Collaborative Design Process Simulation Game

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Abstract

Collaboration is an important aspect of the architect’s education. However, it is not amenable to the traditional project-based learning pedagogy that works so well for developing form-making skills. Being a process, rather than a product, it cannot be revealed by judging the results alone, which is often how form-making skills are taught and judged. Rather, the process of collaboration is only evident when the number of the participants exceeds a certain threshold, and when actions taken by other participants affect an individual’s on-going design decisions. The advent of on-line, multi-player simulation games provides an analogy and an opportunity to explore interactive collaborative design pedagogies. Their abstract nature helps focus attention on the core issues of the simulated phenomenon, while the playful nature of a game, as opposed to “work,” encourages immersion and role playing that contribute to the learning process. This paper describes an on-line game for simulating the design collaboration process. It espouses to simulate, exercise, and provide a feel for the social dimension of collaboration, by embedding mutual dependencies that encourage players to engage each other—in adversarial or collaborative manners—to accomplish their goals. Specifically, it is intended to help students understand what collaboration is, why it is necessary, and how it is done. The game is modeled after popular board games like Scrabble and Monopoly: players build “houses” made of colored cubes on a site shared with other players. Actions taken by one player immediately affect his/her neighbors. A carefully constructed set of rules awards or deducts points for every action taken by a player and by his/her neighbors. The rules were constructed in such a manner that players who collaborate (in a variety of ways) stand to gain more points than those who do not. The player with the most points “wins.”
1 Introduction
Collaboration is an aspect of the architect’s education that is often neglected in favor of developing form-making skills. As a result, when they choose to study architecture many students envision the misleading image of Howard Roark, the fictional hero architect in Ayn Rand’s 1943 novel *The Fountainhead*: a professional who is in complete command of his/her destiny and the project. It is not until they graduate that students confront the socially complex reality of architects as agents in a collaborative enterprise, subject to a multitude of rules, regulations, economic realities, speculation and negotiations that constrain and direct their own professional contributions.

Moreover, collaboration is not amenable to the project-based learning pedagogy that works so well for developing form-making skills. Being a process, rather than a product, it cannot be revealed by judging the results alone, which is often how form-making skills are taught and judged. Rather, the process of collaboration is only evident when the number of the participants exceeds a certain threshold, and when actions taken by other participants affect an individual’s on-going design decisions. For the same reason it is also not amenable to lecture or seminar-style teaching, whose abstract nature allows students to comprehend the social dimension of the process only intellectually, without actually experiencing it.

Attempts to introduce UC Berkeley students to the collaborative dimension of the architectural design process began in the late 1970s, through a comprehensive design exercise given to third year students directed by Architecture Professor Marc Treib (Figure 1). It was intended to teach them, among other things, how to deal with the creation of places as a collaborative form-making enterprise, rather than as an individualized effort. The exercise involved the design and physical construction of a cardboard “city” in a pre-designed “urban landscape.”

Students were assigned 3’x3’ plots in the yard, and instructed to design a “defined place for sitting.” Although the project was assigned as an individual design task, students were required to make an effort to conform their designs to the designs of their neighbors, or come to some common agreement on the vocabulary of form. As in real life, they soon found out that meeting this requirement often entailed endless discussions and political power plays, turning the Cardboard City project into an exercise in collaboration, as much as it was an exercise in physical design. Students learned the importance of politics in design, the destructive force of obstructionists, and the impact decisions made by others had on their own designs. It became the “right of passage” exercise to upper-level studios, and a source of pride to the students who participated in it. But the creation of a large-scale cardboard city by 75 students also inflicted so much damage on the studio facilities - in terms of cardboard mess, gauged tables, floor tiles, and any other surface the students could use for cutting - that the exercise was discontinued.

The advent of computing technology, in particular the Internet, allowed us to resurrect the Cardboard City exercise in the late 1990s, using computer visualization in lieu of cardboard (Figure 2). Archville, as the new exercise was called, was pedagogically similar to the Cardboard City exercise (Peri 2001). As in the original exercise, each student was given a plot in an urban landscape. However instead of a physical space, Archville used a computer model of a hypothetical city. Instead of reduced-scale 3’x3’ physical plots, students were assigned “life-sized” virtual plots. Instead of designing a “defined place for sitting,” students designed houses or other structures. As in the Cardboard City exercise, students were asked to design their houses in agreement with their neighbors. Specifically, they were required to establish and agree upon some common design elements, such as style or color. Using VRML, Archville allowed students to virtual “walk” through the “city.” Each student’s work was always visible to other students, eliminating the problem of making design decisions based on obsolete information. Students could also see each other walking though the environment, in the form of avatars, and communicate with fellow students by chat and e-mail. Work done in previous semesters was not “taken down” at the end of the exercise, as in physical design studios. Rather, it was left on the site, creating a sense of history and a city that grew and evolved over the semesters. When more space was needed, more landscaping was added to the computer model. Paradoxically, Archville’s advantages have also been its limitations: students put most of their effort into creating their individual buildings—a time-consuming activity accomplished through commercial CAD tools like 3DStudioMax, FormZ, and VRML—leaving little time for exercising the social dimensions of the project. Our attempts to extend the exercise to include such dimensions as economics, negotiations, and tradeoffs failed to dislodge the students’ preoccupation with form-making.

