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STIMULATING DESIGN CREATIVITY BY PUBLIC PLACES IN ACADEMIC BUILDINGS

Abstract

Design creativity is constrained by the limitations of knowledge of a given designer or even of a design team. Also, each design process is a dynamic process because novel design ideas may emerge spontaneously and their occurrence is unpredictable. One way to increase the probability that novel ideas are produced is to provide designers with additional knowledge, which will expand their design space. The other way is to create an environment stimulating generation of novel ideas. Such an environment should allow and encourage reflection, relaxation, formal and informal interaction among people, and knowledge sharing. The concept of structural hole in sociology is introduced and extended by distinguishing three classes of structural holes: domain, thinking, and working structural holes. It is postulated that an environment with abundance of structural holes can be created by proper public places. Such places should be comfortable to stay and easily accessible and they could be, for example, entrance halls, restaurants, activity centers, or corridors, which are discussed in the paper.

Keywords: Creativity, environment, structural holes, public place, campus

1. Introduction

Engineering design means to develop an artifact or a description of it to meet the desirable function with limited resources, including available knowledge and problem-specific experience, manufacturing technology, cost and time. There are no simple laws linking the structure of a system to specific functions. Therefore, each design process is like searching for an unknown artifact. A designer develops a design description, generally represented graphically, numerically, and/or by a text, to provide specified functions with available tools within limited time and cost. The designer may be knowledgeable and experienced, or not, but the specified function must be provided by the final design.

One approach to engineering design is to design a novel device, or an engineering system, automatically by a computer-aided design system. Unfortunately, such systems are still in an experimental stage. Hence, the designer must do it himself or herself. What a designer usually does is to decompose the desired function into sub-functions, then to select some known systems and devices or to invent a novel system to achieve the sub-functions, and

finally to combine these substructures into a whole system while satisfying all applied constraints and requirements (Pahl etc. 2007). This process is usually called "conceptual design". The final design depends on the knowledge space of the designer. Creative design emerges when previously unrelated concepts, principles, functions, behaviors and structural elements are brought together and combined in a new but feasible way, which improves with respect to existing designs. Unfortunately, no single designer, or even a design team, has complete knowledge that might be potentially useful in the design being conducted. Therefore, design creativity is usually constrained by knowledge limitation.

On the other hand, the design is "situated". According to the Heisenberg Uncertainty Principle, we cannot actually predict the position of an electron exactly; the best we can say is that the electron is mostly here and partially somewhere else. Quantum mechanics also tells us that radioactive decay occurs entirely by chance and is unpredictable except in the statistical sense. Uncertainty is ingrained in nature. It may be safe to say that novel ideas in design also usually occur by chance and are unpredictable.

One way to increase the probability that novel ideas are produced is to provide designers with additional knowledge, particularly interdisciplinary knowledge, which will extend the design space. The other way is to create an environment that may stimulate generation of novel ideas and developing creativity.

Our claim is that proper public places can create an environment promoting design creativity and increasing the probability that novel design ideas actually emerge. The concept of structural holes (Burt 1992, Gellynck et al 2007) is extended in this paper by distinguishing three specific classes of structural holes: domain, thinking and working structural holes. The three classes of structural holes are used to explain the effect of public places on design creativity. Finally, examples of public places in campus building are discussed. The paper begins with the discussion of impact of environment on creativity, which is partially based on the review of current research. Next, the analysis is provided how proper public places can promote design creativity.

2. Environment Support to Creativity

An extensive literature on creativity has been published, but very little focused on creativity-stimulating environments. "We spent an awful lot of money on how to analyze, but we do not spend much money on creating an environment for creativity (of aircraft design)" (Rutan 1996). It is known, however, that the workplace environment can have a dramatic impact on mood, motivation, creativity and productivity of employees, both positively or negatively (Lee et al 2010). For example, the open information flow, available resources, positive challenges, and negative workload pressure contribute to creativity (Amabile, 1996). The basic assumption of this paper is that a proper physical environment that suits for reflection, relaxation, interaction, and knowledge sharing may foster and stimulate creativity.

First, creativity needs quiet individual reflection. Creativity results from bringing together and combining previously unrelated ideas, and that happens only when a person has been thoroughly involved in a problem or situation for a long time, particularly in the case of engineering design, which requires knowledge retrieval, analysis, and integration.

