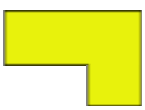
Appendix 1

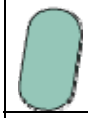
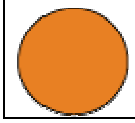
An Example Grammar for Dynamic Design of A Virtual Gallery

The example grammar for dynamic designs of a virtual gallery comprises four sets of design rules. They are applied in the sequence of: layout rules, object placement rules, navigation rules and interaction rules. Appendix 1 supplements Chapter 5 by listing all design rules of the grammar, and giving full annotation to state labels that associate with the design rules.

LAYOUT RULES

Symbols
Symbols that represent the layouts of different areas:

	A reception area of the virtual gallery.
	A corridor that connects two different areas.
	A standard gallery 1 area: a standard gallery area for displaying exhibition 1.
	A standard gallery 2 area: a standard gallery area for displaying exhibition 2.
	An expanded gallery 1 area: an expanded gallery area for displaying exhibition 1.
	An expanded gallery 2 area: an expanded gallery area for displaying exhibition 2.

	The personal studio area for the artist.
	The multi-function area as a conference venue or for exhibiting visually large-scale installations.

Labels that control the layout rule application:

- a spatial label.
- the registration mark.

Initial Design

 a reception area marked with spatial labels.

State Labels

sL=1 is used in all layout rules indicating layout rules are the first set of design rules to be fired in the application of the example grammar.

States labels used in additive layout rules[1]:

sL=S: the personal studio area for the artist is needed in the virtual gallery.	To match sL=S: In interpretation, the GDA interprets that: • The artist is present in the virtual gallery (A_{int}), and • There is no studio space available in the virtual gallery for the artist (O_{int}). In hypothesising, based on the above interpretations: • A design goal: O_{exp}^{F}=S is hypothesised. Therefore, sL=S is matched.
sL=g1: the initial standard gallery 1 area is needed in the virtual gallery.	To match sL=g1: In interpretation, the GDA interprets that: • The artist intends to display exhibition 1 (A_{int} or E_{int}), and • The number of visitors <10 (wA_{int}), and • There is no exhibition space available in the virtual gallery for exhibition 1 (O_{int}). In hypothesising, based on the above interpretations: • A design goal: O_{exp}^{F}=g1 is hypothesised. Therefore, sL=g1 is matched.

[1] The definitions of O_{exp}^{F}, A_{int}, E_{int}, O_{int} and W_{int} used in the annotation of the state labels are discussed in Chapter 3 section 3.2.

sL=g2: the initial standard gallery 2 area is needed in the virtual gallery.	To match sL=g2: In interpretation, the GDA interprets that: • The artist intends to display exhibition 2 (A_{int} or E_{int}), and • The number of visitors <10 (wA_{int}), and • There is no exhibition space available in the virtual gallery for exhibition 2 (O_{int}). In hypothesising, based on the above interpretations: • A design goal: O_{exp}^{F}=g2 is hypothesised. Therefore, sL=g2 is matched.
sL=g1+: an additional standard gallery 1 area is needed in the virtual gallery.	To match sL=g1+: In interpretation, the GDA interprets that: • The number of visitors in a standard gallery 1 area ≥ 10 (wA_{int}). In hypothesising, based on the above interpretation: • A design goal: O_{exp}^{F}=g1+ is hypothesised. Therefore, sL=g1+ is matched.
sL=g2+: an additional standard gallery 2 area is needed in the virtual gallery.	To match sL=g2+: In interpretation, the GDA interprets that: • The number of visitors in a standard gallery 2 area ≥ 10 (wA_{int}). In hypothesising, based on the above interpretation: • A design goal: O_{exp}^{F}=g2+ is hypothesised. Therefore, sL=g2+ is matched.
sL=r+: an additional reception area is needed in the virtual gallery.	To match sL=r+: In interpretation, the GDA interprets that: • A gallery area has no connected reception area (O_{int}). In hypothesising, based on the above interpretation: • A design goal: O_{exp}^{F}=r+ is hypothesised. Therefore, sL=r+ is matched.
sL=gE1: a standard gallery 1 area needs to be expanded.	To match sL=gE1: In interpretation, the GDA interprets that: • The artist requests to display more items in exhibition 1 (A_{int} or E_{int}), and • The gallery 1 area has a standard size (O_{int}). In hypothesising, based on the above interpretations: • A design goal: O_{exp}^{F}=gE1 is hypothesised. Therefore, sL=gE1 is matched.
sL=gE2: a standard gallery 2 area needs to be expanded.	To match sL=gE2: In interpretation, the GDA interprets that: • The artist requests to display more items in exhibition 2 (A_{int} or E_{int}), and • The gallery 2 area has standard size (O_{int}).

	In hypothesising, based on the above interpretations: • A design goal: $O_{exp}{}^{F}$=gE2 is hypothesised. Therefore, sL=gE2 is matched.
sL=mC: the multi-function area is needed as a conference venue.	To match sL=mC: In interpretation, the GDA interprets that: • The artist requests a conference venue for a large crowd > 10 (A_{int} or E_{int}), and • There is no conference venue available in the virtual gallery (O_{int}). In hypothesising, based on the above interpretations: • A design goal: $O_{exp}{}^{F}$=mC is hypothesised. Therefore, sL=mC is matched.
sL=mI: the multi-function area is needed for exhibiting visually large-scale installations.	To match sL=mI: In interpretation, the GDA interprets that: • The artist intends to display visually large-scale installations (A_{int} or E_{int}), and • There is no large-scale exhibition space available in the virtual gallery (O_{int}). In hypothesising, based on the above interpretations: • A design goal: $O_{exp}{}^{F}$=mI is hypothesised. Therefore, sL=mI is matched.

States labels used in subtractive layout rules[2]:

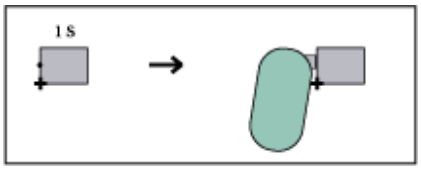
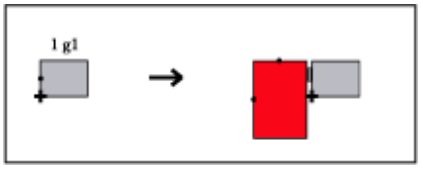
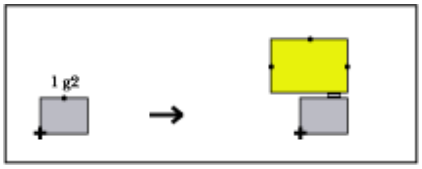
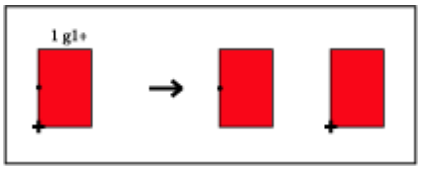
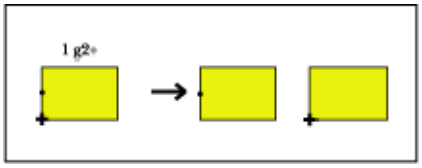
sL=g1-: a standard/ expanded gallery 1 area is redundant.	To match sL=g1-: In interpretation, the GDA interprets that: • The artist cancels or changes exhibition 1 (A_{int} or E_{int}), or • Two standard/expanded gallery 1 areas are overlapped (O_{int}), or • The redundant gallery area has no visitor (wA_{int}). In hypothesising, based on the above interpretations: • A design goal: $O_{exp}{}^{F}$=g1- is hypothesised. Therefore, sL=g1- is matched.
sL=g2-: a standard/ expanded gallery 2 area is redundant.	To match sL=g2-: In interpretation, the GDA interprets that: • The artist cancels or changes exhibition 2 (A_{int} or E_{int}), or • Two standard/expanded gallery 2 areas are overlapped (O_{int}), or • The redundant gallery area has no visitor (wA_{int}). In hypothesising, based on the above interpretations: • A design goal: $O_{exp}{}^{F}$=g2- is hypothesised.

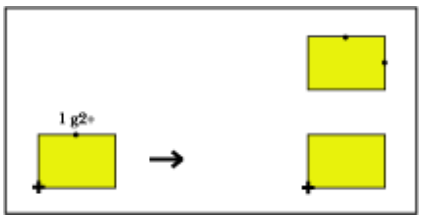
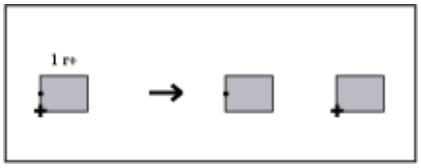
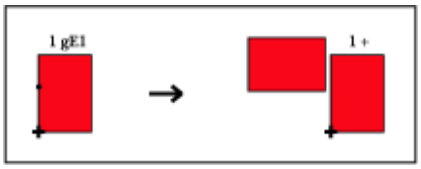
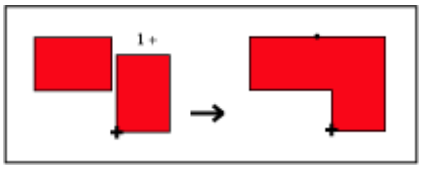
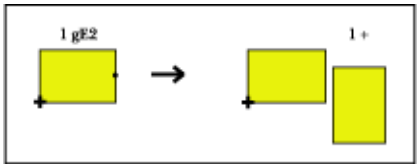
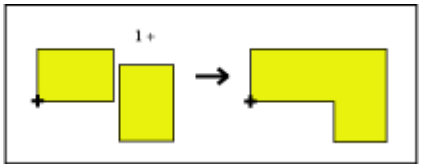
[2] The definitions of $O_{exp}{}^{F}$, A_{int}, E_{int}, O_{int} and W_{int} used in the annotation of the state labels are discussed in Chapter 3 section 3.2.

