COMMUNITY IN THE MIND

A Model for Personal and Collaborative Design

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Abstract. The present paper will discuss a landmark historical change that occurred during the last decade redefining architecture from an insular, solitary, and private activity into a distributed, cooperative, and community-based one. It will inquire into the reasons for this shift and explore the need to develop a new framework for personal and collaborative design and the opportunities resulting from it. How do we reason together in design? What are the criteria for selecting the technology to be used? How is knowledge acquired in such interactive framework? What are the new problems that emerge out of Collaborative Design? What are the new criteria to be applied when evaluating new design methods in the new context of Design Community? The paper will also examine some ideas related to a model for Personal and Collaborative Design and explore cognitive aspects of Community in the Mind. It will raise some basic question concerning new directions for research: The relation between Collaborative Design model to the cross-cultural design practice and the relation between cognitive organization of the Design Mind and the social organization of the Design Community.

1. Introduction

There is a kind of 'architectural' fixation that people have about history. They like to recognize singular landmarks inside what may only be a boundless flow of shapeless events in time. Deplorably, very often we find that these landmarks are what the French historian George Duby called, 'historical mirages', 'powerfully seductive' fabrications of imagination. Once in a while, however, special time markers like this turn of a millennium coincide with a significant historical crucial period of change. The accumulation of major technological, social, geopolitical and cultural developments today show that a New Environment has come about characterized by new needs and new opportunities. These new needs and new opportunities invite creative thinking and action transforming traditional practices of many major professions. One of these is architecture.

The current changes that occur in architectural practice are usually explained under the notion of Globalism, the internationalized and geographically spread

practice, and are linked with the appearance of new communication technologies. Globalism, however, is only an epiphenomenon of deeper, more complex events converting major professions and disciplines, among them architectural design, from insular, solitary, and private practices into distributed, cooperative, and community-based ones. Indicative of this shift is the introduction of the term 'GroupWare', the next step in the hardware, software sequence, to express a mode of production of information based on collaboration between different people and computers. To be able to understand the current transformation of architecture, one has to look deeper into fundamental historical shifts and into the very nature of architectural mind, which after all is the necessary precondition to all these changes.

2. Design Division of Labor

I will focus first on division of labor in architectural design by backtracking briefly into the past. At the beginning of his celebrated biography of Filippo Brunelleschi (1377-1446), Giorgio Vasari writes that 'after the earth had been so many years without a master mind and divine spirit' Filippo 'was given by Heaven to invest architecture with new forms'. Vasari describes young Brunelleschi as a man 'free of the cares of family', cut out of material needs, having 'abandoned himself to his studies neglecting to sleep and eat', a lonely man in life in general and in designing in particular. Vasari narrates that although 'he had found a kindred spirit in Donato, with whom he would have … discussions … on the difficulties of their profession', share the same tastes, travel, walk around, and dug out ruins of ancient buildings, … he would 'not communicate' to him his revolutionary thoughts about design. Throughout the rest of the text Vasari discusses the inventions of Brunelleschi conceived in isolation from others and carried out by fighting against others.

Vasari's text set up a framework defining the architect as a heroic, loner-genius, a definition widely accepted by clients, and society at large as well as by architects themselves till very recently. Typical, to the degree of caricature, is the profile of the designer in the 1940s novel *The Fountainhead* where the 'young brilliant' architect, in the words of the publisher, 'fighting his long and lonely battle', is not only isolated from the world but also 'against' it.

On the other hand, if one looks at the historical facts, it is easy to find that even in antiquity several masterpieces of architecture were carried out in partnership. Two most conspicuous cases are the partnership of Callicrates and Ictinus, the architects of the Parthenon of Athens and the partnership of Anthemios of Tralles and Isidorus of Miletos, the architects of the Justinian Hagia Sophia. During the 16th and 17th centuries, as several fascinating documents show, poets, engineers, and architects were routinely conceiving ephemeral ar-

chitecture for public ceremonies, weddings, funerals, and entries in close collaboration. In the 19th century, as much as some of the romantics aggrandized the idea of the solitary designer others challenged it promoting architecture conceived collectively by a community. Similar models of collective practice also inspired by socialist theories are discussed during the twentieth century. The 'modern' idea of 'team work', juxtaposed to the obsolete Vasarian lonely hero-designer was dear to many Constructivists and Bauhaus designers. Walter Gropius continued to support it in the US teaching at Harvard. Let us not forget that his firm was called architect's 'Collaborative' rather than 'Gropius Associates'. Yet, not only were these beliefs naïve, like most Bauhaus beliefs about building technology and industrialization, they were also politically controversial. The idea of collaborative, community-based design enjoyed a brief and intensive revival more recently embraced by the late late-romantic May '68 generation, and subsequently by HRH The Prince of Wales. Nevertheless, it was only by the end of the 20th century, the end of the millennium, that it was realized that collaborative design was neither a political slogan nor an ideology, but a reality, a necessity, and, like prose, practiced even when one is not aware of it.

