architectural privacy

a topological approach to relational design problems

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abstract

This work studies the abstract architectural quality of privacy as presented in *enclosed*, border-defined space. Furthermore, a programming environment (processing programming language) is implemented as to evaluate given architectural plans and generate conceptual topological diagrams indicating the relation of spaces according to a set or desired degree of privacy. These abstract topological diagrams could then be enriched and implemented as analytic or synthetic means for documentation or experimentation in certain socio-cultural contexts.

keywords

Privacy, privacy regulation, Space, boundary, abstract topological diagram, analysis, synthesis

word count

9,627

"If one sees man surrounded by a series of invisible bubbles which have measurable dimensions, architecture can be seen in a new light"

Hall E.T., 1969, p. 121

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introduction

The following thesis will attempt to illustrate and verify how a long lasting fixed model used in architectural synthesis and analysis can be replaced by a new more flexible one. It will be therefore proposed that the classical separation between public and private spaces within a certain socio-cultural architectural context, (for example the interior of a western house of residence) can be replaced and studied as a set of spaces possessing different degrees of privacy. It is therefore at first suggested, that a bedroom can be seen as a more private space than a kitchen, or that bedroom A is more private than bedroom B for certain reasons which are generally quantifiable. Moreover, it is proposed that privacy is not a static but a dynamic topological property of space and therefore it should be approached in an analogous way. Spaces can be therefore categorized, not only depending on their degree of privacy, but also according to their capacity to regulate privacy. This approach aims at providing a more accurate picture of the architectural arrangement and relation of spaces, and a new perspective in approaching certain architectural problems.

The idea of distinguishing spaces according to their *degree of privacy* is very common for architecture. It is traced back to the beginning of the seventeenth century when the private house started to develop (Riley, 1999, p. 10). For today's architectural practice, this distinction, seems self-evident and almost an essential precondition when approaching a design problem. Nevertheless, in most cases dealing with it ends up in separating social spaces from private spaces. This separation of social and private is pinpointed by Nathan Witte in his thesis on privacy "*Within the architecture discourse, privacy is seen as something to be provided or withheld*" (Witte, 2003, p. 23). The most classic example is that of a common western two- storey residence with social spaces (living room, kitchen, and dining room) on the ground floor and private spaces (bedrooms) on the first floor.

While this approach is frequently applied in contemporary architectural practice as a prerequisite, recent built examples suggest that it might not reflect the current needs of certain social groups or persons. There is evidence that the polarization caused by the long last rigid antithesis of public and private starts to disintegrate. Both technology and modern society have transformed the space into a permeable structure often merging public and private in different levels. Commenting on the private house, Terence Riley suggests that "*the cultural definition of the private house is undergoing a great change, a transformation fuelled by enormous new technical and material resources*" (Riley, 1999, p. 36). Authors like Julia W. Robinson have already identified several different zones of privacy within the single Midwestern house and pinpointed their importance for the individual. Robinson argues that through a series of spaces with different degrees of privacy the autonomy of the resident within a small social group is provided. Furthermore the individual is granted a large measure of control over time, space, activity and social interaction.

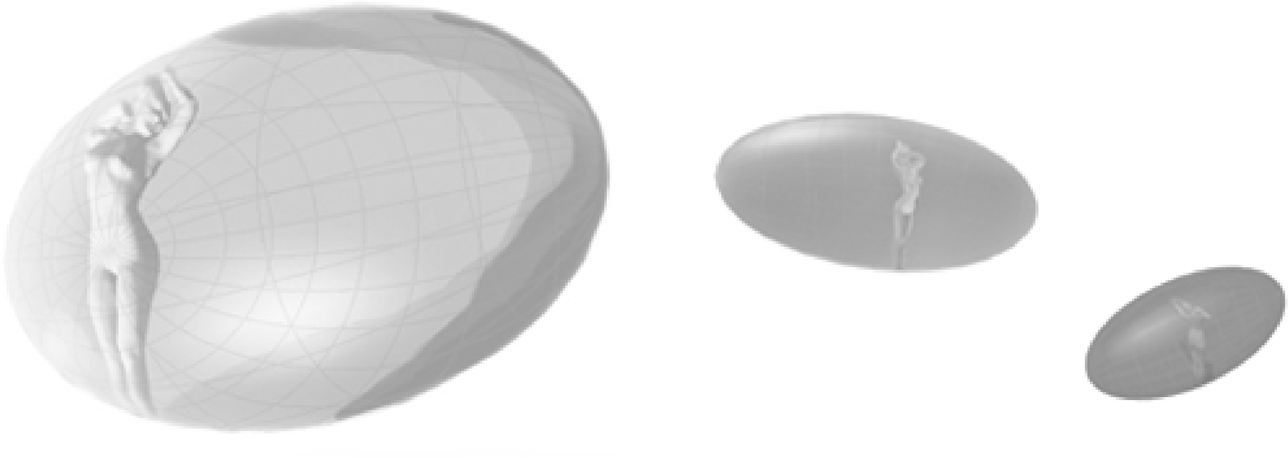
At the same time a complementary approach comes also to counter the strict categorization of spaces into either public or private. According to that point of view, architectural space and its various elements should act as regulators of privacy. In other words a space and its elements should provide the ability to increase or decrease privacy according to the custom needs of its occupants. Following this direction Nathan Witte suggests that "*The environment needs to be supportive of the user's privacy regulation, supporting control over contact with others and supporting the behavioural processes used to regulate privacy*" (Witte, 2003, p. 28). Another quite recent thesis takes the above view to the extreme by proposing a completely new social housing scheme. RAMTV in their book "*Negotiate my boundary*" state that "*the urban residential architecture with negotiating boundaries is a product of today's intricate social situations and interactions. It is a Big Brother case where you can be extremely exposed (if the nature of your ego allows it,) share your facilities with neighbours and the general public, or remain totally isolated (cocoon)"* (Dekleva Aljosa et al, 2003).

Given the above facts this thesis will attempt to refine the distinction between private and public as to create a new perspective from which to approach design. By focusing on privacy as an implicit topological property of space, it will try to reconcile the two entities; private and public. Under current socio-cultural transformations a more precise definition and handling of the spatial aspects of privacy is considered an inevitable cause.

By starting from the notion of privacy in general, this thesis will then focus in the concept of architectural privacy and how it has been approached from contemporary researchers and academic writings. Furthermore, a quite different path will be followed as to exploit the above theories and create a new unified enhanced model for architectural privacy. Based on the idea of personal space as studied in psychology and sociology this endeavour considers the built environment as an extension of the human epidermis. Following this analogy, each border-defined space can be seen as an extended membrane of our body able to communicate with its immediate environment. At this point physical boundaries will be introduced and their importance as regulators of privacy will be explained. Boundaries acting as filters of information are contrasted to the human body and senses. This second metaphor will be used to construct the spatial factors which affect architectural privacy. These factors (visibility, vocals, olfactory, accessibility and proximity) which are generally presented as measurable (with a relative amount of redundancy) will be used in the second part to code the program and provide the relative degree of privacy for each space in a set of given architectural plans. The final section of the first part will briefly review relevant academic works as to denote the contribution of the present endeavour to the architectural discourse. In the second part the methodology followed will be presented. Six case studies will be analyzed along with the different topological diagrams (one for each factor affecting privacy). In the same part the program generating the topological diagrams will be also presented and explained. Finally the findings will be discussed and the conclusion will try to summarize and explicitly set out the general outcome of the thesis.

part I

approaching architectural privacy



“Man and his extensions constitute one interrelated system”

(Hall E.T., 1969, p. 177)

privacy & theory

In this section, the concept of privacy will be discussed in general. In addition the most predominant theories concerning the notion of privacy will be presented.

According to Encyclopaedia Britannica the term privacy dates back to the 15th century. Privacy is defined as the quality or state of being apart from company or observation. As an act, privacy provides freedom from unauthorized intrusion. A second definition states that privacy denotes a place of seclusion (Britannica Encyclopaedia, 2006). A similar definition is also given by the Webster's Online Dictionary; privacy is the quality of being secluded from the presence or view of others or the condition of being concealed or hidden (Webster's Online Dictionary, 2006). The term is correlated with the word seclusion and contrasted with the words communal, public and social.

Privacy is frequently defined in different contexts and acquires a variety of interpretations. It has been studied throughout a number of different discourses such as law, philosophy, sociology, environmental psychology, anthropology, biology, zoology, architecture, while more recently it has preoccupied the field of computer science. Privacy is primarily identified as a vital mechanism for controlling overcrowding in the animal kingdom and also for developing and maintaining the healthy relation of the individual within society. Irwin Altman and Westin suggest that one of its major functions is to serve the individual's self-identity by creating personal boundaries (Altman, 1975, Westin, 1970).

According to Westin *"Privacy is the claim of individuals, groups, or institutions to determine for themselves when, how, and to what extent information about them is communicated to others. Viewed in terms of the relation of the individual to social participation, privacy is the voluntary and temporary withdrawal of a person from the general society through physical or psychological means, either in a state of solitude or small-group intimacy or, when among larger groups, in a condition of anonymity or reserve. The individual's desire for privacy is never absolute, since participation in society is an equally powerful desire. Thus each individual is continually engaged in a personal adjustment process in which he balances the desire for privacy with the desire for disclosure and communication of himself to others, in light of the* *environmental conditions and social norms set by the society in which he lives.* (Westin, 1967 p. 7)

Altman presents privacy as a collection of six points. *"1. Privacy is an interpersonal boundary-control process, which paces and regulates interaction with others. Privacy regulation by persons and groups is somewhat like the shifting permeability of a cell membrane. 2. Two important aspects of privacy are desired privacy and achieved privacy. Desired privacy is a subjective statement of an ideal level of interaction with others-how much or how little contact is desired at some moment in time. 3. Privacy is a dialectic process, which involves both a restriction of interaction and a seeking of interaction. "I shall argue that privacy is a dynamic process that has forces pushing toward a certain level of openness-closeness or accessibility-inaccessibility, with the relative strength of opposing forces shifting over time and with different circumstances." 4. Privacy is an optimizing process. In other words, there is an optimal degree of desired access of the self to others at any moment in time. 5. Privacy is an input and output process; people and groups attempt to regulate contacts coming from others and output they make to others.6. Privacy can involve different types of social units: individuals, families, mixed or homogeneous sex groups, and so on.* (Altman, 1975, p. 10-12)

While the idea of privacy as a communication-control mechanism derives from human behaviour (environmental psychology), it is also often characterized as a physical property of the environment and that is how it is approached in the current thesis (Eric Sundstrom et al., 1980, p 1). The following sections attempt to define architectural privacy, and the factors upon it depends.

privacy & space

The idea of privacy as a property of the built environment has been synonymous with the advent of the humankind. The consolidation of a clearly defined territory occupied by a certain group of people has been one of the primary instinctive concerns of the early occupants of earth. People had the need to protect themselves from the environmental conditions and from their enemies (people and animals) as well as to withdraw from the broader group. The idea of a space capable of providing both security and privacy has been seminal for societies since then. Such kind of private spaces have taken many forms and different kinds of layouts have succeeded one another through time, always in respect to technology and society. Humankind has successively moved from the cave to the private house which has become one of the constitutional entities of modern society (Riley, 1999, p. 10). Nevertheless, privacy not only remained a physical human need, but with recent technological developments it has acquired different multiple layers. Personal data privacy or privacy over the internet or telephone has become a major issue nowadays. Consequently, firewalls and additional protective means are raised in order to control data communication and guarantee a certain level of personal data security.

In the light of the above, recent architectural thought has also been preoccupied with privacy and private space. Nevertheless, the various studies and approaches concerning privacy have often included the contrast between the term and another entity; that of public space. Their consideration as two opposite worlds has resulted in polarization and analogous consequences for the design process. Herman Hertzberger, explicitly states that the inconsistency of private and public is equally wrong as the antithesis of general and specific (Hertzberger, 2005, p. 12). This thesis will focus in verifying the existence of degrees of privacy and therefore attempt to refine the distance between private and public.

