

A Notation to Support Exploring Collaboration in Design Teams

Gil Garcia de Barros and Luiz Gustavo Bertocchi Alves da Silva

School of Architecture and Urban Design, University of Sao Paulo (FAUUSP), Rua do Lago, 876, Sao Paulo, SP 05508-080, Brazil

Abstract: Collaboration in large projects is a major challenge for contemporary architectural practice and this paper presents a notation for describing and analyzing how these collaborations can take place. Based on an extensive literature review some opportunities were found for the development of a notation that combined three particular aspects: network diagrams, Euler diagrams and a model from architectural design. An exploratory case study was conducted based on the collaboration during a complex architectural project, which combined three approaches: document analysis, semi-structured interviews with key stakeholders and a comparison of the documents with results from the interviews. The notation demonstrated to be suitable for two purposes: to improve the understanding of particular design events and as support material for presenting and exploring collaborations. Results indicate that the notation was suitable, comprehensible and flexible, and it demonstrated good value when used in speculative ways, such as an intermediary design artifact that supports discussion and improvements in the collaboration process, which indicates promising future directions. It can also be argued that, similar to a sketch, the notation can also support the process of planning and “designing” the interaction between teams in design fields and even in other project-based organizations.

Key words: Architectural design, collaboration in design, design methods, design artifacts, design cognition, design tools, visualization techniques.

1. Introduction

Design activity has a large body of literature in the field of design research, and there has been significant advancement in the understanding of its nature [1-3]. One particular aspect that has been of much interest is collaboration between design teams [4-7] and while there have been significant improvements in the exploration of design collaboration, some themes remain open.

This is a challenging field to explore, due to the complexity of the design process, which is considered a highly cognitive activity [2, 8-10] and with multidimensional interactions [3, 11], which result in highly differentiated strategies through which team members can constructively share their individual skills and knowledge in search for a common goal.

A number of factors can be identified in the literature,

suggesting a demand for further understanding of this particular kind of collaboration and opening new opportunities for research. For instance, studies indicate a need for better understanding of strategies and actions that facilitate designing collaboratively [6] as well as the methods and tools for supporting a multidisciplinary approach from design teams of diverse fields [7, 12].

In the interest of addressing these questions this article is part of a study to understand and improve collaboration in design, with the objective of investigating and documenting good practices of collaboration between design teams.

To perform this study, an exploratory case study was conducted, based on the collaboration between several teams during an architectural project. In a typical design process in the AEC industry, and particularly in complex buildings such as the one studied here, different teams are combined into clusters. Those work together for a certain period of time to deal with specific problems, which require

Corresponding author: Gil Garcia de Barros, professor, research fields: design methods, design cognition, design artifacts, architectural design.

knowledge from the different disciplines [13]. Some of these clusters are customary, such as the structural engineering and architecture teams [14, 15], when defining or adapting the building structure, or environmental design and building services, to deal with air conditioning and other energy related issues [16, 17]. Once the solution for the problem is reached, these clusters break up and teams move to other clusters or exit the project.

To the purpose of focusing the analysis of this case study, some particular “design events” were selected, which are situations when these clusters formed up and the interactions between the teams took place over a few days or weeks.

The case study was composed of three main approaches: document analysis, semi-structured interviews with key stakeholders and a comparison of the documents with results from the interviews.

The research team explored alternatives to represent the collaboration that occurred in these design events so they could be better analyzed and described, as well as to be used as supporting material for the interviews. After an extensive literature review many interesting insights were found, but a suitable notation was not identified.

Considering this gap a notation was developed to be used in the study. However, this notation proved to be useful not only in this study, but also demonstrated itself as a valuable intermediary design artifact which fosters discussion and improvements when discussing collaboration strategies between design teams. Thus, this particular paper describes, analyses and discusses this notation.

The paper starts by presenting a literature review on representations of collaboration in architectural design, and also on visualization techniques used to describe interactions in social networks. Then it presents the materials and methods used in the study, with particular emphasis on the attributes of the development and application of the notation, followed by the results, demonstrating how the notation was

used and exploring its contributions, and finally expands on how these results relate to other studies and presents further directions for research.

2. Review: Visualize Collaboration in Design

When looking for alternatives to represent collaboration between design teams, some interesting references were found as well as some open questions. While there were many models directed at representing collaboration in design teams, both in architecture and other design fields, none was completely satisfactory.

