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A CASE STUDY OF AFFORDANCE AND AFFORDANCE FEATURE IDENTIFICATION THROUGH USER OBSERVATION

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ABSTRACT
This paper investigates the relationship between affordances and affordance features critical for human activities. *Affordance features* are structural elements of the environment that are closely related to affordances. We conducted a case study in a public space – a building lobby – used by many general people. User activities and behaviors were analyzed in several specific tasks given to twenty participants in the lobby they have never visited before. Then we identified affordances and affordance features. The affordance features have a hierarchical nature, ranging from areas to detailed attributes. Affordance-feature map obtained from user activity studies could be used in developing a repository for affordance based design so that specific affordance features could be retrieved in support of certain affordances.

Keywords: Affordance, Affordance Feature, User Activity, User Observation

1 INTRODUCTION
In design research, the concept of affordance has been introduced due to its psychological and cognitive aspects to effectively reflect the human needs into the products or space. Affordance was coined by perceptual psychologist James J. Gibson as follows: *"The affordances of the environment are what it offers to the animal, what it provides or furnishes, either for good or ill. It implies the interaction of the animal and the environment."*[1]. Affordance has a significant influence on the human life. As Archea [2] mentioned, many accidents in buildings can be attributable to misaffordance. In the case of interior space, the built environment usually allows humans the clue – affordance – to decide what activities they have to do. In the space, there exist features that include properties such as physical size and shape and psychological meaning. These features are critical for affording human behaviors or activities based on the cognitive decision. *Affordance features* are defined as structural elements of the environment or the product that are closely related to affordances. Norman introduced perceived affordance that is about characteristics from the human perspective in the appearance of an object that gives clues for its proper operations [3]. From the user's perspective, he focused on three levels – visceral, behavioral, reflective level – of user's emotional response to a product [4] [5].

This paper investigates the relationship between affordances and features, which are very critical to conveniently allow human activities or behaviors under given tasks in the course of interior space design. A case study on the public space – a lobby – used by many people everyday is conducted to extract the affordances with related actual features that usually exist in the real situation. The affordances are identified by observing the activities of the participants in this case study. The participants' activities and affordances are identified, and the features in various spaces are also mapped to the affordances by generating the affordance-feature matrix. The methodology proposed in this paper can guide the designer to effectively reflect the affordance concept by considering the critical features in the space.

2 BACKGROUND

In the field of engineering design, the research efforts to develop the design theory and methodology reflecting the concept of affordance have made some progress. Maier and Fadel proposed the Affordance-Based Design (ABD) method to overcome the weaknesses of Function-Based Design, thus to take the synergy between affordance and function based approaches for better design [6] [7]. In their affordance-based design, affordances are grouped into two categories as positive affordances and negative affordances, and characterized into artifact-artifact affordance and artifact-user affordance.

Brown and Blessing addressed the relationship between function and affordance. They attempted to clarify the concept of affordances, to relate affordances to function [8]. Galvao and Sato proposed Function-Task Interaction (FTI) Method [9]. The FTI method has been applied in identifying affordances for a conference room [10], where affordances for social issues have been addressed beyond function oriented affordances. Also, Murakami et al. tried formulation of affordance feature for product design with some simple shape (elliptical, conical or rectangular section) objects. In this research, he showed that existence of strong relation between some geometric features (he called that affordance features) such as height, aspect ratio between width and length are associated with humans action such as pushing, pulling, turning and tilting as an example [11].

Maier et al. [12] proposed the affordance-structure matrix to relate the affordance with the components of the products. However, their research did not consider the hierarchical properties of the components *the features in our study*, which are more specific for the affordances of the products. In addition, the user tasks which can link the affordances to products were omitted.

3 USER OBSERVATION

We conducted a case study to investigate the affordances which can be found in a lobby. Thus, we selected the lobby space of a commercial building, referred to as P-building, which has high traffic of general people as the research space for the study. The research space consists of one building and two towers, where the entrances for the towers face each other around piloti. We divided this research space into 5 sub-spaces overall according to their locations, and the sub-spaces were divided into 15 zones in more detail. The floor plan of the research space and associated sub-spaces and zones is given in Figure 1. As can be seen in Figure 1, Space A was further divided into six zones and Space B consisted of three zones. Similarly, Space C was divided into three zones, and Space D was composed of two zones. Finally, Space E had only one zone.