Second, creativity needs relaxation. Creativity often takes place in a natural context. "Someone's best ideas may come while walking on a beach" (Young 2007), while someone's best ideas may be inspired by a chat with other people. Creative

process is iterative and punctuated by periods of incubation. The thoughts and ideas are incubated unconsciously or semiconsciously. Then they re-emerge as a new idea or a concept. "These periods of incubation happen best when we are engaged in relaxing, reflective or playful activity, when the mind has switched off from the problem at hand". (Lee et al 2010). One of the relaxation activities is excursion, which is considered as one of the most effective creative thinking techniques. "It's a simple 5-10 minute exercise that forces you to do something else - get out of the office, take a walk, listen to music - that sort of thing" whenever someone has design block (Leigh-Ann Bartsch 2010). In many cases, according to our personal experiences with designing many new engineering systems, relaxation is a good medicine to cure "no idea" mental state. Particularly, a short break outside the office during work helps with new ideas emergence when focusing a solution of a complex problem for a long time.

Third, creativity needs both formal and informal interaction. Creative ideas may occur at conscious, semiconscious, and subconscious mental sorting, grouping, and matching (Leonard and Sensiper 1998). On the other hand, open information flow is one of important environment components when creativity is concerned (Amabile et al 1996). The interactions between an individual and other human beings stimulate and enhance creative activities (Johnson and Carruthers 2006). Formal interactions such as workshops and seminars are likely to provide information at conscious level, while talks or chats between two people, or between two groups from different domains, help to channel information at semiconscious and subconscious level. In the case of engineering design, the first important thing is to produce a design concept, which requires integration of advanced theories, methods, tools and technology with existing similar products. The behavior of any perceiving individual depends on the information available (Gibson 1972, Neisser 1976). Interactions between two people that do not belong to same specific domain group help with information exchange, and particularly help with acquiring interdisciplinary knowledge, which will likely lead to new products or new engineering systems. Not only a complex engineering system but also even a simple mechanical device may require a team to work out a solution by interaction. In an example of designing a device for mounting and transporting a hiker's backpack on a mountain bicycle, a three-person team developed

a design concept during a short discussion (Cross 1997). Figure 1 illustrates how the design concept was developed by evolution from a concept of bag to the product ideation of a tray-like device. I, J and K in the Figure 1 represent the three members of the team. The process begins with an idea of a bag proposed by I, then the bag is modified as something like a tray by J. The idea of snaps, stapes, and rails are emerged when the talk continues. The final ideation of the device to mount and transport the hiker's backpack is a device that snaps the rails into the tray there. The dash line in the figure 1 shows how the talk continues among the members.
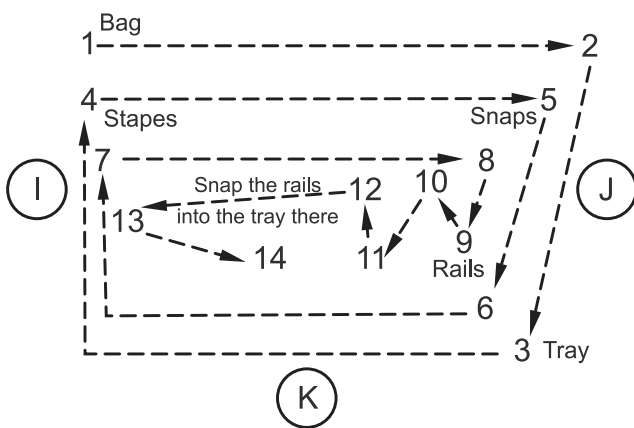

Fig. 1. Idea flow initiated by interaction

Fourth, creativity often occurs as a collective creativity. Creativity likely occurs when distant analogies are discovered (Hargadon and Bechky 2006), which likely emerges when a bisociation is shared by two or more people, called collective creativity (Sanders 2001). Creativity happens in the interaction between a person's thoughts and a socio-cultural context (Csikszentmihalyi 1996) or emerges in interactions (Hargadon and Bechky 2006). Collective creativity can promote creativity by (1) helping to seek assistance of others; (2) helping to make time and attention commitment to assist others; (3) helping to reflectively reframe the comments and actions of others; (4) reinforcing activities that support individuals engaged in the process (Hargadon and Bechky 2006).

Finally, creativity needs knowledge sharing. Creativity most typically happens when people share their knowledge and opinions. Knowledge becomes meaningful in interactions with others and in combination with others' knowledge in order to create new knowledge (Lee et al 2010).