In the following three sections, different approaches on privacy will be combined as to gradually construct the different factors affecting architectural privacy; the potential of space to provide adequate levels of privacy.

from the human skin to the built environment

In this chapter the views of several authors will be presented as to explain why the built environment is regarded as an extended membrane of the human body and therefore is approached in analogous way.

According to environmental psychology, each person is perceived as and individual surrounded by an invisible shelter, or even a series of shelters, extended beyond its epidermis. These personal protective spheres, by which privacy is controlled, vary from person to person and from culture to culture. They also differ from period to period as society and social bonds are continually transformed and reconstructed. Hall defines accordingly four such spheres; intimate, personal, private and public. When the most intimate of these private areas is intruded by other individuals, the person starts to act defensively or to say at least extraordinarily. A typical example of the above fact is indicated by the abnormal behaviour of people when standing in an elevator (Hall, 1969, p. 112).

The proposed idea is that the built environment often acts as to materialize such zones. The above concept is also proposed by Hall. "*Man has created material extensions of territoriality as well as visible and invisible markers"* (Hall, 1969, p. 97). In addition Colomina Beatriz, comments on Loos architecture, "*The spaces of Loos' interiors cover the occupants as clothes cover the body (each occasion has its appropriate "fit")* (Colomina, 1992, p. 92). In such context, the exterior shelter of a space can be seen as the realization of a personal sphere surrounding the individual.

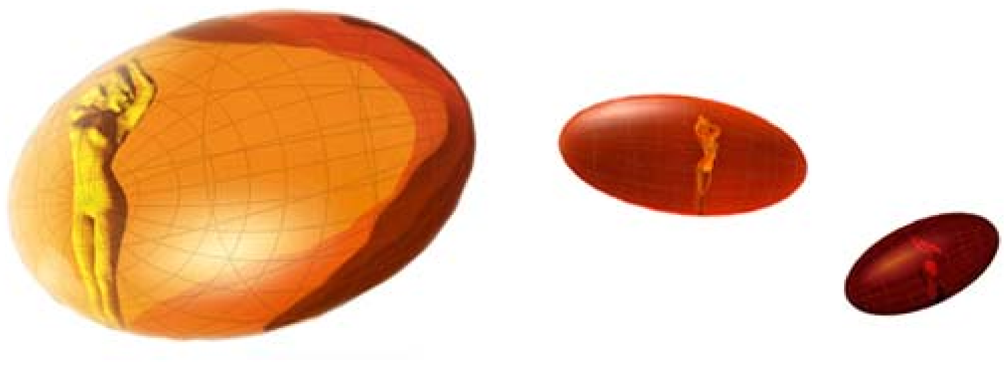


figure 1: *the invisible spheres*

The outer shelter is therefore often commissioned to be capable of providing the desired degree of privacy for the human body. By following the proposed model, architectural privacy can be accordingly defined as the capacity of space to regulate the information which is communicated to its immediate environment. This conclusion leads to the next section which explicitly describes the function of the boundary as a regulator of communication.

Boundaries

Throughout this section the function of the boundaries will be generally discussed. By deriving an analogy from the way the human body regulates communication with its surroundings, the present argument will try to define the function of the spatial boundary. It is essential to note that for the current thesis, spatial boundaries represent the common separating elements (furniture, walls, fences, doors, windows etc.) between two defined territories. Furthermore, the semantic meaning of the boundary is out of the scope of this thesis (For example the cases of restriction of access to a space due to cultural norms).

Privacy in individuals is achieved and regulated by the creation and controlling of interpersonal boundaries. "*These boundaries are expressed in a complex repertoire of finely tuned behaviours"* (Altman, 1975 p. 12-13). In that way the body manages to shut out or to limit any external intrusion affecting its privacy. Hall also adds that such boundaries are defined and regulated by the use of the senses. *"It is the nature of animals, including man, to exhibit behaviour which we call territoriality. In so doing they use the senses to distinguish between one space or distance and another"* (Hall, 1969, p. 120). It is therefore logical to assume that an isolated territory is the one which does not allow any kind of communication through the mechanism of the senses. Since *"the territory is in every sense of the word an extension of the organism, which is marked by visual, vocal and olfactory signs"* (Hall, 1969, p. 97), isolation could be translated as the seclusion of any such signs.

Within the above context space represents an important factor. Use and positioning of individuals in space is important for experiencing and regulating their territory and accordingly the degree of desired privacy. Physical boundaries maintained by spatial elements (furniture, walls, fences, doors, windows etc.) are either to or against someone's efforts in regulating communication. So in the case of an enclosed boarder-defined space, architectural privacy can be described as the property indicating the amount of information which is communicated through the boundaries to the surroundings. In the light of the above, spatial boundaries can act as to separate or bring two or more spaces together (decrease or increase communication). As such, architectural privacy can be expressed as a topological diagram of relations-communication between different spaces which are separated by boundaries.

figure 2: *the territory*

The notion of the boundary as a regulator of privacy can be seen in many architectural examples within different cultures. Several quotations are presented which illustrate how privacy in space is regulated according to the variation of the boundary.

the japanese house

In Japan, walls are movable and rooms are multipurpose. In the Japanese country inns (the ryokan), the guest discovers that things come to him while the scene shifts. He sits in the middle of the room on the tatami(mat) while sliding panels are opened or closed. Depending on the time of day the room can include all outdoors or it can be shrunk in stages until all that remains is a boudoir. (Hall, 1969, p. 141)

the arab house

Arabs avoid partitions and since there is no physical privacy, they use other means to be alone. The form of the home is such as to hold the family together into a single protective shell (Hall, 1969, p. 145)*. In addition, Moucharaby windows provide the interior with light and air as it shades it from the hot African sun. It also permits those* *within to observe the street below and at the same time maintain their privacy, which was particularly important for the women of the segregated Muslim harem* (Britanica Encycloapedia).

the Rietveld Schröder house

The Rietveld Schröder House constitutes both inside and outside a radical break with all architecture before it. The two-storey house is built onto the end of a terrace, but it makes no attempt to relate to its neighbouring buildings. Inside there is no static accumulation of rooms, but a dynamic, changeable open zone. This was achieved with a system of sliding and revolving panels. When entirely partitioned in, the living level comprises three bedrooms, bathroom and living room. The concept was used so that the children could have a bigger open space to play during the day and then close it up to have a more private bedroom at night. In-between this and the open state there is an endless series of permutations, each providing its own spatial experience (Galinsky, 2006).

In the above examples it is clearly illustrated how the levels of communication and accordingly architectural privacy are regulated in terms of the boundaries. The next section will attempt to construct the actual factors affecting architectural privacy.

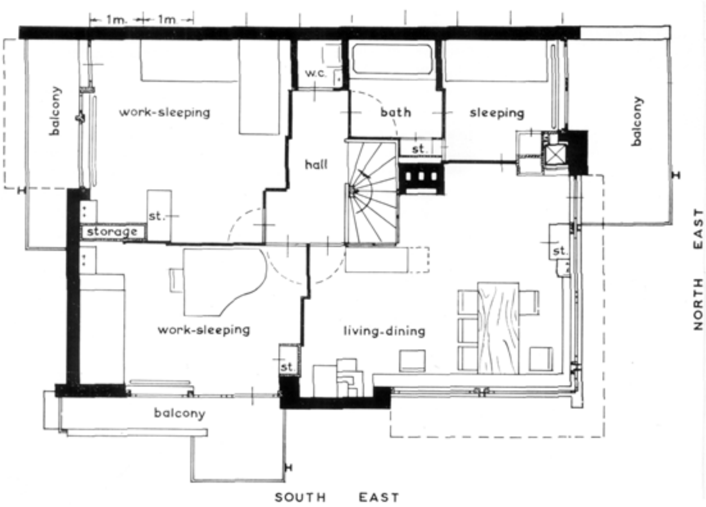


figure 3: (left) *Moucharaby windows*

figure 4: (right) *the Rietveld Schröder House*

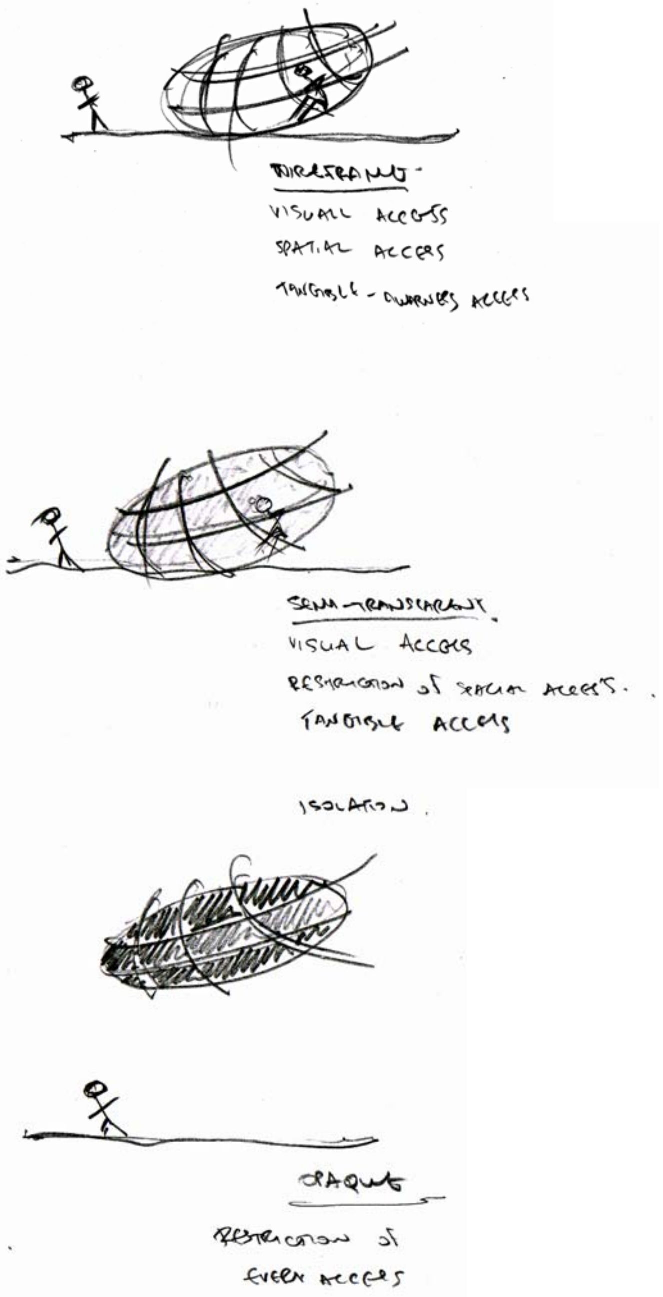
the factors affecting architectural privacy

Throughout this chapter the model sequentially assembled in the previous sections will conclude by defining five different parameters affecting architectural privacy. The five factors derive from the fact that humans communicate with the surroundings through the mechanism of the senses.

Accessibility, visibility, proximity, vocals and olfactory are therefore the five parameters directly analogous to the senses of kinesthesis (muscles and skin), sight (eyes), touch (hands and feet), hearing (ears) and smelling (nose). Hall analyses all the above factors and proposes that *"Man's relationship to his environment is a function of his sensory apparatus plus how this apparatus is conditioned to respond"* (Hall, 1969, p. 59). All five factors affect the way human beings perceive their surroundings and accordingly the mechanism by which they control privacy. Spatial boundaries act as additional means for regulating (limiting or increasing), the communication of the individual with its surroundings.

In the following figure (figure 5.) the gradient of architectural privacy is presented (from public to complete isolation), in respect to the five factors. Public space is defined as the space which applies no restriction to communication, whereas an isolated space is the one which completely constrains communication. In between all other intermediate levels of privacy exist. For example, imagine someone sitting in front of window in his office. On the other hand someone walks in a public pathway and in between there is canal separating the two spaces. In the above case only the visibility communication is realized. Accessibility, proximity, vocals and olfactory are therefore constrained.