Figure 1. Floor plan of research space for the case study

In the case study, we recruited 20 students who were between freshmen and juniors of the Sungkyunkwan University. We assigned 9 different user tasks to each student, and tried to extract as many affordances as possible from the activities of the students doing the given tasks. The observation method was introduced to objectively monitor the student's activities and extract possible affordances with video recording, photographs and voice recording. The tasks were conducted individually, and it took 20-40 minutes for each participant. The user tasks are:

T-1: Waiting / Space A
T-2: Eating snack / Space A
T-3: Reading the magazine / Space A
T-4: Dumping trash / Space A
T-5: Going to Tower 2 lobby / Space B→ C
T-6: Sketching on a piece of paper / Space C
T-7: Going to outside / Space C → D
T-8: Tying shoelaces and Shaking sand out / Space A or D
T-9: Going back to Tower 1 lobby / Space A or E

4 AFFORDANCE IDENTIFICATION

Affordances of the lobby could be obtained from two different points of view. Firstly, we extracted the affordances by *observing* the participants' activities under given tasks. By thoroughly observing user activities in conducting the given tasks, we identified affordances. This was done by identifying when the nature of interaction of user with their surroundings, as well as their belongings and human body parts, changes. Secondly, affordances were extracted from the general *issues* of lobby design as can be obtained in the literature of lobby design.

4.1 Observed affordances from user interaction state change

From the results of 9 tasks of the participants in the experiment, a total of 66 activities of all 20 students were observed and listed in a sequential manner, which are shown in Table 1. As can be seen in Table 1, one or more affordances were mapped to each participant's activity. Figures in parenthesis in Table 1 refer to the number of participants. These 66 activities cannot be regarded as generic ones since they were monitored by observing the participants' activities in the particular research space. The affordances can be summarized as follows:

Look-ability, Walk-ability, Step-ability, Sit-ability, Support-ability, Place-ability, Hang-ability, Touch-ability, Tap-ability, Eat-ability, Drink-ability, Hold-ability, Lean-ability, Read-ability, Dump-ability, Push-ability, Enter/Exit-ability, Information Access-ability, Draw-ability, Rotate-ability, Pull-ability, Tie-ability

Three kinds of affordances were derived from the research space. One is a physical feature of the building itself, another is human body and the other is participants' belongings. For instance, as noted in Table 1, the activity T2-A1 is mapped to three different place-abilities represented by orange, violet and green shadings respectively. The place-ability denoted by the orange shading is attributed to a physical feature of the space such as a stool or a part of the wall. The place-ability indicated by the violet shading is attributed to the human body such as a thigh or a palm, and that denoted by the green shading is due to belongings, such as a bag or a magazine. An example is shown in Figure 2.

Figure 2. Three different kinds of affordance features

To derive the observed affordances, we analyzed recorded videos, photos and voices. In conducting a given task, users may show different activities. We characterize user activity by interaction state of the user, the structural elements of the environment as well as their belongings and their body parts, and possibly other humans. For example, when a student conducted the sketching task in Space C, he was holding a cup with his bag hanging by his shoulder. With this state, the student entered into Space C so that his interaction state with the environment is now changed so that he is within Space C. He walked around in Space C. As long as he walked, this state of interaction with the floor remained.

When he looked at a specific object, the interaction with this object started. Then when he looked at another object, the interaction with new object was generated, thus state being changed. When he touched a button of the elevator, he started new interaction with the button. When he sat on the rim of the plant area, he engaged new interaction with the rim by sitting. When he placed his right leg on top of his left leg, he changed his interaction state with his own body parts. All these interaction changes could be associated with affordances and those structural elements engaged in state changes could also be associated as affordance features.

