The Role of Computer Visualization in Design Review
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Richard M. Levy, Ph.D.
Associate Professor of Urban Design and Planning
Faculty of Environmental Design
University of Calgary, Alberta, Canada
EMAIL: rmlevy@acs.ucalgary.ca
http://ucalgary.ca/~rmlevy

Abstract
Computer modeling can assist the planner who must facilitate goal setting for a community. A CAD (Computer Aided Design) based approach to urban planning promotes the examination of density, zoning, sun and shade, open space and views as part of the design process. By visualizing possible development scenarios, communities have the means to evaluate potential action for and against their vision. In this paper computer visualization will be examined as vehicles for negotiation among all concerned parties: city officials, real estate developers and members of the community. By reviewing the progress made by one community the within the City of Calgary, Alberta, Canada concerning issues of zoning and urban design, a better understanding of the potential role CAD modeling in urban design can be developed.

Introduction
The use of CAD (Computer Aided Design) models have been used by both city planners and developers to develop proposals, to examine current building regulations, to solicit public reactions, to market space, to promote tourism and to provide public information. This development is part of a larger trend that has transformed many design professions. Advancement in computing technology, lower costs for hardware and software and the proliferation of technical skills have contributed to a growing awareness of the potential usefulness of the CAD approach in architectural and urban design (Mahoney, 1994; Novitski, 1998).
A CAD based approach to urban planning allows examination of issues critical in the design of cities. Scale, density, public access, open space, zoning, viewscapes, sun and shade are some of the design issues that can be addressed in an interactive CAD environment. It is not uncommon in the planning of large scale architectural projects to use CAD throughout the design cycle to develop concepts, to produce renderings, animations and the final working drawings. In the last decade many cities have embarked on the creation of fully detailed CAD models of their downtown business districts (Brenner, 1998; Hamit, 1998; Liggett and Jepson, 1993; Littlehales, 1991; Mahoney, 1997). These digital models of cities will enable communities to visualize debate of the issues critical to the design of their cities.

Urban Planning and CGI - Decision Making and Visual Perception

Having an accurate image of a proposed development can empower a local community group by focusing energy on areas of common concern. Though there is no guarantee that computer visualization will reduce the time spent in community consultation, it is hoped that this process will lead to a more equitable land use policy. The premise is that greater clarity of graphic information will reduce potential misunderstandings. Traditionally, a challenging exercise at community planning sessions is to arrive at a common understanding of the three dimensional qualities of a space only from the plans and elevations (Knack, 1991; Forester, 1989). The participants of these review sessions must project in their minds’ eye a 3D form created from 2D drawings. Photographic views of the site can simply add another layer of complexity by requiring the participant to superimpose an image of the proposed building into the photographic view. To complicate matters, architects on behalf of their clients use artistic rendering to show their projects in a favorable light. Atmospheric effects, the addition of attractive landscaping and tree plantings, the selection of a dramatic viewpoints and perspective projections that can never be visualized by the human eye are all part of the practice of creating an artistic rendering (Mitchell, 1994; Tips and Tongchai, 1986).
Furthermore, selecting alternative views of the project for different times of the day and year is very difficult within the static medium of a drawing. Testing whether a proposed design will block a key view of the street or shade a neighbor's back yard requires the preparation of a new drawing. Under these circumstances, members of the community are compelled to accept the professional judgement of architects and planners. One overriding argument for selecting a digital approach may be to answer the questions: "What will I see from my backyard" and "Can residents from the first floor of the proposed development see into my bedroom windows?" By creating a computer model, the answer to these questions can be demonstrated prior to construction of the project.

The mere use of computer modeling may not guarantee greater accuracy in the representation of alternatives. The power to render from a variety of camera angles, focal lengths and atmospheric conditions gives the architect almost unlimited potential in the creation of renderings. In fact, a danger may be posed by computer modeling in community planning because of the association of computing with engineering and scientific precision (Levy 1997). Purposeful misrepresentation of a development proposal can be done in any medium. Finally, there must be a sensitivity to the medium of CGI (computer generated images) by those reviewing the images. Those unfamiliar with CGI may be mesmerized by their photographic quality and will be distracted from the issues under consideration (Guilshan, 1992).

