ry !frame !filler))
(add-filler 'rect110 'btm-rx 'if-added
  '(set-coord-equal !frame !slot !filler))
(add-filler 'rect110 'btm-ry 'if-added
  '(set-coord-equal !frame !slot !filler))

; ; for rect111
(add-filler 'rect111 'top-lx 'if-added
  '(calc-btm-rx !frame !filler))
(add-filler 'rect111 'top-ly 'if-added
  '(calc-btm-ry !frame !filler))
(add-filler 'rect111 'btm-rx 'if-added
  '(set-coord-equal !frame !slot !filler))
(add-filler 'rect111 'btm-ry 'if-added
  '(set-coord-equal !frame !slot !filler))

; ; for rect112
(add-filler 'rect112 'top-lx 'if-added
  '(calc-btm-rx !frame !filler))
(add-filler 'rect112 'top-ly 'if-added
  '(calc-btm-ry !frame !filler))
(add-filler 'rect112 'btm-rx 'if-added
  '(set-coord-equal !frame !slot !filler))
(add-filler 'rect112 'btm-ry 'if-added
  '(set-coord-equal !frame !slot !filler))

; ; for rect113
(add-filler 'rect113 'top-lx 'if-added
  '(calc-btm-rx !frame !filler))
(add-filler 'rect113 'top-ly 'if-added
  '(calc-btm-ry !frame !filler))
(add-filler 'rect113 'btm-rx 'if-added
  '(set-coord-equal !frame !slot !filler))
(add-filler 'rect113 'btm-ry 'if-added
  '(set-coord-equal !frame !slot !filler))

; ;-------------------------------------------------------------------------------
; | demons
; ;-------------------------------------------------------------------------------
; * date  * Nov 10,1990
; * function * sets x or y coordinate value of top left or bottom right corner
; *         * when they were not set yet
; * argument * !frame : current frame name = the name of the rectangle
; *         * !filler : current filler = x or y coordinate value of
; *         *         * top left or bottom right corner
; ;-------------------------------------------------------------------------------
(add-filler 'i-m-coord-equal.1 'length 'if-added
  '(replace-topbtm !frame !filler))

(add-filler 'i-m-coord-equal.2 'length 'if-added
  '(replace-topbtm !frame !filler))

(add-filler 'i-m-coord-equal.3 'length 'if-added
  '(replace-topbtm !frame !filler))

(add-filler 'i-m-coord-equal.4 'length 'if-added
  '(replace-topbtm !frame !filler))

(add-filler 'i-m-coord-equal.5 'length 'if-added
  '(replace-topbtm !frame !filler))

(add-filler 'i-m-coord-equal.6 'length 'if-added
  '(replace-topbtm !frame !filler))

(add-filler 'i-m-coord-equal.7 'length 'if-added
  '(replace-topbtm !frame !filler))

(add-filler 'i-m-coord-equal.8 'length 'if-added
  '(replace-topbtm !frame !filler))

(add-filler 'i-m-coord-equal.9 'length 'if-added
  '(replace-topbtm !frame !filler))

(add-filler 'i-m-coord-equal.10 'length 'if-added
  '(replace-topbtm !frame !filler))

(add-filler 'i-m-coord-equal.11 'length 'if-added
  '(replace-topbtm !frame !filler))

(add-filler 'i-m-coord-equal.12 'length 'if-added
  '(replace-topbtm !frame !filler))

(add-filler 'i-m-coord-equal.13 'length 'if-added
  '(replace-topbtm !frame !filler))

;*************************************************************************
; replace-topbtm
;*************************************************************************

*(# date  Nov 10,1990
* function* sets x or y coordinate value of top left or bottom right corner
*        * when they were not set yet
* argument* coord-equal : mop name under m-coord-equal < ex. i-m-coord-equal.1 >
*        * value : coordinate value
;*************************************************************************

(defun replace-topbtm (coord-equal value)
  (declare (special *room-rectangle*))
  (let ((argument-list (reverse (cdr (reverse (mop-slots coord-equal)))))
    (result nil)
    (dolist (argument argument-list result)
      (let ((coordinate (role-filler 'coordinate (cdr argument)))
            (rect-name (get *room-rectangle* (role-filler 'space-name (cadr argument))))
            (value (get-values rect-name 'top-lx))
            (top-lx value :demons t))
        (cond ((eq coordinate 'top-lx)
                      (replace-value rect-name 'top-lx value))))))
((eq coordinate 'top-ly)
  (cond ((eq (car (get-values rect-name 'top-ly)) nil)
     (replace-value rect-name 'top-ly value :demons t)))