Table 1. Activity and related affordance

Task	Activity No.	Activities of Participants	Related Affordance		
			with Physical Feature	with Human Feature	with Belongings Feature
T-1 (15)	T1-A1	Looking for sitting place.	Look-ability (10), Walk-ability (10)		
	T1-A2	Walking.	Walk-ability (9)		
	T1-A3	Stepping up and down.	Step-ability (8)		
	T1-A4	Sitting.	Sit-ability (15)		
	T1-A5	Supporting a leg.		Support-ability (2)	
	T1-A6	Placing the bag on somewhere.	Place-ability (10)	Place-ability (5)	
	T1-A7	Supporting the bag on somewhere.	Support-ability (1)	Support-ability (4)	
	T1-A8	Hanging the bag.		Hang-ability (5)	
	T1-A9	Looking something.	Look-ability (8)		
	T1-A10	Touching something.	Touch-ability (1)		
T-2 (15)	T2-A1	Placing eggs/bread and a cup of beverage.	Place-ability (14)	Place-ability (1)	Place-ability (2)
	T2-A2	Supporting a cup of beverage.		Support-ability (1)	
	T2-A3	Tapping eggs.	Tap-ability (7)		
	T2-A4	Eating eggs/bread.	Eat-ability (12)		
	T2-A5	Drinking a cup of baverage.	Drink-ability (15)		
	T2-A6	Holding a cup of baverage.		Hold-ability (14)	
T-3 (15)	T3-A1	Placing the magazine.	Place-ability (5)	Place-ability (5)	Place-ability (3)
	T3-A2	Supporting the magazine.		Support-ability (13)	
	T3-A3	Holding the magazine.		Hold-ability (5)	
	T3-A4	Leaning.	Lean-ability (1)		
	T3-A5	Reading the magazine.	Read-ability (15)		
T-4 (15)	T4-A1	Looking for a trash can.	Look-ability (11), Walk-ability (11)		
	T4-A2	Dumping the trash.	Dump-ability (11), Push-ability (11)		
T-5 (15)	T5-A1	Stepping up the winding stairs.	Step-ability (15)		
	T5-A2	Looking something.	Look-ability (1)		
	T5-A3	Exittng outside.	Enter/Exit-ability (15), Walk-ability (15)		
	T5-A4	Looking for the entrance of Tower 2.	Look-ability (15), Walk-ability (15)		
	T5-A5	Looking at the sign.	Information access-ability (15)		
	T5-A6	Entering the entrance.	Enter/Exit-ability (15), Walk-ability (15)		
	T5-A7	Looking for the escalator.	Look-ability (14), Walk-ability (14)		
	T5-A8	Stepping up the escalator.	Step-ability (15)		
	T5-A9	Holding the escalator's handrail	Hold-ability (6)		
T-6 (15)	T6-A1	Entering into the lobby.	Enter/Exit-ability (15), Walk-ability (15)		
	T6-A2	Looking for place to draw a painting.	Look-ability (15), Walk-ability (14)		
	T6-A3	Touching something.	Touch-ability (2)		
	T6-A4	Looking at framed picture.	Look-ability (4)		
	T6-A5	Looking at the warning message.	Look-ability (12), Information access-ability (12)		
	T6-A6	Sitting and Leaning to draw painting.	Sit-ability (7), Lean-ability (1)		
	T6-A7	Hanging the bag.		Hang-ability (6)	
	T6-A8	Holding and Biting a cup and somethings.		Hold-ability (6)	
	T6-A9	Placing the bag and belongings.	Place-ability (11)		
	T6-A10	Supporting a leg.		Support-ability (2)	
	T6-A11	Placing paper.	Place-ability (5)		
	T6-A12	Supporting paper.	Support-ability (4)	Support-ability (5)	Support-ability (3)
	T6-A13	Biting a pen cap with teeth.		Hold-ability (1)	
	T6-A14	Drawing.	Draw-ability (15)		
	T6-A15	Exiting the lobby.	Information access-ability (9), Enter/Exit-ability (15)		
T-7 (15)	T7-A1	Looking for stairs.	Look-ability (15), Walk-ability (15)		
	T7-A2	Looking at the sign.	Information access-ability (13)		
	T7-A3	Rotating the door knob to open.	Hold-ability (15), Rotate-ability (15)		
	T7-A4	Entering into the stair hall.	Enter/Exit-ability (15), Walk-ability (15)		
	T7-A5	Stepping down the stairs.	Step-ability (15)		
	T7-A6	Pulling or Pushing the door handle to open.	Pull-ability (10), Push-ability (3)		
	T7-A7	Exittng outside.	Enter/Exit-ability (14), Walk-ability (14)		
T-8 (14)	T8-A1	Looking for place to tie.	Look-ability (7), Walk-ability (5)		
	T8-A2	Placing bags and belongings.	Place-ability (10)		Place-ability (2)
	T8-A3	Supporting a foot.	Support-ability (4)		
	T8-A4	Supporting a leg.		Support-ability (3)	
	T8-A5	Tapping shoe.	Tap-ability (3)	Tap-ability (4)	
	T8-A6	Tying shoelaces.	Tie-ability (13)		
T-9 (15)	T9-A1	Looking for the entrance of Tower 1.	Look-ability (15), Walk-ability (15)		
	T9-A2	Pushing the door button to open.	Push-ability (11)		
	T9-A3	Entering the entrance.	Enter/Exit-ability (15), Walk-ability (15)		
	T9-A4	Stepping down winding stairs.	Step-ability (15)		
	T9-A5	Touching a beam.	Touch-ability (1)		
	T9-A6	Touching a pendant.	Touch-ability (2)		

