Blucher Design Proceedings
Dezembro de 2014, Volume 1, Número 8
www.proceedings.blucher.com.br/evento/sigradi2014

Campus Information Model: A Participatory Design Tool to Support Qualitative Decision Making

Paula Gómez Zamora
Georgia Institute of Technology
paulagomez@gatech.edu

Jennifer Grimes
Georgia Institute of Technology
jgrimes5@gatech.edu

Matthew Swarts
Georgia Institute of Technology
matthew.swarts@coa.gatech.edu

Abstract

This paper presents our Campus Information Model from a participatory perspective. The primary goal of our Campus Information Model (CIM) is to gather several disciplinary goals into a single model as the platform for collaboration. This intermediate-scale model integrates information and expert knowledge about a university campus design, including landscape planning and building design, allowing users to obtain quantitative feedback in real time to support design facilitating their specific goals. This paper describes first, the concept of collaboration; second, the collaborative system CIM; and third, the strategies to bring quantitative and qualitative goals to the same design environment.

Keywords: Campus Information Model; Participatory Design; Design Decision-making; Campus Design.

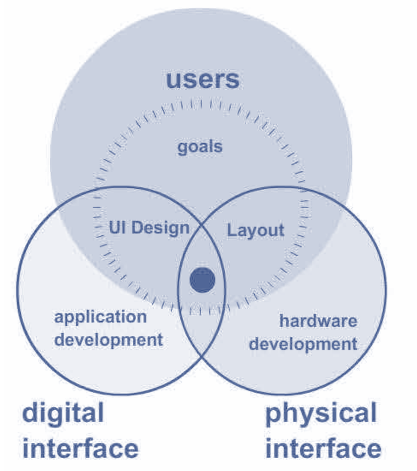
Introduction

The design of a university campus involves several disciplines, including landscape designers, architects, campus managers, owners and directives, among others. Each of them brings a different perspective on projects as well as different goals. Our aim is to support the integration of such perspectives and goals into a single and collaborative design environment by developing a collaborative design system –a Campus Information Model (CIM). We first studied the potential consumers of CIM data: campus landscape designers, planners and directors from internal departments, such as housing, parking, dining, and academic, as well as from administration and "owners". We realized that our potential users do not necessarily share the same knowledge or expertise and, therefore, have different goals and constraints. We also studied existing collaborative environments and developed an understanding of their complexity and challenges that are described in a subsequent section. The challenge of designing a system intended to support information at multiple scales with different sets of expert knowledge for the parameters and constraints, and which points to different or even contradictory goals, is very complex. For that reason, we designed a strategy that will be explained through this paper.

CIM fundamentally consists of two modules: Campus Landscape and Campus Building Information Models (Gómez et al., 2013; Soza et al., 2013). Campus Landscape Information Model (CLIM) gathers information of landscape elements as well as rules and constraints for design, allowing some quantitative evaluation, such as the percentages of green areas and parking spots. Campus Building Information Model (CBIM) also allows quantitative evaluation for factors such as energy consumption and budget management. Our long-term objective is to include qualitative evaluations of spatial qualities as well as some general campus design targets, including campus identity and user satisfaction. CBIM and CLIM share some common aspects (owners, budgets, and campus zones) needed for inclusion as common goals or constraints. These aspects are the information intersecting both modules, which make CIM an original intermediate-scale approach. In this paper we describe our study on collaboration that guides our application design incorporating the objectives and goals for the campus, as well as the information and knowledge exchange necessary for collaborative design in this context. We also explain the methodology we designed and seek to include qualitative evaluations into CIM.

Collaboration

An early concept of collaboration by Applegate et al. (1986), explored the effect of the technology on idea generation and collaborative processes to facilitate problem solving for groups, using computer-mediated communication. Design and implementation strategies for group decision support systems were used in actual planning sessions at the MIS Planning and Decision Laboratory (Applegate, Konsynski, and Nunamaker, 1986). In this context, the use of the computer significantly stimulated task-oriented behavior. It also equalized participation of group members, disallowing the domination of the discussion by any one individual. Some limitations were found on idea generation, including the effect of the computer screen's size on perception of the problem at hand, unfamiliarity with technology or certain user interfaces, and general network capacity for handling file transfers.



