Architectural Design Spaces and Interpersonal Communication:
Changes in Design Vocabulary and Language Expression

Ivanka Iordanova, Lorna Heaton, Manon Guité

[1,3]*Université de Montréal, School of Architecture, GRCAO (CAD Research Group), Canada*

[2]*Université de Montréal, Département de Communication, Canada*

ivanka.iordanova@..., Lorna.Heaton@..., Manon.Guite@umontreal.ca

Abstract. This paper addresses communication during the design process and the mutations it may undergo depending on the medium of design. Three experimental observations were held with students in the context of architectural digital design studios. Each of them was performed when the students were working on a design problem, in groups of two or three, with different design mediums: cardboard mock-up or modeling software with one or two mice used for interaction with the computer. The methodology used for analysing the recorded video and graphical data is based on previous research work in the domains of collaborative communication as well as in the domain of design. It combines purely qualitative interpretation with graphical linkographic analysis. A software prototype was developed in order to allow for an interactive category assignment, exploration and interaction. Gesture, verbal language and design space are studied in order to determine their dependence on the medium and the eventual impact this might have either on the design process or on the object being designed.

Keywords. Design communication; architecture; education; computer-aided architectural design; gesture.

Background

The expansion of Internet communications in recent years has considerably changed the manner of interpersonal communication. This is especially true for the age group of the present students in architecture, who are part of the “generation-Y”, also called the “millennium generation”. We can see that by communicating “through the computer” distant worlds can become “closer”, but what about the person next to us? How does computer technology influence the direct communication that students have around a design object in the architectural studio? And even more, does the nature of the design space (material or digital) influence the language of communication and the vocabulary of design.

The exploratory study outlined here, asks several questions, mainly around the types of communication during the design process (gesture, body movements, verbal and graphical). One interest was to see which types of expression (and in what situation) stimulate design ideas. And even more, are there design ideas that are not pursued, not because of their value, but because they are poorly communicated. Another question of interest was the role of the computer and in communication during the design process. Could we look at it a continuation of the design space, as a tool or as another ‘person’ in the team. The issue of the language expression (in terms of technical software specific ‘dialect’ when working on a computer) was put forward as well, with the hypothesis that its presence might limit the design activities.

This study combines three domains: architectural design, communication and education. The difficulties in the introduction of the computer as a design medium during the creative phases of the design elaboration, have provoked much research work on this problem. Some recent studies are oriented at exploring the changes of communication techniques in different collaborative contexts: face-to-face, computer-mediated using video conferencing, and computer mediated using ‘talk by typing’

(Gabriel and Maher, 2000). In the present research, we have as an objective to keep the students physically face-to-face, but to give them different mediums for the design they are asked to do.

In the domain of design, many research centers perform experiences looking for a better understanding of design and architectural design processes (Schön 1985, Tang and Gero, 2001). Most of them are oriented towards design content and design 'moves', not considering in depth the communication. Even more, a great majority, of these experiments are held with traditional methods of designing (Goldschmidt, 1996). Our specific attention is communication when designing side-by-side on a computer.

The context of a students design studio is often used for research observations (Goldschmidt and Tatsa, 2005, Kvan and Gao, 2005). No evidence of study of communication in a digital design studio has been reported at our knowledge.

Methodology

Given the small number of cases involved and the nature of the questions we are interested in exploring, a qualitative approach appeared most suitable for this pilot study. Our challenge was to put verbal communication, nonverbal or gestual communication and graphic communication side by side in order to bring all to bear in understanding what is going on in during the design process.