((eq coordinate 'btm-rx)
  (cond ((eq (car (get-values rect-name 'btm-rx)) nil)
     ; #DEBUG# => (format t "-% ~s btm-rx" rect-name)
     (replace-value rect-name 'btm-rx value :demons t)))

((eq coordinate 'btm-ry)
  (cond ((eq (car (get-values rect-name 'btm-ry)) nil)
     ; #DEBUG# => (format t "-% ~s btm-ry" rect-name)
     (replace-value rect-name 'btm-ry value :demons t)))

; ;********************************************************************************************************
; ; ; ; get-room-worl
; ;********************************************************************************************************
; ;* date    * Nov 12,1990
; ;* function * returns width or length of the room
; ;* argument * none
; ;********************************************************************************************************
;
(defun get-room-worl ()
  (declare (special *example-mop*
    *room-rectangle*))
  (let ((space-list (mop-specs 'm-space-name))
        (result nil))
    (dolist (space-name space-list result)
      (let ((gnum (car (get-group-number 'space-name space-name *example-mop*)))
        ; #DEBUG# => (format t "-%gnum => ~s" gnum)
        (let ((width (eval `(path-filler '(room ,gnum width ) *example-mop*))
            ; #DEBUG# => (format t "-%name => ~s : width = ~s --- length = ~s" rect width length)
            (length (eval `(path-filler '(room ,gnum length) *example-mop*))
            (rect (get *room-rectangle* space-name)))
        ; #DEBUG# => (format t "-%name => ~s : width = ~s --- length = ~s" rect width length)
        (replace-value rect 'width width)
        (replace-value rect 'length length)
        )))

; ;********************************************************************************************************
; ; ; ; draw-room
; ;********************************************************************************************************
; ;* date    * Nov 12,1990
; ;* function * draws rectangular room in *output-graph* window
; ;* argument * rect-name : the name of rectangle < ex. rect101 >
; ;* var      * top-lx : x-coordinate of top left corner of the rectangle
; ;* var      * top-ly : y-coordinate of top left corner of the rectangle
; ;* var      * btm-rx : x-coordinate of bottom right corner of the rectangle
; ;* var      * btm-ry : y-coordinate of top left corner of the rectangle
; ;********************************************************************************************************
;
(defun draw-room (rect-name)
  (declare (special *output-graph*))
  (let ((top-lx (role-filler 'top-lx rect-name))
        (top-ly (role-filler 'top-ly rect-name))
        (btm-rx (role-filler 'btm-rx rect-name))
        (btm-ry (role-filler 'btm-ry rect-name)))
    (cond ((eq (or (eq top-lx nil)
(eq top-ly nil)
(eq btm-rx nil)
(eq btm-ry nil)) t))

(\text{t})
\begin{verbatim}
(ask *output-graph* (window-select))
(ask *output-graph* (set-pen-rbg-pat 31300 40500 36100))
(ask *output-graph* (move-to top-lx top-ly))
(ask *output-graph* (paint-rect top-lx top-ly btm-rx btm-ry))
(ask *output-graph* (set-pen-pattern *black-pattern*))
(ask *output-graph* (set-pen-size '#(1 1)))
(ask *output-graph* (move-to top-lx top-ly))
(ask *output-graph* (frame-rect top-lx top-ly btm-rx btm-ry)))
\end{verbatim}

\$\)

;******************************************************************************
;\text{paint-room}
;******************************************************************************

;* date * Dec 17, 1990
;* function * paints rectangular room in *output-graph* window
;* argument * rect-name : the name of rectangle < ex. rect101 >
;* \text{red} : red number
;* \text{green} : green number
;* \text{blue} : blue number
;* \text{var} * top-lx : x-coordinate of top left corner of the rectangle
;* \text{var} * top-ly : y-coordinate of top left corner of the rectangle
;* \text{var} * btm-rx : x-coordinate of bottom right corner of the rectangle
;* \text{var} * btm-ry : y-coordinate of top left corner of the rectangle