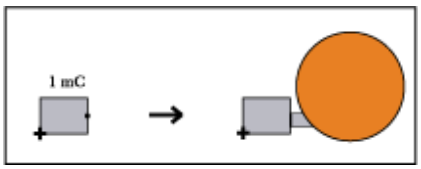
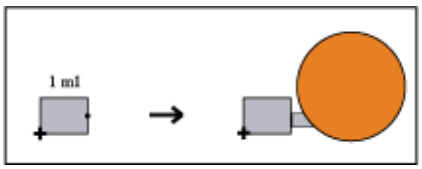
	Therefore, sL=g2- is matched.
sL=r-: a reception area is redundant.	To match sL=r-: In interpretation, the GDA interprets that: • A reception area has no other connected area (O_{int}), or • Two reception areas are overlapped (O_{int}), and • The redundant reception area has no visitor (wA_{int}). In hypothesising, based on the above interpretations: • A design goal: $O_{exp}{}^{F}$=r- is hypothesised. Therefore, sL=r- is matched.
sL=gR1: an expanded gallery 1 area needs to be reduced.	To match sL=gR1: In interpretation, the GDA interprets that: • The artist cancels parts of exhibition 1 (A_{int} or E_{int}). In hypothesising, based on the above interpretation: • A design goal: $O_{exp}{}^{F}$=gR1 is hypothesised. Therefore, sL=gR1 is matched.
sL=gR2: an expanded gallery 2 area needs to be reduced.	To match sL=gR2: In interpretation, the GDA interprets that: • The artist cancels parts of exhibition 2 (A_{int} or E_{int}). In hypothesising, based on the above interpretation: • A design goal: $O_{exp}{}^{F}$=gR2 is hypothesised. Therefore, sL=gR2 is matched.
sL=g-: the initial standard gallery area is not needed.	To match sL=g-: In interpretation, the GDA interprets that: • The artist cancels or changes an exhibition (A_{int} or E_{int}), or • The standard gallery area for displaying the exhibition has no visitor (wA_{int}), and • There is no other additional gallery area for displaying the exhibition (O_{int}). In hypothesising, based on the above interpretation: • A design goal: $O_{exp}{}^{F}$=g- is hypothesised. Therefore, sL=g- is matched.
sL=m-: the multi-function area is not needed.	To match sL=m-: In interpretation, the GDA interprets that: • The artist cancels the exhibition in the multi-function area (A_{int} or E_{int}), or • The public functions in the multi-function area end (E_{int}), and • The multi-function area has no visitor (wA_{int}). In hypothesising, based on the above interpretations: • A design goal: $O_{exp}{}^{F}$=m- is hypothesised. Therefore, sL=m- is matched.

sL=cS: the current design of the virtual gallery is to be used as a static design (the virtual gallery stops being dynamically designed).	To match sL=cS: In interpretation, the GDA interprets that: • The artist is not present (A_{int}). In hypothesising, based on the above interpretation: • A design goal: O_{exp}^{F}=cS is hypothesised. Therefore, sL=cS is matched.

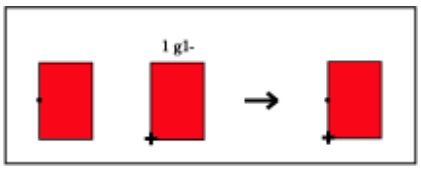
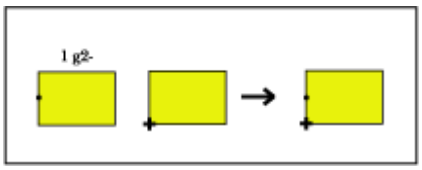
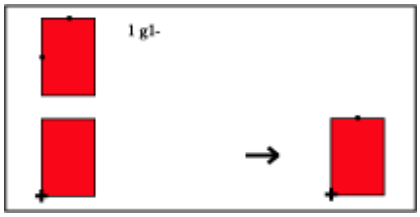
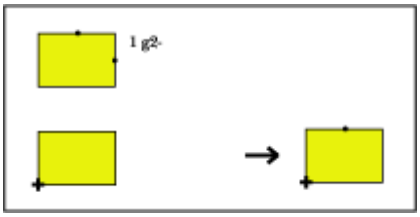
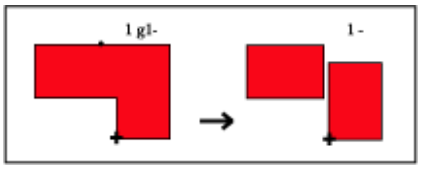
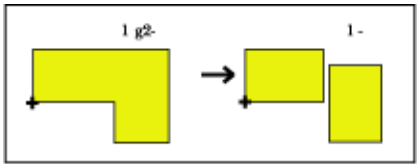
Additive Layout Rules

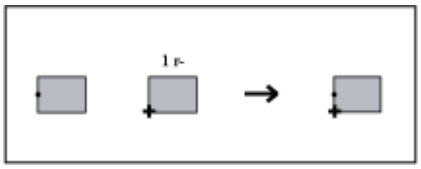
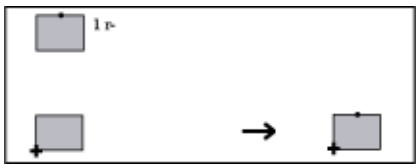
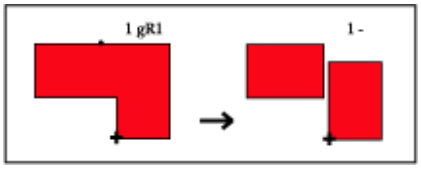
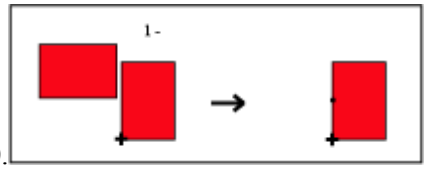
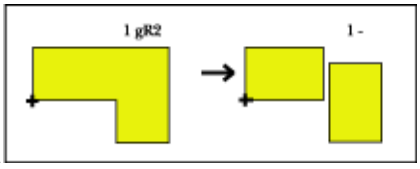
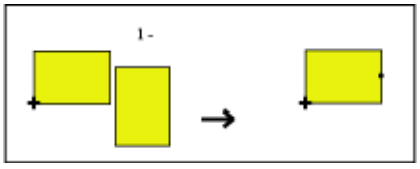
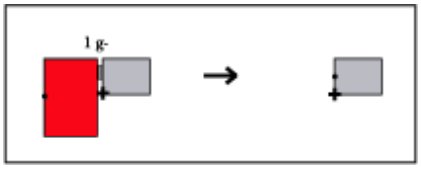
1.  sL=1: this is a layout rule that should be fired first. sL=S: the personal studio area for the artist is needed in the virtual gallery.	
2.  sL=1: this is a layout rule that should be fired first. sL=g1: the initial standard gallery 1 area is needed in the virtual gallery.	3.  sL=1: this is a layout rule that should be fired first. sL=g2: the initial standard gallery 2 area is needed in the virtual gallery.
4.  sL=1: this is a layout rule that should be fired first. sL=g1+: an additional standard gallery 1 area is needed in the virtual gallery.	5.  sL=1: this is a layout rule that should be fired first. sL=g2+: an additional standard gallery 2 area is needed in the virtual gallery.

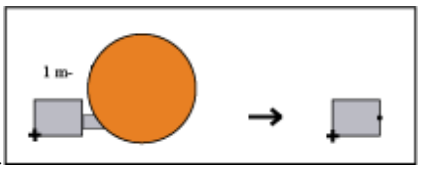
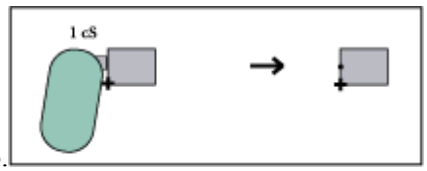
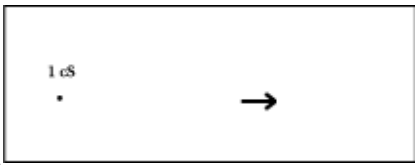
6.  sL=1: this is a layout rule that should be fired first. sL=g1+: an additional standard gallery 1 area is needed in the virtual gallery.	7.  sL=1: this is a layout rule that should be fired first. sL=g2+: an additional standard gallery 2 area is needed in the virtual gallery.
8.  sL=1: this is a layout rule that should be fired first. sL=r+: an additional reception area is needed in the virtual gallery.	9.  sL=1: this is a layout rule that should be fired first. sL=r+: an additional reception area is needed in the virtual gallery.
10.  sL=1: this is a layout rule that should be fired first. sL=gE1: a standard gallery 1 area needs to be expanded. sL=+: a label defined temporarily to connect with another rule.	11.  sL=1: this is a layout rule that should be fired first. sL=+: a label defined temporarily to connect with another rule.
12.  sL=1: this is a layout rule that should be fired first. sL=gE2: a standard gallery 2 area needs to be expanded. sL=+: a label defined temporarily to connect with another rule.	13.  sL=1: this is a layout rule that should be fired first. sL=+: a label defined temporarily to connect with another rule.

14.  sL=1: this is a layout rule that should be fired first. sL=mC: the multi-function area is needed as a conference venue.	15.  sL=1: this is a layout rule that should be fired first. sL=mI: the multi-function area is needed for exhibiting visually large-scale installations.