To summarize, an environment that supports reflection, relaxation, social interaction, formal and informal interaction, and knowledge sharing will foster and promote creativity.

3. Structural Hole

The concept of the structural hole is used in this paper to explain the environment impact on creativity. The term structural hole is coined to refer to a social gap between two groups (Burt 1992). Structural holes mean the weak connections between clusters of densely connected individuals (Granovetter 2005). The structural hole can be also understood as weak ties between the two shortest nodes of two networks and they are more likely to be bridges (Borgatti 2010). The bridges connect people not otherwise connected who are in the adjacent communities (Burt 2002). A simple analogy of a structural hole to an insulator in an electric circuit may help with understating the concept. People on either side of a structural hole are focused on their own activities such that they do not know about activities of people in the other group (Burt 2001). Hence, structural holes can be understood as weak ties between two distant groups or communities, and the weak ties are likely formed by informal links or indirect contacts, e.g. having or overhearing a conversation, or catching a glimpse of something. If all ties between two groups are strong, then there are no structural holes between the two groups.

Structural holes are an opportunity to initiate the flow of information between people from the opposite sides of the holes (Burt 2001). An individual whose network spans the structural holes has an opportunity to access richer information than an individual who only communicates with people within his/her group. An abundance of structural holes creates opportunities for the new combinations and recombinations of ideas (Gellynck et al 2007). Also, structural holes create opportunities to extend knowledge and information space, see Figure 2. Hence, structural holes potentially promote creativity.
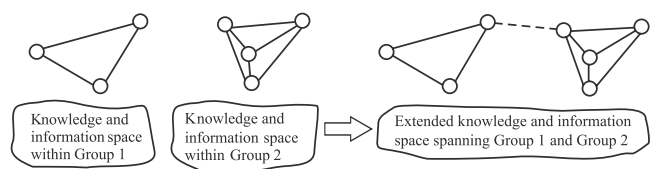

Fig. 2. Extended knowledge and information space

4. Creating an Environment to Promote Design Creativity

We use the concept of structural holes to explain the effect of environment on design creativity. As discussed in Section 3, structural holes potentially

promote creativity. Then it raises a question: is it possible to create structural holes by means of a proper physical environment?

We need an environment that supports reflection, relaxation, social interaction, formal and informal interactions, and knowledge sharing, as discussed in the Section 2. Our assumption is that a proper environment may create structural holes so that it may lead to stimulation of human creativity, particularly design creativity, which requires broad range of engineering knowledge. We will demonstrate this by distinguishing three classes of structural holes and linking them with specific environments.

A structural hole is understood as a weak connection between two different groups. This kind of connection can be reached in various ways, depending on the difference between the two groups. The two groups may differ in their professional backgrounds, in thinking styles, or in locations. For example, the faculty of an aerospace engineering department and the faculty of a biology department belong to different disciplines; one person has a global thinking style while the other person has a local thinking style; people living in one community and people living in a far distant community may have different information space. Furthermore, when we consider a person as a system, he/she will have different mental states in different places. For example, he/she may be in a relaxed state at home or in holiday, and in a focused state in office.

Therefore, we extend the concept of structure hole by distinguishing three classes of structural holes: domain, thinking and working structural holes. The domain structural hole refers to the disciplines gap between two groups; the thinking structural hole refers to the thinking style gap between two groups; and the working structural hole refers to the space gap between working place and home as well as between the working state and non-working state.

A domain structural hole creates opportunities for knowledge sharing and integration across traditional borders, which will leads to an extended knowledge space. A thinking structural hole creates opportunities for distant analogies and new interpretations to promote collective creativity. A working structural hole creates opportunities for unpredictable fresh ideas through formal and informal interaction, quiet individual reflection at conscious, semiconscious, and subconscious levels, as well as relaxation.

An environment with abundance of structural holes can be created by public places. The term "Public places" refers to places or areas that are open and accessible to community members and that are not owned or controlled by private interests (http://ct4ct.com). "Public spaces are an inseparable part of the urban fabric. Such spaces function mostly as passageways from place to place, or for short term activities" (Dekel A et al, 2005).

We focus on public places in a campus building. Proper public places in campus building may be an entrance hall, a restaurant, an activity center, or simply a corridor. All such have potential to create domain, thinking and working structural holes.