;******************************************************************************

(defun paint-room (rect-name red green blue)
  (declare (special *output-graph*))
  (cond (eq rect-name nil)
    (t
      (let ((top-lx (role-filler 'top-lx rect-name))
           (top-ly (role-filler 'top-ly rect-name))
           (btm-rx (role-filler 'btm-rx rect-name))
           (btm-ry (role-filler 'btm-ry rect-name)))
        (cond ((eq (or (eq top-lx nil)
                        (eq top-ly nil))
                (eq btm-rx nil)
                (eq btm-ry nil)) t))
      (t
        (ask *output-graph* (window-select))
        (ask *output-graph* (set-pen-rbg-pat red green blue))
        (ask *output-graph* (move-to top-lx top-ly))
        (ask *output-graph* (paint-rect top-lx top-ly btm-rx)
        (ask *output-graph* (set-pen-pattern *black-pattern*))
        (ask *output-graph* (set-pen-size '#(1 1)))
        (ask *output-graph* (move-to top-lx top-ly))
        (ask *output-graph* (frame-rect top-lx top-ly btm-rx )
        (btm-ry)))))
  ;******************************************************************************
  ;\text{erase-room}
  ;******************************************************************************

;* date * Nov 12, 1990
;* function * erases rectangular room in *output-graph* window
;* argument * rect-name : the name of rectangle < ex. rect101 >
;* \text{var} * top-lx : x-coordinate of top left corner of the rectangle
;;; top-ly : y-coordinate of top left corner of the rectangle
;;; btm-rx : x-coordinate of bottom right corner of the rectangle
;;; btm-ry : y-coordinate of top left corner of the rectangle

(defvar erase-room (rect-name))
  (declare (special *output-graph*))
  (cond ((eq rect-name nil)
    (t
      (let ((top-lx (role-filler 'top-lx rect-name))
          (top-ly (role-filler 'top-ly rect-name))
          (btm-rx (role-filler 'btm-rx rect-name))
          (btm-ry (role-filler 'btm-ry rect-name)))
        (cond ((eq (or (eq top-lx nil)
                          (eq top-ly nil)
                          (eq btm-rx nil)
                          (eq btm-ry nil)) t)
          (t
            (ask *output-graph* (window-select))
            (ask *output-graph* (set-pen-pattern *white-pattern*)
            (ask *output-graph* (move-to top-lx top-ly)
            (ask *output-graph* (paint-rect top-lx top-ly btm-rx

(defun draw-rect ()
  (declare (special *example-mop*
      *output-graph*
      *space-name-list*
      *room-position*
      *rect-name-list*))
  (without-interrupts
    (let ((argument-list (mop-slots (role-filler 'room *example-mop*))
         (result nil)
         (setq *space-name-list* (for (argument :in argument-list)
                                   :save (role-filler 'space-name (cadr argument))))
         (setq *rect-name-list* (for (space-name :in *space-name-list*)
                                  :save (get *room-rectangle* space-name)))
         (dolist (rect-name *rect-name-list* result)
           (draw-room rect-name)
           (let ((top-lx (role-filler 'top-lx rect-name))
                 (top-ly (role-filler 'top-ly rect-name))
                 (btm-rx (role-filler 'btm-rx rect-name))
                 (btm-ry (role-filler 'btm-ry rect-name)))
             (setf result (append result (list (list top-lx top-ly

(defvar click-point)
  (defobfun (window-click-event-handler *output-graph*) (where) ;; get c
    (declare (special *beep-sound*
      *example-mop*
*output-graph*
*room-position*
*space-name-list*
*rect-name-list*
*click-room*
*room-rectangle*
*pop-up-slots*)

(erase-room *click-room*)
(draw-room *click-room*)
(let ((xx (point-h where))
      (yy (point-v where))
      (result 0)
      (space-position 0))
(setf *beep-sound* nil)
(dolist (element *room-position* result)
  (let ((x-min (first element)) (x-max (third element))
        (y-min (second element)) (y-max (fourth element)))
    (cond ((and (and (> xx x-min) (< xx x-max))
                    (and (> yy y-min) (< yy y-max))))
          (setf *beep-sound* (or *beep-sound* t))
          (let ((result1 0) (space-order *space-order*)
            (dotimes (count space-position r)
              (setf space-order (cdr space-order))))
            (let ((space-name (car space-order))
                  (cyan (gnum (car (get-group cyan))))
                  (gnam "space-name")
                  (gray-pattern*)))
              (setf *click-room* (gnum (car (get-group cyan))))
              (ask *output-graph* (gnum (car (get-group cyan))))
              (ask *output-graph* (gnum (car (get-group cyan))))
              (ask *output-graph* (gnum (car (get-group cyan))))
              (pop-up-slots (eval `window-frame-color`)
                (define-redraw-window)
                (print-pop-up-slots)
              )
              (eval `(path-filler `(room ,gnam) *example-mop*))))))
    (t (setf result (+ 1 result))
      (setf *beep-sound* (or *beep-sound* t))
      (setf space-position result)))))
  (when (eql *beep-sound* nil) (ed-beep))))