Considering the objective of the original study, to investigate good practices of collaboration in design situations, there was the need for a notation that would:

- allow focusing on a particular design event and within this event visualize;
- which teams were involved;
- how much involvement each team had;
- how was the relationship between these teams.

Then, also taking into account that these diagrams were intended to be used during the interviews of the present study, as externalizations of the collaboration process as seen from the interviewee perspective, the notation had to:

- be easy to learn and use;
- require basic drawing materials and undemanding drawing skills.

With these objectives in mind, several notations and techniques were found and are described below.

Some common techniques used to represent and coordinate activities in design, and particularly in the built environment, are Gantt charts and Program Evaluation and Review Technique (PERT) charts, usually associated with Critical Path Method (CPM). While they are proven tools for design and construction management [18], their focus is on planning and control of the process as a whole, and not on eliciting the level of involvement nor on showing relationships between actors in a particular event, and thus they proved to be unsuitable.

This difference in perspective was also found in many of the studies analyzed, where the interest was mainly in looking at the whole process instead of particular design events, and the focus concentrated in the design documents and how they evolve during time, instead of the relationship between design actors during one particular event.

Ref. [13] carried out some case studies of buildings with high levels of complexity, such as hospitals, museums and sports facilities, and used diagrams as one of the tools to analyze them. However, they are flowcharts based on Business Process Model and Notation (BPMN) and the focus is on a general overview of the whole design process. This focus is also present in Ref. [19] that developed a notation used in a sophisticated model of the design process for the built environment and in this case, aiming at a generic model and not at particular design events. Ref. [18] also looks at the design process and proposes the use of Collaborative Design Planning Networks (CDPN), which are composed of tasks, defined as design activities, and “infotems” which are any specifiable item of information present in the design documents. Ref. [20] also aims at creating a generic notation to represent the design process, and uses Petri Net notation as starting point. In this notation we have two states, “places” (circles) and “transitions” (vertical bars), and arcs (arrows) to connect the states. States of the same kind are never connected. In this application, places are single design events and transitions are design tasks.

Another study [16] compares two diagramming techniques to analyze case studies of design collaboration aiming at improving energy efficiency in buildings. One technique is the IDEF0 (Integral DEFinition, model 0) modelling language, where activities are depicted as boxes and the interfaces between them are arrows, with defined directions. The other is the proposed Collaborative Design Process Model (CDPM) method, a topological format also based on Petri Nets.

Other studies were more aligned with the objectives of this study, to create representations and analyze the interaction that occur between actors during one design event [21-23], but again, important distinctions were found. While in the previous studies the scope tended to be on the whole project, which is greater than our objective, here the scope of the design event tends to be much smaller than ours, typically in one design session (meeting of a few hours each). Here the scope used is a design event which involves many interactions, typically over some weeks.

Another important difference is that the analysis is based on prescriptive methods which require the design sessions to be initially recorded and transcribed, and then the collaboration during these design sessions is encoded into visualizations, following specific rules. Since the focus of this study was on design situations that had already happened, these representation methods revealed to be inadequate. Besides, these studies have important caveats for our analysis because they tend to ignore influences of emotions and disagreements in the performance of the design team [22] such as seen in Ref. [23], where the team can be in disagreement, but the analysis indicates a strong semantic coherence.

While these studies relate to representing collaborations in design, many specifically in architectural design, and provide many interesting insights, the differences found in scope, focus and methods limited the application of the notations used in them for this study, and indicated the need for the development of a particular notation, described in the results.

For the proposed notation better alternatives were found when looking into studies related to visualization techniques used to study interactions in social networks. While not directly connected to design situations, the purpose of information visualization is to use visual metaphors to represent and facilitate the apprehension of structures and relations from abstract data [24-26]. Specifically linked to the objective of

this study, the area of social network visualizations relies on creating representations that support the process of identifying the actors and understanding relationships between them [27].

One particularly useful diagram in this field is the network diagram, also called node-link visualization because it is composed simply of nodes (circles or dots) and links (lines), which represent the connections between the nodes [28]. Some studies combine this diagram with other techniques, aiming at improving the capacity to communicate meaningful structures [27, 28]. One particular study compared the combination of network diagrams with Euler diagrams and treemap structures and found that the previous brought better results [27]. Thus, in this study we use this approach, to use Euler diagrams, which use overlapping ellipses (or circles) to represent intersections between groups of elements, in combination with network diagrams.