Architectural privacy is often correlated with only a fraction of the above factors. For example Eric Sundstrom et al suggest that "*Architectural privacy refers to the visual and acoustic isolation supplied by an environment. A work area completely enclosed by soundproof walls with lockable doors embodies a high degree of architectural privacy"* (Eric Sundstrom et al., 1980, p. 2). In addition they suggest that *"Privacy showed correlations with the number of enclosed sides, distance from co-workers, having fewer neighbours and not being visible to the supervisor"* (Eric Sundstrom et al., 1980, p. 10).



Public:
Unrestricted communication

Visibility communication
Vocal communication
Accessibility communication
Proximity communication
Olfactory communication

In-between states: (an instance)
Semi-restricted communication

Visibility communication
Low levels of Vocal communication
No Accessibility communication
Proximity communication
No Olfactory communication

Isolation:
Restricted communication

No Visibility communication
No Vocal communication
No Accessibility communication
No Proximity communication
No Olfactory communication

figure 5: *degrees of privacy*

As noticed in the above quotations only two out of five factors are explicitly mentioned. Nevertheless, at least another two can be identified. Accessibility and proximity are indirectly inferred in phrases like *"lockable doors"* or "*distance from co-workers*" and "*fewer neighbours*". It is therefore clear that confusion and inadequacy exist among the scientific community regarding the function and effect of the above factors. That is why the present thesis attempted a methodical approach throughout the previous sections as to finally construct a solid base upon which to found the methodology followed in part two. Nevertheless, further scientific studies and surveys should be carried out for better understanding and quantification of the above factors.

In this section several studies relevant to the notions of privacy and space are going to be presented. This endeavour aims at placing the present work within a wider range of relevant academic works and denoting its contribution. The works will be separated in two groups indicating their difference in terms of theory and application.

To begin with, the views of two authors approaching privacy from a theoretical perspective are presented. Both papers refer to space as the aggregation of interconnected communicating units, characterized by their different degree of privacy. Nevertheless both papers approach privacy in a dissimilar way.

1. The first paper by Nathan Witte regards privacy as an implicit dynamic property while it is suggested that space should be supportive to the user's desire for privacy. *"The environment must allow for one's dynamic closed and open permeability, creating options or places of release from contact and observation"* (Witte, 2003, p. 31)*.*

2. The second approach by Julia W. Robinson perceives privacy as a static, inherent property possessed by different kinds of spaces. By observing typical Midwestern single house plans and by using space syntax methods (accessibility graphs) she initially states that "*their distinctive arrangements seem to reflect three distinct spatial categories and territorial types, public-linking to the outside world, private .relating to community activities within the residence, and intimate activities linked to the individual*" (Robinson, 2001, p. 4). Robinson continues by expanding these three territorial types to seven. She defines accordingly seven degrees of privacy (zones) which she terms as *territorial gradient* (the public civic domain, the public neighbourhood domain, the semi-public or collective domain, the semi-private domain, the private, domain, the semi-intimate domain and the intimate domain) (figure 6.). Finally she proceeds to categorize different housing types according to the existence of such zones.

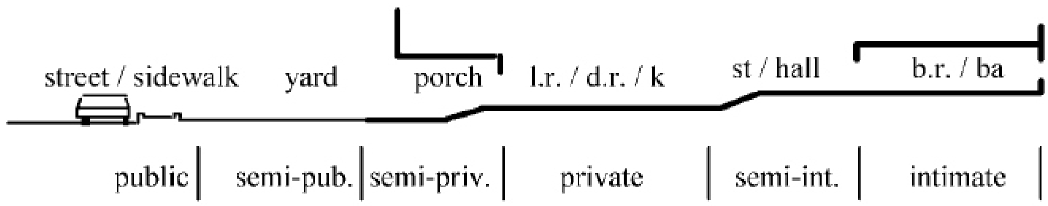


figure 6: *gradient of privacy by Julia W. Robinson*

Both papers support in a complimentary way the existence of a privacy gradient in space. However, while the first study remains at a theoretical level, the second one attempts to verify (by using accessibility graphs) the existence of such categorization but only at a primal stage.

At a practical level, there are several studies which attempt to provide methods and tools for dealing with topological properties of space.

3. In a paper which is titled as "*An intelligent assistant for conceptual design"* Kimberle Koile describes the development of a software able to explore possible design solutions which satisfy specified abstract goals (visual openness, privacy, paths between two design elements). According to the author the program *"evaluates a design with respect to a set of goals, uses an explanation of the evaluation to guide proposal and refinement of design repair suggestions*, *then carries out the repair suggestions to create new designs"* (Koile, 2004, p. 1). The above method is illustrated as a decomposition hierarchy of characteristics shown in the following diagram (figure 7).

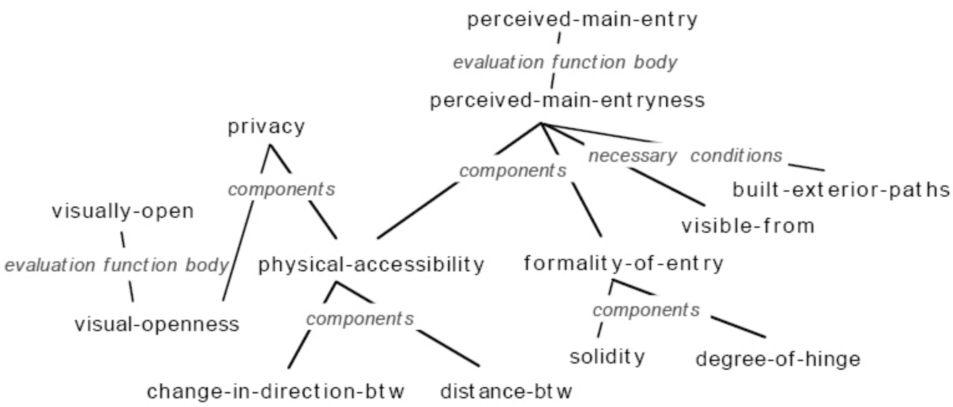


figure 7: *Dependency links by Kimberle Koile*

4. In a second paper titled "*Separating Topology and Geometry in Space Planning",* the authors Benachir Medjdoub and Bernard Yannou (2000), present an architectural CAD approach. By setting a variety of constraints they use a specific enumeration heuristics to reach a set of consisted conceptual designs which they name topological solutions. Initially these solutions do not presume any numerical features like distances or dimensions, but they are based on relations imitating the first sketching steps of the architectural process. On a sequential level, certain geometrical constrains minimize the set of possible solutions and providing a controllable set of optimum solutions. The above process is illustrated in the following diagram (figure 8).

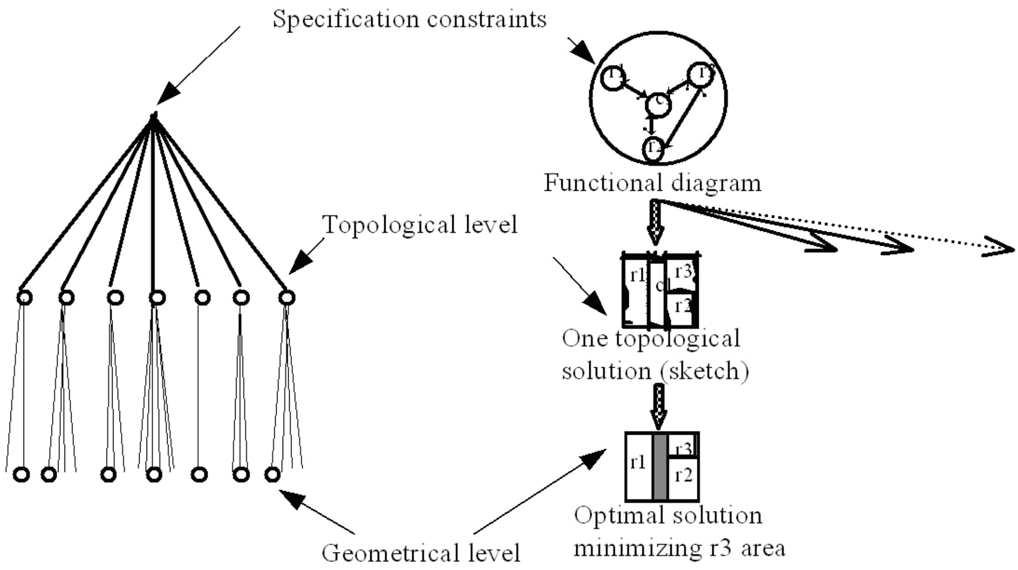


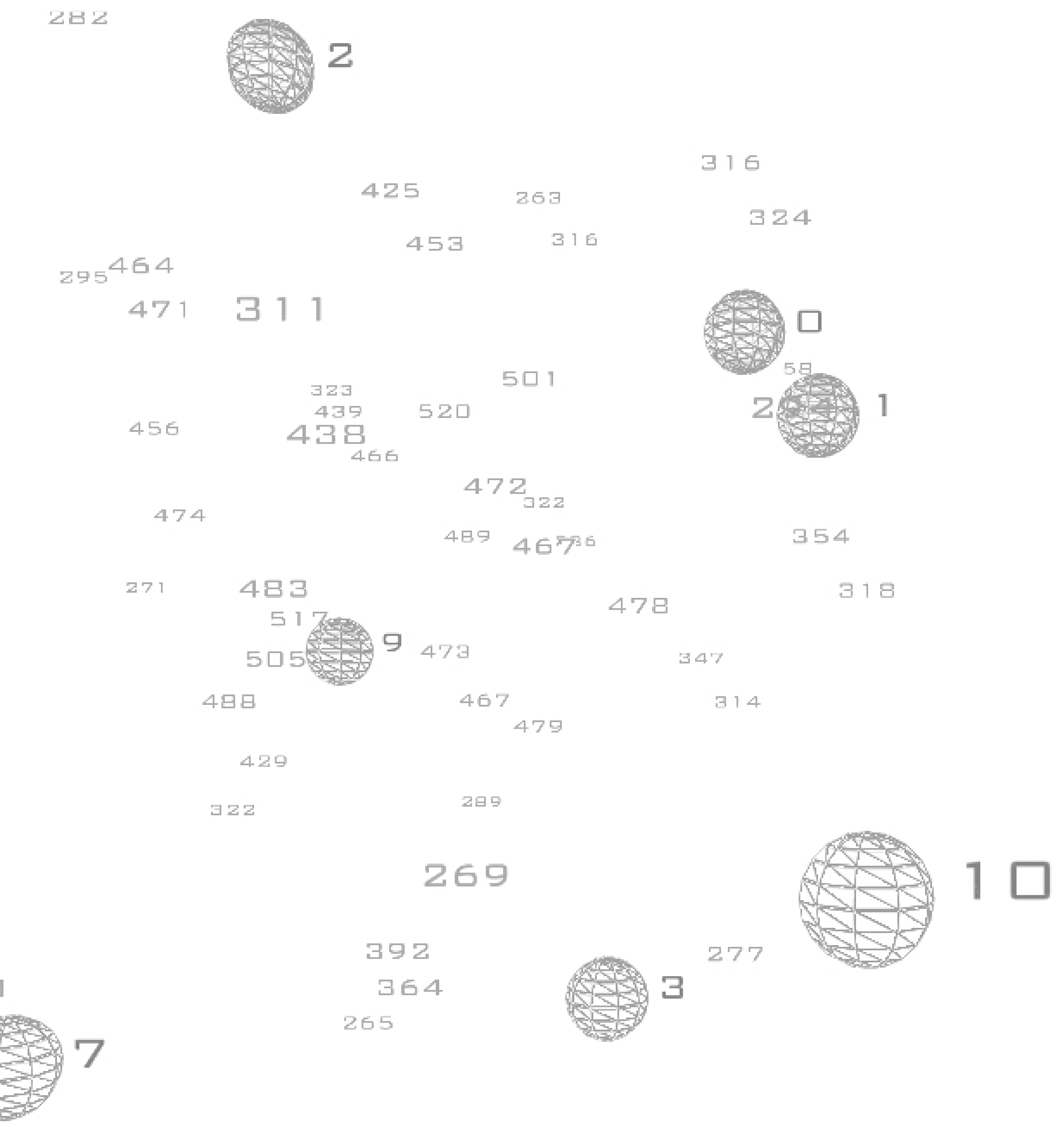
figure 8: *topological and geometrical solution diagram*

5. Finally a paper by Ruth Conroy Dalton and Ciler Kirsan titled "*Small Graph Matching and Building Genotype"* (2005), has implemented Space Syntax Methodology (graphs) to distinguish between houses of two ethnic groups situated in the same region. Through a series of graph transformations and analysis they concluded in indicating a measurable difference between the two ethnic types of houses. The same sample of houses will be used to approach the proposing idea of this paper.