The collaborative nature of design we are referring to now involves a multitude of 'agents'. Engineers, other technology specialists, financial, legal, management, public relations experts, social workers, health advisors, city authorities, industrial designers, interior decorators and last but not least, users conceive together schemes that would have been the product of a single designer in the past. They may 'design together' occasionally located inside the same physical facility but more often they are distributed in different locations with extensive use of 'cross-company' outside contracting. To recall the memorable expression of Andre Malraux, the architectural office is becoming an office without walls, national, geographical, and disciplinarian.

How did this come about? What are the implications? Which are the new needs and the new opportunities emerging?

Without doubt, division of labor and specialization are the primary force behind the development of any collaborative production including collaborative design. The opening lines of Adam Smith's monumental Wealth of Nations identify 'the greatest improvement in the productive powers of labor, and the greatest part of the skill, dexterity, and judgement with which it is anywhere directed, or applied' as the result of ' division of labor'. Subdividing 'employment' into 'a great number of different branches produced all 'improvements'. As Paul A Samuelson said, more than two centuries later, in his celebrated introduction to Economics, (1958 p50) sooner or later 'men learn that, rather than have everyone do everything in a mediocre way, it is better to institute a division of labor' and specialization. As an indispensable complement to division of labor and specialization arrives exchange and collaboration in almost every discipline and profession including architectural design.

3. The New Environment

But why this landmark explosion of division of labor and specialization in architecture today? Here are some basic changes that brought about what we might call a New Environment for architectural practice:

a. An unprecedented complexity of design problems;
b. An unparalleled increase of the cost of land and construction;
c. Revolutionary changes in the legal framework of most countries concerning accountability, and litigation, as well in the acceptance of new standards of human rights, the universal emancipation beyond racial, ethnic, religious, and gender discrimination, and consumer sovereignty;
d. Political and economic involving professional deregulation within domestic borders and relaxation of restrictions of professional practice across national boarders;
e. An explosion of technological breakthroughs in computation and communication and scientific discoveries in the fields of information processing and cognition.

Here are some basic new needs and new opportunities that emerged out the New Environment that transformed traditional design practice into a collaborative practice?

a. The need to be more effective in solving highly complex design problems.
b. The need to be more efficient, cost reducing design practice.
c. The need to develop a transparent, explicit, legal picture of accountabilities in design decisions as well as the need to respect beliefs, needs, and aspirations of a wide range of groups considering them as design participants.
d. The immense opportunities global design practice offers for sharing intellectual resources, finding clients from all over the world, and forming global joint partnerships.
e. The opportunities offered by unmatched up to now, the new means of transportation, new media of communication, computation, and simulation, as well as advances in computer, management, and cognitive sciences in understanding and controlling distributed, collaborative processes.

What can make this new global, distributed, collaborative design function well?

4. Optimizing Planning Methods

Obviously, the sheer existence of information produced by specialists or any other design participant is not enough for collaborative design to occur. It is necessary to conquer the distance between participants. The new means of transportation and communication achieve that. However it is not enough to

move information between collaborating designers. Information originating by distributed specialists has to be available, in place when needed. Thus, the actions of design participants have to be synchronized. Their production of information has to conform to schedules, which 'can be reduced to a simple formula "the right piece of information at the right time at an acceptable expense" (Rueker and Seering 1992). What actually counts in any collaborative production is not metric distance but time distance between cooperating partners. Empirical research has shown that if collaborative design is not well regulated in time, costs accrued in architectural firms due to delaying, waiting, and revising can far exceeded the benefits of having specialized information.

