Research on Digital Technology System of Urban Designers

Junyan Yang1, *, Henrik Schultz2, Beixiang Shi1, Yi Zheng1 and Fangyuan Zhang1

1 School of Architecture, Southeast University, Nanjing, Jiangsu, 210096, China
2 Faculty of Agricultural Science and Landscape Architecture, Hochschule Osnabruck University of Applied Sciences, Osnabrück, Lower Saxony, 49076, Germany
*Corresponding author’s e-mail: yangjy_seu@163.com

Abstract. The paper comprehensively analyses digital technology tendency of urban design subject development, describes all kinds of digital technology professional designers they need. By combining the procedural and periodic characteristics of urban design, the paper divides digital technology into 5 technical clusters, help designers to establish a complete technique framework, and promotes the continuous improvement of urban design.

1. Technological Development of Urban Design under Digital Background
Design technology is the basic method for urban planners to carry out the professional work. Under the background of urban design, technology platform of urban design is changing fundamentally. As professional software like GIS, CAD, PHOTOSHOP, etc. has been popularized, it also provides some new methods for urban planners of communication, design progress and outcome representation, and meanwhile, that is changing with the development of digital technology. Planners must keep up with the changes of the time trend, combining with the new digital technology tools, technology methods and new design ideas to build up a complete technology structure.

The establishment of complete technology structure of urban plan not only makes for improving its professional skills, but also, it makes for a more scientific and more comprehensive development of the urban design subject. The independence of urban design discipline requires the support of the related digital technology, which has great importance to summarize the urban design technology to get more discipline value. As the development of computer hardware, the advance of GIS, and the improvement of artificial intelligence promote the rapid development of the digital technology of urban design, the digital time has an extensive impact for urban design. The exploration of information technology, data analysis, the representation of digital technology, etc. emerges in endlessly, which provides possibility for the rationalization of urban design. It is of great value for urban planners to put forward a comprehensive and forefront technology of urban design.

2. Analysis of Digital Technology System of Urban Design
Whether it is an education school, research institution, management or all kinds of design firm, they are aware of the important role of digital technology in continuously deeper practice of urban design. Accordingly, urban designers should not only stay in the level of learning design knowledge and discussing the design methods, but also should emphasize the improvement of digital technology training. Urban design is a subject that has high applicability, and form its own more mature design methods in the long-term practice, that is a complete method system made up of the four steps of research, analysis, design, and expression. The education of urban design technology should further
form a complete technology structure, by combining with its steps to form the corresponding technology clusters, based on its difference of scale and content. (Figure 1)

![Image of technology structure]

Figure 1. Urban design technology cluster.

3. Site research technology cluster

3.1. The composition of site research technology cluster

Site research is the first step of the design project, to access to site of a more comprehensive information, message, data and feeling to prepare for further analysis and decision. By the impact of architecture and limit of technology conditions, traditional site research technology lack effective research methods. Under the digital background, the urban design technology is constantly improving, the understanding of urban is also gradually deepening. New technology methods need to be used to meet the demands of site research to cognize a larger scale of urban space.

Table 1. Site research technology cluster.

| Technology category                        | Technology name                        | Technology point                                                                 |
|--------------------------------------------|----------------------------------------|----------------------------------------------------------------------------------|
| Site research technology                   | GPS positioning research method         | Using the characteristics of the GPS to accurately locate position, we can find the site of the GPS positioning point, and comprehensively evaluate this record. |
|                                            | Remote control aerial photography research method | Remote controlling the UAV (unmanned aerial vehicle) equipped with camera to shot at low altitude for navigation and framing. |
|                                            | Cluster questionnaire research method   | It is the method to publish questionnaire through the local portals for internal research to select specific people to survey. |
| Spatial cognitive intentions research technology | Mental map research method             | It is the method to survey the residents’ psychological feelings and impressions about the city, by analyzing and translating them to image by designers, or encouraging them to draw the sketch of urban spatial structure by themselves [1]. |
|                                            | Space annotation research method        | To record the feelings of urban space in sketches, photos and texts. |
|                                            | Spatial apperceive research method      | It’s a method to uses GIS to make a comprehensive evaluation of the open degree and perception of the block, water and so on by taking the block as a unit, applied to large scale space design. |
### Technology application case: GPS positioning research method

By taking the GPS positioning research technology as an example, it expounds the application method of this technology. In the large rivers and lakes, the outskirts of the wilderness, hills and mountains and other areas are not easy to locate the marker. It can get accurate and complete space information at each point in the venue, by using GPS positioning to determine observation points position and obtain image by meshing in the whole open place, finally entering the images and the coordinates of each point into the computer to make link.