The case of one particular participant, p-15 executing Task 6, sketching a scene on a piece of paper, is given in Figure 3. It shows p-15's sequential activities and the observed affordances that were derived. Generally, activities T6-A1 to T6-A15 were drawn from Task 6. However, P-15 did not perform T6-A3, T6-A11 and T6-A13.

Figure 3. How was the observed affordance derived?

4.2 Issue affordances

In addition to the task-oriented affordances discussed in the section of 4.1, we also extracted additional affordances that may not easily be seen in the participants' activities from the literature. We referred to the "Issue Check List" that has been used for architectural programming [13]. The "Issue Check List" includes basic issues to be considered in the course of design of architectural space including interior design, which can be interpreted into the affordances of lobby. The "Issue Check List" is given in Table 2. Consequently, we could come up with 10 affordances from the literature including visibility, audibility, mood-ability, maintain-ability, circulate-ability, convenience-ability, comfort-ability, interact-ability, privacy control-ability and safety.

Table 2. Issue check list for architectural programming [13]

- Audibility
- Behavior settings
- Circulation
  - Information
  - Material
  - Parking
  - Pedestrians
  - Vehicles
- Comfort
  - Physical
  - Psychological
- Convenience
- Durability
- Economy
  - Elegant means
  - Phasing
  - Quality
- Energy efficiency
- Environmental impact
- Flexibility
  - Adaptability
  - Choice / Variety
  - Expansion / Contraction
  - Multi-use
- Image
  - Identity
  - Message
  - Ordering / Proportion
  - Status / Hierarchy
  - Symbolism
- Interaction
  - Group participation
  - Social
- Legibility
  - Layering
  - Orientation
  - Plan recognition
  - Sequence
- Maintenance
- Mood / Ambience
  - Attitude
  - Emotional response
  - Spirit of place
- Olfactory
- Personalization
  - Group
  - Individual
- Privacy
  - Group
  - Individual
- Resource Management
- Safety
  - Accidents
  - Hazards
- Security
  - Assault
  - Robbery
  - Unauthorized access / Entry
  - Vandalism
- Territory
  - Group
  - Individual
- Visibility

4.3 List of lobby affordances

A total 32 affordances, consisting of 22 affordances from the observation of participants' activities and 10 affordances from the literature, were identified for the P-building space. These affordances are summarized in Table 3.

Table 3. List of lobby affordances

Issue Affordances	Observed Affordances	
· Visibility	· Walk-ability	· Hold-ability
· Audibility	· Step-ability	· Push-ability
· Mood-ability	· Enter/Exit-ability	· Pull-ability
· Maintain-ability	· Sit-ability	· Rotate-ability
· Circulate-ability	· Lean-ability	· Dump-ability
· Convenience-ability	· Place-ability	· Eat-ability
· Comfort-ability	· Support-ability	· Drink-ability
· Interact-ability	· Look-ability	· Read-ability
· Privacy Control-ability	· Information Access-ability	· Draw-ability
· Safety	· Tap-ability	· Tie-ability
	· Touch-ability	· Hang-ability

5 AFFORDANCE-FEATURE MATRIX

5.1 Hierarchical view of affordance features in lobby

Every object has geometry through which humans interact with it, physically as well as cognitively. But the interactions are made not through the whole geometry, but through some (physically or cognitively) meaningful subset of the geometry, which is *feature*. Therefore, we focus on the cognitively meaningful features as affordance features for providing strong clues for interaction between human and object.