;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
; draw-compass
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
; May 22, 1990
; Draws a compass at the upper right corner
; argument as none
; x : x coordinate of a frame-oval (upper left corner)
; y : y coordinate of a frame-oval (upper left corner)
; ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;;; (defun draw-compass (x y)
  (declare (special *output-graph*))
  (ask *output-graph* (window-select))
  (ask *output-graph* (set-pen-pattern *black-pattern*))
  (ask *output-graph* (set-pen-size '##(1 1)))
  (ask *output-graph* (move-to x y))
  (ask *output-graph* (frame-oval x y (+ x 30) (+ y 30))) ;; draw circle
  (ask *output-graph* (move-to (- x 10) (+ y 15)))
  (ask *output-graph* (line-to (+ x 40) (+ y 15)))
  (ask *output-graph* (move-to (+ x 15) (- y 20))) ;; draw arrow
  (ask *output-graph* (line-to (+ x 15) (+ y 45)))
  (ask *output-graph* (move-to (+ x 15) (- y 20)))
  (ask *output-graph* (line-to (+ x 10) (- y 5)))
  (ask *output-graph* (move-to (+ x 20) (- y 5)))
  (ask *output-graph* (move-to (+ x 10) (- y 25)))
  (ask *output-graph* (set-window-font "times" 15))
  (ask *output-graph* (princ "N" *output-graph*))
)

;; ;---------------------------------------------------------------
;; window-frame-color
;; ;---------------------------------------------------------------
;; date    Nov 12,1990
;; function * sets frame color of window
;; argument * window : the name of window
;; var * red : red value
;; * * green : green value
;; * * blue : blue value
;; ;---------------------------------------------------------------

(defun window-frame-color (window red green blue)
  (let ((color (make-color red green blue)))
    (ask window (set-part-color :frame color))
    (ask window (set-part-color :hilite color))
    (ask window (set-part-color :text color)))
)

;; ;---------------------------------------------------------------
;; calc-measure
;; ;---------------------------------------------------------------
;; date    Nov 20,1990
;; function * calculates coordinate of scale measure lines
;; argument * none
;; var * top-lx : x-coordinate of top left corner of the rectangle
;; * * top-ly : y-coordinate of top left corner of the rectangle
;; * * btm-rx : x-coordinate of bottom right corner of the rectangle
;; * * btm-ry : y-coordinate of bottom left corner of the rectangle
;; ;---------------------------------------------------------------

(defun calc-measure ()
  (declare (special *room-position*
                   *t-list*
                   *v-list*))
  (let ((result 0)
        (top-lx-list nil)
        (top-ly-list nil)
        (btm-rx-list nil)
        (btm-ry-list nil))
    (dolist (element *room-position* result)
      (setq top-lx-list (append top-lx-list (list (first element))))
      (setq top-ly-list (append top-ly-list (list (second element))))
      (setq btm-rx-list (append btm-rx-list (list (third element))))
      (setq btm-ry-list (append btm-ry-list (list (fourth element))))))
(let ((min-x (eval (append ' (min) top-lx-list))))
  (min-y (eval (append ' (min) top-ly-list))))
(max-x (eval (append ' (max) btm-rx-list))))
(max-y (eval (append ' (max) btm-ry-list))))
(let ((point1x min-x) (point1y min-y)
  (point2x min-x) (point2y max-y)
  (point3x max-x) (point3y max-y))
(setq *t-list* (append *t-list*
  (list (list (- point1x 30) point1y))
(setq *t-list* (append *t-list*
  (list (list (- point1x 20) point1y))
(setq *t-list* (append *t-list*
  (list (list (- point2x 30) point2y))
(setq *t-list* (append *t-list*
  (list (list (- point2x 20) point2y))
(setq *t-list* (append *t-list*
  (list (list point2x (+ point2y 10))))
(setq *t-list* (append *t-list*
  (list (list point2x (+ point2y 20))))
(setq *t-list* (append *t-list*
  (list (list point3x (+ point3y 10))))
(setq *t-list* (append *t-list*
  (list (list point3x (+ point3y 20))))
(setq *v-list* (append *v-list*
  (list (list (- point1x 30) (+ (round (* 0.5 (+ point2x p))
  (point3x)) 10) (+ point2y 25)))))
)
)