CASE STUDY

A case study is presented to illustrate the issues arising from adopting computer visualization technology to resolve community conflict. Specifically, the case study involves the rezoning of several blocks in Windsor Park, a neighborhood in the City of Calgary. The area was first officially targeted for rezoning in a policy document "Windsor Park Transitional Area Report," approved by Calgary City Council in June 17, 1980 (City of Calgary, 1980). The document, based partly on neighborhood surveys, recommended the creation of a transition zone to
act as a buffer between higher density apartment development to the south (RM5, four story multifamily apartments) and the older residential neighborhood of single family homes to the north (RM2, single family two story homes). In the years following 1980 a slack demand for multi-family housing discouraged redevelopment of single family sites. It was not until 1998 that a proposed apartment for three adjoining parcels zoned for DC-RM4 (direct control multi-family) provided the first glimpse of the scale of development permitted under the 1980 guidelines. The subsequent reaction to these plans by members of the community was first registered before a meeting of the Subdivision and Development Appeal Board (SDAB) in June 21, 1998 (Fig. 1). The community reaction to a proposal for higher densities compelled the local alderman and the Planning Department to initiate a review process of the Guidelines in the "Windsor Park Transitional Area Report" (City of Calgary, 1980). Two groups emerged during this controversy: those who saw the increased building mass as a threat to the character of the neighborhood of single family homes and those who viewed the higher density proposed in 1980 as the only viable economic development choice given the state of the local real estate market.

This case study provides a test of the use of new visualization technology in urban planning review. The design problem faced by community was relatively simple. The model needed to address the potential impact of several possible zoning alternatives on the character of the neighborhood in this transitional zone (Fig 2). Issues of height, setbacks, views into adjacent properties (overview) and shadowing can easily be examined with a digital model. Computer modeling had been used both as part of the community presentation to SDAB and as a tool during the exploration of zoning alternatives. A continued use of computer modeling over an eight month period helped the community acclimate to computer generated images enabling them to judge various development options.

Limitations of the Study
The author was an active participant throughout the review
process, beginning with helping the group prepare their case to the SDAB. Numerous meetings were held with members of the community in the preparation of their presentation to SDAB in June 21, 1998. In meetings held after the appeal was rejected, the author worked with members of the community on the identification of key design issues throughout this modeling exercise. Though careful notes have been kept throughout this process, the personal association with community members will inevitably contribute to a bias in the reporting of events. In addition, unlike a controlled experiment, the absence of a control group makes it impossible to know if a different conclusion would have been reached without the use of computer modeling.

The Model

In creating the model, data provided by the City formed the basis of the site context. The area selected for modeling included the blocks to the north and south of the site.\(^1\) The model of the site context established the necessary framework for examining the impact of proposed development on properties to the north of the site. The project that was approved by SDAB on June 21 was included in the study model (Fig 1). Based on the architect's plans, a computer model of the recently constructed building demonstrated to the committee the accuracy of CGI in providing a fair comparison between the virtual and the real.

The goal of the modeling effort was to provide images of potential zoning scenarios to stakeholders. Delineation of the massing envelope was meant to provide an accurate analysis of setbacks, viewscapes and shadow patterns cast on adjacent properties. The computer model could also be used to visualize the roof-line profile from properties a block to the north of the transitional zone. To understand

\(^1\) The base model was created in AutoCAD version 14. The architectural forms were created in ArchiCAD and 3DStudio VIZ. Finally rendering was completed in 3DStudio VIZ.
the impact of architectural detailing on the views from the street, windows, door, and porches were added to the model.

**Computer Modeling and Public Participation Planning**

In an attempt to find a compromise between homeowners and potential land developers, images of the model were be presented to the group at the beginning of each planning session. To maintain a common reference frame for each scenario, three prescribed walkthroughs were established. Each of the walk-throughs was designed to test a specify concern of the community: 1) views from properties to the north along a shared laneway 2) views from the front door of properties opposite to the proposed development and 3) views from the sidewalk to the south of the transitional zone. Each walkthrough was presented as an image series and assembled into a multimedia that was distributed to key informants on a CDROM.

Early attempts at using VR to display design alternatives was marked with problems. A simplified version of the CAD model of the site for each design proposal was imported into Sense8's WorldUp. Though WorldUp VR environment offers the potential to view the site from any location, the lack of constancy made it difficult for the group to make comparisons between different alternatives. In addition, shadows and details in the VR version of the site model could not be shown. For these reasons, rendering a sequence of single frames became the preferred alternative. The preparation of animations also posed difficulty given the frequency of the community meetings. Rendering several thousand frames for each session was beyond the capability of the hardware used in this project.