In the urban design of Hangzhou West Lake area, we used computer to make a comprehensive evaluation of the landscape on the east bank of the West Lake from different positions by using GPS positioning research technology to obtain the accurate overwater positions of the grids and panoramic images, and evaluated its landscape effect (Figure 2, a/b). On the basis of this, for better landscape resources areas, the cruise line should be guided to go through the waters area, to make the West Lake visitors to enjoy more Hangzhou modern city scenery; for poor landscape resources areas, specific urban design should be made to promote the landscape quality and make the design goals clearer in the next stage; for those areas where the landscape quality is poor but difficult to renew in short-term, the cruise line can be designed again and guided to avoid those areas while it’s time-consuming, arduously and expensively to dismantle and reconstruct the large building along the West Lake (Figure 2, c). Based on the research results, it put forward a complete framework of urban design and spatial optimization strategy for urban space form.

### Table: Research Methods

| Field                        | Research Method                        | Description                                                                 |
|------------------------------|----------------------------------------|-----------------------------------------------------------------------------|
| Vehicular laser scanning     | research method                        | It's a new method to establish the 3D model and the influence of the object quickly, by obtaining a large amount of spatial coordinate data on the surface of the measured object fast. |
| Portal system research       | method                                 | According to the way into the city, it conducts a comprehensive evaluation to build the system of different levels of portals, and forms the perception of the portal itself by continuous different distance records. |
| Visual corridors system      | research method                        | Visual corridor is the contact access between the important viewpoint and the marking landscape. It's a method to build visual corridors system formed by multiple viewpoints and marking landscapes by constantly observing and selecting. |
| Vegetation community research| method                                 | It's a method to monitor key community types in long-term and evaluate the status and development trends of the community by analyzes the relationship between the community and the environment, based on the quadrats sampling method. |
| Problem matrix research      | method                                 | It's a method to combing the current core problem through the relationship between the inclusion and the importance of the problem by arraying the current problem in category and importance, based on matrix. |
4. Spatial analysis technology cluster

4.1. The composition of spatial analysis technology cluster

In the process of rapid urban development, the spatial problems that urban design faced are more complicated and have larger scale needed to be deeply analyzed, which is difficult to realize through the traditional technology. In the digital background, the new technology tools and methods can be used to make more in-depth analysis of urban space, as a basis for further judgments and planning.

| Technology category              | Technology name                          | Technology point                                                                                                                                 |
|----------------------------------|------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| GIS spatial analysis technology in a large scale | Regional urban Space Succession Calculation | Through the research of track of the urban spatial growth, it analyses the rules of the development of urban space, and then forecasts the development direction of urban space. |
|                                 | Spatial Suitability Evaluation Technology | It puts forward a new technology method for the existing problems of city construction, and provides the scientific and rational judgment basis for the urban construction from a macroscopic and quantitative perspective[2]. |
|                                 | Ecological Security Spatial Pattern Modelling Analysis | It sets up perfect ecological security pattern model to make no damage to basic ecological security in the planning and design[3]. |
|                                 | Urban Functional Structure misalignment Analysis | By the comparative analysis of the main land use type, the size and proportion of space within a certain space, it reflects the distinctiveness of the internal dominant function in a certain piece area or the differentiation of functional structure between different related areas. |

Figure 2. Hangzhou West Lake landscape view positioning survey, evaluation and optimization of tour line

(a) Lake surface observation points positioning
(b) Image of the evaluation of the landscape on the West Lake
(c) The West Lake overwater tour line planning
Figure 3. The advanced, intermediate, basic three levels of ecological security pattern in the design site.
5. Spatial design technology cluster

5.1. The composition of spatial design technology cluster

Digital technology progress is very good to promote the scientific design of urban design. Based on the traditional space design, the new design methods brought up by the new technologies can be more comprehensive and in-depth intervention in the whole process of urban design, to make it more targeted and efficient. And urban design guidelines have become the effective connected way between the design and management.