; ;........................................................................
; ; draw-measure
; ;........................................................................
; * date   * Nov 20, 1990
; * function * draws scale measures in *output-graph* window
; * argument * none
; ;........................................................................
(defun draw-measure ()
  (declare (special *t-list*
    *v-list*
    *measure-length*
    *measure-width*
    *output-graph*))
(let ((result 0))
  (ask *output-graph* (window-select))
  (ask *output-graph* (set-pen-pattern *black-pattern*))
  (ask *output-graph* (set-pen-size '#8(1 1))
  (dolist (element *t-list* result)
    (let ((x1 (first element)) (y1 (second element))
      (x2 (third element)) (y2 (fourth element))
      (ask *output-graph* (move-to x1 y1))
      (ask *output-graph* (line-to x2 y2)))
    (let ((result (list (eval (append ' (max) *measure-length*))))
(eval (append '(max) *measure-width*))))
(dolist (element *v-list* result)
  (let ((x (first element)) (y (second element))
        (value (car result)))
    (ask *output-graph* (move-to x y))
    (ask *output-graph* (set-window-font '("times" 10)))
    (ask *output-graph* (princ value *output-graph*))
    (setq result (cdr result))))))

; draw-output-frame

; draw-output-frame

; date    *  Nov 28,1990
; function * draws rectangular frame around room layout output in *output-graph* window
; argument * none

(defun draw-output-frame ()
  (declare (special *output-graph*)
    (ask *output-graph* (window-select))
    (ask *output-graph* (set-pen-rgb-pat 23400 30200 27200))
    (ask *output-graph* (set-pen-size '('#(2 2)))
    (ask *output-graph* (move-to 10 150))
    (ask *output-graph* (frame-rect 10 175 390 375)))

; put-case-info

; put-case-info

; date    *  Nov 30,1990
; function * puts the information of the case for output
; argument * rect-name : the name of rectangle < ex. rect101 >
; var     * result : the name of case
; * case : the name of case
; * reason : the reason of failure
; * width : width of building area
; * length : length of building area

(defun put-case-info ()
  (declare (special *output-graph*)
    (let ((case-name (car (mop-specs 'm-case)))
      (let (((case
              (car (mop-absts (role-filler 'case-name case-name)))))
            (result (role-filler 'result case-name))
            (reason (role-filler 'reason case-name))
            (width (path-filler '(after building-area width) case-name))
            (length (path-filler '(after building-area length) case-name)))
          (ask *output-graph* (window-select))
          (ask *output-graph* (set-pen-pattern *black-pattern*))
          (ask *output-graph* (set-pen-size '('#(1 1)))
          (ask *output-graph* (set-window-font '("times" 10)))
          (ask *output-graph* (move-to 10 20))
          (ask *output-graph* (princ "CASE NAME" *output-graph*))
          (ask *output-graph* (move-to 100 20))
          (ask *output-graph* (princ ":" *output-graph*))
          (ask *output-graph* (move-to 110 20))
          (ask *output-graph* (princ case *output-graph*))
          (ask *output-graph* (move-to 10 32))
          (ask *output-graph* (princ "RESULT" *output-graph*))
          (ask *output-graph* (move-to 100 32))
          (ask *output-graph* (princ ":" *output-graph*))
          (ask *output-graph* (move-to 110 32))
          (ask *output-graph* (princ result *output-graph*))
          (ask *output-graph* (move-to 10 44)))
        (setq result (cdr result))))))
(ask *output-graph* (princ "REASON" *output-graph*))
(ask *output-graph* (move-to 100 44))
(ask *output-graph* (princ ":" *output-graph*))
(ask *output-graph* (move-to 110 44))
(ask *output-graph* (princ reason *output-graph*))
(ask *output-graph* (move-to 10 56))
(ask *output-graph* (princ "REQUIRED AREA" *output-graph*))
(ask *output-graph* (move-to 10 68))
(ask *output-graph* (princ " WIDTH" *output-graph*))
(ask *output-graph* (move-to 100 68))
(ask *output-graph* (princ ":" *output-graph*))
(ask *output-graph* (move-to 110 68))
(ask *output-graph* (princ width *output-graph*))
(ask *output-graph* (move-to 10 80))
(ask *output-graph* (princ " LENGTH" *output-graph*))
(ask *output-graph* (move-to 100 80))
(ask *output-graph* (princ ":" *output-graph*))
(ask *output-graph* (move-to 110 80))
(ask *output-graph* (princ length *output-graph*))
(ask *output-graph* (move-to 15 127))
(ask *output-graph* (princ "Click the inside of the room !" *output-graph*))

;;
;; ;***********************************************************************
;; ; paint-conflict-area
;; ;***********************************************************************
;; * date * Dec 17,1990
;; * function * paints conflict areas which are hit at constraint-check
;; * argument * none
;; ;***********************************************************************