All five works provide a variety of approaches within which the current work aims to be established. The present paper seeks to refine the gap which exists between theory and practice; to verify and provide an elaborated measure of architectural privacy before being able to implement it as a valid design tool. Even though an initial attempt was made by Julia W. Robinson to categorize spaces according to such gradient, her approach was at a very basic level. Similarly, approaching architectural privacy in terms of visibility and accessibility is only partially correct, which renders the approach of Kimberle Koile and the earlier approach by Eric Sundstrom et al quite incomplete. A more systematic analysis of the property of privacy is needed as to be able to understand and implement it as a conceptual design tool. Further discussion on the above works will be carried out in the discussion section.

part II

re-approaching privacy



“Most communications are in themselves abstractions of events that occur on multiple levels”

Hall E.T., 1969, p. 78

methodology

In this section the methodology used to approach the problem is presented and thoroughly discussed. Six case studies are analyzed according to the privacy factors as to produce sets of relational diagrams. These diagrams (graphs) are then employed to evaluate the initial hypothesis and to code the program. Finally the program is used to categorize spaces within each house and to evaluate and compare the sample cases. At this point the program becomes fully functional as an analytic tool able to topologically relate spaces according to their relative degree of privacy. Nevertheless the outcome presents a single instance of the state of the boundaries; the case in which all openings permit unobstructed accessibility, visibility, vocals and olfactory communication. Further development of the program, in a direction which will be clearly explained, will produce a fully functional tool able to represent and control all instances of the boundaries. This will permit more control and an elaborate description of privacy conditions supported by any given spatial configuration. Finally, synthesis can be achieved by working vice-versa; setting the desired topological diagram of privacy (categorizing spaces according to the desired degree of privacy) and then generating the possible boundary properties and configurations between them.

the conceptual model

To be able to set up the program a conceptual metaphor was implemented. This was followed by the creation and analysis of a series of graphs for each of the six case studies.

This study has been based on physical boundaries as the spatial elements affecting and regulating privacy. These boundaries were tested against their ability to filter the different factors affecting privacy and therefore against their capability to control communication between two spaces. Privacy was therefore initially approached as a one-one relation. The above scheme was directly translated into a simple diagram relating two nodes (spaces) with an edge (boundary) (figure 9.). In a subsequent phase and since this thesis has adopted the idea that the environment should support the user's need for privacy, it has been attempted to include changes-transformations of the boundary.

The concept of spaces connected by boundaries has been translated into programming as a physical forces simulation. Following this metaphor, spaces were represented as particles and boundaries between them as springs. The permeability of each boundary was rendered as an attraction force between two particles. For example if the boundary between two spaces permitted access, then an attraction force was implemented between those two particles (spaces), forcing them to come near each other. Accordingly, if the boundary between two spaces permitted sound, access and vision, a triple attraction force was exerted on the two particles and against the strength of the spring. These relations where predetermined by analyzing the plans and creating the relative graphs. Finally all sets of graphs were superimposed in the program as to produce the final topological diagram.

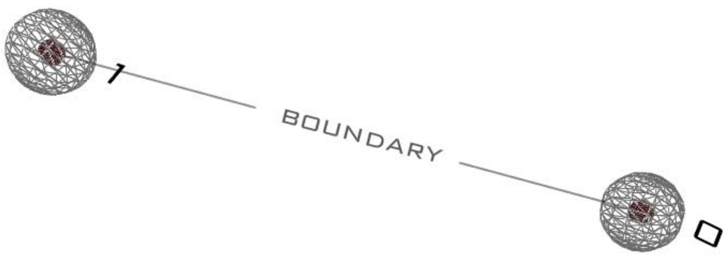


figure 9: *one-one relation*

the first phase

As it was also mentioned above the final program represents only an instance of the boundaries (The instance accessibility, vocals, olfactory, and visibility are unhindered). This was translated in fixed weights between linked nodes for each of the diagrams. The above condition was predetermined from the beginning of this work and it was the first task to be achieved. Even as a mere approximation of real conditions, this method is regarded permissible since each diagram (accessibility, proximity, etc.) represents a stand-alone small graph. Similar graphs are used by Ruth Conroy Dalton and Ciler Kirsan in their method (Conroy Ruth Dalton et al, 2005, p. 1). As such, it can function independently and provide certain information on privacy. Nevertheless, superimposing all graphs provided much more information and more elaborate results which produced a finer categorization of spaces.

the second phase

The next level was achieved by introducing a variable weight for each connection edge (boundary). This corresponded to altering the permeability of a boundary. For example, a door does not permit access or vision when it is closed whereas it permits a certain amount of sound. In a different example a door made of glass permits vision when it is closed whereas a door made of wood does not. These variable qualities which directly affect the degree of privacy of each space became the second required task to achieve and code. This approach would permit more accurate results and enable the user to include real measurements for each factor affecting privacy. This endeavour was not fully achieved as it was extremely time consuming and out of the scope of the present thesis. Nevertheless, determinative steps have been made towards this direction. A program was created enabling regulation of the permeability of the boundaries with the use of sliders. The user can alter the permeability of a certain boundary and see how the rest of the spaces are affected and repositioned. The above effort is achieved by controlling the attraction force between two nodes. The attraction force is based on certain graphs corresponding to all factors affecting privacy. Such graphs are presented in a following section (figures 12, 13, 14.), and also in the appendix. The results of the above approach are expected to be more representative than the first phase and enable more control and understanding of how the levels of privacy change according to the properties of the boundaries. Both phases are illustrated in the subsequent diagram (figure 10.).

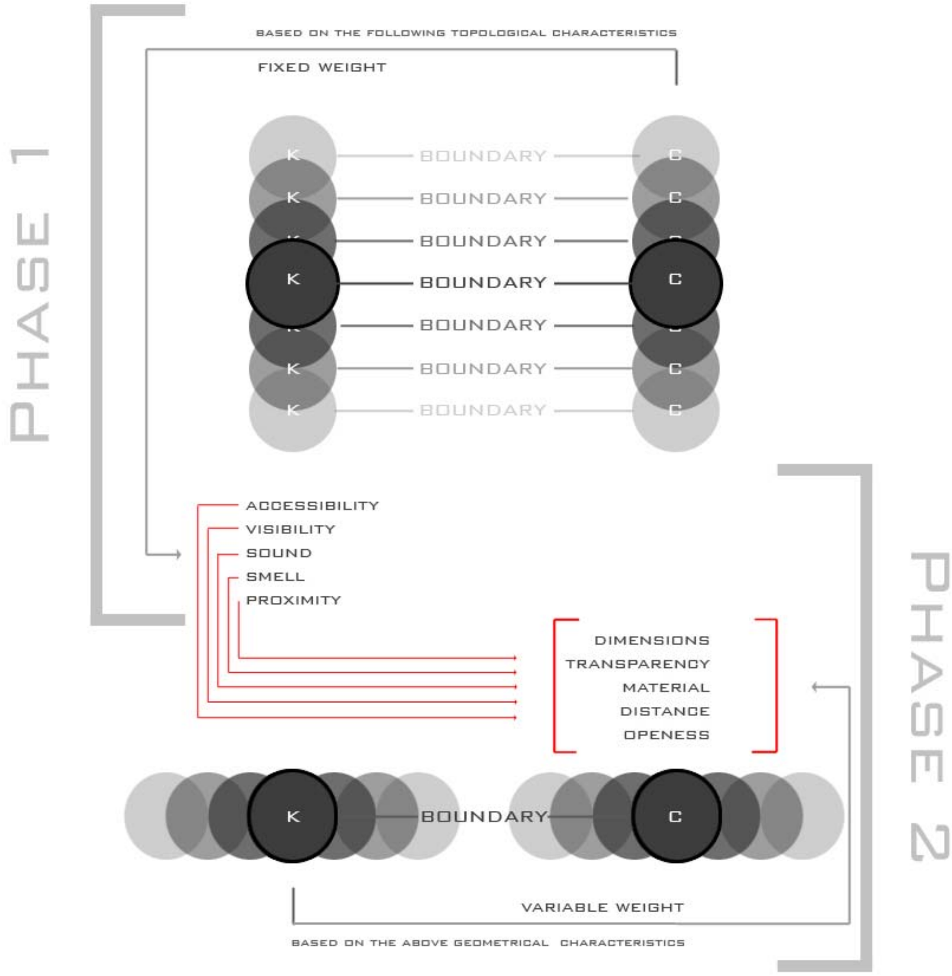


figure 10: *the conceptual model diagram*

The above model needed to be tested as to prove its feasibility. It has been decided to use an already tested set of case studies as to see if the above approach can produce more elaborated or different results. In the following section the case studies are presented.

the case studies

The current thesis attempts to extract its final results and contrast them with the findings of a paper titled "*Small Graph Matching and Building Genotype"* by Ruth Conroy Dalton and Ciler Kirsan (2005). The two authors managed to distinguish between six case studies and to categorize the houses into two different ethnic groups (Turkish Cypriot and Greek Cypriot) by comparing their graphs (accessibility only). They based their results on graph transformations and they used mathematical figures and formulas to reach the final outcome.

The same six case studies have been taken directly from the above paper and have been tested against the proposed topological approach. By contrasting 3 Greek-Cypriot houses to 3 Turkish-Cypriots houses it was attempted, at first to compare the cases at a space to space level, then at a house to house level and finally at a group to group level. This would initially aim to achieve a categorization of spaces according to their relative degree of privacy. This set of results would then be used to describe differences and similarities between each house and each group of houses. Through the group to group comparison cultural differences concerning privacy were expected to emerge. The implementation of more than one set of graphs was expected to give more elaborate results, whereas at the same time to enable comparison of the samples at different levels.

As described by Ruth Conroy Dalton and Ciler Kirsan, all six houses are situated on the island of Cyprus and date back to the period before 1974. Both groups of samples have been selected accordingly from Turkish and Greek villages which are situated in the Mesaoria region of the island. All houses are '*courtyard houses*' adapted to a peasantry-based agricultural economy and way of life. Both groups of houses are formed by similar spatial elements which are shown in the following section. The spatial layouts have been reconstructed through first hand observations and field work by Ciler Kirsan.