One way to secure concurrency in design collaboration is to develop a *plan* capturing the various steps of conception of an architectural scheme, managing the calendars of people and machines working together during, and minimizing waiting and possible revisions due to lack of synchronization. Such an optimal rational plan orders in advance 'who should do what and when', controls which work has to be initiated and when it has to be terminated, and allocates the sequence of human or mechanical activities. This is roughly the logic behind most network-based Planning methods, critical path methods, or PERT involving both a graphical and numerical representations of the process.

Most of such these methods originated in industrial production and in construction, highly distributed processes involving the coordination of equipment as well as people. Not only they can help coordination of distributed actions by prearranging their sequence in time but also allow their parallel, simultaneous execution, which achieves further efficiency. Computers played a most significant role making these models possible from the calculation point of view. Communication media made it even more urgent. From industrial production Planning methods were transferred in information production areas including design.

Planning methods abstractly presented seem rational. On the other hand, trying to fit them in concrete situations it become evident that they cannot deliver what was expected. They are too reductive for the complex interrelationships associated with contemporary architectural design practice. The idea of a comprehensive perfect plan through which one can allocate in time slots all design experts to optimize their participation is impossible to achieve. It requires data and background knowledge that is impossible to gather, to update, and to revise within realistic constraints. Even if it was possible to collect such data, to process them requires computational resources which are unobtainable.

5. Minimal Rationality Distributed Systems

A more realistic approach is to develop a 'practical adequate system' rather than an ideal, perfect one. Such a system should be able to coordinate distrib-

uted design actions within a framework of, what Christopher Cherniak (1986) called, developing further Herbert Simon's idea of a 'satisfactory' system (1957), 'minimal' rationality leading to tractable results. One extreme strategy is to advance a system of interactive rules, a protocol of collaboration, sensitive to the constraints of the specific participants and the specific design problem. Such distributed systems, rather than the planning methods we referred to before, permit multiple design participants to negotiate and instantiate intercourse towards the same design target, if and when needed. Participants, and these can be people or machines, can share specialized design knowledge, without recourse to a central design authority with a God's eye view of the architectural world, or even of the smaller world of the design partners. While planning methods were aimed initially to coordinate machines producing physical objects, Distributed Methods in Artficial Intelligence involving Multi-Agent Systems (Lesser 1995) were targeted for coordinating machines producing information. No wonder, they come closer to how people producing information, the "symbolic analysts,"[i] as Robert Reich called them, behave, and certainly the way designers work together. Thus, as Barbara Grosz, (1996), a computer scientist, remarked, there is a difference between simple interaction and collaboration. A system of interacting agents is less competent to solve problems in general, and I would add, design problems in particular. It cannot cope with incomplete information, partial views, and revisions. On the other hand, if design specialists are what Jeffrey S Rosenschein and Gilad Zlotkin (1994b) called, truly 'heterogeneous, self motivated agents' they can negotiate through dialogue how to be engaged in a design cooperation venture without the need of a complete, detailed plan. What they need is only a minimum number of 'rules of encouner' procedures to structure their negotiations, a protocol (Rosenschein and Gilad Zlotkin 1994a,). Initially, work in Distributed Systems did not involve conflict among agents. Increasingly they became more realistic. Thus, 'society' and 'social law' metaphors' were introduced. These models in turn serve understand deeper collaborative design among humans. However, more conditions have to be satisfied for designers to work together in addition to transportation and communication media overcoming distance and a protocol to master inconsistencies and delays?

6. Conceptual Systems for Design Conflict Resolution

Distributed design partners must be in agreement about what has to be achieved and how to do it. Yet, instead of that, they may disagree about what has to be done or how important is each of the things that have to be achieved. In addition, they may be in competition. Collaboration, however, is possible only when these conflicts are resolved. Thus, besides overcoming space and time distance

through new technologies of communication and computation another kind of distance obstructing human interaction has to be spanned related to differences in design objectives, obligations and prohibitions.

How can this be achieved?