(defvar *example-mop* 'example-mop)
(defvar *compass* 'compass)
(defvar *warning-msg* 'warning-msg)
(defvar *space-check-table* 'space-check-table)

(setq *warning-msg* nil) ;; clear *warning-msg*

(let ((constraint (path-filler 'constraint-check) (car (mop-specs 'm-case))))

(cond ((eq constraint 'i-m-empty-group)
 (format t "-% This is empty %")
 (t
 (let ((slots (mop-slots constraint))
        (result nil))
   (let ((area-list (for (slot :in slots)
                        :save (cadr slot))))
    (princ area-list)
    (dolist (element area-list result)
      (cond ((eq element 'i-m-total-space)
               (format t "-% total check %")
               (conflict-total-size))
             (setq *warning-msg* (append *warning-msg* 'total-space)))
    (or (eq element 'i-m-north-length)
        (eq element 'i-m-east-length)
        (eq element 'i-m-south-length)
        (eq element 'i-m-west-length))))


(format t "~%*** length check *** ~S" element)
(setq *warning-msg* (append *warning-msg* '(~ nil))
(let ((direction (get *compass* element)))
 (let ((slots (mop-slots (eval '~path-filler (orientation ,direction) ',*example-mop*)])))
 (let ((space-list (for (slot :in space-list)
 :save (for (space-name :in space-list)
 :do (let ((rect-name direction))
 (t
 (let ((gnum-list (get-group-number 'use (get *sp\r ace-check-table* element) ',*example-mop*)))))
 #DEBUG# => (format t "~%-~s~" gnum-list)
 (setq *warning-msg* (append *warning-msg* '(~ nil))
 (for (gnum :in gnum-list)
 :do (let ((space-name (eval `\r (path-filler (room ,gnum space-name) ',*example-mop*)))))
 #DEBUG# => (format t "~%-~s~" space-name)
 (om-rectangle* space-name 40500 22700 23100)))))
 (format t "~%-~s~" *warning-msg*))))))

;******************************************************************************************
 ; paint-shrunk-room
 ;******************************************************************************************
 ;* date  * Feb 12,1991
 ;* function * paints partially shrunk rooms
 ;* argument * none
 ;******************************************************************************************
 (defun paint-shrunk-room ()
 (declare (special *shrunk-room-list* *warning-msg* *room-rectangle*))
 (cond ((eq *shrunk-room-list* nil))
 (t
 (remove-duplicates *shrunk-room-list* nil)
 (for (space-name :in *shrunk-room-list*)
 :do (paint-room (get *room-rectangle* space-name 63000 58)
 300 22000))
 (setq *warning-msg* (append *warning-msg* '(partial-shrink)))
 (format t "~%-~s~" *warning-msg*))))

;******************************************************************************************
 ; conflict-total-size
 ;******************************************************************************************
 ;* date  * Dec 17,1990
 ;* function * draws warining rectangle when result is bigger than required total size
 ;* argument * none
 ;******************************************************************************************
 (defun conflict-total-size ()
(declare (special *layout-origine*
   *example-mop*
   *multiplier*
   *output-graph*)
(let ((top-lx (car *layout-origine*))
   (top-ly (cadr *layout-origine*))
   (width (round (* *multiplier* (path-filler 'building-area width) *example*
   *mop*)))))
   (length (round (* *multiplier* (path-filler 'building-area length) *example*
   *mop*))))))
(ask *output-graph* (window-select))
(ask *output-graph* (set-pen-size '#(2 2)))
(ask *output-graph* (set-pen-rgb-pat 40500 22700 23100))
(ask *output-graph* (move-to top-lx top-ly))
(ask *output-graph* (frame-rect top-lx top-ly (+ top-lx width) (+
   top-ly length))))

;FLICT-LENGTH
;****************************************************************************
;/* date   * Dec 17, 1990
/* function * draw warning triangle when result broke required side length
/* argument * rect-name : name of rectangle < ex. rect101 >
/*          * direction : name of direction < one of north, east, south, and west >

(defun conflict-length (rect-name direction)
  (let ((top-lx (role-filler 'top-lx rect-name))
    (top-ly (role-filler 'top-ly rect-name))
    (btm-rx (role-filler 'btm-rx rect-name))
    (btm-ry (role-filler 'btm-ry rect-name))
    (half-btm 5)
    (height 5))
    (cond ((eq direction 'north)
       (let ((point1x (+ top-lx (round (* 0.5 (- btm-rx top-lx)))))
         (point1y (- top-ly 2)))
         (let ((point2x (+ point1x half-btm))
           (point2y (- point1y height)))
           (let ((point3x (- point1x half-btm))
             (point3y point2y))
             (paint-triangle point1x point1y
             point2x point2y
             point3x point3y))))))