A proper public place means a place that is comfortable to stay for chat, rest, and thinking, even for doing nothing, just relaxing. No reason is needed for coming or leaving. Such a places should only take one or several minutes to get there. And the place itself should be a spacious and enjoyable physical space and should always have something to attract visitors, such as information board, newspapers and magazines, snacks and drinks, various models such as machine models or architecture models, photos, sculptures, paintings, posters, plants and flowers, long tables and long benches, a beautiful scene, fresh air, even computers and internet access. Several examples of such spaces are discussed next.

(1) Entrance hall

Entrance halls provide thinking and working structural holes. They are places where faculty members and students meet frequently every day. They say "hello" to each other and have brief talks whenever they meet. They may discuss news or current issues or talk about a poster or a conference flyer. They may exchange ideas regarding a specific event or activity. People learn and understand different thinking styles and learn from each other unconsciously. Therefore, thinking holes can be provided by an entrance hall. An individual may watch a machine model, a painting, a sculpture, or an evolving scene outside the glass wall or doors while he/she takes drinks. What to see is important because one can get relaxed only if he/she sees something enjoyable. However, the most important is that the models, sculptures and the like switch his/her mind from his/her work, but not far away. In this way, he/she is in neither at work nor at home so that his/her mental state would be neither entirely relaxed nor fully focused on work, a state in which novel ideas will likely emerge. Hence, working structural holes are provided.

Figure 3 shows the entrance hall in the Aerospace Building at TU Delft, the Netherlands. It is a large space with front and back doors as well as several

other entrances to connect several sections of the building and a small restaurant. A big model of a rocket is located in the lobby at the entrance hall of the building. There are big photos of famous scientists that are also alumni on the wall across from the staircase. The stairs face the entrance and there is a large space between the front door and the stairs, which is often used for reception lectures with speakers standing on the stairs, like speakers in ancient Rome. The entrance hall is also used for receptions, meetings, lectures, exhibitions, dinner parties, and concerts.
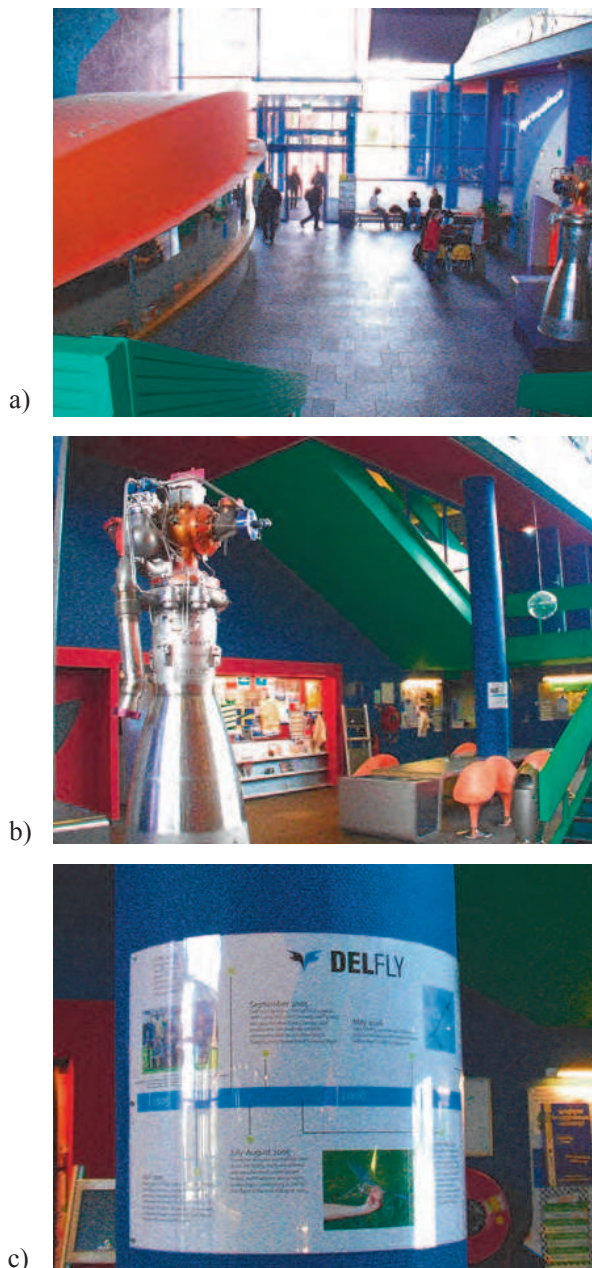

a)

b)

c)