It has been observed that what makes the process of resolving such conflicts more difficult is that participants are not even aware where they agree and where their views contradict each other. Thus, one step towards design collaboration is to turn these implicit points of view into explicit positions. This can be done through a method that can truck down and analyze streams of statements used by design participants in dialogue arguing about the various design tasks that have to be carried out in collaboration. Drawing from previous work on the cognitive structure of design reasoning (Tzonis 1975) and on the kernel of design argumentation that interrelates design beliefs, desires, intentions, and plans, Hoang-Ell Jeng (1995), developed a method to monitor design dialogues. The method depicts the implicit cognitive structure that underlies design discussions. It facilitates design participants to monitor each individual's strings of argumentation in discussions and to become aware of agreements or disagreements between each other. More importantly, it makes easy to detect the roots of disagreements. This permits designers to have more self control over collaborative process, and negotiate, deal, and compromise more efficiently and effectively. The system makes it easier to proceed applying voting techniques to aggregate partial views arriving at collective design decisions. Obviously there are shortcomings in such approaches. Even more promising however is to invite participants to set their disagreements in a game theoretic framework, once they diagnose the origins of their conflict,. Placing design conflicts in a broader framework permits what is a perceived as a zero sum game between participants to be turned into a win-win one (Axelrod, 1984, Coombs, 1988). In many respects such a method follows the approach of cognitive therapy (Beck, 1976) suggesting that conflicts might occur because of inadequate information and incorrect inferences among design participants, many times caused by limitations of working memory, irrational belief persistence, self deception or biases which awareness helps overcome.

7. Bridgeheads for Design Translation

Are there any other conditions to be met for collaborative design to happen in addition to transportation and communication media overcoming distance, to a minimal distributed system overcoming inconsistencies and delays, and to a conceptual system facilitating conflict resolution? Indeed more is needed. For distributed design partners agreeing to engage in collaborative decisions, information has to be not only in place and on time but also in the *form* each collaborator needs it. Thus, besides overcoming space, time, and objectives distance,

another kind of distance between collaborators has to be spanned: epistemic and cultural distance. To be able to make use of a message that arrives from a design specialist the recipient has to be able to understand it. And this is not always the case. There are major gaps between dialects, conventions of representation, and jargon terminology used by members of the new design partnerships cutting across disciplines, professions, and cultures that has to be bridged. We should be reminded that according to our definition of collaborative design in a global context given above, design participants in today's world are not only technical specialists, but, in a more universal way, any 'agent' who takes part in discussions leading to design decisions, including clients, users, and machines. Given the heterogeneity of these partners, it is a challenging task to turn them from dispersed tribes into a community of designers. One has to develop a method that can bridge all types of gaps terminological ravines, intellectual gorges, and conceptual chasms.

How can we overcome such gaps? A standard approach already in practice is to employ technical 'translation manuals' or general dictionaries. A powerful Universal Dictionary of Design is a kind of database that establishes equivalencies between disciplinarian terms or design terms bound to subcultures. However, exchanging information from one design discipline to another and from one subcultural background of a user or client to an other, and making it applicable in each case and each phase of design, is a problem that cannot be solved through simple matchings any dictionary offers. The differences between professional languages and languages of people with different cultural background are more than differences between words. They relate to a big divide between theories that try to interpret the design world from views that have a long and rich history that is very hard to reproduce it in a dictionary matching.

Despite all these difficulties, however, it is a fact that people design together and the gap was and is bridged in design practice with varying degree of success and cost. How can we identify a procedure that is more reliable and more efficient than the improvised ways used already by 'global' designers? How can we develop a framework for establishing collaborative design that can incorporate new technologies of computation and communication in a way that improves design practice globally and not in few aspects at the expense of others, favors one set of collaborators while disappointing the rest? One possible solution to this problem would have been to develop a 'Theory of Everything' related to design. Such a Universal Theory of Design would have to encompass all particular design theories and all versions of them. The idea is obviously attractive. Unfortunately, it has the same pragmatic weaknesses, like the planning methods mentioned before. It is ideal, perfect, but practically intractable. Once more what is needed to bridge the gap is not universality and perfection but a minimal framework with a circumscribed agenda of application which will be

able to bridge not in an ideal but enough to get knowledge come and go over the conceptual gaps separating possible design collaborators.

'Bridgeheads,' was a metaphor used by Martin Hollis (1982) for the presupposed internal and external constraints in the minds of people discussing that 'get argument going' even if each partner, temporarily, does not believe what the other one says is complete, true, or even sincere. Such 'bridgeheads' sustain the dialogue between people coming from different disciplines or cultural and subcultural backgrounds rendering interhuman, mutual intelligibility possible. To quote D Davidson (1984) 'the method is not to eliminate disagreement, nor can it; its purpose is to make meaningful disagreement possible, and this depends entirely on a foundation – some foundation- in agreement'. How can one establish such a foundation? What is it made up? Where can one get the materials to construct it?