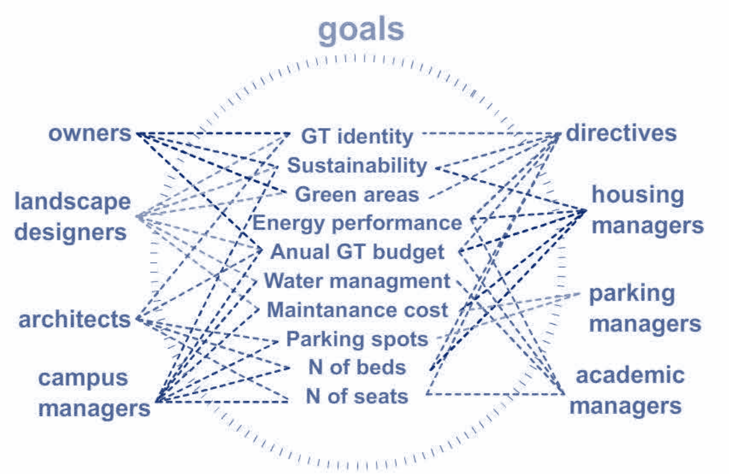


Figure 1: Diagram of CIM´s digital and physical interface parts that allow collaboration and participation of users.

Figure 2: Diagram of CIM´s users and their goals.

As for participatory design methodologies, Asaro (2000) contrasts the traditional idea of simply using technology as a platform for dialog with what he considers the more effective practice of developing the technology itself in relation to the designer and user as well as their end goals and values, such as democracy in the workplace and improved quality of life. The dynamics –or dialectics– between users and designers, Béguin (2003) posits, demonstrate that the inventiveness of the user in using artifacts is equally important to the continual design of a tool as the inventiveness of the designer. He notes that only in using the tool can we truly understand how to design it for optimal functionality. Additionally, different perspectives on the inherent relationship between user and designer are noted as being critical determinants of the process that is used, as cyclical exchanges between designers and users are critical for optimally instrumentalizing an artifact. Moreover, they mentioned the importance of conceptualizing the exchanges in the proper context of the environment in which they are taking place.

Björgvinsson et al. (2010) assess the divergence in collaborative participatory design from primarily taking place in the workplace to becoming a more universal method of "democrative innovation". The authors discussed the notions of "things" versus objects, "agonistic public spaces" versus consensual decision-making, and "infrastructuring" versus projects (Björgvinsson et al., 2010). The divergence represents a shift from focusing on predefined goals to facilitating infrastructure, which the author terms agonistic public spaces, that allows for open-ended collaboration. The concept of the 'Living Lab' is explored with special attention focused on Malmö Living Labs as a nontraditional conduit for long-term, open-ended collaboration and innovation. Gerard Fischer discusses barriers to collaborative design, including spatial, temporal, conceptual, and technological elements that challenge social creativity. Some obstacles were presented, such as the inability to establish shared understanding in situations where conceptual barriers are present.

CIM Collaborative System

Our system is developed specifically for planning the Georgia Tech Campus. Campus Landscape Information Model takes in raw databases that we structured into raster and vector models. The raster models store land data typology (i.e., grass, meadow) and digital elevation model (DEM) data. Vector models store information of detail elements on the campus (i.e., trees, lamps, trashcans) based on planning documents, aerial imagery, observation of land use, and databases (such as tree inventory). These two models are stored together, and the data is visually rendered onto an illustrated aerial view of the Georgia Tech campus. CLIM also supports operations for evaluations and analyses, and it stores information about spatial as well as non-spatial features, such as goals. We designed CLIM to be able to integrate temporal-referenced information by scenario structure, displaying it as spatial and temporal representations.

CLIM map allows users to access information about land types, specific elements, projects and their attributes through multi-touch interaction on the horizontal interactive surface. Elements are visually displayed in the model representation, while the dashboard displays real-time updates on objects –such as the number of trees or parking spots. Elements' attributes is graphically presented in the vertical dashboard as bar and pie graphs to more easily understand the constraints, assessments, and goal achievements. Attributes are the percentages of trees types, or Landtype's attributes such as areas types, water permeability, density of vegetation, tree location, height, canopy radius, age, species and condition, among others. Project information –i.e. the overall number of trees, total percentage of green areas, and comparison among alternative projects– and real-time assessments of some aspects of the model – whether percentages of land types meet the goals in terms of green areas, tree canopy, water efficiency, energy efficiency and cost, is also represented in the dashboard for accessibility.

