Policy-Driven Visualization of Urban Forms for Planning Support

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ABSTRACT
In this paper, we introduce a policy-driven visualization tool to assist planners and architects in designing new urban developments. Our tool generates a visual representation of building form parameters resulting from policy requirements that restrict physical form. As a scenario based planning tool, our visualization assists decision-makers in understanding how policy decisions affect urban form. The tool is easy-to-use, offers free access over the Internet, and can be employed by planners as well as non-expert users, e.g. with public participation. As a practical example, we will present a visualization of urban forms for the Phoenix (AZ) Downtown area using a selected set of parameters.

Keywords: Policy-driven visualization, Form-Based Code, urban form visualization, database visualization, interactive planning support tool, participatory planning, Google Earth.

Index Terms: H.2.8 [Database Management]: Database Applications—Spatial databases and GIS;

1 INTRODUCTION
In recent years, planning tasks have become more and more complex. This is due to an increasing number of highly sophisticated planning policies which have to be considered and an increasing number of people with differing interests who are closely involved in the planning process [3]. Lately, planning in the U.S. experiences a paradigm shift away from conventional land-use planning toward a regulation of urban form. The New Urbanism movement [7] implicates novel kinds of ordinances to resolve the shortcomings of traditional planning instruments such as zoning. Form-Based Code is a flexible approach to achieve a specific urban form and to create a sense of place. The introduction of Form-Based Code reverses the “form follows function” principle of modern architecture which applied to land use regulations of the past. This opens up new perspectives for urban design, but simultaneously, creates the demand for new visualization tools in planning processes. Experiencing a paradigm shift from zoning to Form-Based Code, planners have to be retooled with new visual planning support systems to analyze and better understand how policy decisions impact urban form.

2 FROM ZONING TO FORM-BASED CODE
Previously introduced policy-driven planning support tools (e.g., UrbanSim [8]) base their analyses on the changes of land use. This is due to the fact that conventional zoning ordinances are based on micromanagement and the segregation of land uses, but disregard urban design. Only recently, Form-Based Code emerged as a new land development regulatory tool. Form-Based Code controls the physical form of built environments to achieve a specific urban form [6]. The focus is less on the segregation of land use and more on the physical layout of the built environment, in particular, the form of buildings and the arrangement of streets and sidewalks [2]. This way, Form-Based Code can produce a more predictable result when it comes to appearance and public realm of the built environment [4]. Parameters to regulate urban form standards include, e.g., lot coverage, density, building setbacks, and building heights for individual parcels. Form-Based Code regulations are usually illustrated by color-coded maps, visualizing one parameter at a time. Figure 1 shows an example of ordinance parameters for Downtown Phoenix, AZ. This map-based visualization has major drawbacks: it is not interactive, it does not allow for a combination of different form parameters, and it does not convey a sense of space. Therefore, we propose a comprehensive visual representation of urban form in three dimensions. In the following, we will present the framework of our policy-driven visualization tool, advancing the conceptual framework developed by Middel et al. [5].

3 FRAMEWORK FOR POLICY-DRIVEN VISUALIZATION
Our policy-driven visualization tool generates 3D bounding volumes resulting from Form-Based Code regulations to visualize urban forms. Form-Based Code parameters and other policy-related datasets are stored and managed in an object relational PostGreSQL data base with a geospatial PostGIS extension (see Figure 2). The geo-database is linked to QuantumGIS 1 to enable spatial analyses and data manipulation. For the visualization, we calculate bounding volumes based on the code parameters within the geo-database as 3D multi-polygons. A server-side PHP script encodes the geometries into KML on-the-fly and streams the generated file to Google Earth for display. QuantumGIS enables the user to edit PostGIS database layers and to change Form-Based Code parameters in the geo-database. After modification, the visualization of the corresponding bounding volumes in Google Earth can be updated through an integrated web browser in nearly real-time. QuantumGIS also provides sketching functionality to generate new zones and edit associated parameters on-the-fly.

As an example, we generated and visualized urban forms based on selected parameters from the Phoenix Downtown Form-Based

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1 QuantumGIS is an Open Source Geographic Information System. It is available for free over the Internet and offers support for many data formats.
Figure 2: Framework for policy-driven visualization

Code. Figure 3 (top) shows how the code parameters, here parcel information and height zones, are visualized and manipulated in QuantumGIS. To generate the bounding volumes for display in Google Earth, the height zones are automatically intersected with the parcels. The resulting polygons are extruded according to height restrictions in the urban form regulating plan. The resulting scene can be explored by the user as illustrated in Figure 3 (bottom). Changes of Form-Based Code parameters in the QuantumGIS environment, e.g., increasing the maximum allowed height for a specified zone, appear in Google Earth nearly on-the-fly. The view content can be updated through the integrated web browser.

Figure 3: User interfaces of the policy-driven framework

The visualization at hand gives a good impression of the building masses that are permitted by the design regulations in the Form-Based Code. Exploring the scene, the user can experience a sense of space and grasp how height restrictions in the Phoenix Downtown area affect urban forms.

4 DISCUSSION OF APPLICATION AREAS

We envision three main application areas for the presented tool: planning support, decision support, and participatory planning. As a planning support system, our tool will assist planners in evaluating whether new developments are compliant with current building codes. This is achieved by intersecting architectural models of proposed urban developments with the calculated bounding volumes in Google Earth. Moreover, our system is appropriate to support decision-making in planning processes. 3D representations of urban form in Google Earth can be modified interactively by changing the Form-Based Code parameters in QuantumGIS. A visualization of different policy scenarios helps planners to understand how policy decisions impact urban form. Finally, our tool allows internet-based planning support in public participations. Urban forms resulting from code regulations can be showcased in real context to the general public over the Internet. Thereby, community members can view and understand the implications of policy decisions more easily.

5 CONCLUSIONS AND FUTURE WORK

Previous research has focused largely on modeling and visualizing land use, but little attention has been dedicated to the visualization of physical forms resulting from policy regulations in urban design. Our planning support tool differs from existing approaches in that we focus on the visual representation of urban form determined by Form-Based Code instead of visualizing land use changes.

The synthesis of Google Earth and GIS capabilities provides an intuitive and powerful decision support system. Form-Based Code parameters can be modified, visualized, and analyzed in an exploratory context. In this way, our tool assists planners and decision-makers in designing new urban developments and in evaluating alternative policies.

To date, a limited number of Form-Based Code parameters are implemented in our prototype which is still in a nascent stage. Future work will include an integration of additional code regulations, especially the core parameters building setback and lot coverage.

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