One idea is that Davidson's foundations or Hollis's bridgeheads do not preexist. They emerge on the way to building bridges. They are made as prospective design partners come together to collaborate. If this is the case what is needed, once more, is only a 'protocol for translating' to be used by disciplinarian specialists and members of various subcultures in design dialogue and the bridgehead will rise gradually. This is the process described by Peter Galison (1997) discussing ways scientists collaborate. Galison uses the metaphor of 'pidgin' and 'Creole', for 'languages' emerging 'at the boundary between groups'. 'My intention', Galison asserts, is 'to include structured symbolic systems that would not normally be included within the domain of 'natural languages'. It is obvious that Galison's ideas are relevant not only to collaborating scientists but to any collaborating producers of scientific and technological innovation, including collaborating designers. Yet the question remains. From where does this 'protocol for translating' will come which eventually will lead to the new 'Creole' dialect?

To come back to Hollis, for him, if I understand completely his idea, the bridgehead is a set of universally hold 'beliefs about beliefs', which constitutes 'a core' 'as a precondition of the possibility of understanding beliefs'. From where does this core come? If we try to find it in the environment, tradition, and history then it is not difficult to see that we are searching in the wrong places. In fact Hollis quotes D P F Strawson's phrase to clarify bridgehead as 'a massive core of human thinking which has no history.' The background of each individual, each institution, and each subculture is fatally 'incommensurable' and it can bring about only part of the structure we try to identify.

We have to look therefore at another place for presuppositions to any dialogue and any social behavior including design dialogues and collaborative design. And this is our own human nature, our mind endowed by nature and evolution with the prewired intelligence to acquire, store, and process information in a certain manner. The bridgehead is in our heads offering us the capacity to

generate, 'head down', on one hand consensus among us, as members of the same group, the human group, on the other to generate infinite variations and differences between us. Because community is in the mind we are competent to make communities, including communities of collaborating designers. No wonder we are able throughout history to divide and create innumerable specializations of labor and knowledge as well as to keep on coming back to work together, to create together, and to design together.

To be endowed with such a mental potential is a necessary condition, a presupposition that works unconsciously for doing things together. It is not however enough to establish a full-blown collaborative design practice. To develop such a practice requires mobilizing the mental potential to interact with the environment, disciplinarian, cultural, and social. To control, even more improve design collaboration involving people and machines, demands becoming conscious of the structure and function, limitations and potentials of the bridgehead, the endowed collaborative design intelligence. Thus, the request for inquiring into the nature of collaborative design intelligence that encompasses both:

a. Designing as such, that is spatial-functional intelligence that makes possible recognizing, recalling, intentionally manipulating, and planning artifacts.
b. Collaborating as such, social intelligence that makes possible recognizing or imagining persons belonging to groups, being actors with purposeful behavior, intentions, and roles, and most importantly being able to do things together, work together, think together, form a community.

8. Towards Dialogical Design

Up to now we spoke about collaborating designers, holding their own beliefs and desires, developing their specialized knowledge, and exchanging information, which leads to a final design product. We discussed the needs and opportunities involving collaborative design process, and pointed out to some tools available, or necessary to develop to make this process successful. Finally we pointed out cognitive aspects of collaborative design. We mentioned the characteristic elements of the abstract kernel of design thinking that makes possible to abstract out of a design dialogue the argumentation structure and facilitate conflict resolution. But we left vague the elements of interrogative design reasoning. Indeed this is an area that very little has been achieved up to now. Some efforts have been made to apply speech acts theory to understand the structure of dialogical design thinking. Speech acts can help tag and classify messages between participants in collaborative design. They cannot capture, however, the structure that connects individual statements and moves design decisions.

What has to be developed is a model that captures the contribution of design collaborators, architects, technical experts, clients, and users as participants in a

process of learning and discovery. Crucial for this development is to complement the structure of abstract design reasoning involving spatial-functional relations embedded into a structure interrelating statements of belief, desire, intention, and plan with a structure of Socratic *elenchus*, what Jaakko Hintikka has called 'interrogative (questioning) steps'.

9. Coda

Architecture like a very large number of disciplines and professions of our time is benefiting by division of labor, specialization, new media of computation and communication, which develop a opulent global practice. But it also runs the danger to erect barricades within, splitting designers into insular "incommensurable" conceptual tribes, thus rendering mutual intelligibility and dialogue increasingly difficult. As a recent study concerning the use of web technology in science has shown a paradoxical situation may emerge whereby deregulation, universal emancipation, and ease of distant interaction, may lead to Balkanized rather than true universal of design.