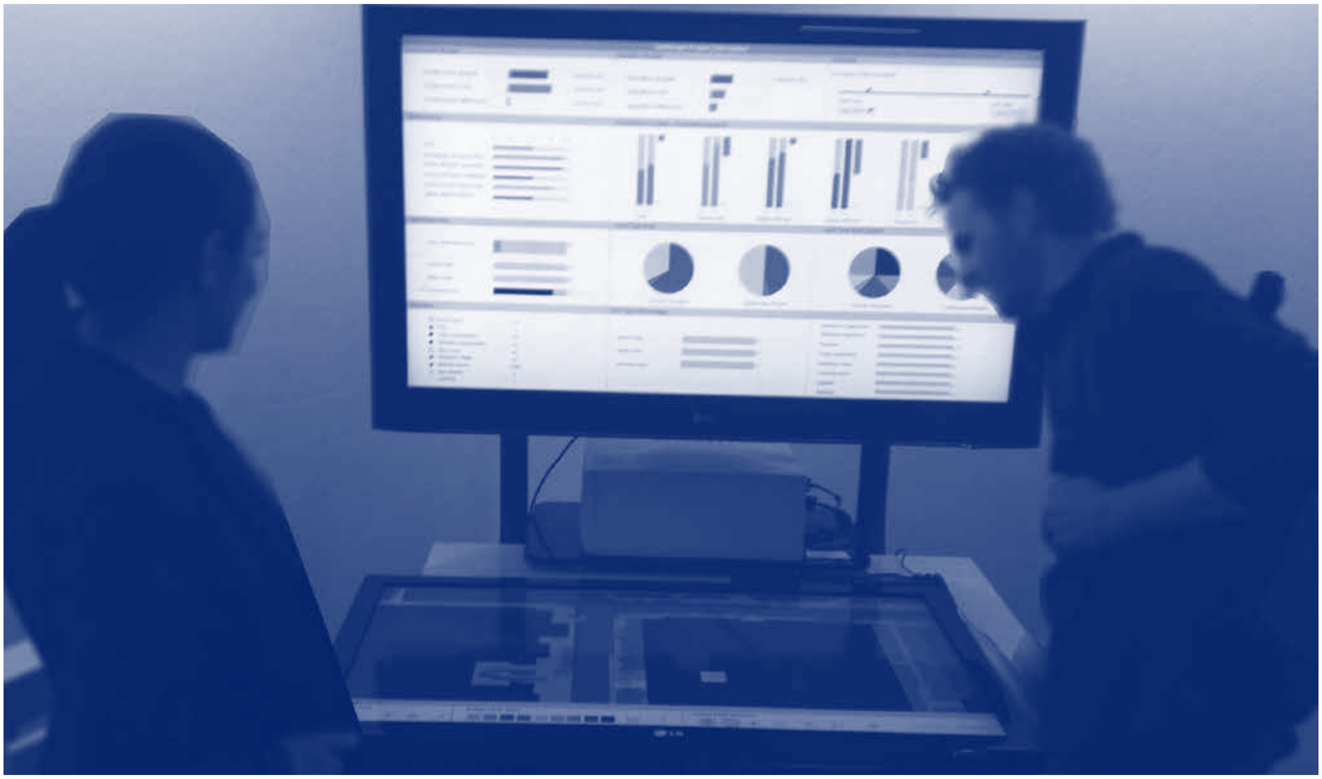


Figure 3: Campus Information Model (CIM) collaborative design environment in Landscape mode first edition (CLIM tool).

Our interactive design environment consists of two fundamental interfaces: 1) the physical interface that allows user co-presence and participation, and 2) the digital interface that is conformed by information and knowledge, structured to make it accessible. Physical hardware, such as screen sizes and positions, are key to allow participation of up to ten users at the early stage of the problem definition, allowing simultaneous modeling of problem framing and problem solving. One 55” horizontal screen acts as an interactive table to receive inputs, displaying a top view representation of campus. One vertical screen displays real time feedback of every decision made (Figure 3). The user interaction design allows users to access information and expert knowledge, supporting collaborative design constrained by different goals (Figure 4).