Another model that based the notation is used by Ref. [4] to describe possible models of coordination of multidisciplinary teams in architectural design. It became an interesting starting point for the notation because it is consistent with network diagrams and because of its simplicity and straightforwardness, rendering it easy to understand and to create, both important factors in this study.

So, taking into consideration the goals of this study: (a) to represent collaborations focused on one design event at a time, and for this event illustrate its actors, their involvement and relationships; and (b) to use these representations to support the interviews; the model from Ref. [4] was combined with network and Euler diagrams, arriving at the proposed notation.

3. Materials and Methods

To perform this study, the method was an exploratory case study based on the collaboration between several teams during an architectural project. The project occurred approximately between mid 2004 and mid 2006 and it is a public building, with an

architectural program of high complexity, similar to a hospital or research facility [13], with more than 120 thousand square meters of building area and located in a coastal city in the tropical savanna climate (Aw in the Köppen climate classification). The project encompassed more than 20 design companies of different sizes and from several architectural and engineering disciplines.

This particular project was chosen because of some exceptional characteristics:

- Since it is a large and high complexity building, the demands for good collaboration between teams of different disciplines are very demanding;
- Because of contractual requirements of the project, the project was very well documented;
- Due to agreements between the research team and the leading architectural firm, all this documentation was accessible to the research team;
- Many of the professionals involved in the project were also accessible, enabling the interviews.

The reason for a single-case design in this case study was due to the uniqueness of this particular project [29]. Furthermore, two important characteristics should be noted. Building Information Modelling (BIM) tools were not available during the development of this project, so the collaboration between disciplines could not benefit from them. Also, due to confidentiality agreements the project and the companies involved cannot be disclosed.

To conduct the study, the case study was structured in three main approaches: document analysis [30], semi-structured interviews with key stakeholders [31, 32] and a comparison of documents with interviews for triangulation of data [29, 31, 33]. This last step was fundamental for construct and internal validation purposes [29] and equally important in terms of producing better descriptions of the design events we were studying [34].

This more embodied and naturalistic approach has emerged as an important trend to study collaborations in design because they provide insight into complex

situations of people working together [5, 12, 35]. It provides insights into situations when interactions occur in many different ways, such as meetings, documentation and other means of communication and is a good complement to other research methods which emphasize more controlled conditions, such as protocol analysis [21, 22].

The specific focus of this paper, the notation to represent collaboration, played a key role in all of the three approaches. It helped during the document analysis to assist the research team visualize and understand better the interactions that occurred during the project. It played a key role during the interviews, when it was used as support material to elicit how particular collaborations occurred. Finally, these diagrams were also used as tools for comparing results from documents and interviews.

The initial stage of document analysis took four months and involved an initial filtering of the overall material. Starting with 84 archival boxes with approximately $50 \times 40 \times 30$ cm 38 boxes were excluded because they were not related to the project. The 46 remaining boxes were indexed indicating the types of content contained in them (Fig. 1a). This indexing was composed of: design phase (from viability studies to detailed design), dates, building

sector, type of document (contracts, meeting minutes, reports, invoices, building documents and messages) and teams involved.

From this overview of the documents it was possible to tailor an outline of the project schedule, and some particular events were chosen, because they showed evidence of unique collaboration opportunities, due to the number and nature of teams involved as well as the amount and quality of information available in the documentation.

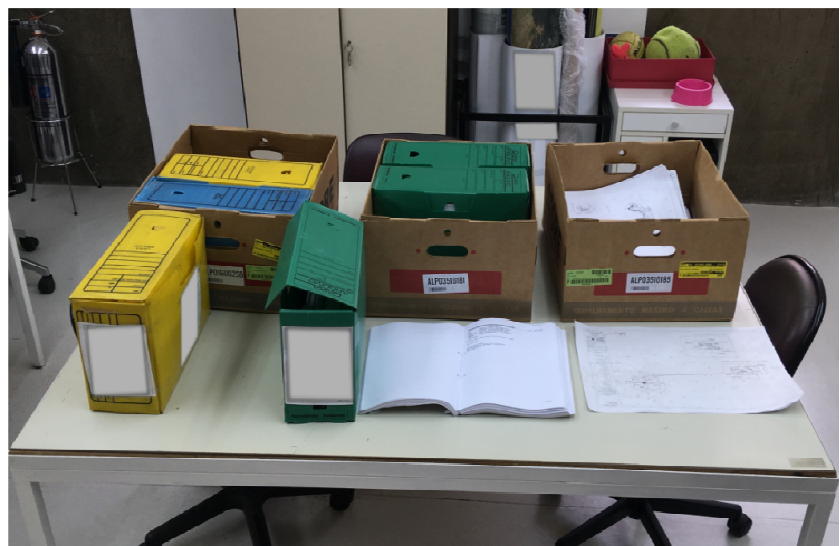
A further analysis was carried out to better understand these situations. It consisted of cataloguing and documenting in greater detail the contents of 12 boxes in particular, as seen in Fig. 1b. This material was mostly composed of large collections of drawings, from hand drawn sketches to blueprints, meeting minutes, planning schedules, spreadsheets and many printed emails.