C = courtyard

c = animal courtyard

L = loggia

R = room

M = main room

K = kitchen

A = Animal shed

E = exterior

m = main upper room

S = semi-closed central space/hallway

H = closed central space/hallway

P = produce store

T = straw store

h = upper closed central space/hallway

s = upper semi-closed central space/hallway

r = upper room

t = toilet

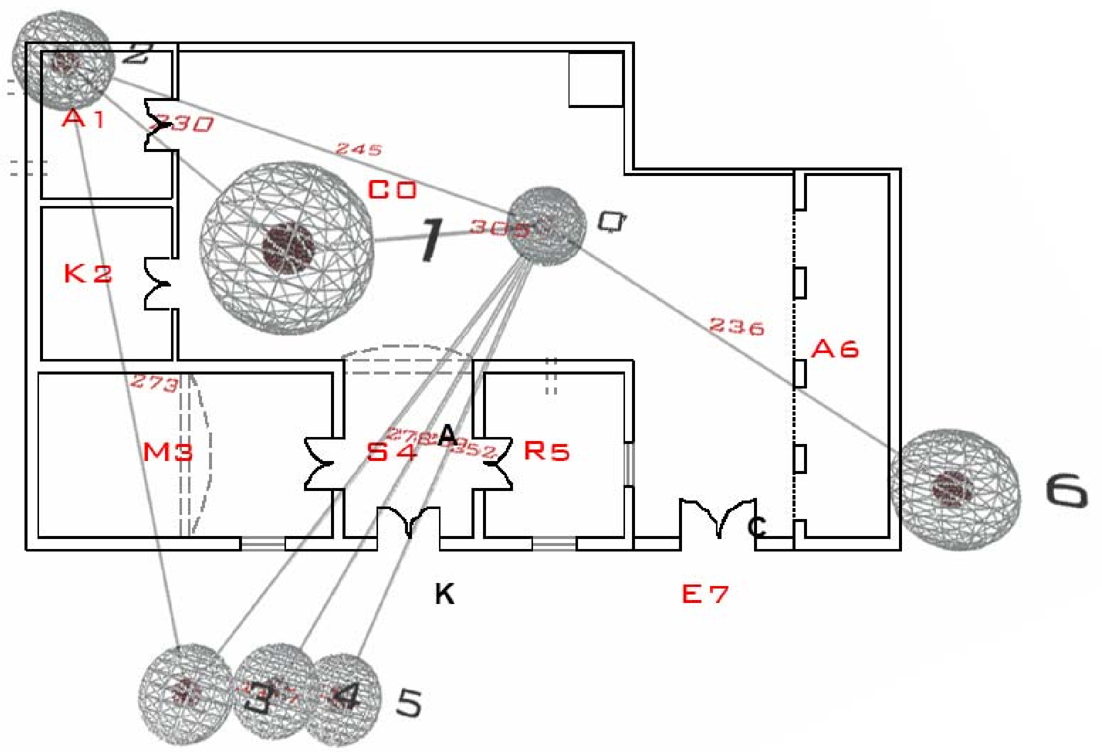


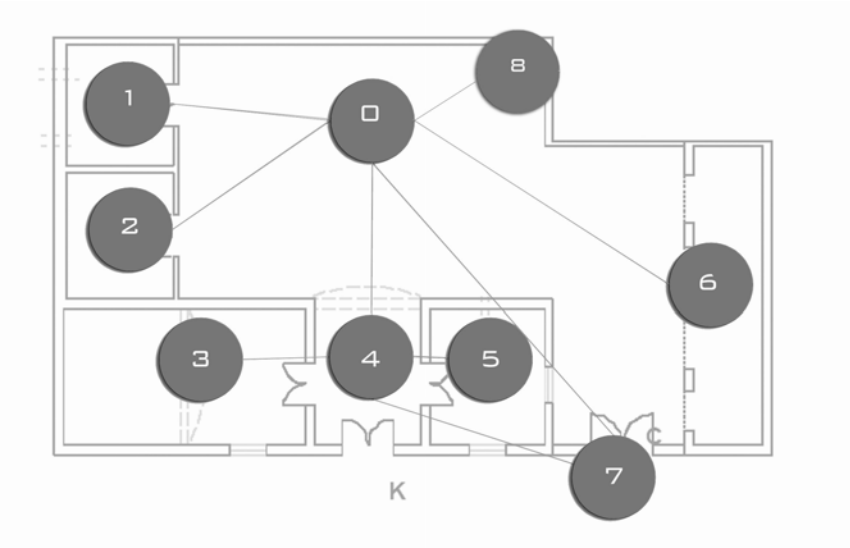
figure 11: *plan and privacy topological diagram for G2*

the graphs

For the first phase the five factors affecting privacy were reduced to three and accordingly only three out of five graphs were created. It was observed that the vocals and olfactory graphs were actually included in the other three graphs for the given fixed instance of the boundaries. It was noticed that each of the two graphs was similar to those of accessibility and visibility composed together. Consequently they could be neglected without any significant change in the final result. Further discussion for the omission of the first two graphs will take place in the section explaining the limitations of methodology.

Accessibility graphs

The following diagram illustrates an accessibility graph which presents the spaces connected to each other via a door, a passage or an accessible opening. This type of graph is identical with those used in the paper "*Small Graph Matching and Building Genotype".* Such graphs are also frequently used in Space Syntax theory. The essence of justified permeability graphs is thoroughly analyzed in chapter 4, "*Buildings and their genotypes"* in the book "*The Social Logic of Space*" by Bill Hiller and Julienne Hanson (Hiller B, Hanson J., 1984, p. 147 -154). Accessibility graphs for the current work indicate the spaces which share a common boundary which permits access. It is proposed that spaces which share a boundary with an accessible opening are less private and consequently they enable communication between them. Such examples of spaces in the given plan (figure 12.) are spaces four (4) and five (5) or spaces one (1) and zero (0).



visibility graphs

The visibility graph indicates which spaces are connected via an opening which permits view from one space to another. This is a graph which includes all the above connections (accessibility graph) and also those enabled by windows or other not accessible openings on boundaries. Similar graphs and lines of sight have been also used in Space Syntax methodology as to indicate the intelligibility of space. In the present example such lines of sight are used to indicate the exchange of visual information between two spaces. The start and end points of such lines are taken from the centre of each space. It is noticeable that in visibility graphs the notion of boundary becomes quite controversial. For example in the case of a space A which can be seen from space B and the two spaces are situated in the opposite sites of a courtyard, then the notion of boundary needs to be redefined. It is not a separating surface anymore but a separating space. The courtyard becomes the boundary between the two spaces. This is more evident in the case of an olfactory graph, were smell for example from a kitchen can reach only up to certain point before it fades out. Boundaries are therefore regarded as relative entities which can take many forms as filters of communication between two spaces. For the given example (Greek-Cypriot house G2, figure 13.) spaces 0 and 4 are connected with such line of sight. Nevertheless, the above example presents an approximation of the real situation. It is obvious that spaces and openings between them differ in size. The amount of space that can be seen from either part of the boundary is different. It is therefore logical to conclude that the connection between those two spaces might not be given by a linear relation. For the visibility graphs used in this thesis, an edge (link) between two spaces is realized if more than half of the area of each space is exposed to the other. This corresponds to less privacy between the two spaces. The above matter will also be further discussed in the limitations of methodology part.

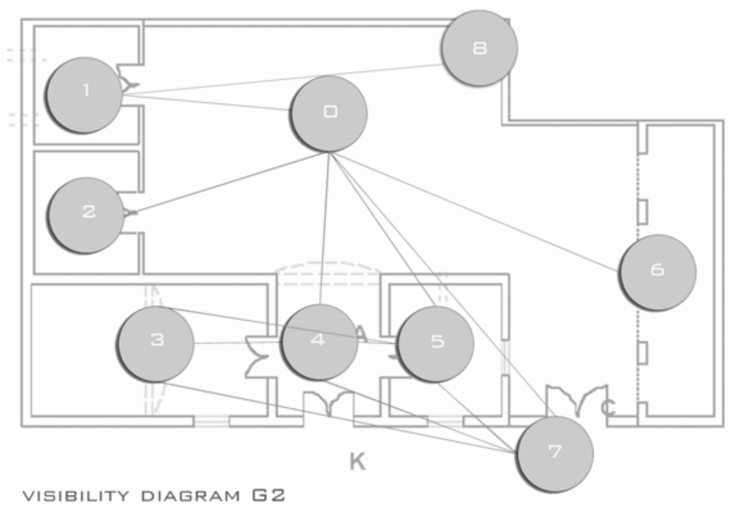


figure 13: *visibility graph for G2*

proximity graphs

Proximity graphs resemble a quite indirect link between spaces. Proximity can be parallelized with the sense of touch as a communication mechanism. Two spaces in proximity share a common boundary, which regardless of the other factors (visibility, accessibility, vocals and olfactory) affects the privacy of both spaces. Proximity is a conceptual measure rather than a metric one. This fact is better illustrated in the following quotation by Hall. *Japanese have strong feelings against sharing a wall of their house with others. He considers his house and the zone immediately surrounding it as one structure. This sliver of space is considered to be as much part of the house as the roof is*. (Hall, 1969, p. 142). A link is therefore realized between two adjacent spaces that share a common boundary to express proximity communication. This is translated as a decrease of privacy between two adjacent spaces (figure 14.).

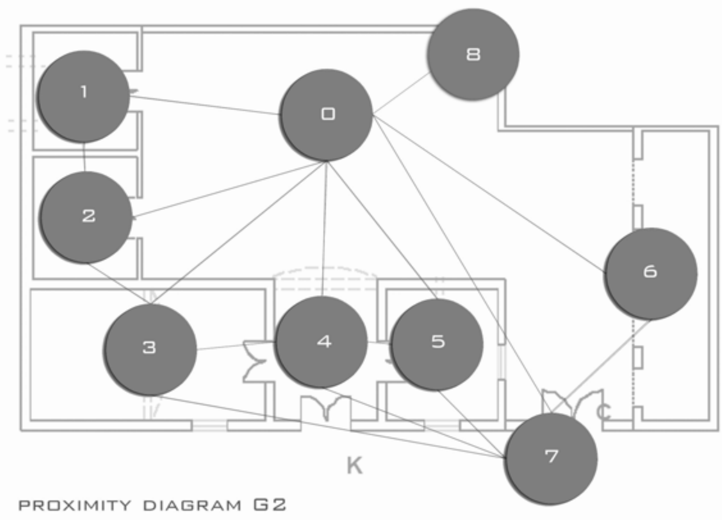


figure 14: *proximity graph for G2*

The above three graphs can be expanded to five when the program is further developed in the second phase. The above diagrams would eventually include vocals and olfactory graphs. All new graphs will differ from the above in the sense that they will enable multiple instances of the boundaries. A boundary with changeable features (doors, windows, blinds, curtains), will be represented in a dynamic way. This will basically mean that the new graphs will have variable weights enabling the user to examine all the variations of privacy in respect to the desired state of the boundary. More details concerning each graph could then be coded as to provide more control for the user. For example features like the actual area of the common boundary, the area of the openings, materials, the fading away process of sounds and smells could be calculated and feed in the program. Some of these features will be fixed; for example the sound permeability of a blank wall or a door when closed. On the other hand other features could be relative for instance how the acoustics or visibility changes when a door is opened or closed. All these fixed and changeable features could be altered as to examine the final results on the topological diagram of privacy.

the program

According to the official webpage, processing is an open source programming language used by students, artists, designers, architects, researchers, and hobbyists for learning, prototyping, and production. It was developed by artists and designers as an alternative to commercial software tools in the same domain. Processing language was implemented to code the program. Specifically, physics library was used to create the nodes (spaces) and the springs (edges-links) between them. All particles were interconnected before any attraction force was applied to the system (figure 15.).