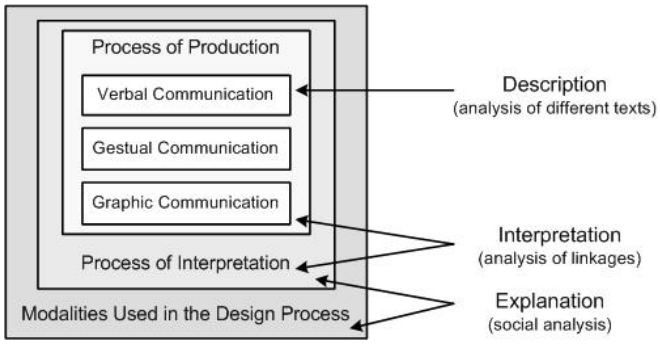


Figure 1 Dimensions of the analysis (adapted from Titscher et al 2000)

All design sessions were recorded on video. For those which involved the computer, screen capture software was used to capture the graphic information. The verbal expression and physical actions made by design team members during the session were then transcribed in two columns. This initial transcription was purely descriptive, with no interpretation involved.

Coding scheme

A coding scheme was developed for both these types of communication. It is based on Bakhtin's notion of *utterance* (Bakhtin, 1981 in Holland et al 1998), a temporarily performed and unique configuration of context, subject positions, and meaning between interacting, dialogical people. In other words, we coded units which seem to hold together and contribute to a single sense unit or idea. Categories were derived using a semi-grounded approach, where data were separated into first- and second-order concepts (Van Maanen and Barley). Thus recurrent elements were first identified, then reduced through repeated reading to higher level concepts. As with all semi-grounded approaches involving the identification and distillation of recurrent elements, this exercise inevitably involved subjective judgments on the part of the researchers and, as a result, there can be no definitive analysis. We did, however, take

precautions to examine the data separately and to subsequently compare our interpretations.

We considered a number of different coding schemes presented in the fields of computer-supported cooperative work and design communication. The coding for the verbal content closely resembles that presented by Gabriel et Maher (2000). It includes four major classifications, with project-related communication further subdivided. These are:

1) conversation about the project – concept ideas, function, form. This category is derived from both the data and from literature which distinguishes between design ideas, design scope and design task.

2) conversation about how to translate ideas into something concrete. This corresponds to the design task, particularly how to represent the design

3) conversation about the technology used : a data derived structure. We used this data-derived category to indicate when participants talked about or had questions about strictly technical matters, such as various software functions.

4) social communication : this category is both theoretically and data-derived. It looks at social talk, such as making jokes, or comments that have nothing to do with the task at hand.

We did not retain a category for 'communication control'. Although this question has been widely discussed in literature on computer-supported communication, issues such as interruptions, overlaps and hand-overs seem less pertinent since our teams were colocated, i.e. sitting beside each other.

Our classification of nonverbal and gestural communication was inspired by Roberts' (1996) taxonomy of embodied actions in cooperative work. The work of Gaver (1992) on affordances offered by media spaces as opposed to those offered by physical space was also influential. Finally, we also drew on Tang's (1989) work on the role of enactment (animating the behaviour of an object, pretending to be the user of a building, etc.) in design. Our gestural coding scheme has five categories. Within most categories, there is a further distinction between physical space and virtual space, that of the computer screen. It is as follows :

Pointing at something: in physical space: in virtual space

Pretending to be another body: illustrating the movement of a object (physical or virtual); illustrating the appearance of an object

Using/moving an object: in physical space (mouse, pencil, notebook, etc.); in virtual space (cursor, selection, viewpoint, etc.)

Looking (gaze): the colleague in physical space; an object or person in physical space; an object in virtual space

Moving

For both verbal and gestual communication, we made the choice not to code what appears to us as 'noise' ('umms' and 'ers', and fidgeting). We paid special attention, to exclamations such as 'Ah' or 'Oh', however, since they may indicate a so-called 'aha' event of unexpected discovery.

In terms of graphical communication, we inserted screen shots illustrating significant changes on screen in a third column of our grid. Once the video recordings have been visionned, these thumbnail screen shots give a quick and easy reference to graphical information, without having to play the movies again. It creates a visual sequence with the 'key-frames' of the recordings.