Subtractive Layout Rules

1.  sL=1: this is a layout rule that should be fired first. sL=g1-: a standard/ expanded gallery 1 area is redundant.	2.  sL=1: this is a layout rule that should be fired first. sL=g2-: a standard/ expanded gallery 2 area is redundant.
3.  sL=1: this is a layout rule that should be fired first. sL=g1-: a standard/ expanded gallery 1 area is redundant.	4.  sL=1: this is a layout rule that should be fired first. sL=g2-: a standard/ expanded gallery 2 area is redundant.
5.  sL=1: this is a layout rule that should be fired first. sL=g1-: a standard/ expanded gallery 1 area is redundant. sL=-: a label defined temporarily to connect with another rule.	6.  sL=1: this is a layout rule that should be fired first. sL=g2-: a standard/ expanded gallery 2 area is redundant. sL=-: a label defined temporarily to connect with another rule.

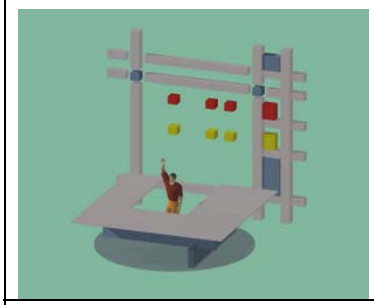
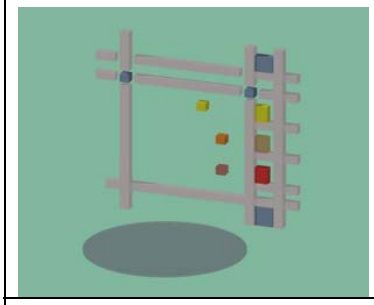
7.  sL=1: this is a layout rule that should be fired first. sL=r-: a reception area is redundant.	8.  sL=1: this is a layout rule that should be fired first. sL=r-: a reception area is redundant.
9  sL=1: this is a layout rule that should be fired first. sL=gR1: an expanded gallery 1 area needs to be reduced. sL=-: a label defined temporarily to connect with another rule.	10.  sL=1: this is a layout rule that should be fired first. sL=-: a label defined temporarily to connect with another rule.
11.  sL=1: this is a layout rule that should be fired first. sL=gR2: an expanded gallery 2 area needs to be reduced. sL=-: a label defined temporarily to connect with another rule.	12.  sL=1: this is a layout rule that should be fired first. sL=-: a label defined temporarily to connect with another rule.
13.  sL=1: this is a layout rule that should be fired first. sL=g-: the initial standard gallery area is not needed.	14.  sL=1: this is a layout rule that should be fired first. sL=g-: the initial standard gallery area is not needed.

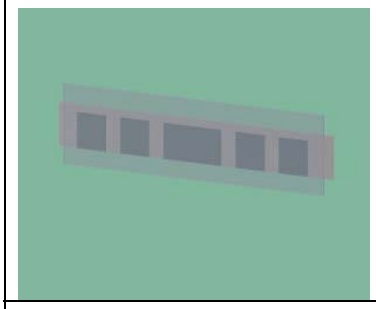
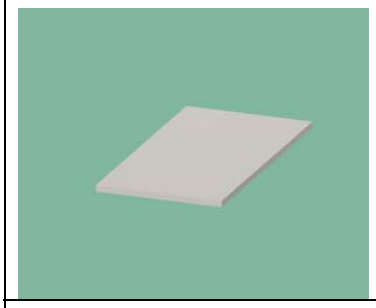
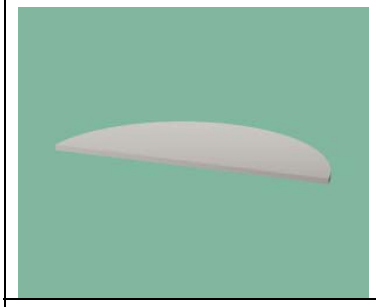
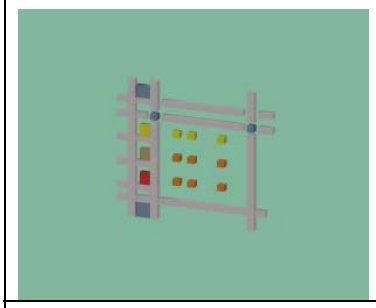
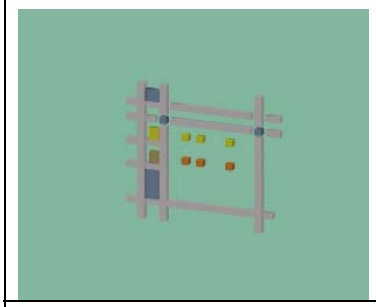
15.  sL=1: this is a layout rule that should be fired first. sL=m-: the multi-function area is not needed.	16.  sL=1: this is a layout rule that should be fired first. sL=cS: the current design of the virtual gallery is to be used as a static design (the virtual gallery stops being dynamically designed).
17.  sL=1: this is a layout rule that should be fired first. sL=cS: the current design of the virtual gallery is to be used as a static design (the virtual gallery stops being dynamically designed).	Rule 17 is a termination rule for removing spatial labels so that the application of the example grammar can be terminated.

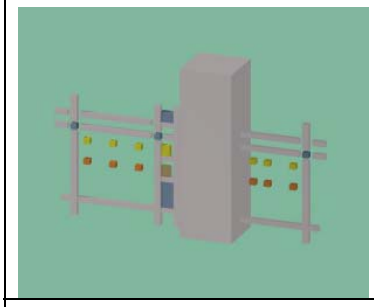
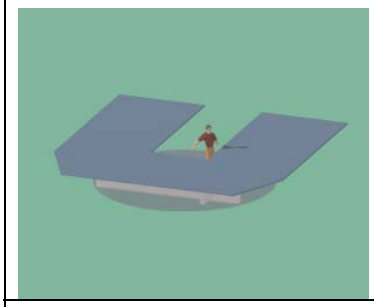
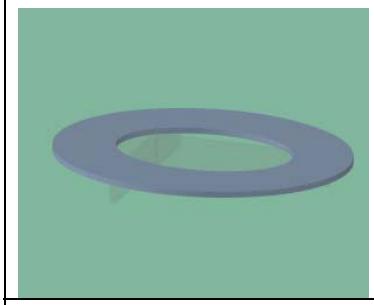
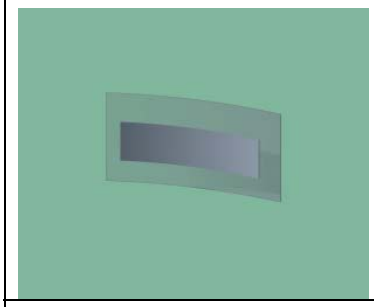
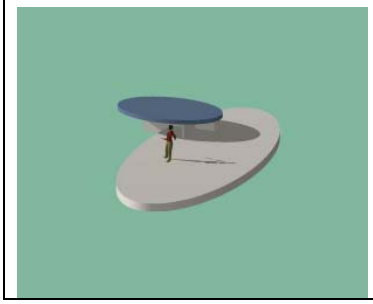
OBJECT PLACEMENT RULES

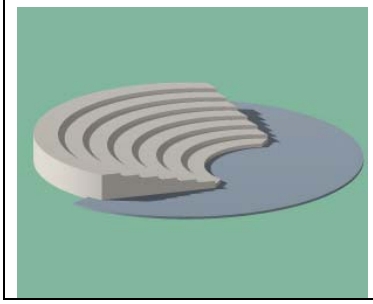
Symbols/Illustrations

Additional symbols/illustrations used in object placement rules:

	A helpdesk to be placed in a reception area providing information about the virtual gallery and the exhibitions. The information is visualised by the warm-colour cubes placed on the frame-like partition behind the desk.
	A frame-like partition to be placed in a reception area for storing hyperlink portals for assisting navigation. The portals are visualised by the warm-colour cubes. By rolling over these cubes the destinations of the hyperlink portals will be shown, and by clicking on the cubes the visitors will be transported to different designated locations in the virtual gallery.

	A partition to be placed in a gallery area for displaying digital images.
	A stand to be placed in a gallery area for displaying interactive installations.
	A stand to be placed in the multi-function area for displaying interactive installations.
	A frame-like partition to be placed in the artist's personal studio area for storing digital tools and information, visualised by the warm-colour cubes.
	A frame-like partition to be placed in the artist's personal studio area for storing digital tools and information, visualised by the warm-colour cubes.

	A frame-like partition to be placed in the artist's personal studio area for storing digital tools and information, visualised by the warm-colour cubes.
	A working desk to be placed in the artist's personal studio area.
	A meeting table to be placed in the artist's personal studio area.
	A presentation screen to be placed in the artist's personal studio area or the multi-function area for displaying meeting/conference materials.
	The podium to be placed in the multi-function area as a part of the conference facilities.

	The auditorium to be placed in the multi-function area as a part of the conference facilities.

State Labels

sL=2 is used in all object placement rules indicating object placement rules are the second set of design rules to be fired in the application of the example grammar.

States labels used in additive placement rules[3]:

sL=cC: to apply a cold-colour scheme for the interior of the virtual gallery.	To match sL=cC: In interpretation, the GDA interprets that: • The artist prefers cold-colour scheme for the interior of the virtual gallery (A_{int} or E_{int}). In hypothesising, based on the above interpretation: • A design goal: O_{exp}^{F}=cC is hypothesised. Therefore, sL=cC is matched.
sL=gIM1: to arrange a gallery area for displaying digital images using configuration 1.	To match sL=gIM1: In interpretation, the GDA interprets that: • The exhibition consists of digital images only (A_{int} or E_{int}), and • If the total number of digital images in the exhibition is a, the average length of the images is b, the maximum length of any image is c (A_{int} or E_{int}), a*b+(a-4)/2<58m and c<18m, and • The gallery area is currently not arranged (O_{int}). In hypothesising, based on the above interpretations: • A design goal: O_{exp}^{F}=gIM1 is hypothesised. Therefore, sL=gIM1 is matched.
sL=gIM2: to arrange a gallery area for displaying digital images using configuration 2.	To match sL=gIM2: In interpretation, the GDA interprets that: • The exhibition consists of digital images only (A_{int} or E_{int}), and • If the total number of digital images in the exhibition is a, the average length of the images is b, the maximum length of any image is c (A_{int} or E_{int}), 58m<a*b+(a-8)/2<80m and c<18m, and

[3] The definitions of O_{exp}^{F}, A_{int}, E_{int}, O_{int} and W_{int} used in the annotation of the state labels are discussed in Chapter 3 section 3.2.