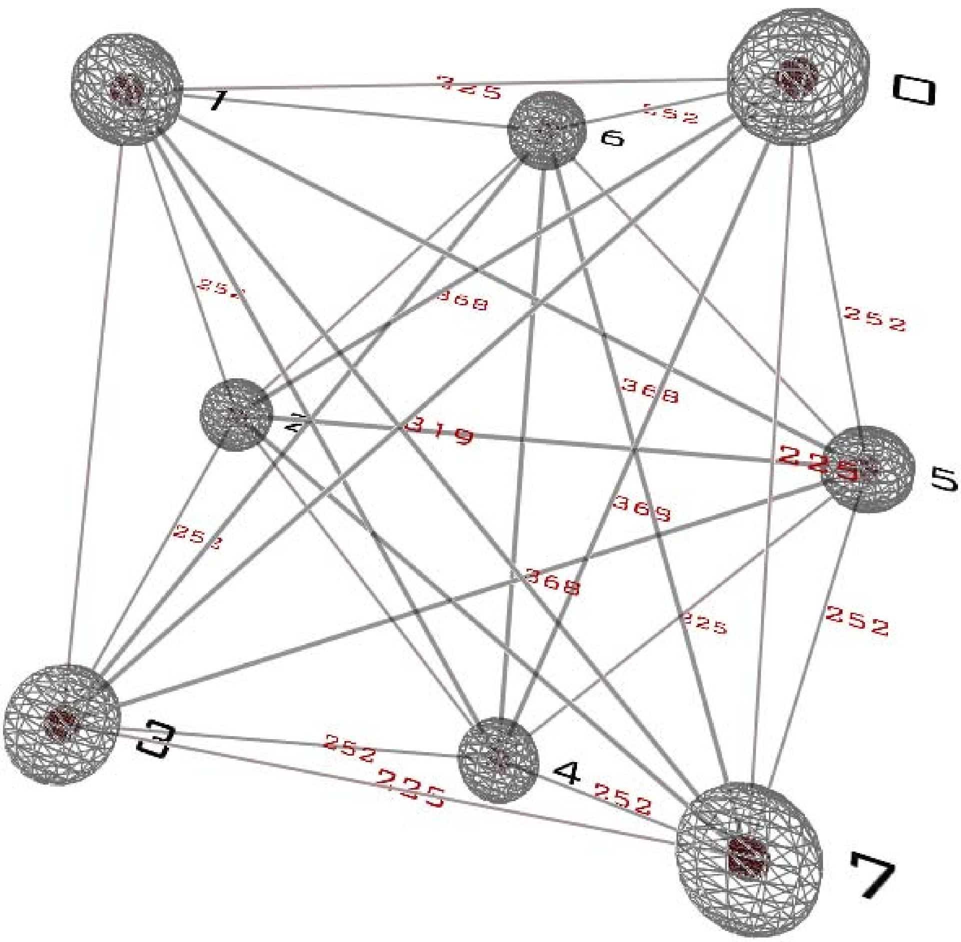


figure 15: *the interconnected particle system*

During the first phase each spring was assigned a fixed weight (a fixed attraction force) corresponding to each realized link in one of the three graphs (accessibility, visibility, proximity). Three layers of attractions were then superimposed as to combine the three different graphs and produce the final result. The program was able to render the relative position between two spaces and place them accordingly. The whole system of interconnected spaces (nodes) indicates with a relative accuracy the arrangement of all spaces according to their degree of privacy. Less private spaces would come together whereas the more private spaces would stay as far as possible from each other group or space. Nevertheless, minor implications with the geometric arrangement of nodes imposed the introduction of a constant value as to produce more accurate results regarding the categorization of spaces.

The *mean edge distance* of each space (node) is defined as the sum of the length of all the edges connected to it divided by the number of the edges. This value can give a relative measure of how public or private a space is. *Mean edge distance* actually indicates the amount of realized communication links with the space under investigation. The smaller the *mean edge* value the more public the space is.

During the second phase a more advanced tactic was implemented. The program was actually able to represent how the privacy relations in the topological diagram change according to the regulation of certain boundaries. This direction was not fully exploited as it was extremely time consuming to measure the different properties and code the program. Such an effort would be out of the expectations of the current study.

In this second phase, sliders were implemented to control the attraction force exerted between each pair of connected nodes. This directly affected the rest of the system by repositioning the various particles. Being able to vary the attraction force was analogous to regulating the permeability of the boundary. In the final version one could be able to vary all five factors affecting privacy for each boundary in the system. The following example is given to illustrate the above feature. Let us suppose that the boundary between space A and space B is a wall with a wooden door. When the door is closed the only realized links between the two spaces are vocals (at low levels, depending on the material of wall and door, and their dimensions) and proximity. When the door starts gradually to open, other factors start to affect privacy. Consequently we have an increase in vocals, visibility, accessibility and olfactory levels. Proximity remains constant. When the point at which the door is fully open is reached, then we have an instance similar to the one described in the first phase of the program.

Phase two was only tested with four particles and three sliders able to control three realized boundaries. Each slider affects all five factors simultaneously. Nevertheless, each factor can be regulated manually from the source code of the program (Assigned a desired value) (figure 16).

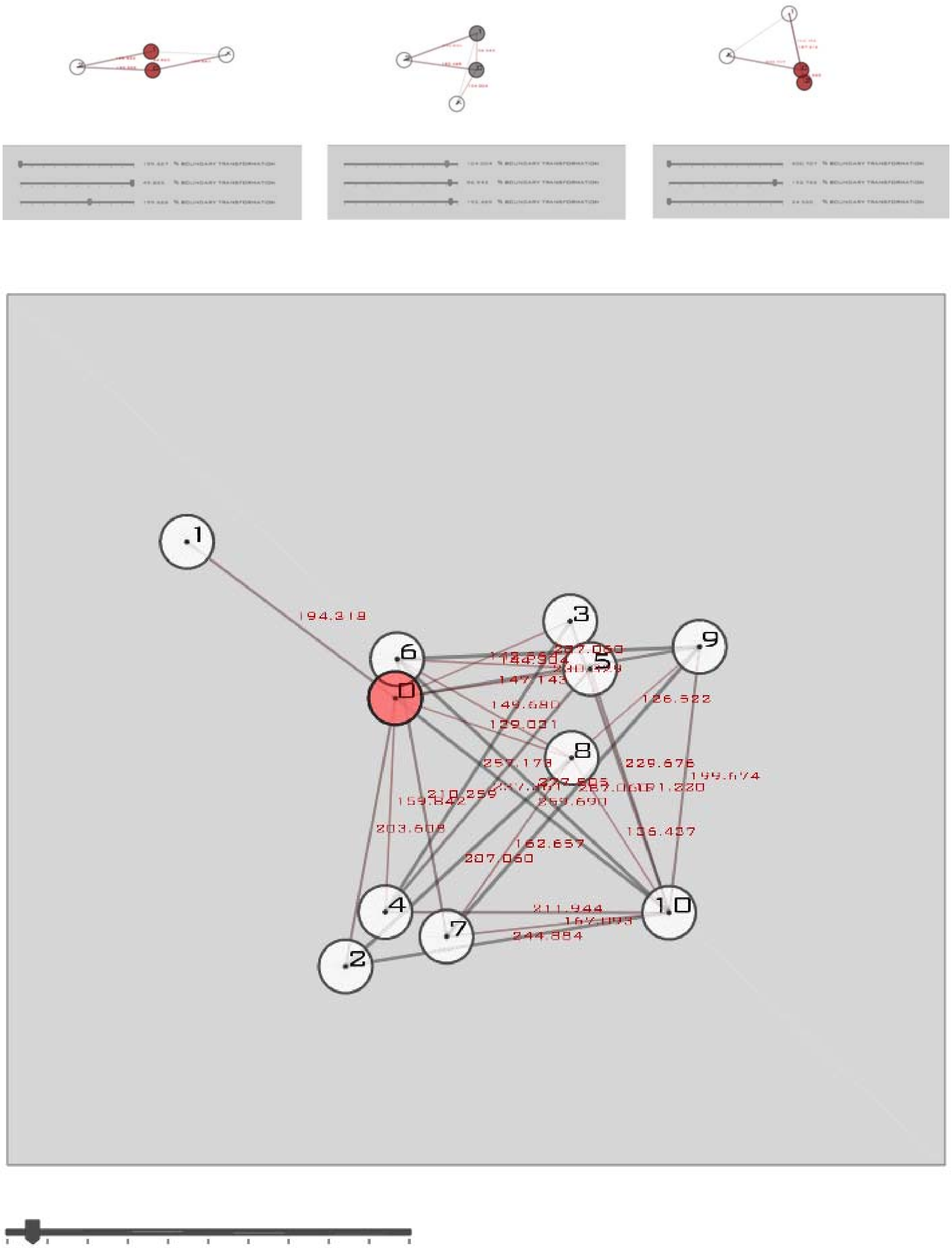


figure 16: *the second phase of the program*

limitations of the methodology

the graphs

Several problems were encountered during the creation of the graphs which represent the factors affecting privacy.

A general problem is the relative weight of each of the five factors when superimposed to produce the final topological diagram. Obviously this is a subjective measure which varies from culture to culture and even from person to person. Someone would suggest that visibility and accessibility could be more important than the rest of the factors. A certain house layout might seem quite private for one family and not so private for another. Nevertheless, the above program presents an instrument which is able to include all this variations. One can set the relative importance of one factor over the other by doubling its effect on the system. For example the attraction force exerted by a visibility link can be double the size of the one exerted by a proximity link. For the purposes of the current study all three factors carried equal weight in the system.

As it was also mentioned before, two out of five graphs were neglected in the first phase of the program. This was rendered possible given that all graphs had equal weights and that the two graphs (olfactory and vocals) were the same as the ones already used (for the given instance). The omission of those graphs did not have any topological effect on the system since they could be included in the rest three without producing different results. Actually only one graph would have been enough to produce some results. The idea was to be able to approximate the way space regulates privacy as much as possible and therefore more than one factors needed to be included in the system. The two graphs (olfactory, vocals) would have an effect in the second phase of the program as their change would not be linear and it would affect the system differently at the different instances of the boundary.

As it was also mention before, visibility is a relative measure and it does not depend only on the boundary but also on the place of the spectator-viewer. Furthermore the relation of one space to another is a bidirectional but not with equal weights. That means that from the centre of space A you might be able to see more area of space

B, but that might not be the fact if you are situated in the centre of space B. Furthermore, since the present work studies only two dimensional plans, only the two dimensions of the openings are taken into consideration. For the first phase of the program, these facts were confronted and solved by setting some rules mentioned in the visibility graph section. In the second phase it is expected that they are going to be fully addressed and solved.

For the second phase, all the factors are expected to be quantified. Obviously this is a huge and quite utopian cause and nobody would be able to come up with absolute values. This is obviously due to the unpredictability governing the behaviour of factors such as olfactory or vocals as well as their strength and nature. Certain values have to be set for these features and accordingly, measurements should be carried out. Nevertheless even an approximation of how these factors behave will provide a more accurate picture of how privacy is distributed in space. Certainly features like dimensions of openings and common boundaries or properties of certain materials will be able to give much more accurate results and better approximation of the real situation.

the case studies

Six case studies can be considered a small sample to provide accurate results. As it is also noted by Ruth Conroy Dalton and Ciler Kirsan "*the sample was extremely small and cannot be deemed statistically significant*" (Conroy Ruth Dalton, 2005, p. 25). However, given that it is an extremely time consuming effort to analyze and create all the sets of graphs it can be considered as an initial attempt towards measuring privacy, capable of producing a number of interesting results.

the program

Using programming as a method of representing dynamic topological diagrams was a decision upon which the rest of the work was based. Programming enabled the visualization of the results and accordingly a graphical environment to interpret them. At the same time a manual approach was implemented as to verify the results taken from the program. Both methods were extremely time consuming and fall into high probability of error.

There was also a geometrical restriction to the program due to the fact that all nodes were interconnected together. This resulted in uneven links between certain nodes. When the number of nodes increased above three different groups of such measures where identified. The program was soon transformed into 3 a dimensional representation as to limit the number of such groups and be able to measure the relative distances between the attracted nodes.

findings

By calculating the *mean edge distance* for every space (node) in each sample house it has been possible to determine a degree (rank) of privacy for each space. The results for a single case are illustrated in the following figure. A topological equivalent of this categorization was also given by the program (figure 17.). Complete presentation of all the results is given in the appendix section. Case G2 for example, denotes that space *C0* (courtyard) is the less private, followed by space *S4* (semi-closed central space/hallway). Spaces *R5* (room) and *M3* (main room) are situated somewhere in the middle, whereas spaces *A1* (animal shed), *A2* (animal shed) and *K2* (kitchen) are the more private ones. The most private space is *t8* which apparently is the toilet. The topological diagram illustrates which spaces are connected and what is the level of communication between them. As communication causes attraction it is noticed that the most private spaces are situated further away whereas the ones with less privacy aggregate together.