In a fourth column, based on some previous work (Iordanova and De Paoli, 2005), we described the actions creating the design object: on the screen, when the design was done on the computer, and the manipulations on the cardboard mock-up, when the design was realised with traditional tools. The description is quite detailed in order to

allow a good understanding of both the process and its objectives. This is a first step away from description and towards analysis, though, it provides a strict minimum of explications. The data was then segmented in order to be put in parallel with the other types of activities.

The resulting table allows us to see at a glance what was happening, in which modality and in temporal sequence. Color coding facilitates this overview.

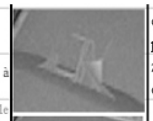
	L Est-ce que ça crée un espace intérieur? Normalement oui hein?			change le type d'affichage pour mieux voir la surface
17,30	A Ben là ici, oui là.	Lucie pointe quelque chose de précis à l'écran **et** fait le geste de tirer vers le haut.		zoom, re-position de la caméra
	L Ouais je pense que ça devrait aller.	Annie fait un grand geste de la main vers le haut.		
	Là on a pas de dessous, mais si tu lèves les deux points là ça va faire des..	Lucie pointe à l'écran, **recule**, repointe et tourne son doigt autour d'un point précis à l'écran. **Elle appuie sa tête dans ses deux mains.**		
	A Oui, pis si tu lèves dans le milieu, ben ça va faire un espace intérieur.	Annie appuie sur un bouton.		
	L Prend ça de points là… oh pardon. Prend le point… tout en… bon point sur le…	Lucie pointe son doigt vers le haut, près de l'écran **et** le fait monter.		sélectionne des points et « tire » vers le haut

Figure 2: A screenshot of a part of the data table. In the columns: time, verbatim, gestural communication, screenshots of screen or camera, description of the graphical actions

Linkographic interpretation

The design process is not a linear one, however. In order to make the transition to linkography and to examine the chaining of ideas throughout the process, we needed to 'flatten' our three categories – verbal, gestual and graphic – but without losing the detail we had worked to generate. A sequence of 'design moves' (as described by Goldschmidt (1996)) were identified on this basis. In order to introduce subjectivity to this otherwise extremely interpretative data manipulation, the items identified as 'design moves' were crosschecked by several members of the research team. The same technique was applied when assigning the links between the items, as well as their category.

As the interests of this study combine different domains of knowledge and include multimodal activities which must be considered in their simultaneous interaction, we were looking for a way to be able to combine and analyse the data in a qualitative way. This lead to the idea of a software tool that would help the researcher to explore the interaction between the different kinds of communication recorded. We developed a software prototype for interactive assigning, exploring and interrelating categories from the different domains. It provides three types of indicators: colour (levels of gray in this article), shape of entry and pattern of the linkograph.

Coding categories

As we have already mentioned, different types of categories had to be taken into consideration, coded and analyzed in their interaction. A major coding scheme describes the communication mode. In order to indicate the way in which a 'design move' was made or communicated, we assigned a 'communication type' category to each item. We generated a separate symbol for each of the possible permutations and combinations of our categories : verbal, graphic, gestual, verbal and graphic, verbal and gestual, gestual and graphic, verbal, gestual and graphic.

Another category shows the 'actor', the author of each item. In the collaborative design situation we recorded, it was interesting to investigate the interaction between the participants: do they work in parallel (each one on a different part of the object of design), or do they act sequentially (one after the other on the same thing), or do they

work together (on the same thing), and finally does one act more in support of the other one.

The interest in the mutations endured by the verbal expression when working with a 'non-direct' medium (like the computer), lead us to design a coding scheme to indicate the type of language: 'of common use' and 'technical' (in terms of a 'dialect' using software-induced computer terminology).

The study of design process itself is not a direct objective of this study, but we created a coding scheme specifying the 'design content' of each item. This was done in order to see eventual communication changes depending on the design content.

A final coding scheme was inspired by the question on the design space (real and virtual) and its 'prolongation' into the computer virtual space. Among different potential indicators of this phenomenon, the first one that we have implemented, concerns the gestural activity of the students during design. Gestures like 'showing' (on the screen or on the mock-up model), or 'imitating' (pretending to be another body) were expected to provide some insight on this question.