	• The gallery area is currently not arranged (O_{int}). In hypothesising, based on the above interpretations: • A design goal: O_{exp}^{F}=gIM2 is hypothesised. Therefore, sL=gIM2 is matched.
sL=gIM3: to arrange a gallery area for displaying digital images using configuration 3.	To match sL=gIM3: In interpretation, the GDA interprets that: • The exhibition consists of digital images only (A_{int} or E_{int}), and • If the total number of digital images in the exhibition is a, the average length of the images is b, the maximum length of any image is c (A_{int} or E_{int}), 80m<a*b+(a-6)/2<108m and c<35m, and • The gallery area is currently not arranged (O_{int}). In hypothesising, based on the above interpretations: • A design goal: O_{exp}^{F}=gIM3 is hypothesised. Therefore, sL=gIM3 is matched.
sL=gIM4: to arrange a gallery area for displaying digital images using configuration 4.	To match sL=gIM4: In interpretation, the GDA interprets that: • The exhibition consists of digital images only (A_{int} or E_{int}), and • If the total number of digital images in the exhibition is a, the average length of the images is b, the maximum length of any image is c (A_{int} or E_{int}), 80m<a*b+(a-14)/2<108m and c<35m, and • The gallery area is currently not arranged (O_{int}). In hypothesising, based on the above interpretations: • A design goal: O_{exp}^{F}=gIM4 is hypothesised. Therefore, sL=gIM4 is matched.
sL=gIS1: to arrange a gallery area for displaying interactive installations using configuration 1.	To match sL=gIS1: In interpretation, the GDA interprets that: • The exhibition consists of interactive installations only (A_{int} or E_{int}), and • If the total number of interactive installations in the exhibition is d, the average length of the installations is e, the maximum length of any installation is f, the maximum width of any installation is g, the maximum height of any installation is h (A_{int} or E_{int}), d*e+(d-1)<24m, f<24m, g<9m and h<6m, and • The gallery area is currently not arranged (O_{int}). In hypothesising, based on the above interpretations: • A design goal: O_{exp}^{F}=gIS1 is hypothesised. Therefore, sL=gIS1 is matched.

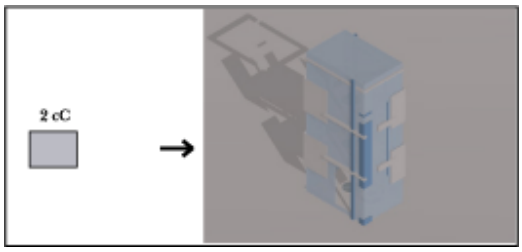
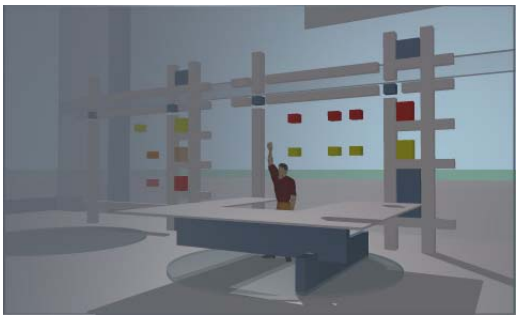
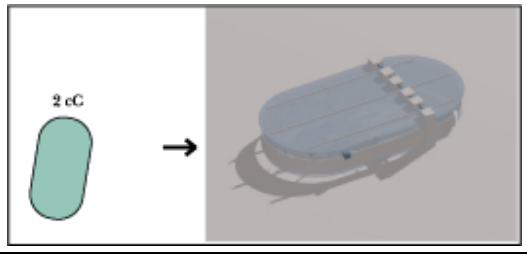
sL=gIS2: to arrange a gallery area for displaying interactive installations using configuration 2.	To match sL=gIS2: In interpretation, the GDA interprets that: • The exhibition consists of interactive installations only (A_{int} or E_{int}), and • If the total number of interactive installations in the exhibition is d, the average length of the installations is e, the maximum length of any installation is f, the maximum width of any installation is g, the maximum height of any installation is h (A_{int} or E_{int}), d*e+(d-2)<39m, f<21m, g<9m and h<6m, and • The gallery area is currently not arranged (O_{int}). In hypothesising, based on the above interpretations: • A design goal: O_{exp}^{F}=gIS2 is hypothesised. Therefore, sL=gIS2 is matched.
sL=gIMS: to arrange a gallery area for displaying both digital images and interactive installations.	To match sL=gIMS: In interpretation, the GDA interprets that: • The exhibition consists of both digital images and interactive installations (A_{int} or E_{int}), and • If the total number of digital images in the exhibition is a, the average length of the images is b, the maximum length of any image is c (A_{int} or E_{int}), a*b+(a-8)/2<81m and c<20m, and • If the total number of interactive installations in the exhibition is d, the average length of the installations is e, the maximum length of any installation is f, the maximum width of any installation is g, the maximum height of any installation is h (A_{int} or E_{int}), d*e+(d-1)<21m, f<21m, g<9m and h<6m, and • The gallery area is currently not arranged (O_{int}). In hypothesising, based on the above interpretations: • A design goal: O_{exp}^{F}=gIMS is hypothesised. Therefore, sL=gIMS is matched.
sL=mS: to configure a meeting area in the artist's personal studio area.	To match sL=mS: In interpretation, the GDA interprets that: • The artist requests a meeting venue for a small crowd ≤ 10 (A_{int} or E_{int}), and • There is no meeting venue available in the virtual gallery (O_{int}). In hypothesising, based on the above interpretations: • A design goal: O_{exp}^{F}=mS is hypothesised. Therefore, sL=mS is matched.

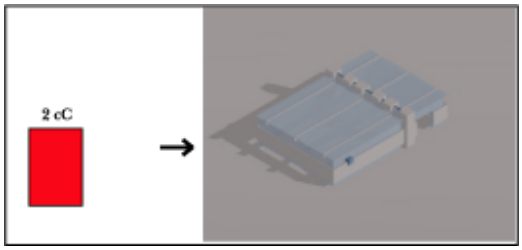
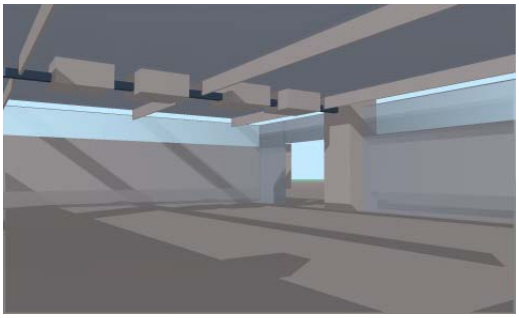
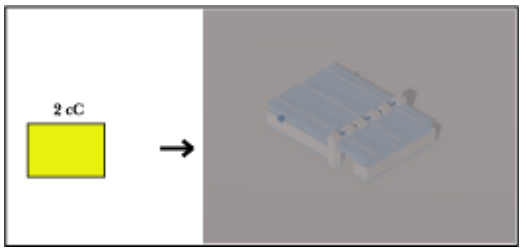
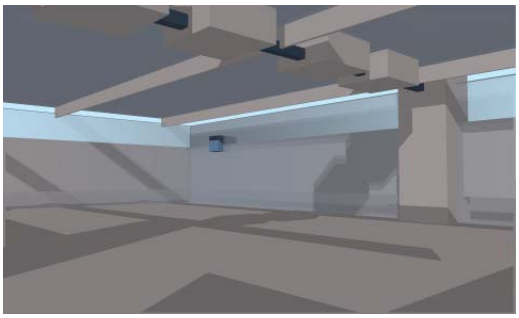
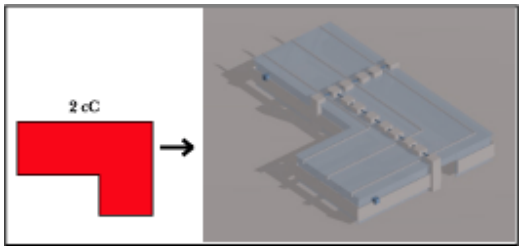
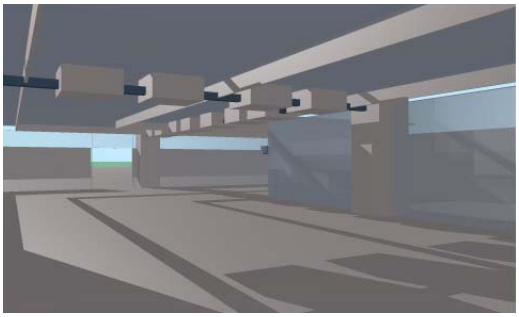
sL= mMc: to arrange the multi-function area as a conference venue.	To match sL=mMc: In interpretation, the GDA interprets that: • A design goal O_{exp}^{F}=mC was previously hypothesised, and • The multi-function area is currently not arranged (O_{int}). In hypothesising, based on the above interpretations: • A design goal: O_{exp}^{F}=mMc is hypothesised. Therefore, sL=mMc is matched.
sL=mMi: to arrange the multi-function area for exhibiting visually large-scale installations.	To match sL=mMi: In interpretation, the GDA interprets that: • A design goal O_{exp}^{F}=mI was previously hypothesised, and • The multi-function area is currently not arranged (O_{int}). In hypothesising, based on the above interpretations: • A design goal: O_{exp}^{F}=mMi is hypothesised. Therefore, sL=mMi is matched.