In this research, we have investigated the features of the research space. We organize features into a hierarchy of attributes, which includes *area*, *set*, *object* and *detail attributes*. The detail attribute represents the lowest stage of features and composes the object. A number of objects make up a set, and finally, the sets compose an area. These four entities can be classified as features of the research space. Area is the space having certain purposes. The red-stool area, revolving door area and winding stairs area can be area features in this research space. The set is defined by the elements of an interior space such as floors, ceilings, walls, column, beams and their compositional layout, which defines the space. The objects are the elements that exist in the space, and include table, red stool, stone stool, and so on. Finally, the detail attribute is a lower-order feature to compose the object, and the color, material, line and point serve as examples. The hierarchical relationship among features is figuratively shown in Figure 4, left side. In this case study, we came up with 27 areas, 153 sets, 76 objects and 166 detail attributes, resulting in 422 total features.

Sit-ability can be afforded by the flat surface (detail attribute-level feature), but can also be afforded by a bench (object-level feature), the set of benches (set-level feature) and the bench area including those benches (area-level feature) as shown in Figure 4, right side. Therefore, the feature composed of detail attribute-level, object-level, set-level and area-level features can afford one particular affordance. However, the degree of perception of each feature in the whole feature cannot be fixed, and it depends on personal experience, habit, knowledge, environment and culture.

Figure 4. Hierarchical relationship among features in the research space

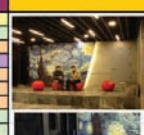
5.2 Affordance-feature matrix

After finding the features in the research space, we developed the affordance-feature matrix to identify the association between the features and affordances. In the affordance-feature matrix, the 899 association between affordances and features were checked and denoted with 1s. In the rightmost columns, the sum of each feature's association with affordances is given, and the sum of each affordance's association with features is given in the lowest row.

5.2.1. Association between affordances and features in red stool area B

More detailed discussions on the association between 22 observed affordances and features are given hereafter. The part of the affordance-feature matrix pertinent to the area-level feature of red stool area B is given in Table 4. As can be seen in Table 4, not only walk-ability, drink-ability and read-ability but also eat-ability and tie-ability have association with area-level and set-level features. Therefore, it is believed that this area – red stool area B of Space A – affords more privacy control than the winding stair area, which is an open area. In addition to above features, the object-level features of red stool and stone stool also provided not only sit-ability and place-ability but also tie-ability.

Table 4. Part of affordance feature matrix (SA-ZD)

Features	Pictures of Features	Walk-ability	Stop-ability	Enter/Exit-ability	Sit-ability	Lean-ability	Place-ability	Support-ability	Look-ability	Information access-	Tap-ability	Touch-ability	Hold-ability	Push-ability	Pull-ability	Rotate-ability	Dump-ability	Eat-ability	Drink-ability	Read-ability	Draw-ability	Lace-ability	Hang-ability	SUM	
Red Stool area B		1			1													1	1	1		1		6	46
floors		1																						1	
flat surface		1																						1	
1-step			1				1																	2	
stone material			1				1																	2	
height 300mm			1				1																	2	
ㄱ surface			1																					1	
ceilings																									
walls (+ virtual walls)						1																		1	
stone tile material						1																		1	
wall partition									1															1	
Gogh, V, V.'s painting									1															1	
lighting									1															1	
columns & beams																									
general lightings																									
red stools					1																			1	
red stool B					1		1															1		3	
red color																									
FRP material (hard surface)					1		1																	2	
height 350mm sphere mass					1		1																	2	
hipline surface					1																			1	
stone stool B					1		1				1							1		1		1		6	
stone material					1		1				1													3	
height 350mm parallelepiped					1		1				1													3	
depth 400mm flat surface					1		1				1													3	
ㄱ surface					1						1													2	

5.2.2. High-ranking affordances

We consider the sums of association of affordances with features. Of all observed affordances, walk-ability has most association (64) with features: 27 association with area-level features, 27 association with set-level features, 4 association with object-level features and 6 association with detail attribute-level features. The affordance having the second most association with features was information-access-ability, which has 50 total association with various features. Since guidance is an important issue in a public space, information-access-ability related to signs and symbols has a lot of association with features. The observed affordances having the third and fourth most association with features were sit-ability and place-ability, respectively. From these results, it is believed that walk-ability and information-access-ability reflect the space issue, and that sit-ability and place-ability reflect the purpose of space in terms of lobby.