This analysis arrived at nine particular situations, which combined both an interesting collaboration pattern with good documentation found in the archives and these were defined as the key “design events” for the study [29].

These design events were collaborations that focused on a particular design challenge, such as shading of the building or an underpass for building services, and



(a)



(b)

Fig. 1 Process of document analysis.

involved a group of teams, many interactions between the actors, and took place over a few days or weeks. These collaborations were documented in meeting minutes, conversations through email and a series of revisions of technical documents, such as drawings, spreadsheets and reports.

At this stage the first version of the notation started to be generated, with the purpose of guiding the research team's understanding on these particular collaboration events between design teams. This first version was made by combining good practices from other studies, as well as the requirements which were defined for the study, both of them presented in the previous section.

The next step in the process was to define who were the key players to interview, regarding the particular design events that we selected. The notation was also improved, as more design events were documented, and the notation formalized and documented to become the support material for the interviews.

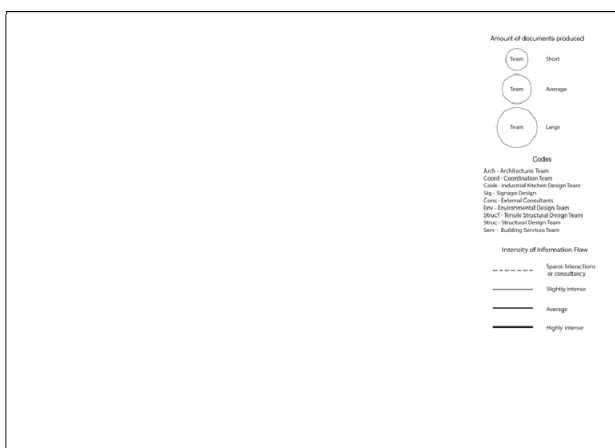
Five interviews were conducted with representatives from the following teams: environmental design, structural engineering, building services, architecture and project coordination. The teams of Architecture and Project coordination were from the same company, but they performed different roles and functions in the project. The interviews were recorded and lasted from 60 to 100 minutes. Drawings and notes produced

during the interviews were scanned for further analysis and discussion.

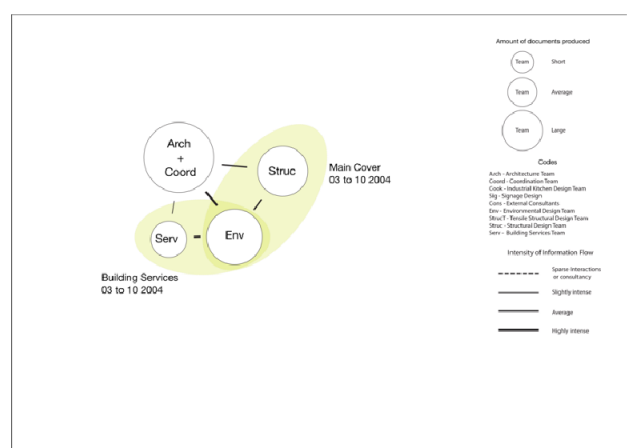
The interviews were semi-structured and composed of the following parts: introduction of research and informed consent procedure; general questions about collaboration practices during this particular project; presentation of the collaboration notation (Fig. 2a); interviewee creates one or more diagrams from particular design events; specific questions about these design events and diagrams; diagrams of one or more design events previously elaborated by the interviewers are presented and discussed (Fig. 2b); final acknowledgements and closure.

