FORM-BASED CODE IN PARAMETRIC MODELLING FOR CONTINUOUS URBAN DESIGN

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Abstract. This paper analyses parametric modelling in connection with the Form-based Code (FBC) methodology to support continuous design in an urban scale. FBC is an approach to optimize conventional zoning regulations and has been implemented by a number of cities. Akin to a utopian urban design solution, we argue that the FBC is crucial to develop main objectives, characteristics, trends and impacts in a design process systematically and logically. Zoning emphasizes excessively on land use and intensity control, however, FBC promotes to (re-)create and predict urban-rural environments through controlling forms. FBC is developing and offers opportunities for flexible coding processes, adjustment of density and seamless public participation. Parametric modelling, being rule based, is a significant step towards a continuous urban design creating a mechanism for FBC. This paper presents a framework to connect parametric modelling with FBC processes, and how parametric modelling methodologies allow the form-based coding processes to be more impeccable hence being more appropriate in the process of continuous design flow.

Keywords. Form-based code; continuous urban design; parametric modelling; utopian design solution.

1. Introduction

With the New Urbanism arising in 1980s, people began to rethink urban problems caused by rigid segregation zoning, such as the decline of pedestrian and use public transport, disappearing of public realms, damage of natural environment and decay of central areas. Yet there are still many problems leading to a more holistic and persistent design involvement. Form-based Code (FBC) is considered as a more appropriate method to analysis urban space and environment than traditional zoning, which is a “new city-making
approach” (Marshall, 2011) basing on Smart Growth, New Urbanism and Transect (Figure 1).

![Figure 1: Transect diagram with six normative Transect Zones (T-zones) used for the zoning of urban areas as well as natural lands (taken from Duany Plater-Zyberk, 2008).](image)

Unlike traditional zoning emphasizing land use and intensity control excessively, FBC promotes to predict built environment through controlling and regulating forms. FBC offers a more contemporary method for continuous designing of urban and rural regions in different scales and types. Thus, akin like a utopian urban design solution, FBC is crucial to demonstrate the destinations, characteristics, trends and impacts of a design project from its original concept to implementation. This allows us to interrogate the notion of continuity in order to map and discover opportunities for further design innovation.

In 1982, the development of the town of Seaside, Florida, is “significant for its use of codes; in particular, the reinvention or revival of codes prescribing three-dimensional forms and urban components” (Parolek et al, 2008). The Seaside development designed by Duany Plater-Zyberk (DPZ) can be regarded as the beginning of the FBC practice. In 2004, the Form-based Codes Institute was founded, which dedicated to advancing the understanding and use of FBC. Up to now, there are nearly 500 urbans and regions have formulated their FBC system in the USA. FBC enables diversity with local identity by using Smart Codes, Transect FBCs and FBC Guides, whereby Smart Code has the biggest impact on FBC. Smart code was originally developed by DPZ and the first implementation of Smart Code was an overlay control plan in Petaluma, California in 2003. In the following developing stage, Smart code worked as a creative way to regulate urban planning in Gulfport, Montgomery and Mississippi region. Smart Code clarifies the standard of “region-urban-community-architecture” in variety of scales and typologies in rigorous view processes. Besides, they make the Smart Code approach more modularized and easy-manufactured.
At the meantime, the use of parametric modelling turns into a mainstream technique in architecture design processing. It offers architects and urban designers immense opportunities to tie various building elements imbedded with information together. Parameters are “manipulable” and allow different sectors to collaborate and communicate intentions. Basing on this kind of property, parametric modelling has a potential to act as a supporter for FBC implementation by optimizing the procedures and public participation. Our research aims to achieve flexible and continuous urban design by using form-based coding, and developing the parametric model to fulfil the goal.

2. Challenges of FBC

The raising of FBC is a critical reflection of conventional zoning which aims to improve the use-based design approach. FBCs have proven to prescribe urban form, implement mixed-use developments, and address place-based characteristics of sites (Parolek et al, 2008). Current FBC has five components, including regulating plans, public space standards, building form standards, administration and definitions. In form-based coding procedure, “transect code” always represents “form code”. Because transects show actual development requirements such as building location, set back lines, or allowable building heights (Kim and Clayton, 2010).

FBC can be divided into three phases, documenting, visioning and assembling. At the documenting phase, designers collect data of a target region or community, and translate an illustration plan into a regulation plan. Data collection contains neighbourhoods, zones and galleries, architecture typologies, layouts, street space details, public green realms and so on. In the second phase, designers code or recode the building typologies, streetscapes, blocks contexts to build a FBC model. In this phase, designers need to adjust or refine the program and coding grammar continuously to match the urban development requirement. In the last phase, designers translate FBC models into visual 3D layouts to offer interfaces for public participations that is a user-friendly and interactive. Compare with the zoning method, FBC is more flexible. It allows designers easily renew or alter programs, layouts and typologies basing on public comments.