In the case of issue affordances, convenience-ability had the most association with features. A total of 79 association with various features – 22 with area-level features, 18 with set-level features, 37 with object-level features and 2 with detail attribute-level features – were identified. The second most association were found in the case of safety with 70 total association. The issue affordances with the third and fourth most association with features were comfort-ability and circulate-ability.

5.2.3. High-ranking features

We investigated the features with a great number of association with affordances. For each area feature, the number of association depended on the characteristics of each area. The issue affordances associated with red stool area A, B and bench area were comfort-ability, convenience-ability and interact-ability. On the other hand, in the case of gardening areas like artificial pond and garden areas, it is likely that mood-ability was of more significance. In the space design, the mood should be reflected since it represents the spirit of a place, resulting in the emotional response of humans inside the space. Therefore, the gardening areas are necessary in the space design to enhance the mood-ability. The red stool area B has most association (70) with 32 affordances and the second most association with affordances (60) was the red stool area A. The third and fourth most association with affordances were bench area (54) and artificial tree area (48).

5.3 Human features and belongings

5.3.1. Human body features

It is likely that humans usually recognize the affordances through their needs. For instance, if a person holds a heavy bag for 10 minutes and feels tired, he/she looks for the place to put the bag down. The need to put the bag down due to its heavy weight makes him/her search for a feature that affords place-ability. On the other hand, if he/she cannot find the objects with the affordance satisfying his/her needs, he/she creates the affordance feature using his/her own body to satisfy his/her needs. The 10 human body features which the participants utilized were extracted from the observations, and they are related to five affordances. These relationships are given in Figure 5.

Figure 5. Human body features and related affordances

5.3.2. Participant's belongings

Humans may create features with better usage by using their belongings. They combine their human body features, belongings and outer objects to provide better affordances. An example is shown in Figure 6. The participant put the magazine on the bollard and the paper was located on the magazine. A cup of beverage was then placed on the paper. In Figure 6, the participant in left side could put his

belongings on the flat surface easily. On the other hand, the participant in right side had the need to put his belongings down because he had to tie his shoes. However, he could not find any feature that sufficiently provides the affordance – place-ability. Instead, he found the bollard on the sidewalk, and he used the bollard to provide the affordance of place-ability by combining with his belongings. He recognized that a bollard can support a relatively thick magazine, and paper can be put on the flat surface that the magazine created. He also recognized the feature combined by the bollard, magazine and paper, on which he could put a cup of beverage. Consequently, we have found out that a human creates the feature that sufficiently provides the specific affordances when there existed no such affordance features that sufficiently and directly satisfied the needs.

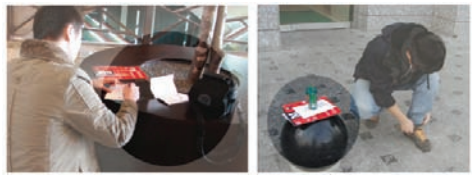


Figure 6. Afford placing by physical feature and belongings feature

5.4 Affordance features

In this section, more detailed discussions on the features which are highly related to certain affordances will be addressed. The particular affordances and their related features are shown in Figure 7. We considered the affordance and their corresponding related features are summarized. Text colors indicate the level of feature (gray: area-level, green: set-level, violet: object-level, orange: detail attribute-level). For example, the features of a stone stool, floor, stair, one step, a bench, a table and sidewalk bollard could afford place-ability, as shown in Figure 7.