The first step after the interviews was to build a coding frame [36], by organizing and cross-referencing all the materials generated: interview notes, recordings and diagrams, both produced and presented during the interview. Particular excerpts were transcribed to help interpretation and to clarify some topics [31].

As a good practice in case studies, results from interviews were cross checked with documents selected during the document analysis. This allowed us to validate many of the aspects but also to discard some aspects which were not supported by the documentation. Also, as mentioned beforehand, this step of comparing interview results with documentation also led to new interpretations and insights about the document analysis.



(a)



(b)

Fig. 2 Materials used in interview.

From these notes some recurring codes started to form, which were then compared with other interviews. As new interviews were performed these codes were revised in search of patterns [36]. This particular procedure allowed us to see some evidence of good practices of collaboration. These good practices are too extensive to be described in this article and so they will be presented and discussed in another opportunity.

But of particular interest for this paper are the means through which the diagrams were used in the process, how the notation was developed and how it advanced the understanding and discussion about collaboration in design events, which we now present.

4. Results: A Notation to Visualize Collaboration in Design Events

This topic begins by presenting the notation developed to support this study, aimed at understanding and discussing the collaboration between teams during particular design events. Then we present how the notation was important for the analysis of good practices of collaboration and conclude by exploring

some particularities of the notation.

The notation is based on the following rules:

- Each team is represented as one circle and the size of the circles represents the amount of involvement of the team;
- Connectors between circles describe the relationship between teams, with four kinds of relation: high, medium, low (lines thicker to thin) and occasional collaboration (dashed line);
- Teams were referred to by codes, which are described in Table 1.

As an example, in Fig. 3 this situation involved five design teams and the level of involvement of team “Arch + Coord” was the highest while teams Struc and Land were the least involved (indicated by the size of circles). Also, the relationship between “Arch + Coord” and Env was the strongest, followed by Env and Serv (indicated by the line weight). The relationship between Env and Struc was only occasional and is represented by a dashed line.

In Fig. 3 there are two perimeters in color, one which involves Land and Env, and another with Env

Table 1 Codes used for the design teams in the notation.

Code	Team description	Code	Team description	Code	Team description
Arch	Architecture	Found	Foundation	Hydr	Building services-hydraulics
Client	Client technical staff	Land	Landscape architecture	ServEl	Building services-electronics
Coord	Project coordinator	Light	Lighting design team	SigD	Signage design
Cook	Industrial kitchen design	Serv	Building services	Struc	Structural engineering
Cons	External consultant	Elec	Building services-electrical	StrucT	Structural engineering-tensile struct
Env	Environmental design	HVAC	Building services-HVAC		

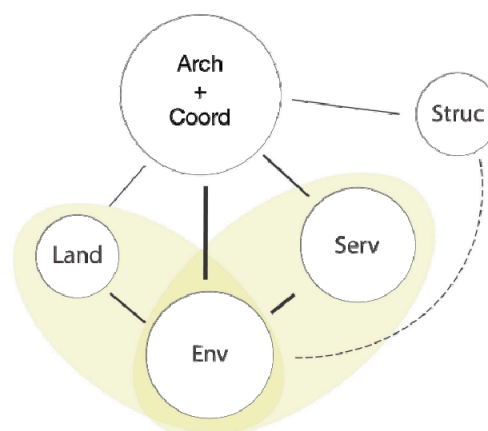


Fig. 3 Notation used to represent collaboration between five design teams (Environmental Design interviewee).

and Serv. The leftmost perimeter refers to a particular design event, when the Environmental Design (Env) and Landscape Architecture (Land) teams were combining their knowledge to make better decisions in fitting the selection of species and their position with an optimized pattern of shading throughout the year. The rightmost perimeter is a more traditional collaboration, between Environmental Design and Building Services (Serv), to minimize energy consumption.

This collaboration between the teams of Environmental Design and Landscape Architecture depicted in the leftmost perimeter of Fig. 3 is an interesting example of how the notation was used to call the attention for interesting patterns of collaboration, in this case, the collaboration between teams that do not usually work together and as intensely.

This unusual collaboration was not evident during the analysis of the documents, and it was only because of the diagrams made during the interviews that the subject came to light. When the Environmental Design representative indicated in her diagram that this connection was stronger than expected this issue was investigated. She explained that this unusual collaboration was repeatedly encouraged during the project, and also that it yielded good results.