((eq direction 'east)
  (let ((point1x (+ btm-rx 2))
    (point1y (- btm-ry (round (* 0.5 (- btm-ry top-ly))))))
    (let ((point2x (+ point1x height))
      (point2y (+ point1y half-btm)))
      (let ((point3x (+ point1x height))
        (point3y (- point1y half-btm)))
        (paint-triangle point1x point1y
        point2x point2y
        point3x point3y))))))

((eq direction 'south)
  (let ((point1x (- btm-rx (round (* 0.5 (- btm-rx top-lx))))))
    (point1y (+ btm-ry 2)))
    (let ((point2x (- point1x half-btm))
      (point2y (+ point1y height)))
      (let ((point3x (+ point1x half-btm))
        (point3y (+ point1y height)))
        (paint-triangle point1x point1y
        point2x point2y
        point3x point3y))))))
((eq direction 'west)
 (let ((pointlx (- top-1x 2))
       (pointly (- top-1y (rounf (* 0.5 (- btm-ry top-1y))))))
   (let ((point2x (- pointlx height))
         (point2y (- pointly half-btm)))
     (let ((point3x (- pointlx height))
           (point3y (- pointly half-btm)))
       (paint-triangle pointlx pointly
                        point2x point2y
                        point3x point3y)))))))

;******************************************************************************
; paint-triangle
;******************************************************************************

;** date   * Dec 17,1990
;** function * draw painted triangle with color
;** argument * pointlx  : x coordinate of first vertex
;**             * pointly : y coordinate of first vertex
;**             * point2x : x coordinate of second vertex
;**             * point2y : y coordinate of second vertex
;**             * point3x : x coordinate of third vertex
;**             * point3y : y coordinate of third vertex
;******************************************************************************

(defun paint-triangle (pointlx pointly point2x point2y point3x point3y)
  (declare (special *output-graph*))
  (ask *output-graph* (window-select))
  (ask *output-graph* (set-pen-rgb-pat 40500 22700 23100))
  (ask *output-graph* (move-to pointlx pointly))
  (ask *output-graph* (start-polygon))
  (ask *output-graph* (line-to point2x point2y))
  (ask *output-graph* (line-to point3x point3y))
  (let ((polygon (ask *output-graph* (get-polygon))))
    (ask *output-graph* (paint-polygon polygon))
    (ask *output-graph* (set-pen-pattern *black-pattern*))
    (ask *output-graph* (set-pen-size '#@(1 1)'))
    (ask *output-graph* (move-to pointlx pointly))
    (ask *output-graph* (frame-polygon polygon))))

;******************************************************************************
; warning-message
;******************************************************************************

;** date   * Feb 12,1991
;** function * draw warning message on output-graphics window
;** argument * startx  : x coordinate of warning start point
;**             * starty  : y coordinate of warning start point
;******************************************************************************

(defun warning-message (startx starty)
  (declare (special *output-graph* *warning-msg*))
  (setq *warning-msg* (remove-duplicates *warning-msg*))
  (ask *output-graph* (window-select))
  (let ((result 0))
    (dolist (warning *warning-msg* result)
      (cond ((eq warning 'total-space)
              (ask *output-graph* (set-pen-rgb-pat 40500 22))
              (ask *output-graph* (move-to startx (+ starty 2))
                                (set-mag (v* 700 23100))
                                result)))
    result)))
(ask *output-graph* (frame-rect startx starty)
  (ask *output-graph* (set-pen-size '#(1 l))
  (ask *output-graph* (set-window-font "times"
  (ask *output-graph* (set-pen-pattern *black-p
  (ask *output-graph* (move-to (+ startx 20) (+
  (ask *output-graph* (princ "Warning! : Total
  (setq result (+ result 20))
  (eq warning 'room-size)
  (ask *output-graph* (set-pen-rgb-pat 40500 22
  (ask *output-graph* (move-to startx (+ starty
  (ask *output-graph* (paint-rect startx
    (+ startx 10)
  (ask *output-graph* (set-pen-size '#(1 l))
  (ask *output-graph* (set-window-font "times"
  (ask *output-graph* (set-pen-pattern *black-p
  (ask *output-graph* (move-to startx (+ starty
  (ask *output-graph* (frame-rect startx
    (+ startx 10)
  (ask *output-graph* (move-to (+ startx 20) (+
  (ask *output-graph* (princ "Warning! : Room S
  (setq result (+ result 20))
  (eq warning 'side-length)
  (ask *output-graph* (set-pen-rgb-pat 40500 22
  (ask *output-graph* (move-to startx (+ starty
  (paint-triangle (+ startx 5) (+ starty resu
    startx (+ 10 (+ starty
      (+ startx 10) (+ 10 (+ starty
  (ask *output-graph* (set-pen-size '#(1 l))
  (ask *output-graph* (set-window-font "times"
  (ask *output-graph* (set-pen-pattern *black-p
  (ask *output-graph* (move-to (+ startx 20) (+
  (ask *output-graph* (princ "Warning! : Side L
  (setq result (+ result 20))
  (eq warning 'partial-shrink)
  (ask *output-graph* (set-pen-rgb-pat 63000 58
  (ask *output-graph* (move-to startx (+ starty