Interesting separately, these coding categories are much more informative when put together, and in the timeline of the design process.

Experiments

Three experimental observations were held with students from architectural digital design studios (in third and fourth year of education in architecture). Each of them was performed when the students were working on a design problem, in groups of two or three. The sessions (around one hour each) were recorded on a video camera. The recording device did not seem to bother or to influence the behaviour of the students. Ideas, intentions and comments were 'externalised' by the participants in a most natural way, by the dialogue between them. In terms of data quality, this is the least biasing method, compared to the other types of protocols used when studying the design process (concurrent and retrospective protocols).

Three different design environments were used for each experiment. The first design task had to be realized with a cardboard mock-up, so the students were discussing their project around a 'material' design object. The second one was performed on a computer, using a 3D modelling software. The third recording was done while the students were working in a 3D modelling environment proposing a large variety of parametric design, together with visual and conventional programming possibilities. In the last two experiments the screen sessions were also recorded. Even though the recordings are rich of data on the process of design and design education, these aspects are not the main object of this paper.

The students' task was limited to conceptual phase of architectural object. The project had to satisfy some conceptual and functional requirements such as 'exposition hall', 'summer theatre', etc. The software used for the computer work was Cinema 4D, a 3D modelling program that was taught to the students in the same studio, during the same university term.

Nine teams of two or three students were recorded, three of them when working on a paper mock-up, and the others – on a computer. The observations took place during three different recording sessions. The three teams working with the same medium and at the same time, were placed in a large common space, so that they could even interact between the teams (although this was not frequent), and at the same time, the conversation could be relatively well distinguished.

We noted that a period of discussion at the beginning was common to all design sessions, whatever the medium. Its length differed considerably, but some very interesting conceptual discussions were held during this stage. As this period of the

design process did not involve the medium, we decided not to use it for the detailed analysis discussed in this paper.

Data analysis

The recordings as well as the graphical material from the experiments were firstly reviewed. Several discussions of the research team gave interesting insights on the studied issues, and created the background for a further more detailed analysis. Discussions were all the richer and varied (communication and architecture) backgrounds of various team members. Given the length of the recordings and the large number of categories of interest, for the purposes of this paper, short segments of each design session were selected for detailed coding. One criterion of selection was the good quality of the data, as well as its richness (in terms of variety of categories met).

Another criterion was put forward by the cyclic evolution of the design idea: When designers look at their own previous depictions, they don't necessarily interpret the depictions in the same way, but sometimes tend to associate them with a new concept, function or meaning. Goldschmidt (1996) called this phenomenon "seeing-as" activity, and Goel (1995) called it "lateral transformation". This kind of unexpected discovery is usually discussed in the bibliography when recording design activity by sketching. If we could call this phenomenon ‘medium-provoked’ design idea, we could find similar events when working on a paper-mock-up or on a digital model in a computer software. This provided us with a second criterion for the selection of the segments to me analyzed in detail for this study.

Looking at the video recordings of the pre-selected teams, we identified several moments of emergence of a (small) design idea, provoked by the medium. In one case, it is the accidental repositioning of a part of the mock-up model, that received special attention and became a structural element of the mock-up; and in the other, it is the ‘seeing of’ an arbitrary modifying operation in the modeling software, that was reconsidered as a space-generation method.

Several variations of coding were tried in order to look for interesting interactions and link between the different communication modes on one hand, and the design process, on the other. Generally, as shown in the Figure 3 below, we can compare: (a) between two different modality design sessions, coded according to the same categories; or (b) between multiple codings of the same design session.