**Phase I: Presenting Two Extremes**

The goals in building the first CAD model of the area were to establish the minimum and maximum massing permitted under the existing (R2, two story single family homes) and proposed zoning (RM4, 3 story multifamily apartments) and to suggest that a potential compromise might be found by incorporating characteristics of both
housing types. However, rather than promoting compromise, the model merely heightened the tension between developers and the homeowners in the community. Later that same evening a solution based on the proposed RM4 zoning was to be presented by a developer’s architect. The architect’s concern was that the computer model unfairly prejudiced the group against his firm’s proposal. Fortunately, agreement was reached in principle on the form of future development for the transitional zone. Housing form would be restricted to 50 ft. lots with an envelope not to exceed a width of 42 ft. and a height of 33 ft. Rear setbacks were to be maximized (45 ft.) and front setbacks reduced (6 to 3 meters) to reduce the shade patterns produced by new construction on both adjacent properties and on those properties to the north of the laneway. Designs were to incorporate the character and detailing of single family homes in the neighborhood. In particular, roof-lines were to resemble the infills and large homes in the immediate area.

Phase II: Seeking a Design Solution

Because of the difficulty in developing guidelines among a group of 50 individuals, a subcommittee was established to explore potential design options based on the principles agreed on by the community at the previous meeting. To facilitate the exploration of zoning alternatives, a series of building types were created and placed within the study model (Fig 2). To assess the massing of each zoning alternative, a catalogue of housing types including single family infills (R2), townhouses (R2A), multi-family homes (RM4 and DC-RM4 transitional zoning) were placed on a single block in the study area. By displaying a range of housing types, consideration could be given to the visual impact of different arrangements of form allowed under the transitional area report. Under the original report guidelines setbacks at the second and third floors were encouraged. Along the front facade of the building, a setback of 8 ft. at the second and third floors was suggested while along the rear facade the setback was extended to 10 ft.

To explore how buildings could be designed to minimize the
impact of shade and massing on adjacent properties a series of alternative massing solutions was created (Fig. 2). All of the proposed building forms had a maximum height of 33 ft. and approximately the same square footage (7200 sq. ft. units on a 50 ft. lot). In one case the total setback of 36 ft. was divided equally among all floors resulting in a depth of 60 ft. In the three other cases the setback was applied to the second and third floor resulting in a first floor and second floor depth of 67 and 50 ft. respectively. An attempt at this stage was also made to introduce architectural elements borrowed from infills (two-story detached units on 25 ft. lots), including bay windows, porches and a roof-pitch of one to one. The recent construction of a multi-family condo in the transitional area made the architectural treatment of both front and rear facades a concern for the community. Views of any new construction from across the laneway would need to be compatible in character with existing single family homes to the north.

Using the walkthrough paths established at the previous community meeting, images of each alternative along with the pertinent technical data were assembled into an interactive multimedia, copied onto a CDROM and distributed to key members of the committee. This served as a common foundation for examining issues of size, density and architectural character. One key issue that emerged for the developers at this stage of the review process was the level of profit that could be achieved under each scenario. Solutions that limited profit were clearly seen as unattractive alternatives, making it difficult to achieve compromises on issues of density, parking, and building depth and height.

For the developers, a maximum height of 33 ft. would make it impossible to build units with nine-foot ceiling, as currently demanded by more affluent condo buyers. In an attempt to achieve heights greater than 33 ft, the developers suggested that this height should be maintained only along the rear of the properties. The rational was that since buildings on the opposite side of the street were in excess of 40 ft., some additional height could be achieved without compromise views,
especially on sites that sloped from back to front. A building under this scenario could easily have a height of 36 ft. along the front facade. For many members of the community this position was considered unacceptable because of the shade and overview problems created for the adjacent property owners.

The developers on the committee also opposed zoning alternatives with a character reminiscent of existing single family homes because of limited upper floor development that reduces overall square footage and profit. Consequently, the use of basement apartments (three to four feet below grade) to reduce the height of the building from 33 to 29 ft. was seen as an unmarketable design. Not only were these basement apartments viewed as unprofitable, they also posed an obstacle in developing the basement area for enclosed parking, required by the zoning ordinance and demanded by the marketplace.

Early in the design review process, placing the square footage permitted in an RM4 design into a smaller envelope proved impossible. The community's desire for a building with a depth of 60 ft. and height no greater than 33 ft. was clearly in conflict with the developer's desire to establish an RM4 envelope for this transitional area. At various points in the discussion the focus was fixed on density. For the developer, higher densities translated directly into higher profit, approximately $20,000/unit. A building with a depth less than 67 ft. resulted in floor plans with only 36 upa (units per acres) instead of 45 upa attained under an unrestricted RM4. The potential reduction in profit of 20% was clearly unacceptable to those looking to redevelop property for maximum gain. For the community, lower densities were more consistent with a neighborhood of single family homes.