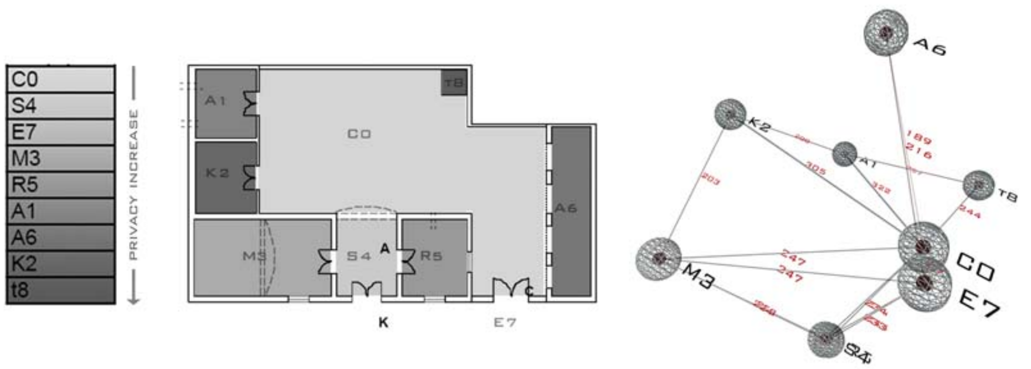


figure 17: *degrees of privacy and privacy topological diagram for G2*

Surprisingly all houses present similar spatial arrangement as the example described above. Spaces *C* (courtyard), *H* (closed central space/hallway), *S* (semi-closed central space/hallway), and *L* (loggia) and of course *E* (exterior) have been higher in the rank as they comprise the less private spaces. On the other hand spaces *K* (kitchen), *A* (Animal Shed), *t* (toilet) and *T* (straw store) are lower in the rank which denotes them as the least private spaces.

By comparing the two ethnic groups, a characteristic difference is observed. Spaces *m* (main rooms) of the Turkish-Cypriot houses are ranked as highly private whereas for the Greek-Cypriot houses are categorized somewhere between private and public. Someone could infer several conclusions regarding cultural or ethnic differences based on this fact but the specimen is not adequate enough to allow statistically approved connotations. In addition the Turkish Cypriot sample consists of two storey houses with the main rooms placed on the second floor. This fact raises the uncertainty of the result. Probably a larger sample from two storey houses should be gathered for both ethnic groups before any final conclusions are extracted.

The above results can be judged as rational and expected if seen from an architectural perspective. The more disturbing, malodorous and problematic a function is, the less it communicates with the living and sleeping areas of the house. Accordingly, animals, toilets and kitchens are isolated and kept apart from rooms and living areas. Courtyards act as communication nodes separating the malicious from the sleeping and living areas and thus they comprise the less private spaces since they present higher levels of activity. Central halls and loggias interconnect living and sleeping spaces and usually include the entrance of the house and staircase to the upper floor. They are also spaces with high levels of activity and therefore they are also higher in the rank as less private spaces.

discussion

In this chapter the findings of the study will be compared and discussed in accordance to similar academic work at both theoretic and practical levels.

At a theoretic level the above findings verify that space can acquire different degrees of privacy and therefore it can be studied and designed accordingly. Following the above analysis, the spaces with similar degree of privacy can be also clustered into groups or zones of privacy. This fact could be compared with the work of Julia W. Robinson and reinforce her approach. At first the general categorization of spaces she pursues, (intimate-private-public) seems to be applicable in all the above examined cases. Nevertheless, the different nature of the two specimens must be taken into account. The cases studied in this paper belong to a peasantry-based agricultural economy whereas the ones examined by Robinson are typically traditional American detached houses. Given the above fact one would expect certain differences to emerge by the comparison of the two specimens. It is observed for instance that for case G2, the courtyard and the central hall are directly analogous to the yard and porch of the typical American house. These spaces are described as semi public and semi private by Robinson who positions them higher in the rank (less private). That is also exactly the case for the example G2. The differences between the two examples are in the position of the kitchen and the bedroom. The kitchen becomes an intimate space for the Greek Cypriot houses whereas the bedroom becomes a private space. Toilet and living areas remain similar to the rank proposed by Robinson.

The interesting result is that the Turkish Cypriot house resembles much more the typical American layout of privacy as the main bedroom is classified as one of the most intimate spaces. The only difference is the position of the kitchen which can be logically accounted for, since it was considered a malicious function for the peasantry-based agricultural economy house.

The above comparison verifies that the proposed method presented in this paper is able to provide an evaluation and an elaborate topological categorization of spaces, as proposed by several academic authors. Based on spatial configurations and spatial characteristics one is able to provide a relative measure of the degree of privacy provided by each space in certain spatial aggregations. Nevertheless, such spatial aggregations are subject to cultural, ethnic, climatic, and other differences. For example, in certain cultures, transformations of the same space result in a variety of functions and degrees of privacy applied to the certain space; a living room for instance, under a certain transformation might become a bedroom and so on. It is therefore pointless to apply general definitions to which spaces belong to which group. RAMTV in their project completely rejected the idea of spaces belonging to fixed privacy zones by proposing a new approach to contemporary housing. By re-defining the interior layout of the present-day apartment, they propose a complex system of shared facilities as to address the needs of modern society. As a result the residents are able to share his kitchen or other spaces of their house with one or more of their neighbours. This fact unavoidably alters the degree of privacy of each shared space and comes to support the need for a topological diagram as the basis for approaching such kind of relational problems.

Approaching architectural problems which are governed by abstract qualities and representing them as topological diagrams is also the direction followed by Benachir Medjdoub, Bernard Yannou and Kimberle Koile. At a practical level the current work pursued an analytical approach with synthetic potential closer to the concept of the two first authors. Following their direction it reinforces their approach by presenting an explicit analysis of the abstract quality of privacy before proceeding to expressing it in topological terms. An elaborate topological tool able to dynamically represent the communication level between aggregated spaces was therefore the outcome of this endeavour. This aims in assisting analysts and in its second phase designers in the primary sketching phase of architectural process. As such, it provides a methodical topological tool which will be then translated either manually or by the use of appropriate software into actual design plans.

By following the direction of Ruth Conroy Dalton and Ciler Kirsan and by implementing more than one set of graphs this current work, has achieved not only to specify that there are differences and similarities between the six case studies but also to clarify where the differences and similarities are (in terms of specific spaces). As such, further development of the current method might present a useful synthetic tool.

Further work

Further work should include a larger sample of houses from different cultures as to produce more statistically accurate results and reinforce the current method. At another level, a comparison with a sample of modern courtyard houses could be carried out. This could provide information on how the re-placement of certain modern features (like the kitchen inside the house) has changed the spatial configuration and the distribution of privacy within the single house.

Finally, further work should be directed towards developing the second phase of the program as to be able to dynamically represent and control the variations of privacy. This idea will encompass the approach proposed by Nathan Witte according to which environment should be able to regulate privacy. Nevertheless, a systematic approach of such regulation is needed before we can unquestionably implement privacy as a conceptual tool in the design process.

epilogue

In the first part, privacy was approached from a broader perspective. The thesis has then gradually developed as to define architectural privacy, and eventually construct the five factors affecting it. In the second part those five factors were implemented as the basis for the methodology which was followed to validate the hypothesis of the current thesis.

The present work succeeded at a theoretical level by verifying the existence of a gradient of privacy, proposed by many authors. A new model of approaching privacy has been proposed; in other words spaces possessing different degrees of privacy instead of the fixed dipole private-public often used in architectural discourse.

At a practical level the current work provided a method for confronting problems related to architectural privacy. Even though there are several software pertaining the above cause, the current thesis managed to refine the space between theory and practice dynamically by actually providing an elaborate topological tool for analyzing and synthesizing at the first abstract stages of architectural process.

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appendix

case study graphs

In this section the six case studies are present along with the three graphs created for each case.

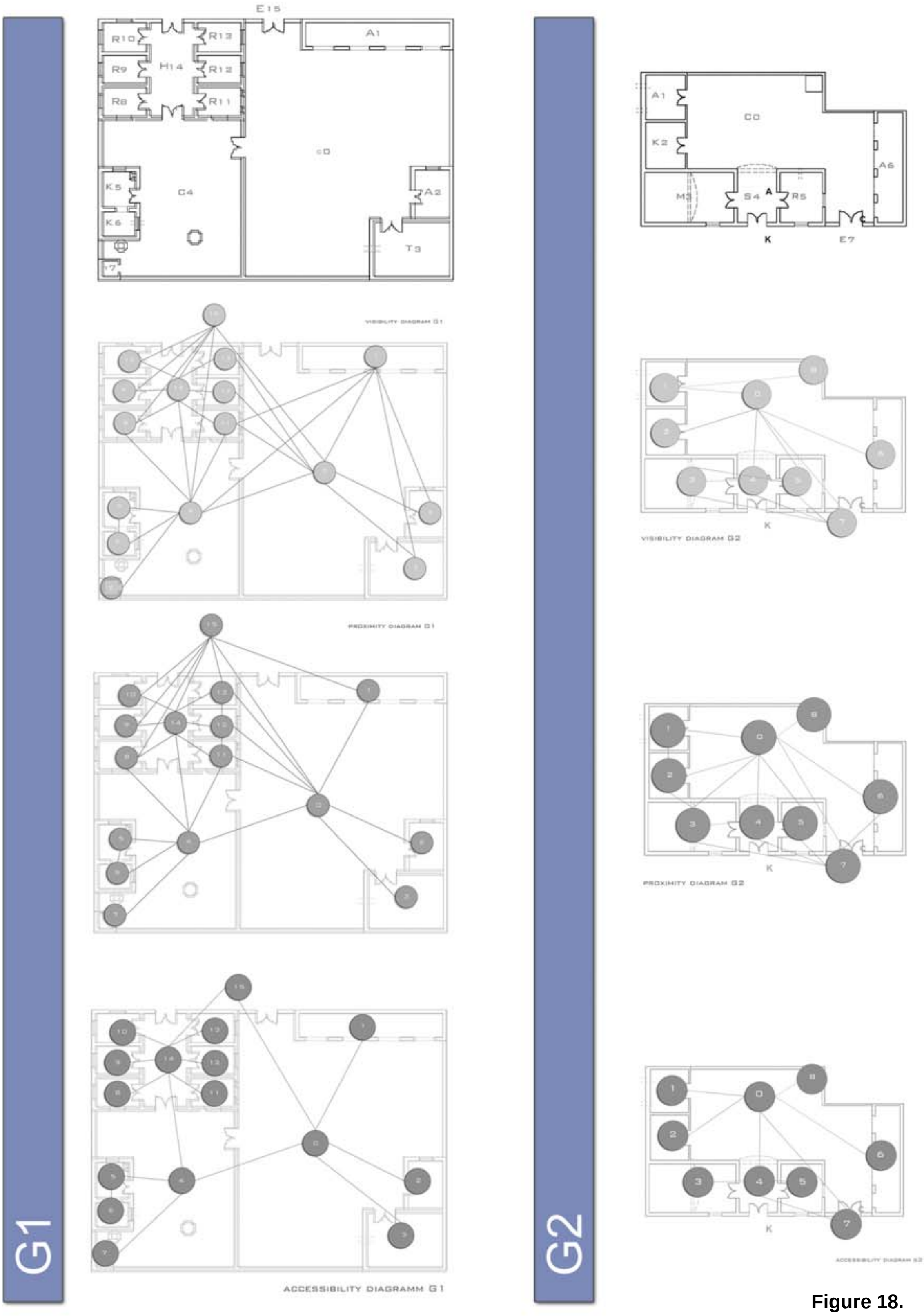
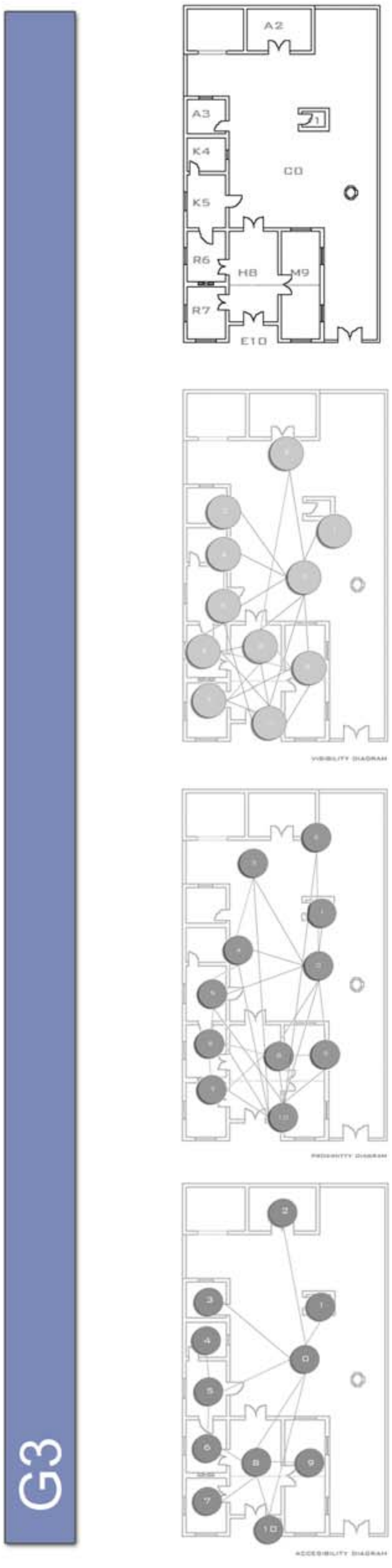


Figure 18.