To support a shared understanding, we structured the data in three levels: Elements, aggregation of elements with an intention –or Projects— and aggregation of projects –or Scenarios. This structure allows us to visualize information from every disciplinary perspective in order to allow communication and understanding of the parts, framing of the problem, and construction of alternative projects and scenarios for comparison. To allow an informed collaboration, we structured the knowledge gathered from several disciplinary sources into four categories: details or elements; categories, models and structures; algorithms and procedures; and design strategies (Gómez et al, 2013). This understanding of problems helps us to overcome some conceptual barriers among disciplines, allowing us to visualize the parameters and constraints that define the different goals.

Users’ goals and knowledge

From documentation and interviews of experts we extracted the most significant goals of CIM potential users, such as the crucial categories that are the main objectives of the GT campus planning: Design Corridors, Ecological Performance Zones, and Campus Identity and Sense of Place (CMPU, 2010). Also from the Postsecondary Education Facilities Inventory (FICM) (Cyros and Korb, 2006), we extracted the main elements, classifications of elements, rules, parameters and constraints that experts use to communicate their knowledge. We ran a series of interviews with experts that helped us to better understand the design and model of CIM.

We classified the knowledge we extracted from those sources into a knowledge-based system strategy, and into a data structure described in the next section. The specific users’ goals emerged from the construction of a causal model whose intent was to correlate all the information, knowledge, evaluations and goals that users of the tool and users of the actual campus may have. This paper describes first, the concept of collaboration; second, the collaborative system CIM; and third, the strategies to bring quantitative and qualitative goals to the same design environment.

A number of tools have been developed to support collaboration and interaction among experts in a landscape design scenario. They are explained in more detail in the Campus Landscape Information Model publication (Gómez et al., 2013), as well as the formats in which CIM embeds the expert knowledge towards integrating qualitative evaluations.