Although FBC has been tested in hundreds of cities and regions, it still has some challenges, or opportunities. First, high density cities are ignored by FBC applications and Floor Area Ratio (FAR) is omitted. However, density is one of the most vital indicators in urban development analysis. FAR is also important to value environment and growth capacities. At this point, FBC should be expected to accomplish more preciseness and comprehensiveness by dealing with density. Besides, FBC is not just a text-based de-
sign approach. Prescribing urban form needs visual files and graphics. How to express form-based coding more intuitively has the direct bearing on communications between different sectors. FBC needs an effective and smart platform to share data and allow people to access design information in multiple ways.

3. Parametric modelling in FBC

The introduction of digital tools and the related processes for dynamic architectural pieces has been increasingly important in designing a project. Parametric modelling differs from traditional hand sketching, building physical models and manual models by adding to the modelling procedure the ability to change, during all the design process, allowing the production and experimenting of several versions of the same, within a controlled design environment, by simply changing the values of specific parameters. Since Architecture, Engineering and Construction (AEC) Industries already have accumulated experiments by taking the idea of parametric modelling techniques, it has become clear that parametric tools could bring similar benefits to urban design projects, having even effectiveness in higher scale urban cases (Nagy, 2009).

Using parameter to define land use and fabric in region or city scale is more aptly in contemporary urban development in last decades. In parametric urbanism methodology, urban design is controlled by the distribution of existing urban fabric instead of the objects position; by the compositional gradients instead of axial forces. For the purpose of see the parametric modelling applied in city, for example the Kartal Pendik Masterplan can be chosen as a relative mature project to study. It presents a grid structure as the basis of the master plan’s organization. Using a Cartesian grid for the organization of space is a very common approach, however the grid employed in the Kartal Pendik Masterplan is not Cartesian but topological. The streets and axes are shaped and adapted according to the terrain features and other exterior conditions, in order to facilitate access and promote connections (Pinto et al, 2013).

In FBC, parametric modelling has a potential to support making FBC both in procedures and expressions. Since FBC aims to create or recreate physical urban environment, considerable data represented space form information should be collected, as mentioned before. In addition, FBC is a numeric-based design approach. Some related illustrations have to be changed when values in sections are changed. That makes FBC less flexible. Parametric modelling can help FBC overcome these kind of limitations. It becomes easier for planners to update models by changing parameters in
form-based coding, avoiding spending time to re-edit illustrations. Besides, sharing database to sectors is another benefit parametric modelling offers for FBC. Additionally public participation has become an important aspect of contemporary urban planning and design. In a parametric model making process, public sectors can check the block geometries and transects; allowing members of the communities to understand the future development via three-dimensional models more directly; giving planners and designers the opportunities to refine their FBC models basing on the public feedbacks.

4. Application of FBCs in continuous urban design

The concept of continuous urban design provides an associative framework for design implementation. It proposes that a city development should be “edible”. Different from the conventional and narrow urban design which is decided only by specific groups, like government officers, designers and experts, continuous urban design is more like a kind of public policy. The design procedure should guarantee a variety of interest subjects participate into the course, no matter policy makers, designers, developers or community neighbourhoods. Continuous urban design flow more respects to citizen’s experience. Each region has a unique set of conditions, however, the conditions can be changed with the change of developing situation. So continuous urban design methodology is appropriate and flexible to meet the requirement of contemporary urban growth.

As a response of zoning pattern, FBC has potentials to be applied in continuous urban design. Firstly, FBC is supported by existing form and fabric to create physical environment, which helps this new approach get solid foundation of data and materials to support continuous design flow. Secondly, FBC is concerned with creating public-open mechanism. FBC makers tend to use interlinked platform to obtain relevance feedbacks from communities. That’s beneficial to achieve sustainable urban development. Thirdly, FBC is a method of emphasising on coherent visible outcomes, “one-size-fits-all” approach will never be displayed in continuous urban design practice.

Making a successful FBC system needs a smart tool, as mentioned, parametric modelling is able to support the implementation. For our research we choose Esri CityEngine as a parametric analysis tool. The purpose of rising CityEngine is to transform 2D GIS data into smart 3D models for urban planning, architecture and design. CityEngine provides opportunities to turn zoning laws into vivid 3D visualizations and change the way to understand future environment. It consists of several procedural and interactive ways to layout street networks, align and subdivide shapes. On the one hand, streets
is grown according to different patterns and edited in an interactive way. For example, street-crossings can be moved, streets can be deleted or selected and the street growth wizard can be applied again on the selection. On the other hand, tools for the editing of lot shapes are available, such as aligning building lots to a terrain etc. The tools usually work on the selection done in the 3D view window, the viewport, or operate on the whole layer.