One concern raised at this point in the review was the maximum permitted facade length. A smaller building would make elevators and underground parking prohibitively expensive. From the developers perspective the only profitable solution was a single building on a 150 ft. lot. With a smaller building, parking could only be provided
by a continuous line of garages along the laneway. Though it is common to find parking in covered garages along the laneway in this residential neighborhood, there was little agreement on whether the increased density of these proposed garages at grade was an acceptable alternative to underground parking (Fig. 2 & 3). For the community, the concern over sheer mass and the impact on views from both the front and rear of the property was seen as contrary to the principle of "Development in the transitional zone shall be compatible with the R2 area to the north" (City of Calgary, 1980, p.7).

**Phase III: Building Elevation**

To focus attention on the single issue of maximum facade length permitted under the new plan, two scenarios were devised. The first scenario considered buildings on lots 50 ft. wide and 125 ft. deep, while the second scenario considered lots which were either 100 or 150 ft. wide. A building similar in scale to those larger duplexes in the area was placed in multiples within the study site (Fig. 3). Having these two alternatives gave the community the opportunity to consider the importance of having sideyards every 42, 92 and 142 feet. Would it be possible to see the break between units from along the 55th Ave., the rear lane-ways and properties to the north? Would a street assembled from 42 ft. buildings look any different than those made up of the same building type on larger lots? In viewing the computer model of these two alternatives members of the community determined that other factors were more likely to contribute to the massiveness of a proposed design. Architectural character, surface treatments, roof profile, building depth and height would be a more crucial factor in determining the massiveness of the building than facade length. At this stage, members of the community were willing to make the trade-off of longer facade lengths against lower height (33 ft.), less depth (60 ft.) and more restrictive architectural guidelines. They also realized that if concessions were made to allow a single building on a 150 ft.lot, underground parking could be considered, replacing the unsightly assembly of garages that otherwise would be visible from across the lane way to the north.
An Architectural Proposal

At the next meeting of the design committee, the architect for the developer presented a design for a 150 x 125 ft. parcel in the transitional zone. Unlike the drawings presented at the first meeting, the bays of building's adjacent to existing homes would have a character reminiscent of infills in the area. Though taller in height (36 ft.) than the community had wished, the building depth had been modified to reduced its impact on adjacent properties. The building (142 ft. in length) was divided into three 48 ft. bays. The bays adjacent to existing single family homes would be 52 ft. in depth while the centre bay of 50 ft. would be increased to 78 ft. Noteworthy, the square footage of the floor plate was slightly smaller than a proposal presented at the first community meeting by the same architect. The proposal also called for a building of greater floor space than that articulated in transitional guidelines. The community response to the height of 36 ft. and maximum depth of 78 ft. for the building was predictably negative.

The developer was then asked to develop a plan with no more than 33 ft. in height and 60 ft. in depth. After several weeks a new plan was presented to the community. Though the height of 33 ft. was maintained throughout the plan, the building footprint had been increased. With an average depth of 70.5 ft. the building now exceeded both previous designs in total square footage. An examination of the FAR (floor area ratio) for these proposals revealed a FAR of 1.6 higher than recommended for the area in the Transitional Area Report of 1.0. With little incentive to continue negotiations, discussions ceased, placing the responsibility of finding a compromise on the City of Calgary's Planning Staff. Ultimately, this debate will come before City Council for the final judgment between developers and the community.

Achieving a Compromise

The use of CAD modeling in planning can help communities understanding the role of density, building mass and architectural character in creating urban space. In this case study, a digital model was useful as an instructional tool. By providing the community with an
environment for testing solutions, it was possible to evaluate a number of alternative designs. The impact of massing on views, sun and shade could be determined with some certainty. By limiting the number of changes in each successive design it was possible for the community to consider the visual impact of potential changes in zoning against their vision for the neighborhood.

Achieving a compromise between developer and the community at the time of writing this paper appears less than certain. Consensus building is difficult to achieve when there is a lack of commitment to the public participatory planning process. However, the process of design review using CAD and visualization tools has given the community an understanding of the critical bargaining issues that will emerge in this next stage of negotiations. If new techniques are used to improve community based planning, attention must be focused on the design review process. Community groups and the developers can use CAD and computer visualization to resolve conflict, but only if a process can be found which focuses on finding solutions to contentious problems.
References
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Figures
Fig. 1 - Computer generated Image used in the appeal before the Subdivision and Development Appeal Board, June 21, 1998. Image is of the proposed development of a proposed multifamily development, Windsor Park, City of Calgary, 1998.

Fig. 2 - Computer Model, Elevations and perspectives of building types permitted under the Transitional Area Report (top, elevation; bottom left, view from street; bottom middle, view from street; bottom right, view from laneway).

Fig. 3 - Computer Model, Perspective view of R2A development on 50 ft. lots from the street (left) and rear laneways (right).
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