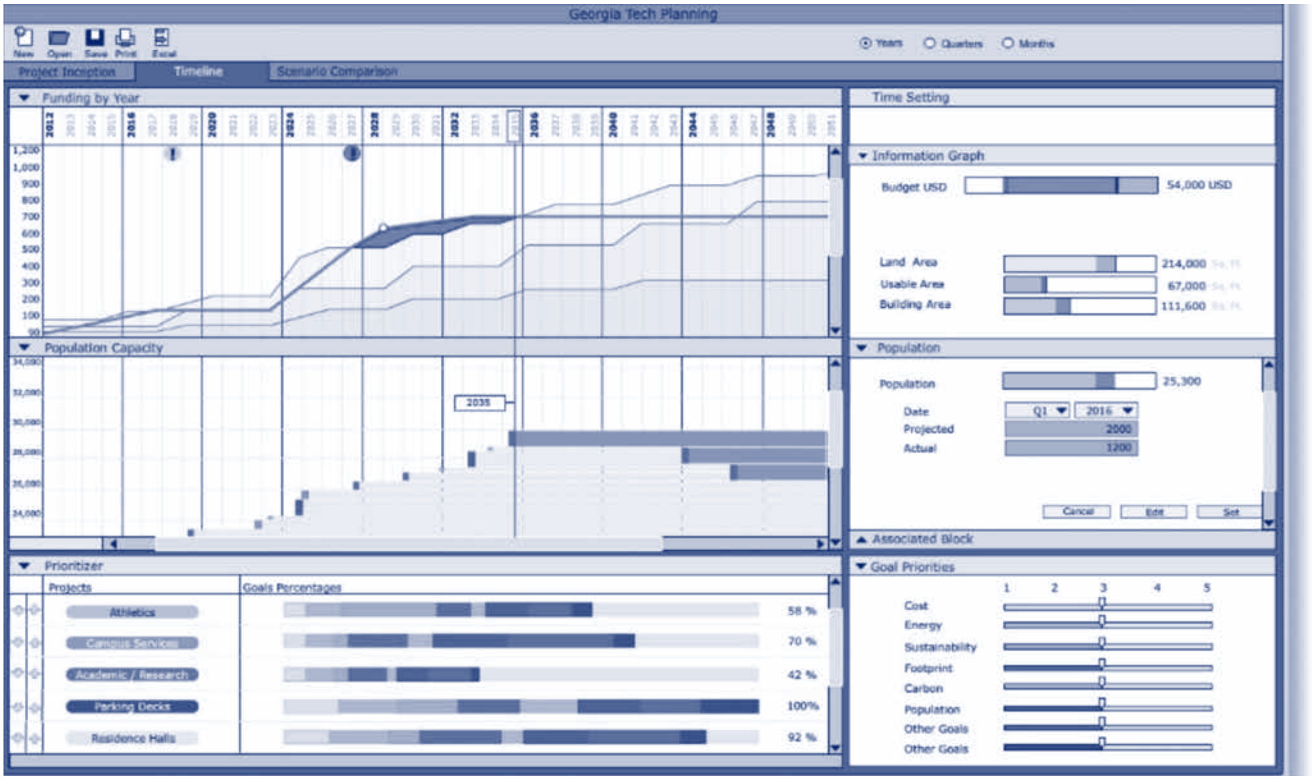


Figure 4: Interactive Dashboard to set up goals, such as budget in time, cost, energy, sustainability, date, among others.

Our aim was to upgrade the analysis module beyond the traditional quantitative analyses and evaluations of landscape, and represent the information graphically in order to better communicate it with different experts and stakeholders. To support these goals, we have designed and developed a strategy to measure qualitative landscape aspects using structured causal models. We used the classical usability metrics to understand and score how well the built environment is performing in terms of ease of use the campus landscape (Béguin, 2003). The expected effects are efficiency, effectiveness, and satisfaction. To capture the performance we designed a process to first define the causal model and then modified it by the impact of expert knowledge, which was captured in a set of unstructured interviews. Afterwards, when we had defined the main trends to study, we selected a part of the main causal model and adapted it based on existing literature.

Campus Causal Model

We constructed an initial causal model to help us recognize the most influential campus qualitative aspects and test it against specific user goals. Our final objective on this model was the satisfaction of campus users. Among them we find administrators and owners, students, families, alumni, faculty, visitors, prospective students, alumni, and prospective donors. To construct the causal model we gather all aspects of users and goals that are part of campus planning and that affect user satisfaction, from spatial characteristics to more intangible ones such as excellence in academia and sense of place. Four main threads emerged from the process of structuring the elements of user satisfaction: Campus Identity, Sustainability, Space Use, and Management. Following the track of the most abstract and high level concept of satisfaction, from literature and from the model, we have Georgia Tech identity.

Identity is one of the main goals from the Campus Planning (CMPU, 2006) perspective, followed by sustainability; however, it is at the same time a qualitative and abstract goal and very difficult to measure. Identity and Sustainability, in turn, are influenced by space and space use, which are theoretically quantitatively measurable. Our Causal model, therefore, includes quantitative and qualitative aspects to be measured through different mechanisms ranging from algorithms to social statistical metrics. Thus, each of these sub-factors is influenced by a set of quantitative and qualitative measures that can be computed directly either from explicit data or from surveys capturing social behavior. This could include, for example, the amount of lighting and visibility in a spot, or the level of familiarity and level of attachment related to some characteristics of the space.

To adapt the model to the specific Georgia Tech planning perspective, we included a series of interviews with campus planning experts toward restructuring the initial causal model that we had proposed. During these interviews, the participants (who are also potential CIM users) modified the causal model adding or subtracting aspects or causal relations. From this process of restructuring the model, and comparing it against the literature, we found that the Sense of Identity is a construction of five main perceptive aspects of campus: Sense of Place, Sense of Belonging, Sense of Space, Sense of Control, and Sense of Community. Sense of Place carried more weight, since it is related to the understanding of meanings, concepts, symbol and identity of the campus' design quality (Najafi & Shariff, 2011), in relation to various aspects of campus settings (Lounsbury et.al., 2005).

Conclusions and Future work

At this stage and in order to capture the qualitative aspects mentioned above, our project is collecting data on two fronts: Users' movements from campus video-captured from aerial quadcopters, and social activities ranging from surveys to cognitive mapping. The purpose is to track the influence of the aforementioned aspects over specific campus zones.