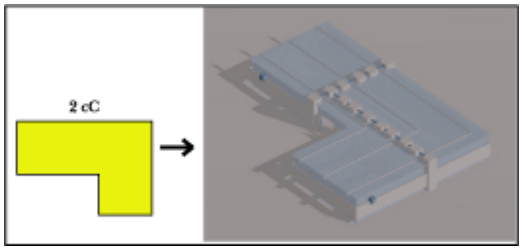
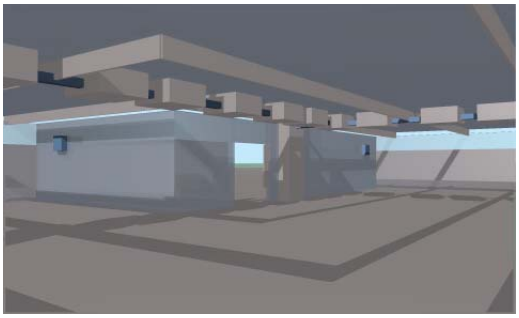
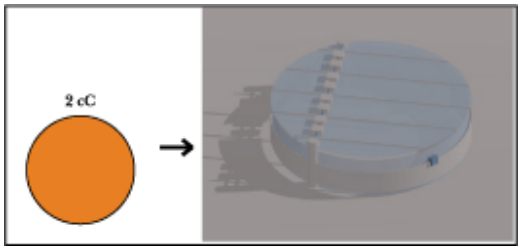
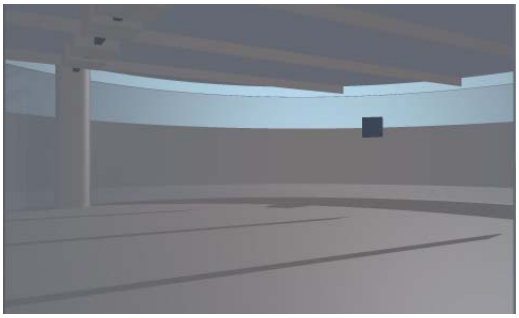
Subtractive placement rules share the same group of state labels, defined earlier for subtractive layout rules.

Additive Placement Rules

Additive placement rules that replace 2D layouts with 3D objects to define visual boundaries, and specify purposeful objects, for different areas of the virtual gallery:

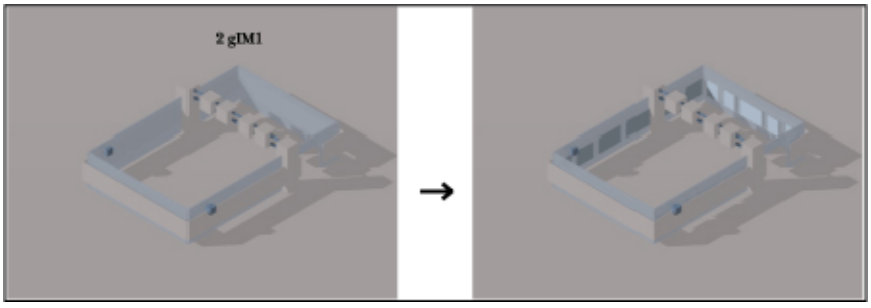
1.  sL=2: this is an object placement rule that should be fired second. sL=cC: to apply a cold-colour scheme for the interior of the virtual gallery.	 An interior view of a reception area.
2.  sL=2: this is an object placement rule that should be fired second. sL=cC: to apply a cold-colour scheme for the interior of the virtual gallery.	 An interior view of the artist's personal studio area.

3.  sL=2: this is an object placement rule that should be fired second. sL=cC: to apply a cold-colour scheme for the interior of the virtual gallery.	 An interior view of a standard gallery 1 area.
4.  sL=2: this is an object placement rule that should be fired second. sL=cC: to apply a cold-colour scheme for the interior of the virtual gallery.	 An interior view of a standard gallery 2 area.
5.  sL=2: this is an object placement rule that should be fired second. sL=cC: to apply a cold-colour scheme for the interior of the virtual gallery.	 An interior view of an expanded gallery 1 area.

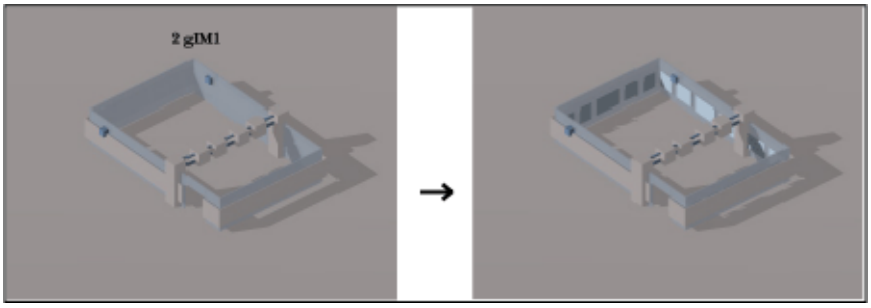
6.  sL=2: this is an object placement rule that should be fired second. sL=cC: to apply a cold-colour scheme for the interior of the virtual gallery.	 An interior view of an expanded gallery 2 area.
7.  sL=2: this is an object placement rule that should be fired second. sL=cC: to apply a cold-colour scheme for the interior of the virtual gallery.	 An interior view of the multi-function area.

Similar to additive placement rules 1 to 7, a set of design rules that apply a warm-colour scheme for the interior of the virtual gallery can be developed if the artist has a different preference in colours.

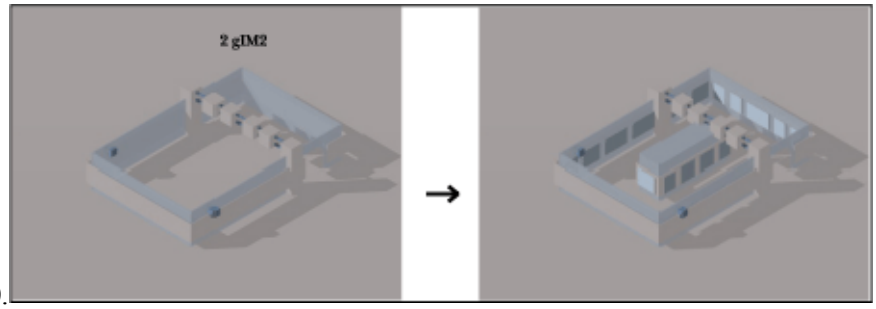
Additive placement rules that further arrange each area for different purpose (in the following illustrations, the roof of each area is removed in order to show the interior):

8. 

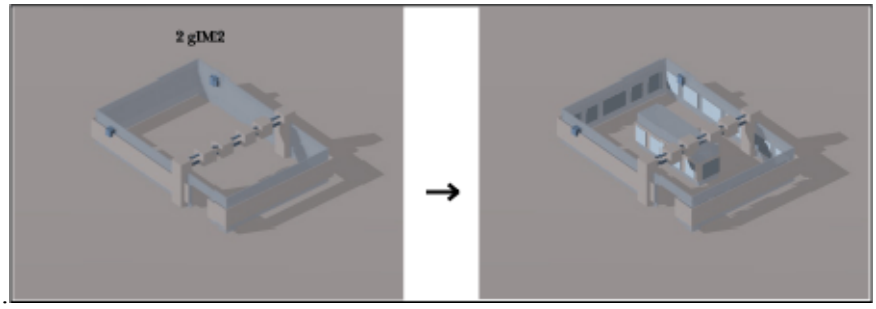
sL=2: this is an object placement rule that should be fired second.
sL=gIM1: to arrange a gallery area for displaying digital images using configuration 1.

9. 

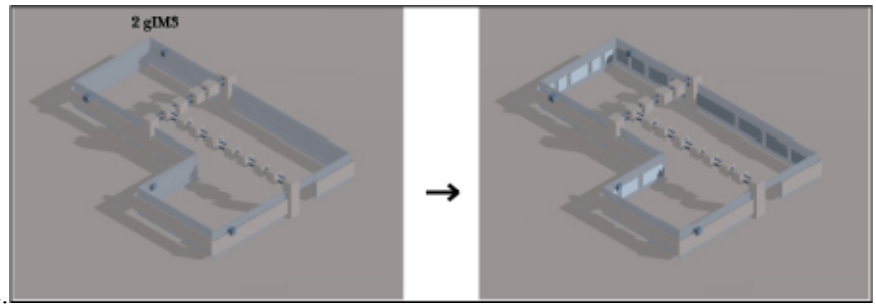
sL=2: this is an object placement rule that should be fired second.
sL=gIM1: to arrange a gallery area for displaying digital images using configuration 1.

10. 

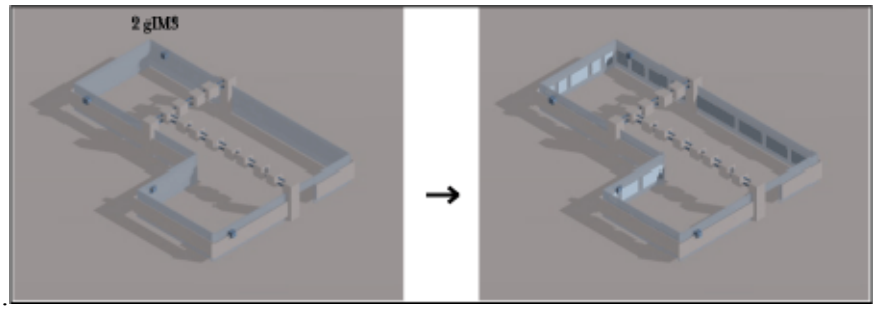
sL=2: this is an object placement rule that should be fired second.
sL=gIM2: to arrange a gallery area for displaying digital images using configuration 2.