Fig. 3. a) The entrance hall of the Aerospace Building, TU Delft, the Netherland, b) the back entrance to the same building, c) the recruitment poster of an e-dragonfly design team in the entrance hall, the same building

Figure 4 shows the entrance hall in the School of Architecture Building at the Technische Universität Berlin, Germany. It is spacious, bright, and warm in winter. Outside the glass wall is a garden, to which people can go through a glass door to enjoy trees, flowers, sunshine, fresh air, as well as sculptures. So it is easy for anyone to go to the garden for a walk and a moment of relaxation. In this way, working structural holes are provided. Along the glass wall is a row of heaters, which are also designed to serve as seats. So, people can seat there and have a chat, or a discussion. The entrance hall is also used for receptions, dinner parties, and lectures.

a)

b)

Fig. 4. a) The entrance hall of the Architecture Building, the Technische Universität Berlin, Germany; b) the back door of the entrance hall, the same building

(2) University restaurants

Restaurants in a campus building provide thinking and working structural holes. They generally serve lunches, snacks and drinks. Faculty and students from different departments with differentiated research background and thinking styles meet there every day for lunch and also for a chance of talk. In this way, they learn from each other unconsciously. Therefore, thinking holes are provided. Obviously,

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not all restaurants are proper places for thinking and working structural holes. A preferable restaurant is located within the faculty building or very close to that building. Besides, it should be comfortable to stay as discussed above and it should serve delicious food so that people really enjoy the stay there both for lunch and for social activities. When people are there, their minds are forced to turn away from their professional activities either by lunch, by talk or by the involving scene outside the low windows. In this way, working structural holes are provided. However, a restaurant will not provide any structural holes if it is far from the faculty building, crowded, hot in summer and cold in winter, and uncomfortable to stay.

Fig. 5. a) University restaurant in the Aerospace Building, TU Delft, The Netherlands; b) University restaurant at GMU, USA

Figure 5a is a small restaurant in the Aerospace Building at TU Delft, the Netherlands. The university restaurant is located on the ground floor of the main building and has four entrances, two on the ground floor of the main building, one on the first floor of the main building, one on the first floor of the other building, so it is easily accessible from both buildings.

A model of an airplane is hanging from the ceiling of the hall in this restaurant. Outside the glass wall of the restaurant, there is a small pond with plants, fountain, and swimming ducks. The sky and grass all are visible through the glass wall. The restaurant is a nice place to talk, and also for small meetings and exhibitions. Figure 5b shows a university restaurant at George Mason University in Fairfax, USA. The restaurant is located on the first floor of a building called "Johnson Center", which is located in the center of the campus and has five entrances from all directions so that it is easy to go into this building from any building on the campus. Also, it functions as passageways from one place to another place since it provides a short cut between several buildings. The restaurant is spacious, with nice setting, and serves lunches, drinks and snacks (also providing computers and access to the Internet) and it opens from the early morning to midnight. Therefore, visit to this restaurant becomes an everyday activity for many peoples of the university.

(3) Activity centers

Activity centers provide domain, thinking and working structural holes. Events, conferences, and various activities frequently take place in activity centers. People from various departments, disciplines, and countries, and also at different professional levels (e.g. students, professors, experts, scientists, engineers, managers, administrators and the like) meet here to work together for several days or weeks, or simply meet here for discussions. They learn new knowledge from various domains and different thinking styles from other people. In this way, domain structural holes are provided. Besides academic activities, an activity center is usually used as performance center (usually with free entrance) too, particularly for students' bands. Concerts, drama performances, movies, and dance parties can be held here. People can participate in such activities easily, just leaving their offices, laboratories or classrooms and taking a short walk to the activity center. In this way, working structural holes are provided.