A similar tendency to focus on form-making, rather than the collaborative aspects of the architectural design process, was exhibited when the virtual environment was substituted by a physical scale model of a city. Called CADville, this exercise combined computer-aided design and physical scale modeling to create 80-100 houses located on scaled city plots. The students were asked to respect (actual) local zoning laws, existing
structures and morphologies, and coordinate their designs with other students in their immediate vicinity (Figure 3).

The result was a scaled-down city center, which generated much excitement for one afternoon every semester. But the students’ preoccupation with their own designs, their reckless disregard of fellow students’ designs, and the difficulty of (manually) enforcing collaboration, resulted in architectural chaos. While this outcome was appreciated by the students, and served to underscore the need for collaboration, it did little to help them actually experience it.

To overcome the students’ natural tendency to focus on form-making, and to concentrate their efforts on the collaborative aspects of the design process, we have been developing a simulation game that provides a simplified framework within which a large number of students can experience the process of collaboration. In essence, it replaces complex form-making with simple colored cube-shaped “rooms,” which the players must “buy” or “trade” with each other. Instead of intricately-crafted buildings, the game emphasizes the impact of actions taken...
The collaborative design simulation game

To exercise and provide a feel for inter-dependent decision making, albeit in a highly abstracted form, we have developed a collaborative on-line design simulation game. Unlike other networked collaboration exercises (discussed in the Conclusion section of this paper) which focus on the results of the collaboration, our Game is intended to help students understand the process of collaboration, by providing positive reasons to collaborate (to achieve more than can be done alone), and illustrating the negative effects insufficient collaboration (e.g., interference with one’s ability to accomplish his/her goals). The vehicle we chose for implementing these objectives is building a “house” made of colored cubes, on a site shared with other students who build, their own houses (Figure 4). A carefully constructed set of rules awards or deducts points for every action taken by a player or by his/her neighbors. Players who collaborate (in a variety of ways) stand to gain more points than those who do not. The player with the most points “wins.”

3.1 Method

The game is modeled after popular board games like Scrabble and Monopoly, though without “turns” (players do not have to wait for others to complete their transactions to make their move). Players build “houses” like words in Scrabble: using individual cubes on a gridded site. Individual cubes represent a different types of “room,” each with a certain point value. Adjacency rules restrict the placement of cubes (which color cubes must be adjacent to other cubes, and which cubes must not touch one another). Additionally, a complete “house,” much like an acceptable word in Scrabble, must include a certain number of cubes of certain types (the equivalent of having a bathroom, a kitchen, a bedroom, etc.). The value of a house depends on its number and types of rooms (i.e., a small house may have only a kitchen, one bedroom and one bathroom, whereas a large house may have a kitchen, five bedrooms and three bathrooms), and on the values of the neighboring houses.
3.2 The “economic” model

Collaboration, like other human activities, requires motivation. To encourage and measure collaboration, a point system indicates the value of each player’s house. This value is not only a function of the value inherent in the cubes that make up a player’s own house, but also a function of improvements other players make to neighboring plots. Thus, a house that neighbors large houses has more value than a similar house that neighbors small houses or un-developed plots. The economic model underlying the game is thus based on real-estate “speculation”: players gain points through growth in the property value, due to the development of their own plot and owned by other players. Since improving one’s own property also increases adjacent property values, it is in the players’ best interest, to help their neighbors improve their properties.

Property is defined as a contiguous set of squares belonging to the same player (a player may own more than one property). Its value is calculated according to the following formula:

\[ V_p = \sum S_{i,p} \times I_p \times \prod N_{j,p} \]

where \( \sum S_{i,p} \) is the sum of the values of all the squares from which property \( P \) is made; \( I_p \) is the overall improvement factor; and \( \prod N_{j,p} \) is a ‘neighbors factor’ multiplier.

The value of each square \( S_{i,p} \) is calculated as follows (Figure 5):
1) Original value of the square (as determined by the site).
2) The value added by each room associated with this square (stacked vertically).