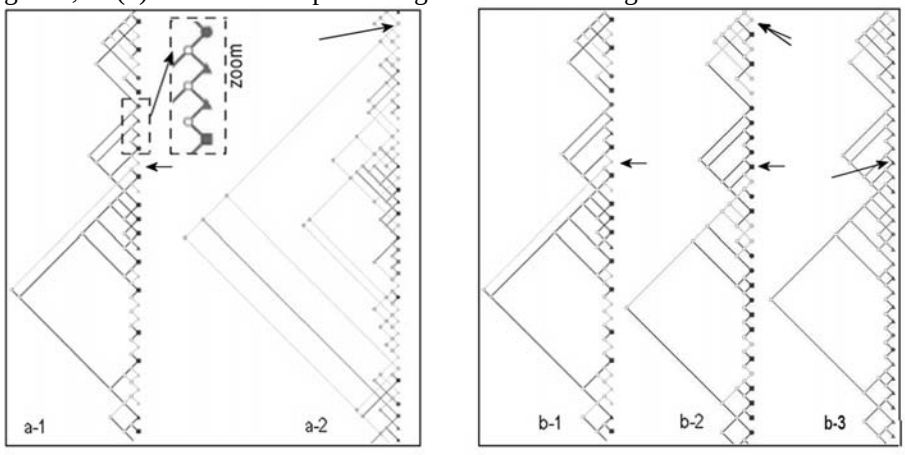


Figure 3: (a) different design sessions, same coding (author and communication type); (b) same design session, multiple coding of a segment of a digital design session: b-1 actor and verbal communication type;b-2 type of language and gesture (show or imitate); b-3 contents and type of language.

Some results

The first impression was the great variety of kinds of communication used during the design session. But we could identify that this phenomenon is cyclic and is not present when the actual design forming is made, independently from the medium. This is especially true for the student manipulating the computer, and who rarely uses gesture.

The linkograph of the selected segments show a relatively important design idea as a bigger triangle, and its emergence is at the upper end of the form (indicated with an arrow on Fig.3). Linking the 'communication type' category coding to the linkographic pattern, (and having in mind the 'development' phase of the project), we could remark that ideas frequently emerged from an action (on the object), the verbal end verbal-gestual emergence being common for the conceptual phase. This can be seen on the example a-1 and a-2 where the origin of the big triangular pattern is color-coded as a graphical action in both segments coded (digital and mock-up design).

In respect to the 'actors', we remarked that a parallel exploration was taking place when working on the mock-up (each participant working on her own object), while when designing on the computer, a type of sequential alternation of roles was installed (when working with two mice), and a type of 'instructions-realization' relationship was established between the students (when working with one mouse).

As far as the attitude to the computer is concerned, we observed a continuous passing from the real space (but imagined and imitated) to the computer virtual space. This leads to the conclusion that the virtual space is a prolongation of the real world, but of the one imagined and imitated as well (Fig.3, b-2). More exploration in this respect could reveal some differences between a 'virtual' computer space on one hand, and 'technical space' on the other. Sometimes, reactions like talking to the computer, asking questions, considering its overcharge (overheat), etc. make think that it is considered as a member of the team. It is not always very cooperative, though.

When exploring the gestures of 'showing' and 'imitating', we found out similar behaviour with both mediums. Imitating seems to be less present in the development stage when working on a real mock-up. This might be the result of the physical presence of the object that can be used for showing (modifications, movement of people, etc.). Some differences are noticed in body movements, due to the 2-dimensional projection of the model on the screen when working on computer. Further study of this aspect of gestural communication could bring details to this phenomenon.

Looking at the language expression, we could state a considerable amount of 'technical language' (linked to the tool, the medium) in both cases. The technical 'dialect' was of constant use, given the fact that the specific vocabulary was familiar to the two participants and was not causing any misunderstandings. The comparison with the coding of the 'design content' categories showed that except for the technical (tool-specific) content, 'technical language' was used for the 'formal' content, and was much less present when the design content was 'functional' or 'structural'. The development of the design idea presented at the linkograph, however, was done only in 'common language' (fig.3, b-3). The verbal communication of the student manipulating the computer was frequently non-finished, and the language – considerably influenced by the software terminology. In the segment explored in detail, only one design move (of 40) was characterized as 'technical language' that was accompanied by gesture (dashed arrow on Fig.3, b-2).