(ask *output-graph* (paint-rect startx (+ startx 10))
(ask *output-graph* (set-size '#(1 l))
(ask *output-graph* (set-window-font "times")
(ask *output-graph* (set-pattern *black-p)
(ask *output-graph* (frame-rect startx (+ startx 10))
(ask *output-graph* (move-to (+ startx 20) (+)
(ask *output-graph* (princ "Shrinked!" *output-
(setq result (+ result 20)))))

;********************************************************************
; init-room-rectangle
;********************************************************************
(*date * Dec 17,1990
; function * initializes instances of m-room-rectangle and m-coord-equal
; argument * none
;********************************************************************
(defun init-room-rectangle ()
(let ((rect-name-list (mop-specs 'm-room-rectangle))
(result nil))
(dolist (rect-name rect-name-list result)
(replace-value rect-name 'top-lx nil)
(replace-value rect-name 'top-ly nil)
(replace-value rect-name 'btm-rx nil)
(replace-value rect-name 'btm-ry nil)
(replace-value rect-name 'width nil)
(replace-value rect-name 'length nil)))
(let ((coord-equal-list (mop-specs 'm-coord-equal))
(result nil))
(dolist (coord-equal coord-equal-list result)
(replace-value coord-equal 'length 0)))

;********************************************************************
; store-output-graph
;********************************************************************
(*date * Nov 25,1990
; function * stores the procedure of drawing on *output-graph* window
; argument * none
;********************************************************************
(defun store-output-graph ()
(declare (special *output-graph*))
(ask *output-graph* (start-picture))
(put-case-info)
(draw-compass 350 40)
(draw-output-frame)
(draw-rect)
(paint-conflict-area)
(paint-shrunked-room)
(warning-message 240 115)
(draw-measure)
(ask *output-graph* (have 'saved-pict (ask *output-graph* (get-picture)))))
; ; draw-layout
; ;...........................................................................
; *
; * function * makes *output-graph* window to run drawing functions
; * argument * none
; ;...........................................................................
;
(defun draw-layout ()
  (declare (special *room-position*
   *space-name-list*
   *rect-name-list*
   *click-room*
   *t-list*
   *v-list*
   *measure-length*
   *measure-width*
   *layout-origine*
   *output-graph*))

  (init-room-rectangle)
  (get-room-worl)
  ;; x coordinate of the origin of la
  $yout output
  (replace-value 'i-m-coord-equal.1 'length (car *layout-origine*) :dmons t)
  ;; y coordinate of the origin of la
  $yout output
  (replace-value 'i-m-coord-equal.10 'length (cadr *layout-origine*) :dmons t)
  (open-output-window)

  ;; the list of the top left corner
  (setq *room-position* nil)
  ;; the list of the bottom
  ;; the right corner of coordinates of t
  (setq *space-name-list* nil)
  ;; the name of the space  < ex. 
  % space101 >
  (setq *rect-name-list* nil)
  ;; the name of the rectangle < ex. 
  % rect101 >
  (setq *click-room* nil)
  ;; the name of the rectangle which
  % was clicked
  (setq *t-list* nil)
  ;; the list of measure line coordin
  $ates
  (setq *v-list* nil)
  ;; the list of measure values

  (define-redraw-window *output-graph*)
  (window-frame-color *output-graph* 15000 9300 29000)
  (put-case-info)
  (draw-compass 350 45)
  (draw-output-frame)
  (draw-rect)
  (paint-conflict-area)
  (paint-shrinked-room)
  (warning-message 240 115)
  (calc-measure)
  (draw-measure)
  (store-output-graph))