We choose Hong Kong to conduct a pilot study of FBC. Actually, there are no mature applications of FBC in high dense cities of Asia, however, high dense urban environments are in much greater need of an interactive tool to predict urban developments. With the rapid urbanization and population aggregation, high dense cities need a more efficient and practical way to meet urban development requirement, no matter in land-use intensification, public participation or urban form rationalization. There is a blank in the field using FBC in urban planning and design in high dense cities. Whether FBC can be used smoothly in high dense cities in Asia and how it can be used is our hypothesis of our research.

Before making FBCs, a rural-to-urban transect has to be prepared, which describes basic information of neighbourhood characteristics and architecture diversity. Hong Kong is a highly compounded city and it does not have a common pattern that can be summarized in a single district (Figure 2).

![Figure 2: High-dense neighbourhoods in Hong Kong. Row by row from left: Tsuen King, North Point, Tai Koo, Sai Ying Pun, Sham Shui Po and Tai Po (taken from Kandt, 2011).](image)

High-rise urban form and extreme population density make government to be cautious with the regulation plan policy and the developing strategies of diverse regions. Obviously, the development situation in the core of Hong Kong Island differs from other areas such as the New Territories. Therefore, it is a challenge to generalize the six transect zones as Parolek proposed before. There is a rough transect summary to explain the transect zones of Hong Kong (Figure 3).
By using CityEngine as the parametric model-making tool (Figure 4), designers and programmers compose platforms, or websites, to make urban form code information more visualized and public participating more convenient (Figure 5).

Different interest groups, such as government, policy makers, developers and neighbourhoods, all have a chance to search information as they want, or try to change the virtual model parameters under simple guide, which is meaningful for strengthening the sense of space identity and belonging. Continuous urban design is not only a “result”, but also a “process”.

Figure 3: Territorial-wide transect of Hong Kong (taken from Kan, 2012).

Figure 4: Working interface of CityEngine in Sai Ying Pun, Hong Kong (taken from Diwan, 2015).
5. Discussion

Through the analysis of FBC development and utility of parametric modelling tools, we propose that FBC methodology is utopian for continuous urban design by generating proposals that work based on physical urban form and fabric. However, FBC is a relative “young” approach in urban development research realm, designers and FBC makers need effective, smart and flexible tools to implement it into real practice. Parametric modelling, as a computer aided design tool, is able to fulfil the requirement.

- Continuous urban design describes the vision of sustainable urban-rural development and impacts on the space qualitatively. It becomes a tendency of contemporary urban design with dynamic and “processing” property.
- As a replacement of conventional zoning, FBC is noted as a positive design methodology for creating the edible, predictable and reasonable outcome of the built environment in planning process.
- Parametric modelling is a new way to conceive design because of its property, that is, the nature of an element in a parametric family won’t be changed with the value changing. In urban scale, parametric urbanism studies already have been practiced around the world.

Parametric modelling is a broad category. In statistics, a parametric model or parametric family is a codes group that can be created using a number of parameters. In architecture and urban design, architects use parameters predefined before design process to code and create scenarios by specific software. In our research, we employ CityEngine work as the parametric
modelling tool. The core concept of CityEngine is the ‘procedural’ way for modelling efficiently. Layouts become a dynamic process and user-friendly platform. People can change the options and create interactive streets, buildings, public spaces in real time.

Our application of parametric modelling tools in FBC is at an early stage. Since FBC is a critical response of zoning in the USA, there are not many mature cases in the rest regions and cities in the world, especially in high density cities like Hong Kong. Yet, high density cities are in urgent need of flexible and continuous planning implementation mechanism as public participation platform supported by parametric modelling. The application of FBC in high density cities has great potential and prospect. Besides, current FBC making method still depends on manual data collection, community investigation and designers’ experience. Popularizing parametric modelling and creating evaluation system in FBC making processes need more time and practice.

6. Conclusion

In the past decades a shift happened and how planning and zoning are developed and employed are redeveloped to facilitate sustainable development and continuous growth. This became a crucial instrument of urban evaluation standards no matter in urban-rural spaces, economy and society. As reaction to New Urbanism and Smart Growth, FBC aims to (re-)create regulations and controlling (re-)developing scenarios by setting a more flexible and interactive urban design framework to support sustainable and continuous design flow.

From the study of the preceding expressions, it appears that parametric modelling is an appropriate tool to support and expand the development and implementation of FBC. By using parametric design methodologies, designers can explore a variety of space form components type, to draw up dynamic equilibrium modularized systems to guide design practices. This is especially valuable in high density cities like Hong Kong. Furthermore, parametric modelling tools and platforms provide visualized 3D scenarios to professionals and laypersons. Subsequently, it contributes to create effective communication between FBC makers, stakeholders and the general public through allowing real time feedback of different stakeholders. Although still in a developing stage, parametric FBC has potentials to set up a synergistic urban design mechanism and result in a continuous urban environment.
References


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