The “improvement factor” \( I_p \) is calculated as follows:
0.9 – if the property is not owned by any player (it belongs to the “bank”)
1.0 – if the property is owned by a player who made no improvements to it (i.e., no rooms, no landscaping)
1.1 – if the player has purchased some rooms, but they don’t yet add up to a “house”
1.2 – if the player has built a small “house” (kitchen, one bathroom, and one bedroom)
1.3 – if the player has built a medium ‘house’ (entrance, kitchen, two bathrooms and three bedrooms)
1.4 – if the player has built a large “house” (entrance, kitchen, three bathrooms and five bedrooms)

The “neighbors factor” \( N_{j,p} \) is the product of each neighbor’s property value index, calculated according to the following algorithm:

a. set \( N_{j,p} = 1 \)
b. for each neighbor \( j \) calculate its own Improvement Factor \( I_j \)
c. for each neighbor \( j \) of \( P \): \( N_{j,p} \leftarrow N_{j,p} \times I_j \)

A ‘neighbor’ is defined as an adjacent property that shares \( n \) squares with the evaluated property.

For example, the house depicted in Figure 5 would have the following value:

\[ V_p = \sum S_{i,p} \times I_p \times \prod N_{j,p} = 450 \times 1.3 \times 2.002 = 1,171.17 \]

calculated as:

\[ \sum S_{i,p} = \text{values of all squares + improvements} = 450 \]
\( I_p = 1.3 \) (medium house)
\( N1,p = 1.0 \) (owned by a player, but no improvements)
\( N2,p = 1.1 \) (not yet a house)
\( N3,p = 1.3 \) (medium house)
\( N4,p = 1.4 \) (large house)
\( \prod N_{j,p} = 1.0 \times 1.1 \times 1.3 \times 1.4 = 2.002 \)

Note the dramatic effect of the neighbors’ houses: although the player’s investment in the property amounts only 450 points, its value—according to this example—is over 1,171 points. If all neighbors had built large houses, its value would rise to more than 2,247 points. This dramatic effect should be enough to encourage players to help each other improve their properties (in later versions of the game we allowed players to use this “equity” to purchase and develop additional properties, thereby allowing them to further capitalize on their investments).

3.3 Implementation

The game has been programmed in Java3D, as a web-accessible, multi-user domain (MUD). It allows for accommodating a large number of players, administering the rules and calculating point values. Players log-on to the game web site, where they are able to see what other players have been doing, and communicate with each other through chats and e-mail.

In addition to tools that allow players to add, remove, and re-locate cubes, and change the view parameters (zoom, rotate,
etc.), several tools allow players to gain information about the status of their own and other players’ buildings. One tool, called “property” (Figure 6a), lets players see what types of rooms they have acquired, and check the state of their resources. Another tool, called “consol” (Figure 6b), allows them to study in detail how the value of every players’ property has been calculated at any given time. Together, these tools provide real-time, immediate and total transparency to all players, who can use the information to determine where improvements may be made, either to one’s own property or to his/her neighbors. Total transparency and real-time evidence are key elements in collaborative processes, although they can be used for individual gains as well.

4 Collaboration strategies
At the start of the game players are assigned a given sum of “money,” in the form of points, which they can use to “buy” cubes and plots. Much of the game’s strategy, however, is in the types of agreements the players make among themselves, which lead to association, teamwork, and even creative collaborations:
3) Association occurs when players organize into groups for joint purchases of plots, thereby avoiding the speculative, inflationary effects of development: since the value of a property depends on the state of improvements of its neighboring properties, it is less expensive to buy a plot neighboring undeveloped plots, rather than to buy into an already developed neighborhood.
4) Teamwork occurs when a player purchases a large number of cubes (“rooms”) of a particular type and sells or “rents” them to others. Since the number of rooms of any given type is finite, owning many rooms of a particular type is a kind of franchising, and a source of additional revenue (and competition) among players. “Renting,” in the context of this game, means that the original player retains "ownership" of the cube, even though they are used in constructing other players' houses. The owner is "paid" in points proportional to the value of his/her rented room within the context of someone else's house. Thus, franchising and renting represent specialization of individual players, who choose to “invest” in one type of cubes. Players may even choose not to build a house of their own at all, only sell or rent their cubes to other players.
5) Creative collaboration occurs when two or more players decide to share their resources and combine their talents in pursuit of more expensive plots or more elaborate houses. In this case, the rewards are also shared.

Despite the simplicity of the game, the flexibility afforded by the cubes, plots, and rules provides a rich gaming environment, which can be tested and changed subject to mutual consent of the players. Concepts borrowed from the business world allow participants to test different methods of contracting, including multi-player secondary and tertiary agreements that may be needed to complete a “deal.”