A general statement is that the 'moves' executed at the computer are greater in number, than the ones in paper mockup. This means that the computer medium is less direct and demands more sub-actions to reach a goal. This could be studied in a later development of the present research work.

Potential for future development

There is no doubt that the computer is not only a tool. It is difficult, however, to distinguish where and when the tool finishes and begins the medium. In our opinion, the joint study of verbal, gestural and graphic communication between the actors of a design team allow for a better comprehension of tools and mediums, as well as of the design process dynamics. The present results are a small portion of the universe that could be explored with the methodology presented. Apart from the amelioration of the linkographic software prototype, and from enlarging the studied sample, we have planned studies on several other research questions, like 'What types of mediation are generated by the various mediums?', 'Which factors could make more dynamic the interactions between actors and the design object?', 'How the type of gesture is influenced by the medium and is there any impact from this modification on the design process'. Conclusions from these studies could be useful for designing mediums that facilitate the communication, and in this way, ameliorate the design process and architectural design education.

Acknowledgements

Bell Chair in Interdisciplinary Research on Emerging Technologies, for the Research grant for the project: "Traces, perspectives et process: A video analysis of practice", project leader Lorna Heaton; members: Manon Guite, Giovanni De Paoli, Jacques Lachapelle; research assistants Tristan Audet, Ivanka Iordanova; The students from the digital design studio ARC-6813D with tutor Temy Tidafi for providing framework the field study; Carl-Antonyn Dufault for coding the software prototype.

References

Gabriel, G. and Maher, M. L.: 2000, Analysis of design communication with and without computer mediation, *Collaborative Design: Proceedings of Codesigning 2000,* Scrivener, S. A. R., Ball, L. J. and Woodcock, A. (eds), Springer, London, pp. 329-337.

Gaver, W. : 1992, The Affordances of Media Spaces for Collaboration, in *Proceedings of CSCW'92,* New York, ACM Press, pp. 7-24

Goldschmidt, G.: 1996, The Designer as a Team of One, *in*, Cross, N., Christiaans, H. and Dorst, K. (Eds), *Analysing Design Activity* John Wiley & Sons, pp. 65-91.

Goldschmidt, G. and Tatsa, D.: 2005, How Good are Good Ideas?, *Design studies*, 26, 593-611.

Iordanova, I. and Paoli, G. D.: 2005, Hypotheses Verification on the Role of the Medium, *23th Conference eCAADe*, Duarte, J., Ducla-Soares, G. and Sampaio, Z. (eds), Lisbon, pp. 99-107

Kvan, T. and Gao, S.: 2005, Examining Learning in Multiple Settings, *CAAD Futures 2005*, Martens, B. and Brown, A. (eds), Springer, Vienna, pp. 187-197.

Maanen, J. V. and S. R. Barley: 1985, Cultural Organization: Fragments of a Theory in P. J. Frost, L. F. Moore, M. R. Louis, C. C. Lundberg and J. Martin.(Eds.) *Organizational Culture*. Sage, Beverly Hills, pp. 31-53.

Robertson, T.: 1997 Cooperative Work and Lived Cognition: A taxonomy of Embodied Actions, in Hughes, J. et al. (eds) *Proceedings of the Fifth European Conference on Computer Supported Cooperative Work*, Kluwer, Amsterdam, pp. 205-220.

Schön, D.: 1985, *The Design Studio*, RIBA.

Tang, H.-H. and Gero, J.: 2001, Cognition-based CAAD, *CAADFutures*

Tang, J.C.:1989, Listing, Drawing and Gesturing in Design: A study of the Use of Shared Workspaces by Design Teams. *Xerox PARC Technical Report, SSL-89-3*, Palo Alto, CA

Titscher, S., Meyter, M, Wodak, R. and Vetter, E. : 2000, *Methods of Text and Discourse Analysis: In Search of Meaning*, Sage, Beverly Hills, CA.