It is well known that most novel questions can be answered by leaping over knowledge barriers, disrupting boundaries of stereotypes and not by multiplying them. To borrow Wittgenstein's metaphor about language, the more specialists succeed erecting such "suburbs" of knowledge the more they fail in building a City of Knowledge, in fact turning what exists of it into a slum.[ii] Further increase in the division of design labor, design specialization, and globalism might turn out, in this case to be a hindrance rather than an asset. Design becomes in this case not only a highly divided and shattered activity but also a divisive and shattering one. Thus a major challenge for collaborative design is to enhance the conditions for dialogue and learning, enlarging the communities of specializing designers and integrating them within the larger human community.

Appendix

Over the last eight years Design Knowledge Systems Research Center, has been working on the subject of Collaborative Design. Professors S J Doorman of the faculty of philosophy and the late Donald Schön of MIT were part of this project. Researchers also were advised by William Porter and John Habraken of MIT, and Dr F Duffy of DEGW. The Center, a multidisciplinary unit established to improve design methods and theory, emphasizes the development of new design tools through better understanding of designing as a cognitive process embedded in social practice. As a result of rapid changes in architectural practice which transformed design from a solitary creative act into an interactive, participatory process, the Center has defined the area of Collaborative De-

sign as one of its top priorities. A number of research projects have been carried out which have as a unique characteristic the integration of empirical investigations of architectural practice, studies in the field, with highly theoretical studies drawing from computer and cognitive science.

Given the newness of the problem the research departed from a number of empirical comparative case studies. The purpose was primarily heuristic. To identify an ontology of collaborative architectural design:

a. A pilot comparative case study investigating in great detail how Collaborative Design occurs in professional practice in the context of global practice considering two similar design firms but different national situations. Design. The project analyzed exhaustively the interactions that took place during the development of two projects, one by the French firm of Ferrier Architectes, the other by Dutch firm, Mecanoo Architecten**.** The cases were studied retrospectively; consulting the firm's archives. (1996-7).
b. A second case-study was undertaken by P Donker to test the hypotheses derived from the previous one, still with the Dutch firm, Mecanoo Architecten, examining the SABU-huis redevelopment project. The collection of data took place this time through direct observation. The researcher was present in the design team meetings. All meetings were recorded in detail and parts of the data were sampled for analysis.
c. Almost simultaneously, a third case study explored the relevance of this kind of work focused on collaborating technical experts in western countries to participatory design in a Taiwanese environment by Dr. Hoang-Ell Jeng (1995). He investigated the participatory design of Ho-Chu-Wei Park in Taipei, Taiwan.

Dr. Hoang-Ell Jeng (1995) in his study tried out of given dialogues to reconstruct the implicit cognitive structure that underlies dialogue and a group-reasoning model, based on the collected data from the case. It also involved analysing the nature of problems emerging during group design discussions in relation to: 1. Collective generation of new concepts through discussion, dialogical interactions., 2. Sharing, and learning of belief systems and value systems and conflict resolution.

Message Information System for Architects (MISA), was developed by P Donker (1999) as a first, rough approximation of a dialogical design model. It focused on aspects of a tool that can function as a database tailored for architectural archives involving projects carried out in collaboration. The System approximated the structure of communication in design teams, to be used to retrieve past discussions according to multiple agents and criteria related to their collaboration.

A more realistic and more complex system was developed by Dr P Donker (1999) for Structuring Communication in the Architectural Forum For On-Line

Design (SCAFFOLD). It consisted of two layers: a design reasoning layer, based on the Conceptual Systems of Design model, and communication layer, based on the Speech Acts model working in combination. The structure captures realistically the dialogical characteristics of design group interactions and thinking meeting pragmatic criteria.

The concept of the social contract, especially as developed by John Rawls in his work on Social Justice was applied by Dr. J Heintz (1999) to capture an other aspect of design collaboration, how participants agree to undertake partial tasks related to their special role in the design process. The Collaborative Design team is compared to a 'society' engaged in a particular practice: collaborative building design.

From the cognitive point of view, the research drew from earlier work on modeling the conceptual system underlying design reasoning by Prof. Alexander Tzonis (1975).

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[ii] Ludwig Wittgenstein, *Philosophical Investigations*, 3rd. ed., (New York, MacMillan, 1969), 18.