G3
A2
A3
K4
C0
K5
R6
H8
M9
R7
E10
VISIBILITY DIAGRAM
PROXIMITY DIAGRAM
ACCESSIBILITY DIAGRAM

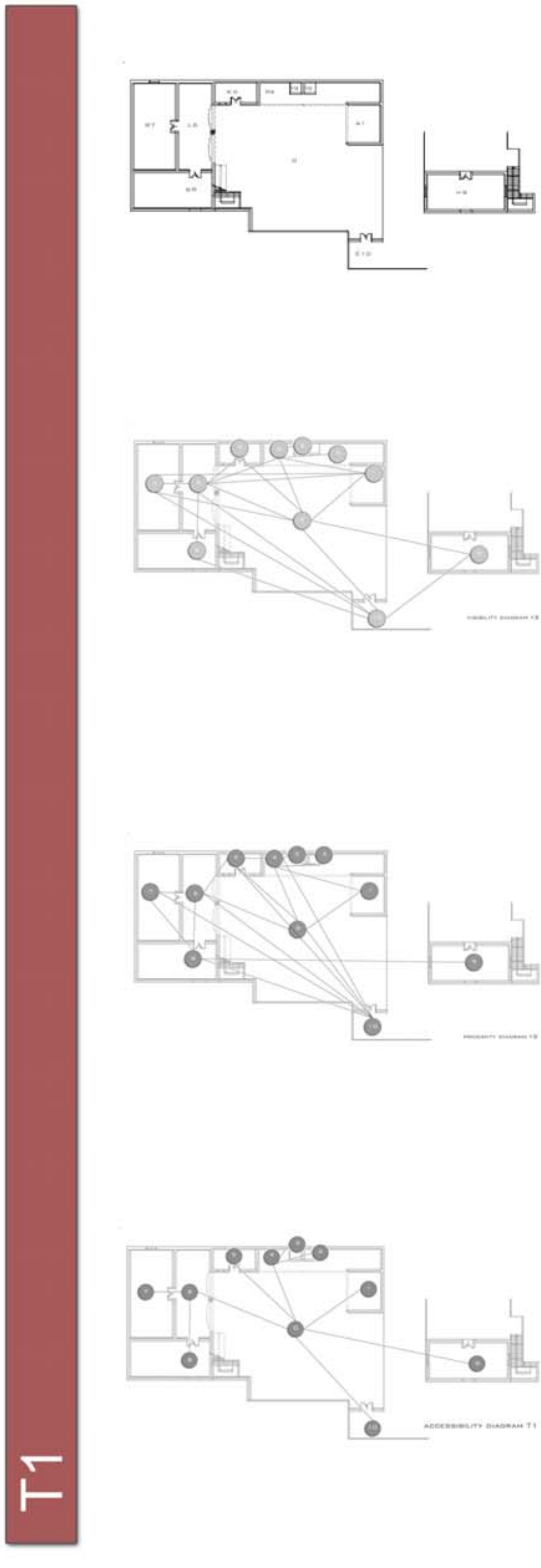

T1

Figure 19.

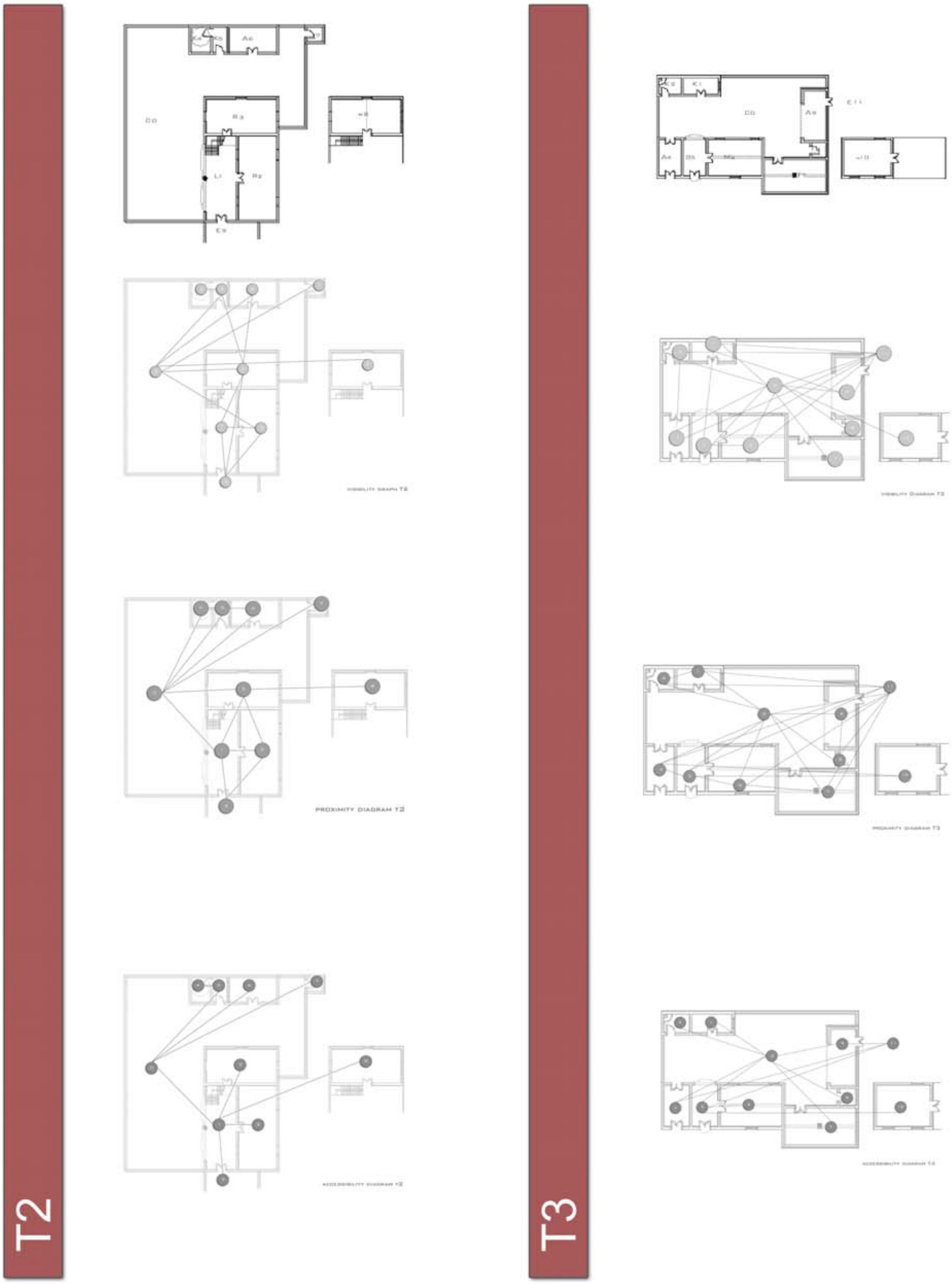


figure 20.

Greek-Cypriot samples

The following tables illustrate the analysis of the 3 Greek-Cypriot houses. The p-p column is the gradient of architectural privacy from the most private to the most public space within each sample.

G1

	A	P	V		sum	RANK	p-p
c0	5	8	8		21	2	H14
A1	1	2	5		8	6	c0
A2	1	1	2		4	14	C4
T3	1	1	2		4	14	E15
C4	4	7	9		20	3	R11
K5	2	2	2		6	10	A1
K6	1	2	2		5	11	R8
t7	1	1	1		3	16	R12
R8	1	3	3		7	7	R13
R9	1	2	2		5	11	K5
R10	1	2	2		5	11	K6
R11	1	4	4		9	5	R9
R12	1	4	2		7	7	R10
R13	1	4	2		7	7	A2
H14	8	8	8		24	1	T3
E15	2	7	6		15	4	t7

courtyard
toilet
entrance halll
public
rooms
main room
kitchen
animal shed
loggia

G2

	A	P	V		sum	RANK	p-p
C0	5	7	6		18	1	C0
A1	1	2	1		4	6	S4
K2	1	2	1		4	6	E7
M3	1	4	3		8	4	M3
S4	4	4	4		12	2	R5
R5	1	3	4		8	4	A1
A6	1	2	1		4	6	A6
E7	2	5	5		12	2	K2
t8	1	1	1		3	8	t8

courtyard
toilet
entrance halll
public
rooms
main room
kitchen
animal shed
loggia

G3

	A	P	V		sum	RANK	p-p
C0	6	8	8		22	1	C0
t1	1	1	1		3	10	E10
A2	1	2	2		5	9	H8
A3	1	3	1		5	9	K5
K4	1	4	2		7	7	R6
K5	3	4	4		11	4	M9
R6	2	4	4		10	5	R7
R7	1	3	3		7	7	K4
H8	5	5	6		16	3	A2
M9	1	3	5		9	6	A3
E10	2	9	6		17	2	t1

courtyard
toilet
entrance halll
public
rooms
main room
kitchen
animal shed
loggia

figure 21.

Turkish-Cypriot samples

The following tables illustrate the analysis of the 3 Turkish-Cypriot houses. The p-p column is the gradient of architectural privacy from the most private to the most public space within each sample.

T2

	A	P	V		sum	RANK	p-p
C0	4	6	6		16	1	C0
L1	5	3	4		12	2	L1
R2	1	3	3		7	5	R3
R3	1	5	4		10	3	K5
K4	1	1	2		4	8	R2
K5	2	3	3		8	4	E9
A6	1	2	2		5	7	A6
t7	1	1	1		3	9	K4
m8	1	1	1		3	9	m8
E9	1	3	2		6	6	t7

courtyard
toilet
entrance halll
public
rooms
main room
kitchen
animal shed
loggia

T1

	A	P	V		sum	RANK	p-p
C0	6	7	5		18	1	C0
A1	1	4	2		7	5	L6
t2	1	1	2		4	9	E10
t2	1	1	2		4	9	P4
P4	2	4	6		12	3	R7
K5	1	2	4		7	6	A1
L6	3	7	5		15	2	R8
R7	1	4	3		8	5	K5
R8	1	2	4		7	6	m8
m9	1	2	1		4	9	t2
E10	1	5	6		12	3	t2

courtyard
toilet
entrance halll
public
rooms
main room
kitchen
animal shed
loggia

T3

	A	P	V		sum	RANK	p-p
C0	7	9	10		26	1	C0
K1	1	3	4		8	4	E11
K2	1	3	3		7	8	S5
A4	2	4	3		9	4	A4
S5	4	5	4		13	3	K1
R6	1	4	3		8	5	A9
T7	1	4	1		6	9	R6
t8	1	4	1		6	9	K2
A9	2	3	3		8	5	t7
m10	1	2	1		4	11	T8
E11	3	9	7		19	2	m10

courtyard
toilet
entrance halll
public
rooms
main room
kitchen
animal shed
loggia

figure 22.

cd – rom

The cd–rom includes a *.pdf and a *.doc documents of the thesis along with working applets from the two different phases of the programm.