This called the attention of the research team who later found that these unusual collaborations were a pattern in the study and an interesting aspect to be explored in terms of larger results, related to good practices of collaboration in design situations.

Another interesting result related to patterns of collaboration where the notation played an important role is associated to the level of involvement of the project coordinator in different situations. The first suggestions of this pattern came from the analysis of the documentation; however during the interviews the diagrams played an important role to better understand how these interactions between teams occurred.

Two different approaches were found for this level

of involvement, one where the teams would work closely together, have direct communication and cooperation, and the coordinator would be less involved, only being informed about key decisions. In the other approach the flow of information between the teams was mostly channeled through the coordinator, who was directly involved in the process in every step.

An example of each of these two situations was found in the interactions between the teams of Building Services, Environmental Design and the Client technical staff (architects and engineers from the client company), when discussing environmental comfort, particularly related to thermal aspects.

As an example of the first kind of interaction, the teams of Building Services and the Client technical staff collaborated directly when discussing and defining some aspects of the project that had some very particular demands and much interference between different specialties, such as HVAC, electrical and hydraulics.

However, when working with highly innovative solutions, which demanded balancing technical choices with many other demands from the project, the interactions between teams were mostly channeled through the coordinator.

These two situations are represented in Fig. 4. Fig. 4a represents the option where the Coordination team (Coord) is less involved, and the direct interaction between the teams of Building Services (Serv) and the Client technical staff (Client) is greater. Fig. 4b demonstrates the situation where the interaction between actors is heavily mediated and the connectors with the mediators (Coord and Arch) are stronger than the lines that connect the teams directly.

It was also found in the interviews that the notation was capable of depicting the relationships in almost all of the design events studied and was simple enough to be learned and applied during the interviews, which indicates that it was both easy and effective.

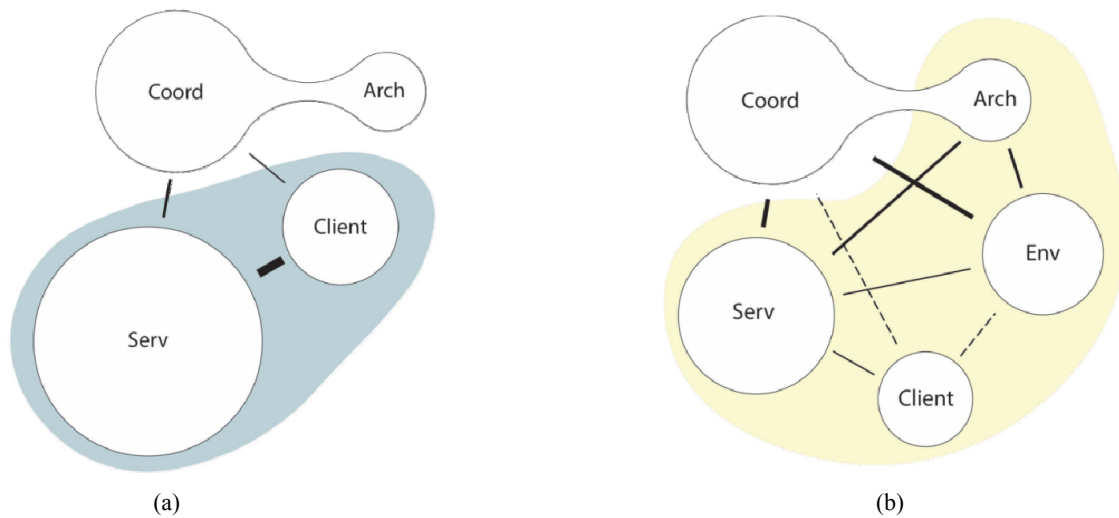


Fig. 4 Different involvement of the coordinator.