We expect to corroborate that "campus identity" is the most important goal to achieve for campus landscape design. The expected results are a set of campus maps, which will represent different qualities that, when overlapped, will help represent qualitative aspects of space correlated with quantitative ones. Sense of safety, sense of control, the perspective of iconic buildings, and key photo-spots will be some of the aspects that will compose the "sense of identity map", "sense of safety map", and "green perception map", among others. The final and long-term goal is to connect the area of qualitative research to information models in a participatory environment. We expect to demonstrate that, with a proof of concept project of Georgia Tech master planning, the factors that influence qualitative aspects can be directly measured, such as lighting and connectivity of the space, and that others that can not be directly measured but could be captured through interviews and surveys can be later mapped into an information model.

Acknowledgments

We thank Pedro Soza for his feedback on relevant stages during this project, and Adetania Pramanik for her insights on "sense of place" concept. We also thank Georgia Tech's College of Architecture and Capital Planning & Space Management.

References

Applegate, L. M., Konsynski, B. R., & Nunamaker, J. F. (1986, December). A group decision support system for idea generation and issue analysis in organization planning. In Proceedings of the 1986 ACM conference on Computer-supported cooperative work (pp. 16-34). ACM.

Asaro, P. M. (2000). Transforming society by transforming technology: the science and politics of participatory design. Accounting, Management and Information Technologies, 10(4), 257-290.

Ball, J., Capanni, N., & Watt, S. (2005). Virtual reality for mutual understanding in landscape planning. Development, 2.

Béguin, P. (2003). Design as a mutual learning process between users and designers. Interacting with Computers, 15(5), 709-730.

Bevan, N. (2001). International Standards for HCI and Usability. International Journal of Human- Computer Studies, 55, p. 533-552.

Birt, A. G., Xi, W., & Coulson, R. N. (2009). LANDISVIEW: A visualization tool for landscape modelling. Environmental Modelling & Software, 24(11), 1339-1341.

Cyros, K. L., & Korb, R. (2006). Postsecondary Education Facilities Inventory and Classification Manual (FICM): 2006 Edition.

CMPU Landscape Master Plan (2010). Retrieved September, 2011, from Georgia Institute of Technology, Space and Management, website, http://www.space.gatech.edu/landscapeplan.

Fall, A., Daust, D., & Morgan, D. G. (2001). A framework and software tool to support collaborative landscape analysis: fitting square pegs into square holes. Transactions in GIS, 5(1), 67-86.

Gómez, P., Shaw, J., Swarts, M., MacDaniel, J., Soza Ruiz, P. A., & Moore, D. (2013). Campus Landscape Information Modeling: Intermediate Scale Model that Embeds Information and Multidisciplinary Knowledge for Landscape Planning.

Krathwohl, D. R. (2002). A revision of Bloom's taxonomy: An overview. Theory into practice, 41(4), 212-218.

MacEachren, A. M., Cai, G., Brewer, I., & Chen, J. (2006). Supporting map-based geocollaboration through natural interfaces to large-screen displays. Cartographic Perspectives, (54), 16-34.

Piper, B., Ratti, C., & Ishii, H. (2002, April). Illuminating clay: a 3-D tangible interface for landscape analysis. In Proceedings of the SIGCHI conference on Human factors in computing systems (pp. 355-362). ACM.

Sasaki (2012, June 4). Smartplan with Sasaki [Web blog post]. Retrieved from http://www.sasaki.com/blog/view/182/

Soza Ruiz, P. A., Gómez, P., Swarts, M., & Shaw, J. (2013). On the Process of Building Knowledge to Support the Design of Digital Tools: A Case Study for Future Residential Buildings on Campus.

Swarts, M., Gomez, P., Soza, P., Shaw, J., MacDaniel, J., & Moore, D. (2013). CLIM: An Interactive Tabletop for Landscape Modeling HCI International 2013-Posters' Extended Abstracts (pp. 691-695): Springer.

Najafi, Mina, & Shariff, Mustafa Kamal Bin Mohd. (2011). The concept of place and sense of place in architectural studies. World Academy of Science, Engineering and Technology, 56(08-24), 951-957.

Lounsbury, John W., Huffstetler, Beverly C., Leong, Frederick T., & Gibson, Lucy W. (2005). Sense of identity and collegiate academic achievement. Journal of College Student Development, 46(5), 501-514. doi: 10.1353/csd.2005.0051

UML, Retrieved from http://www.uml.org