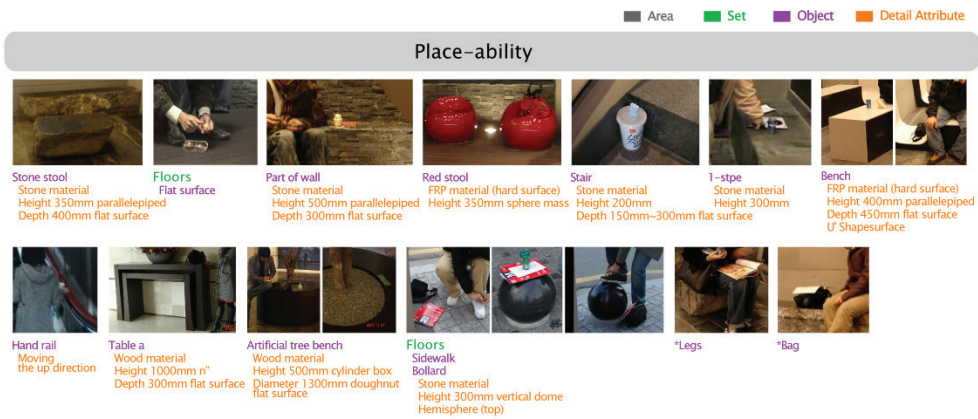


Figure 7. Part of affordance related features

6 AFFORDANCE FEATURES IN LOBBY DESIGN

Through the instances of affordances and features, an affordance-feature map has been constructed as shown in Figure 8. This map represents the relations between each area feature and set its features, and between set features and object features. Relations with affordances are also represented. From left to right, observed affordances, issue affordances, area level features, set level features, and object level features are shown with their relations. Related area features for issue affordances are explicitly shown. By using affordance inter-relationship map introduced in an earlier section, the related observed affordances for each area can be identified.

Affordance-feature map could be used as guidance in high-level decision making for lobby design tasks. For example, in designing a space where comfort issue is critical, areas related with the comfort-ability affordance could be referred to. Also, set level features of that area as well as objects could be

identified for specific affordances so that design decisions can be supported considering critical affordances. Identifying the areas to enrich convenience of the building or designing or purchasing the objects to enhance the mood of the building. In modifying designs to reduce cost, on the other hand, those features related to less critical affordances could be identified and excluded from the design.

A portion of the affordance-feature map for red stool area A and winding stairs area is shown in Figure-9. Both red stool area A and winding stairs area have convenience-ability. Red stool area A has comfort-ability, and winding stairs area has safety. To improve safety, for example, handrail and fence feature could be designed-in.