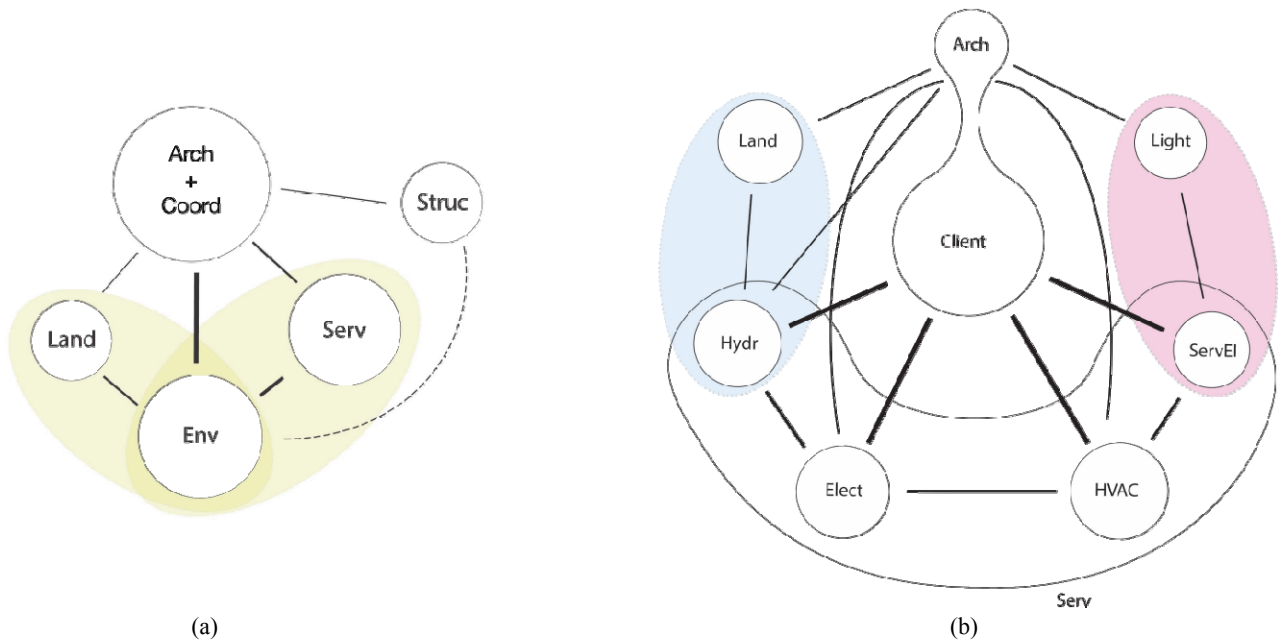


Fig. 5 Examples of adaptations of the notation.

In the situations when the notation was not sufficient it was possible to verify that the participants quickly adapted it to cover these unforeseen demands. It is important to notice that these adaptations did not contradict the rules but worked as extensions to the proposed rules, which suggests that the notation is both simple and coherent, and that it allows for some flexibility.

Fig. 5a (repeated from Fig. 3 for clarity purposes) poses one of these adaptations, done by the

Environmental Design representative, where the teams Arch and Coord are inside one circle and connected by a plus sign (+), because they are one company.

Fig. 5b presents two other adaptations, as seen from the perspective of Building services representative. First, instead of combining Arch and Coord with the plus sign, as shown in Fig. 5a, only Arch is represented as the coordinator and the Client technical staff (Client) is combined with Arch into a single shape.

This contrast between different ways to represent the Arch and Coord teams (the plus sign of Fig. 5a or just Arch in Fig. 5b) is an interesting result, because it relates to how these different actors understood the roles of Arch, Coord and Client teams. While both saw Arch and Coord as working very closely, Environmental Design clearly saw them as two teams, while Building Services saw as just one. Additionally, Building Services understood the Client technical staff with much more importance than Environmental Design.

The second adaptation in Fig. 5b is that Building Service is split into four separate teams (Hydraulics, Electrical, HVAC and Electronics), but since these teams are all inside one company there is a line around them, demonstrating this union. Again, this result is significant because it indicates that for this particular actor (the Building Services representative), her team was not one team, but was split between four internal teams inside the company, and this was not how it was represented by other actors.

5. Discussion: Using the Notation to Improve Collaborations

After presenting how the notation was important and useful in the study, the paper explores its contributions. In this section the focus is on how the notation was employed, its limitations and possible improvements.

As shown in the results, the notation served well two purposes:

(1) It allowed improving the understanding of the selected design events by: focusing on one event at a time; describing the actors involved; visualizing the level of involvement of each actor and; depicting the relationships between actors.

(2) It was also useful as supporting material during the interviews, when the participants created diagrams of particular events using the notation, as well as when presenting diagrams made from other situations to explore and elucidate those situations.