11. 

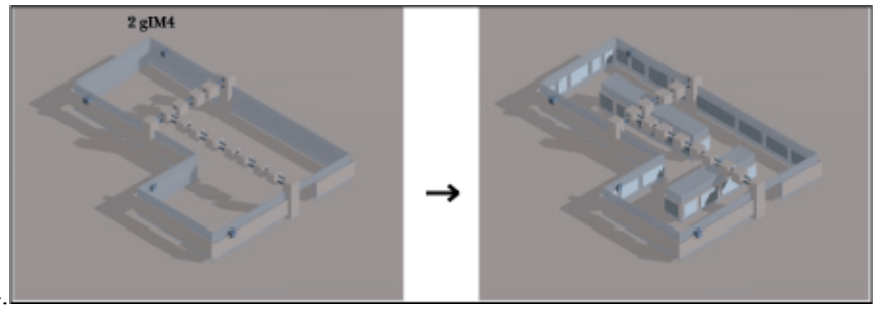
sL=2: this is an object placement rule that should be fired second.
sL=gIM2: to arrange a gallery area for displaying digital images using configuration 2.

12. 

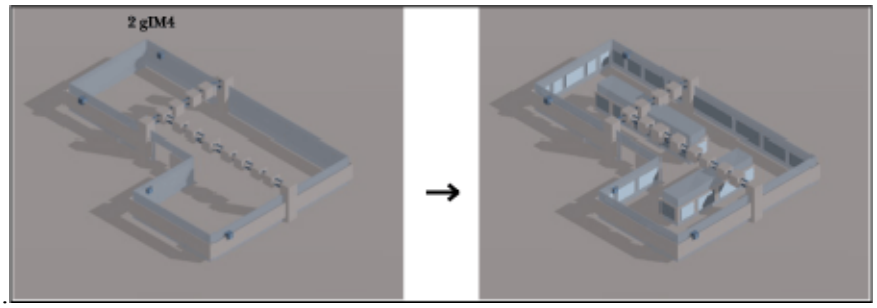
sL=2: this is an object placement rule that should be fired second.
sL=gIM3: to arrange a gallery area for displaying digital images using configuration 3.

13. 

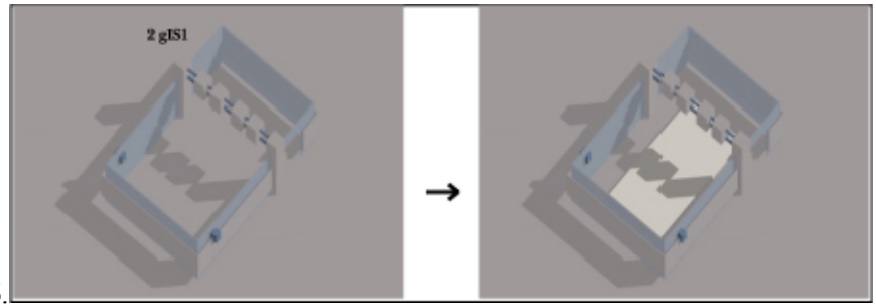
sL=2: this is an object placement rule that should be fired second.
sL=gIM3: to arrange a gallery area for displaying digital images using configuration 3.

14. 

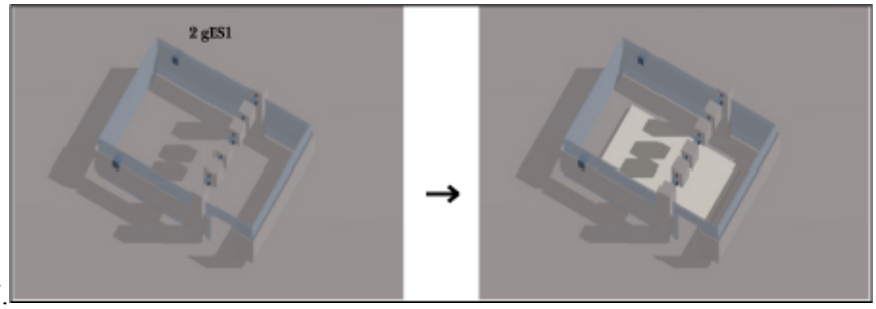
sL=2: this is an object placement rule that should be fired second.
sL=gIM4: to arrange a gallery area for displaying digital images using configuration 4.

15. 

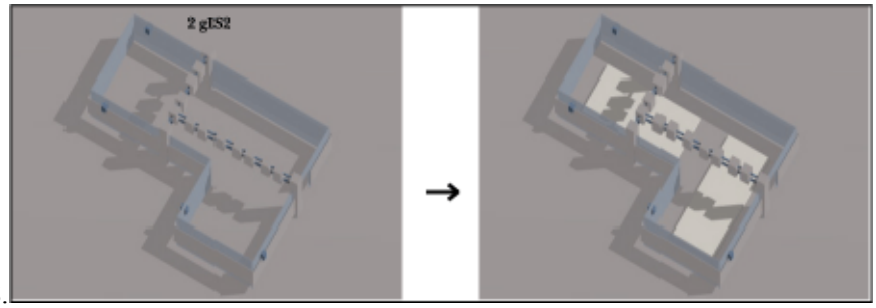
sL=2: this is an object placement rule that should be fired second.
sL=gIM4: to arrange a gallery area for displaying digital images using configuration 4.

16. 

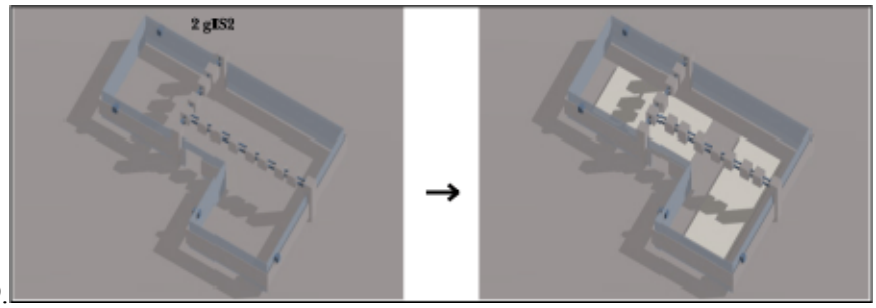
sL=2: this is an object placement rule that should be fired second.
sL=gIS1: to arrange a gallery area for displaying interactive installations using configuration 1.

17. 

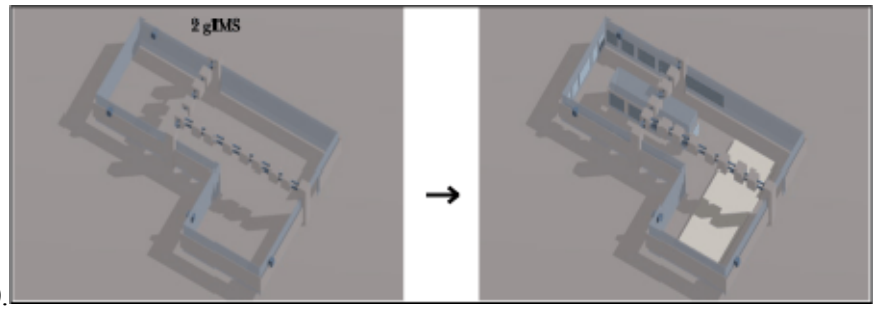
sL=2: this is an object placement rule that should be fired second.
sL=gIS1: to arrange a gallery area for displaying interactive installations using configuration 1.

18. 

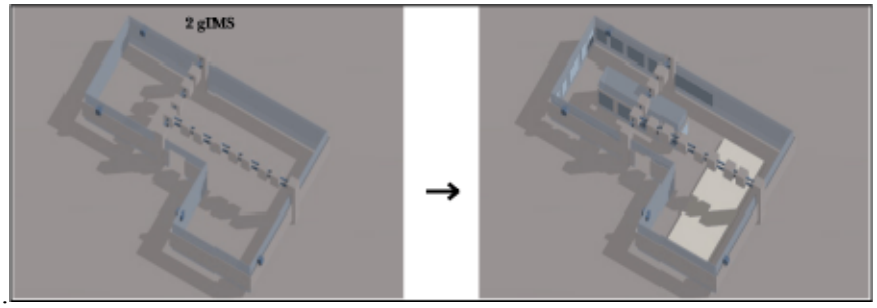
sL=2: this is an object placement rule that should be fired second.
sL=gIS2: to arrange a gallery area for displaying interactive installations using configuration 2.

19. 

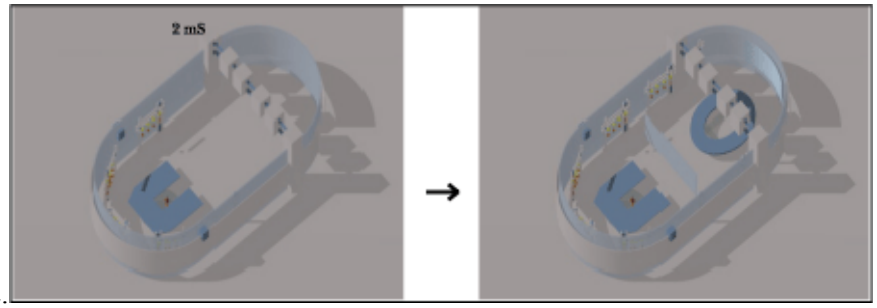
sL=2: this is an object placement rule that should be fired second.
sL=gIS2: to arrange a gallery area for displaying interactive installations using configuration 2.