Figure 6 shows the Johnson Center, which is used for various activities at the George Mason University, including social, cultural, and political activities, such as meeting, conference, opening ceremony, performance, concert, and students activities. It is also has a restaurant, a commercial bank, a library, a news center, many meeting and computer rooms as well as multimedia rooms.

a)

b)

c)

Fig. 6. Johnson Centre at the GMU: a) The commercial center, bank, and news centre in the first floor and meeting rooms, computer rooms and multimedia rooms in the second and third floor of the building; b) the news centre in the first floor of the building; c) the library in the second floor of the building

(4) Corridor space

The corridor space also provides working structural holes. This space is special since it provides a short and easy transition from work to relaxation at any time. When people get tired with their regular works and it is not the end of their regular working hours, they need a short break, five or ten minutes. In this case, the corridor space is an ideal place for a short relaxation. Drink a cup of coffee, have a chat with a person happening to be there, or just be there for a change. On the other hand, it also provides a flexible space to involve a dynamic team working together, whenever needed. People from different offices can arrange brief meetings there. The meetings are informal, so they may not think they are working. In these ways, working structural holes are provided.

Figure 7 shows the corridor of the engineering building of the Università Politecnica delle Marche, Italy. The corridor is also used as study space, discussion space and an information board. Figure 8 shows space for discussion and relaxation in the corridor of the aerospace building of TU Delft. Several aircraft models are exhibited, and printers, automatic vending machines and hot drinks machines are placed in the corridor of each floor of the building. People can take a drink, talk to someone happening to be there when they use the printer or simply take a rest in a chair.

a)

b)

Fig. 7. a) The corridor of the Engineering Building, the Università Politecnica delle Marche, Italy; b) one of the entrances to the building

Fig. 8. a) The discussion and rest space in the corridor, the Aerospace Engineering Building, TU Delft; b) the aircraft models and facilities, same building

(5) Discussion

A better understanding of the concept of a structural hole may be developed using an analogy to a gap on the ground and a bridge across the gap. The difference between a gap and a structural hole lies in the bridge that may emerge naturally across the gap. Such a bridge may possibly emerge naturally through communication, contemplate, or incubating. We want bridges since they inspire or promote creativity, but we cannot build them with steel, concrete, or stone. What we can do is to create many gaps to facilitate an environment in which many bridges may emerge. Domain and thinking structural holes provide more and wider gaps to cross, while working structural hole provides more gaps to cross. Particularly, in the case of this paper, the concept of structural holes may be simply understood as the mental state gap between working place and home, the thinking style gap between different groups, and the domain gap between different disciplines and backgrounds.

The fundamental assumption of this paper is that bridges may possibly emerge naturally when structural holes are created through formal or informal interaction and unconscious or semiconscious incubation, which can be supported by the studies on the environmental support to creativity. Hence an expanded knowledge space is achieved and the probability of design creativity is increased when structural holes exist.

Structural holes are used here as a theoretical framework to analyze the impact of environment on creativity. The analysis can also be done under a historical framework and psychological framework, as discussed in the book "Successful Education" (Arciszewski 2009). In the book, "Medici Effect" is introduced to illustrate the environment factor in engineering creativity; "Engineering Village" and "Design Studio" are proposed to practice "Da Vinci Seven Principles" in order to develop student's creativity. The book investigates complex factors that will influence the development of creativity, including management, psychology, economics, politics, public policy, education paradigm, teaching style, thinking style, and architecture etc. The research presented here focuses on explaining how proper public space can promote creativity.

5. Summary

An environment supporting reflection, relaxation, formal and informal interaction, and knowledge sharing will foster and promote design creativity. The concept of structural hole is extended in this paper by distinguishing three classes of structure holes: domain, thinking and working structural holes. The domain structural hole refers to the disciplines gap between two groups; the thinking structural hole refers to the thinking style gaps between two groups or two persons; and the working structural hole refers to the space gaps between the working state and non-working state as well as relaxed mental state and focused mental state.

The domain structural holes create opportunities for knowledge sharing and integration across traditional borders so that the knowledge space can be expended. The thinking structural hole creates opportunities for distant analogies and new interpretations to promote collective creativity. The working structural hole creates opportunities for unpredictable fresh ideas through formal and informal interaction, individual reflection as well as relaxation.

An environment with abundance of structural holes can be created by proper public places. The proper public places in campus buildings create domain, thinking and working structural holes. A public place means a place that is comfortable to stay, takes only several minutes to get there, and it is a large and

enjoyable physical space that always has something to attract visitors. Proper public places in campus building may be an entrance hall, a restaurant, an activity center, or simply a corridor space.

A better understanding of the concept of structural hole may be achieved by comparing it to a bridge across a gap. The bridge can possibly emerges naturally through communication, contemplate, or incubation when gaps (structural holes) are created.

The next step of this research is to establish a design framework of creativity-oriented public spaces.

Acknowledgements

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