This indicates that the proposed notation has at least three positive aspects: it was suitable, comprehensible and flexible. It is suitable because the results indicate that it is adequate to represent this type of situation. This is in line with other studies, which suggest the appropriateness of network diagrams [28] for the situation and that the metaphors used are adequate for visualizing interpersonal dynamics [23]. Also, during this study the notation was completely capable of describing almost all the situations needed and when that was not the case, its flexibility proved valuable, as discussed below.

In terms of being comprehensible, the tool was simple to explain and use, even during the interviews. One probable reason for that is the combination of network and Euler diagrams, which indicated synergistic effects for explaining and exploring relationships [27]. As seen in the results, the choice of line weight and type, circle size and perimeters also provided a consistent vocabulary.

The third positive aspect is the flexibility. It was present in the study particularly during the interviews, when participants used in unexpected ways. But since the proposed vocabulary was coherent, these situations acted as extensions to the notation and allowed for important interpretations to arise.

The flexibility also indicates situations in which the notation might not be so adequate. Because it allows for different interpretations, it also means that some situations might be represented in different ways, leading to possible ambiguous representations. This means that the notation is not adequate if the objective is to create a precise and unambiguous record of the collaboration. This was never the intended objective, but it is important to acknowledge this specificity.

But if flexibility and ambiguity do not give support for a precise record, it allows for the representation to be used in speculative ways, which is very important in other situations, such as when discussing how collaborations can occur, or in other terms, when the

teams are “designing” the collaboration between them. Framing it as a representation to support the design of collaborations brings some interesting repercussions that are now discussed.

During the design process, designers use representations as support materials as cognitive aids [8]. For example, in early stages of the design process individual designers use sketches more as support for their internal cognitive process than as final drawings to be presented to others [9, 37]. It can be argued that in these situations it is the process of sketching that is critical, and not the representation itself [38].

Expanding the design process to the team, designing can be seen as a distributed cognitive process, involving the designers, their materials and environments [39, 40]. Thus also in this case, representations of various kinds support this distributed cognitive process working as “material anchors”, influencing the process and allowing the team to evolve and to reach a final proposition [41-43].

What we propose here is that the collaboration between teams can be designed and discussed, in a similar way to what happens with design objects. In the same way that the sketch of a building provides valuable support for the design team to discuss and evolve in better configurations for this building, representing the collaboration with the proposed notation can be a valuable asset to define better how this collaboration should happen in various situations.

Therefore, while the proposed notation might not be as adequate as a final specification, it demonstrated good value as an intermediary design artifact that supports exploration and improvements in the process. In an analogy, although it might not be a good notation for creating blueprints of collaborations, it is a good notation to sketch and support defining how these collaborations might take place.

The notation also provides opportunities for further exploration of research questions which still present

important gaps, such as the development of parameters for good practices in design collaboration [6], for guidelines for effective collaboration [5] and for deeper understanding on multidisciplinary engagement [12].

Moreover, this study was particularly related to collaboration in architectural design teams. Considering that many aspects of collaboration between specialists exist in many fields of design, it is possible to propose that this notation might also be suitable for the collaboration in other design fields. One aspect for future studies, though, would be to analyze if it is also adequate for collaboration in other project-based organizations [44], which can encompass software companies, film companies, strategy and IT consulting and even dedicated biotechnology firms.

6. Conclusions

Collaboration in large design projects is a major challenge for contemporary architectural projects [6]. As part of a larger study which aims at understanding good practices in design collaboration, this paper focuses on a notation for describing and exploring how these collaborations can take place, and this notation should be able to:

- (1) Improve our understanding of the selected design events by: focusing on one event at a time; describing the actors involved; visualizing the level of involvement of each actor and; depicting the relationships between actors;
- (2) Be used as supporting material for presenting and exploring collaborations during these design events.

Based on a literature review several studies were found which provided interesting insights, but a suitable notation was not identified. Thus a notation was proposed that combined three particular aspects: network diagrams, Euler diagrams [27] and a simple and straightforward model from the architectural design field [4].

During the experiments the notation allowed to uncover and to better comprehend some interesting patterns of collaboration in the case study.

It also demonstrated to be suitable, comprehensible and flexible, and indicated good value when used in speculative ways, such as an intermediary design artifact that supports discussion and improvements in the process of collaboration.

It can be argued that, in a similar way that a sketch can be used as an intermediate artifact to support the discussion of building design alternatives; this notation can also support the process of planning and “designing” the interaction between teams. It might also be fruitful to study how to apply the notation to other design fields, and even other project-based organizations.

Acknowledgments

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