20. 

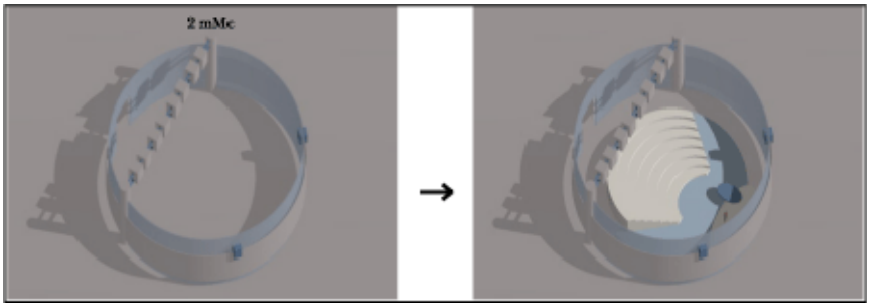
sL=2: this is an object placement rule that should be fired second.
sL=gIMS: to arrange a gallery area for displaying both digital images and interactive installations.

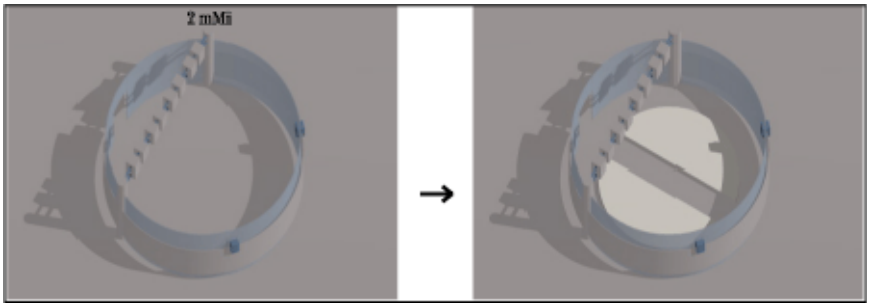
21. 

sL=2: this is an object placement rule that should be fired second.
sL=gIMS: to arrange a gallery area for displaying both digital images and interactive installations.

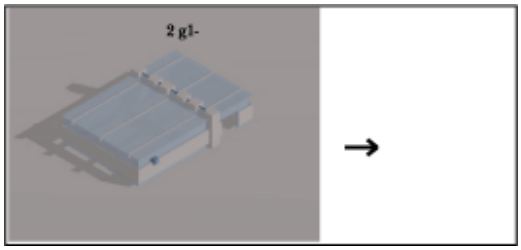
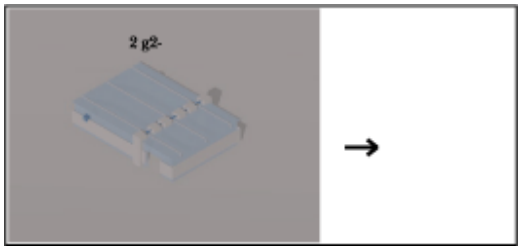
22. 

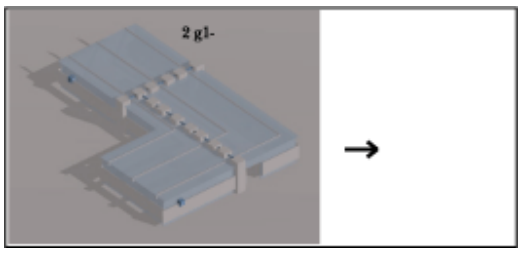
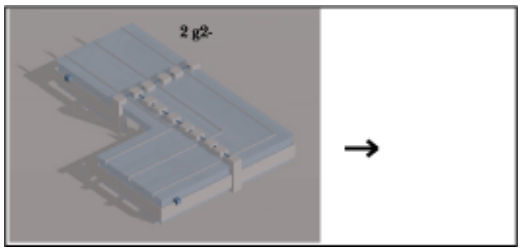
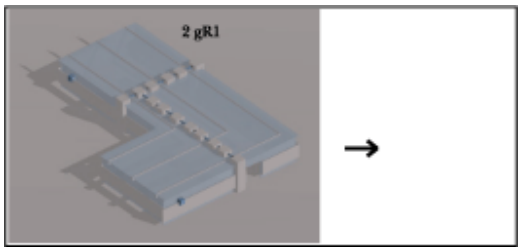
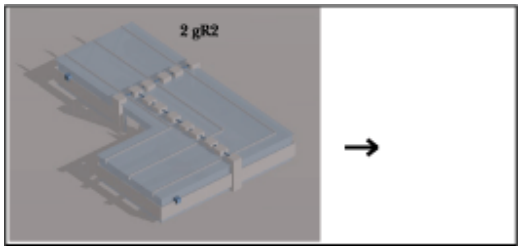
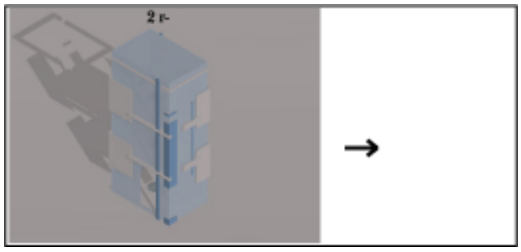
sL=2: this is an object placement rule that should be fired second.
sL=mS: to configure a meeting area in the artist's personal studio area.

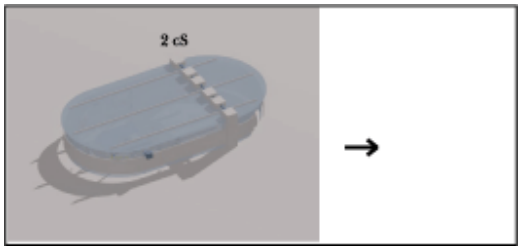
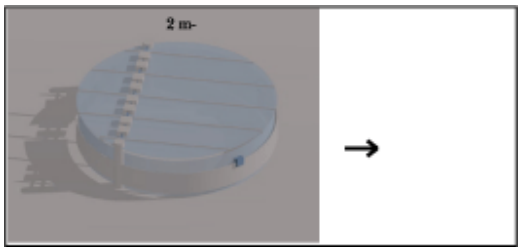
23. 	
sL=2: this is an object placement rule that should be fired second. sL= mMc: to arrange the multi-function area as a conference venue.	

24. 	
sL=2: this is an object placement rule that should be fired second. sL=mMi: to arrange the multi-function area for exhibiting visually large-scale installations.	

Subtractive Placement Rules

1. 	sL=2: this is an object placement rule that should be fired second. sL=g1-: a standard/expanded gallery 1 area is redundant.
2. 	sL=2: this is an object placement rule that should be fired second. sL=g2-: a standard/expanded gallery 2 area is redundant.

3. 	sL=2: this is an object placement rule that should be fired second. sL=g1-: a standard/expanded gallery 1 area is redundant.
4. 	sL=2: this is an object placement rule that should be fired second. sL=g2-: a standard/expanded gallery 2 area is redundant.
5. 	sL=2: this is an object placement rule that should be fired second. sL=gR1: an expanded gallery 1 area needs to be reduced.
6. 	sL=2: this is an object placement rule that should be fired second. sL=gR2: an expanded gallery 2 area needs to be reduced.
7. 	sL=2: this is an object placement rule that should be fired second. sL=r-: a reception area is redundant.

8. 	sL=2: this is an object placement rule that should be fired second. sL=cS: the current design of the virtual gallery is to be used as a static design (the virtual gallery stops being dynamically designed).
9. 	sL=2: this is an object placement rule that should be fired second. sL=m-: the multi-function area is not needed.

NAVIGATION RULES

Symbols

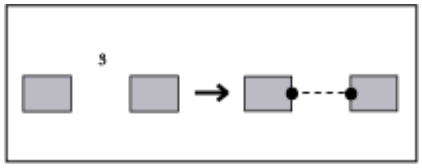
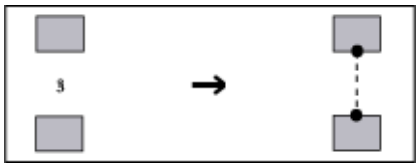
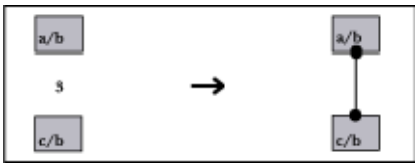
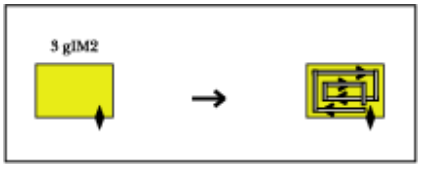
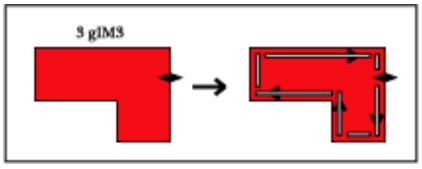
Additional symbols used in navigation rules:

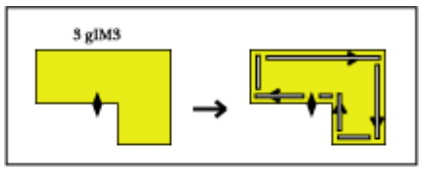
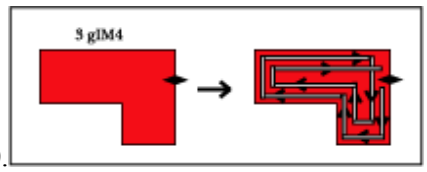
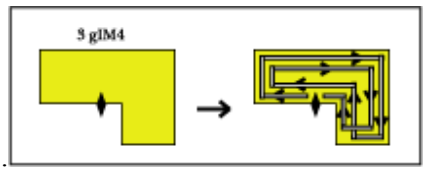
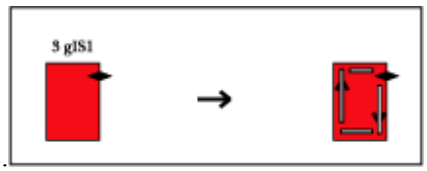
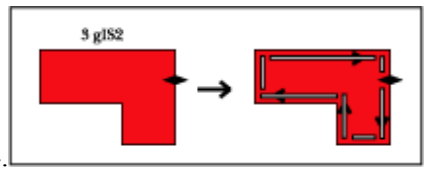
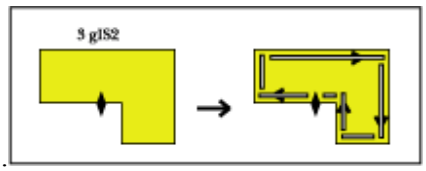
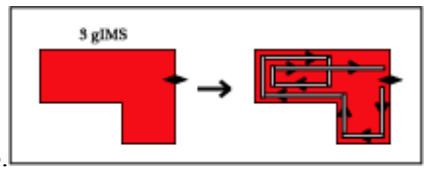
	An opening to connect two spatially adjacent areas.
	A pair of hyperlink portals that teleports GDAs/avatars between any two locations in the virtual gallery. In the example grammar, this kind of hyperlink portal is used in different reception areas of the virtual gallery.
	A pair of hyperlink portals that warps GDAs/avatars between any two locations in the virtual gallery. In this example grammar, this kind of hyperlink portal is used in different floors of a reception area.
	A path laid between two spatially adjacent areas for directing visitors from one area to the other.
	A path laid in a gallery area for guiding visitors in an exhibition.
	floor a of reception area b.
	floor c of the same reception area b.

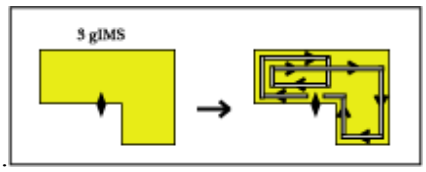
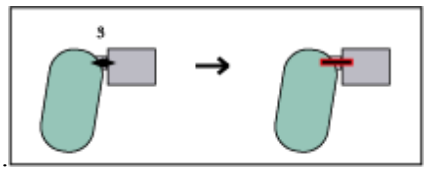
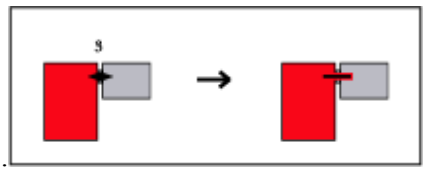
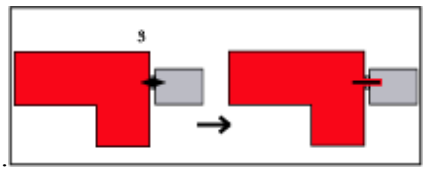
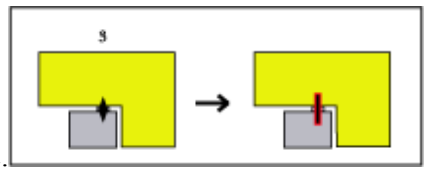
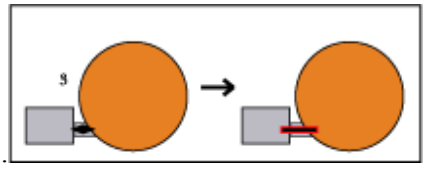
State labels:

sL=3 are used in all navigation rules indicating navigation rules are the third set of design rules to be fired in the application of the example grammar. Navigation rules also share some of the state labels, defined earlier for object placement rules.

Additive Navigation Rules

1.  sL=3: this is a navigation rule that should be fired third.	2.  sL=3: this is a navigation rule that should be fired third.
3.  sL=3: this is a navigation rule that should be fired third.	4.  sL=3: this is a navigation rule that should be fired third. sL=gIM1: to arrange a gallery area for displaying digital images using configuration 1.
5.  sL=3: this is a navigation rule that should be fired third. sL=gIM1: to arrange a gallery area for displaying digital images using configuration 1.	6.  sL=3: this is a navigation rule that should be fired third. sL=gIM2: to arrange a gallery area for displaying digital images using configuration 2.
7.  sL=3: this is a navigation rule that should be fired third. sL=gIM2: to arrange a gallery area for displaying digital images using configuration 2.	8.  sL=3: this is a navigation rule that should be fired third. sL=gIM3: to arrange a gallery area for displaying digital images using configuration 3.

9.  sL=3: this is a navigation rule that should be fired third. sL=gIM3: to arrange a gallery area for displaying digital images using configuration 3.	10.  sL=3: this is a navigation rule that should be fired third. sL=gIM4: to arrange a gallery area for displaying digital images using configuration 4.
11.  sL=3: this is a navigation rule that should be fired third. sL=gIM4: to arrange a gallery area for displaying digital images using configuration 4.	12.  sL=3: this is a navigation rule that should be fired third. sL=gIS1: to arrange a gallery area for displaying interactive installations using configuration 1.
13.  sL=3: this is a navigation rule that should be fired third. sL=gIS1: to arrange a gallery area for displaying interactive installations using configuration 1.	14.  sL=3: this is a navigation rule that should be fired third. sL=gIS2: to arrange a gallery area for displaying interactive installations using configuration 2.
15.  sL=3: this is a navigation rule that should be fired third. sL=gIS2: to arrange a gallery area for displaying interactive installations using configuration 2.	16.  sL=3: this is a navigation rule that should be fired third. sL=gIMS: to arrange a gallery area for displaying both digital images and interactive installations.

17.  sL=3: this is a navigation rule that should be fired third. sL=gIMS: to arrange a gallery area for displaying both digital images and interactive installations.	18.  sL=3: this is a navigation rule that should be fired third.
19.  sL=3: this is a navigation rule that should be fired third.	20.  sL=3: this is a navigation rule that should be fired third.
21.  sL=3: this is a navigation rule that should be fired third.	22.  sL=3: this is a navigation rule that should be fired third.
23.  sL=3: this is a navigation rule that should be fired third.	

Subtractive Navigation Rules

1. sL=3 IF: A pair of hyperlink portals (teleport) connects reception area a with reception area b. AND Reception area a is not sensed in the virtual gallery. AND/OR Reception area b is not sensed in the virtual gallery. THEN: Remove the hyperlink portals.
2. sL=3 IF: A pair of hyperlink portals (warp) connects floor a with floor b in a reception area. AND

Floor a is not sensed in the reception area. AND/OR Floor b is not sensed in the reception area. THEN: Remove the hyperlink portals..
3. sL=3 IF: A path is laid in a gallery area for guiding visitors in an exhibition. AND The layout of the gallery area changes. AND/OR The visual boundaries of the gallery area change. THEN: Remove the path.
4. sL=3 IF: A path connects a reception area with the artist's personal studio area. AND The reception area is not sensed in the virtual gallery. AND/OR The artist's personal studio area is not sensed in the virtual gallery. THEN: Remove the path.
5. sL=3 IF: A path connects a reception area with a gallery area. AND The reception area is not sensed in the virtual gallery. AND/OR The gallery area is not sensed in the virtual gallery. THEN: Remove the path.
6. sL=3 IF: A path connects a reception area with the multi-function area. AND The reception area is not sensed in the virtual gallery. AND/OR The multi-function area is not sensed in the virtual gallery. THEN: Remove the path.

INTERACTION RULES

State Labels

sL=4 is the only state label used in interaction rules indicating interaction rules are the final set of design rules to be fired in the application of the example grammar.

Additive Interaction Rules

1. sL=4 IF: The 3D model of a digital picture frame object is recognised within a gallery area. AND The digital picture frame object is currently not configured. THEN: Render the appropriate digital image onto the surface of the 3D model from the artist's exhibition. AND Enable the digital image to be enlarged and accessed from the web browser.
2. sL=4 IF: The 3D model of an object that forms a part of an interactive installation is recognised within a gallery area or the multi-function area. AND The object is currently not configured. THEN: Ascribe appropriate behaviours to the object according to the artist's exhibition requirements.
3. sL=4 IF: The 3D model of a digital document object is recognised within a reception area, the artist's personal studio area, or the multi-function area. AND The digital document object is currently not configured. THEN: Attach the relevant digital information to the object. AND Enable the detail of the information to be accessed from the web browser.
4. sL=4 IF: A 3D model of a digital projector object is recognised in the multi-function area or the artist's personal studio area. AND The digital projector object is currently not configured. THEN: Load the conference/meeting materials to the object for presentation.
5. sL=4 IF: The 3D models of a pair of hyperlink portals (teleport) are recognised connecting two reception areas. AND The portals are currently not configured. THEN: Detect the coordinates of the portals. AND Activate the portals using the detected coordinates.
6. sL=4 IF: The 3D models of a pair of hyperlink portals (warp) are recognised connecting two different floors of a reception area. AND The portals are currently not configured.

THEN: Detect the coordinates of the portals.
AND
Detect any obstacle between these two locations.
IF: No obstacle exists.
THEN: Activate the portals using the detected coordinates.
IF: Any obstacle exists.
THEN: Change the hyperlink portals (from warp to teleport).
AND
Activate the portals using the detected coordinates.

Subtractive Interaction Rules

For the example grammar, subtractive interaction rules do not need to be explicitly defined. The application of additive interaction rules ascribes appropriate behaviours to selected objects in the virtual gallery. The programming scripts that support the behaviours become attributes of the objects. Therefore, when other design rules of the grammar are applied to remove or make changes to the objects any attributes previously associated with the objects will be automatically removed.