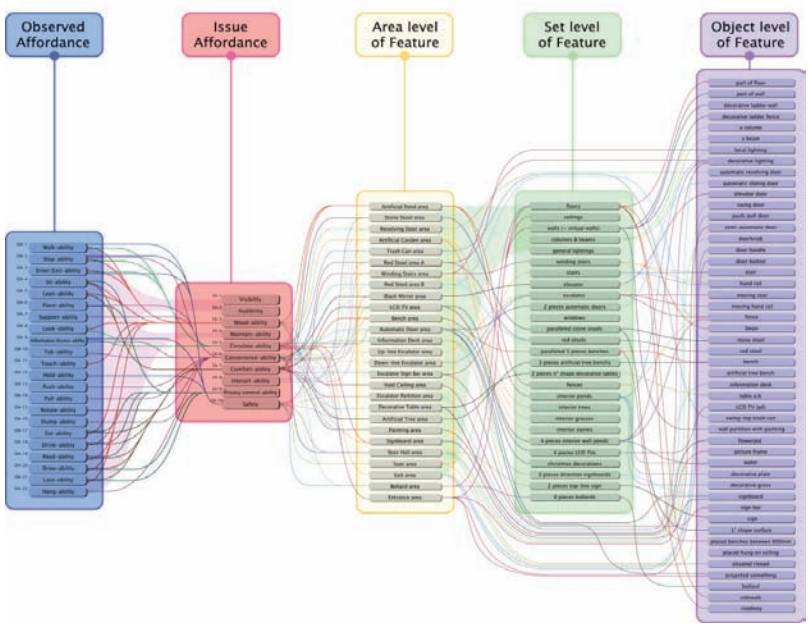


Figure 8. Affordance-feature map

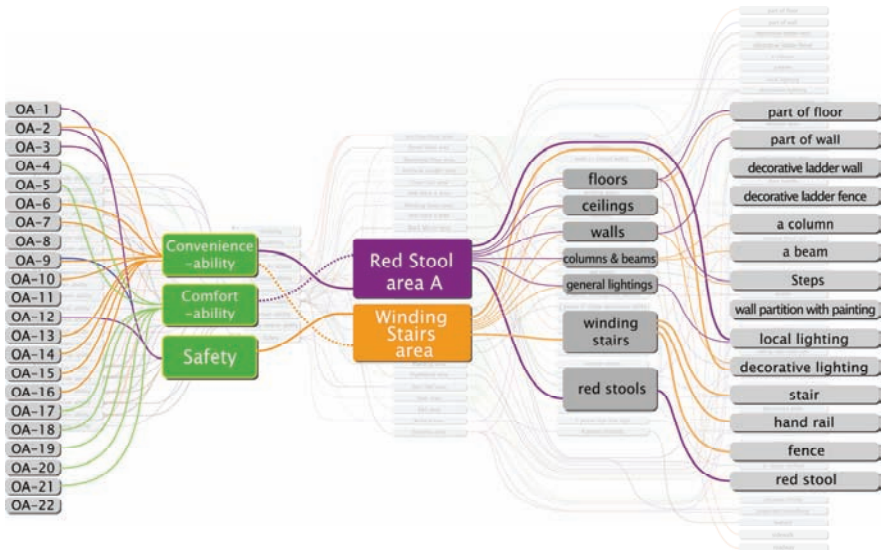


Figure 9. Partial enlarged Affordance-Feature Map

7 CONCLUSIONS AND FUTURE WORK

In this research, affordance and their features have been identified from analyzing user activities for several given tasks in a lobby of a building where the users have not visited before. This could serve as an initial guide in lobby design for affordance and support in identifying features for certain affordances. With more case studies in different buildings using more tasks, a repository for design for affordance could be constructed with a suitable classification scheme. User task analysis can be improved with additional interviews with the users so that more detailed information about the features can be identified. Note that research work toward feature-based ontological representations for generic classes of objects [14] could be combined with these kinds of case studies. The approach of identifying affordances and features of this research could be applied in other design domain where user activities can be observed meaningfully. Also, with diverse user groups, cultural and social influences on affordances could be tried.

REFERENCES

[1] Gibson, J.J., *The Theory of Affordances in the Ecological Approach to Visual Perceptual*, Houghton Mifflin, 1979.

[2] Archea, J., Environmental factors associated with stair accidents by the elderly, *Clinics in Geriatric Medicine*, **1**, 555-569, 1985.

[3] Norman, D.A., *The Design of Everyday Things*, Basic Books, New York, 2002.

[4] Norman, D.A., *Emotional Design*, Basic Books, New York, 2004.

[5] Norman, D.A. and Ortony, A., Designers and Users: Two Perspectives on Emotion and Design, *Symposium on Foundations of Interaction Design*, Ivrea, Italy, 2003.

[6] Maier, J.R.A. and Fadel G.M., Affordance-Based Methods for Design, *Proc. Int'l Conf. on Design Theory and Methodology*, DETC03/DTM-48673, Chicago, 2003.

[7] Maier, J.R.A. and Fadel G.M., A Case Study Contrasting German Systematic Engineering Design with Affordance Based Design, *Proc. Int'l Conf. on Design Theory and Methodology*, DETC2005-84954, Long Beach, 2005.

[8] Brown, D.C. and Blessing, L., The Relationship between Function and Affordance, *Proc. ASME Int'l. Conf. on Design Theory and Methodology*, DETC2005-85017, Long Beach, 2005.

[9] Galvao, A.B. and Sato, K., Affordances in Product Architecture: Linking Technical Functions and Users' Tasks, *Proc. Int'l Conf. on Design Theory and Methodology*, DETC2005-84525, Long Beach, 2005.

[10] Kim, Y.S., Kim, M.K., Lee, S.W., Lee, C.S., Lee, C.H. and Lim, J.S., Affordances in Interior Design: A Case Study of Affordances in Interior Design of Conference Room Using Enhanced Function and Task Interaction, *Proc. ASME Int'l. Conf. on Design Theory and Methodology*, DETC2007-35864, Las Vegas, 2007.

[11] Murakami, T., Cheng, L.M., Higuchi, M. and Yanagisawa, H., Trial for Formulation of Affordance Feature for Product Design, *Proc. the Human Interface Symposium*, 403-408, 2006. (in Japanese)

[12] Maier J.R.A., Ezhilan T., Fadel G.M., The Affordance Structure Matrix - A Concept Exploration and Attention Directing Tool for Affordance Based Design, *Proc. ASME Int'l. Conf. on Design Theory and Methodology*, DETC2007-34562, Las Vegas, 2007.

[13] Duerk, D.P., *Architectural programming: Information management for design*, VNR, 1993.

[14] Wang, E., and Kim, Y.S., Object Ontology with Justification Graphs for Form-Function Reasoning, *Proc. ASME Int'l. Conf. on Computers and Information in Engineering*, DETC2008-50016, Brooklyn, 2008.

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