5 Results
In a course on collaboration several different versions of the Game were used. The simplification of the “buildings” to colored cubes had the desired effect of focusing students’ attention on collaboration strategies, rather than on building beautiful houses. This, in turn, proved successful, though not always in the manner intended by the instructor.

The first implementation of the game allowed players to purchase individual “squares” for their building site. Students quickly discovered that the most profitable strategy does not require collaboration, only maximizing the number of neighbors. This could be accomplished by purchasing squares that made for highly irregular plots, with “tentacles” reaching the sites of as many other players as geometry allowed (see Figure 4). A side effect of this strategy has been “choking off” other players, by surrounding their site with a single row of squares.

To counter this strategy, the game was modified to consist of pre-defined plots, much like a housing development. Players could only purchase entire lots, rather than single squares. This restricted their neighbors to a fixed number, and put the emphasis on collaboration (Figure 7). Active e-mail, chat, even phone calls were used to nudge and encourage neighbors to take action they might not have intended. Quid pro quo bartering occurred, even acts of philanthropy where students helped neighbors who ran out of money to buy more rooms, so the value of their property would rise. Still, scheming and strategizing were in evidence, each student trying to maximize his/her own equity value. This became even more apparent when equity could be used to purchase additional plots, making some students very “rich.” It leads us to believe that the game engine might lend itself to exercising other subject matters and pedagogies. For example, it could be used to teach different business models, economic models, social models, and political models. Clearly, the kinds
of rules needed to support such pedagogies must be carefully considered, a task that can only be done when the game is available for testing them.

By observing the students while they were playing the Game (through their actions and chat), and from their comments, it is clear that the Game helped them understand the dynamics of collaborative action. It was also clear that their collaboration was motivated by their desire to “win” the Game, through gaining as many points as possible. This led to carefully choosing plots with many neighbors, examining each other’s designs to discover how they could be improved, and making suggestions to that effect. Although the Game is designed to be asynchronous—players do not have to be logged in at the same time—students made arrangements to do so, for on-line chats. The students also made many suggestions to improve the game, which were implemented, as much as possible, during the semester, resulting in improved versions of the game.

6 Conclusions
The notion of digital collaborative design exercises is not new. At Stanford University, Fruchter and her colleagues have been engaged in digitally-enhanced collaborative A/E/C research and education for over a decade (Fruchter 1998). At the ETH in Zurich, Schmitt and his colleagues have been experimenting with different networked design collaboration tools (Engeli & Mueller 1999). And digital collaborative design studios have been popular, for a while, in many parts of the world (Hirschberg et al. 1999, Wojtowicz et al. 1993).

Yet, the overt goal of these experiments has been to foster the production of one or more architectural (and other) designs that reflect the collective wisdom and creative talent of many individuals. That was not our goal. Rather, this particular collaboration game has been designed to introduce students to the essence of the collaborative process itself. Hence, the results
of their collaboration - actual “houses”- have been intentionally made abstract, and of no architectural value. Instead, their “value” has been explicitly defined in a quantitative, measurable way which, like a thermometer, is used only to judge the success or failure of the process itself. It has no intrinsic value of its own. In fact, a “house” can be small, or a plot can be completely un-developed, yet it may have a high point value due to the improvements made by its neighbors. In terms of our Game, such a plot will be considered more successful and have higher point value than a large house surrounded by un-developed properties (an evidence of non-collaboration).

Moreover, most, if not all, exercises cited above tended to partition the design process spatially, temporally, or by disciplinary contributions. Thus, for example, in the ETH’s phase(x) project, “collaboration” is understood to be the disjointed, temporally-distinct continued development of another designer’s product (Hirschberg 1997). Its Information Landscape project partitions the design spatially: each team of designers is responsible for one tile in the overall information landscape. While students were encouraged to match their contributions to those of others, they were not likely to suffer adverse effects had they chosen not to do so (Engeli & Mueller 1999). And Stanford’s Computer Integrated Architecture, Engineering and Construction project follows the traditional division of labor (and expertise) of the A/E/C industry, which enshrines, rather than overcomes, the travails of collaboration (Fruchter 1998).

In contrast, the goal of our Collaboration Game has been to engender a contemporaneous, highly-dependent type of collaboration, where the actions of one student immediately and explicitly affect the efforts of other students. Agreements among the players are a necessary condition to achieve success. The motivation for collaboration is clear (if simplistic), as are the means to accomplish it: they are not subject to personal taste or interpretation. As such, the product may not qualify as particularly aesthetically pleasing, or even innovative. Instead, the exercise clearly focuses on the role, value, and pitfalls of the collaborative process itself: the fact that collaboration can lead, in some cases, to inferior products is a valuable lesson in and of itself.

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References