| Technology category | Technology name                                      | Technology point                                                                 |
|---------------------|-----------------------------------------------------|----------------------------------------------------------------------------------|
| Grid design method  | It’s a method to establish a suitable terrain grid system, consider the various design elements as independent layer, and through merger, segmentation, selection to carry on the design. |
| Unit design method  | It’s a method to decompose a complex urban system or design process into some independent and half-self-discipline subsystem and design through the decomposition and the integration of the module. |
| Situational assessment of urban layout optimal situation | According to different development conditions, it’s a method to purpose different city development situation, and on the basis of the selected evaluation in different situations, find out the optimal way of urban development. |
| Virtual-real framework method | It’s a method to create a unique landscape through nuclear and shaft system and open space system to build space and skeleton of the "solid" and "virtual" space, and through combination of two pairs of space frame. |
| Landscape two-way interaction design technology | | |
| Landscape visibility | Landscape viewing related to the visibility directly, combined with the atmospheric visibility to form different viewpoints centered visibility of envelopes, can better organization city skyline and the top is decorated. |
| Virtual line circle layer atmospheric visibility definition | Based on the grid network, it is a technology to evaluate the landscape scores of the grid points, use the scores as the height values of each point, and generates 3D model by the GIS platform. |
| Equi-potential Line Division Vision Analysis Technology | | |
| Heat Preservation And Saving Energy Design Technology | Through design of urban structure, building density, street grid and other external space, this technology is used to make the urban environment more appropriate to achieve the purpose of thermal insulation. |
| Low Carbon And Green Circular Design Technology | This technology achieves the high utilization of resources based on the reduction of greenhouse gas emission, so that urban construction does not hurt the environment, achieving urban construction and environmental protection perfect unity. |
| Digital Aided Design Technology | | |
| Parametric Aided Design Technology | This technology is used to choose the parameter establishment procedure, transform the architectural design question into the logical reasoning question, use the rational thinking to design. |
| Visual Model Aided Design Technology | This technology uses the real-time and convenient digital model to consider the spatial program, modifies the model directly by digital ways, and improves the design intent [42]. |
| Place Aided Design Technology | This technology is used to evaluate the design space from the perspective of the natural environment, help to better grasp the base information, and make the appropriate design improvements combined with the characteristics of the site. |
| Block classification Development mode | This technology puts forward a modular technology method for the construction of the spatial form in each block, which controls and guides the relevant elements to be convenient for urban planning management. |
| MiCro-community Renewal Mode in Existing Urban Area | This technology is used to divide district into a number of neighborhood units with a certain spatial characteristics and social characteristics of the community population, and do targeted transformation for them. |
| Three-In-One Guidelines in Planning | This technology by establishing the unified regulatory detailed planning guidelines, urban design guidelines and historical protection guidelines management unit, definite the control points in the guidelines to form a complete management system. |
5.2. **Technology application case: virtual-real framework method**

In the planning of urban space, this method has good spatial layout value and planning guidance sense, by combining the corresponding function and spatial characteristics to build the virtual-real space framework system of the city, to form organic unity of urban spatial formation. In the case of spatial strategic planning, it put forward some prominent problems facing in urban development: First, the development of urban areas was relatively weak, the level of urbanization was low, and the scale of the city was too small; the second was that the industrial nucleus effect of the city was not strong, and the large service pattern had not formed yet; Third, the city's spatial agglomeration advantage was not obvious. Thus, the urban design proposed that the spatial organization should follow the basic idea of "the city along the river and the industry along the road" to gradually form the development mode of the urban group real framework and the ecological green wedge virtual framework crossed and synergetic, and build the space form of “three-horizons, one-longitude, four-areas” (Figure 4).

6. **Design expression technology cluster**

6.1. **The composition of Design expression technology cluster**

In the digital background, the technology of expression has occurred fundamental changes: on the one hand, there is the big tendency of design expression technology development, that was all using the computer as a tool from design to communication, and the expression also changed from hand-painted to digital computer expression, to facilitate the integrity of the entire process; On the other hand, the expression of the design results occurred a variety of new expression ways, such as virtual reality, digital hand-painted, and so on. These technologies are based on an accurate architectural model, making the design more realistic, and some professional software can also render the actual effect of the special scenes, to increase the three-dimensional sense and depth scene of the design expression.

| Technology category | Technology name | Technology point |
|---------------------|----------------|------------------|
| Planar rendering technology | Vector Effect Expression Technology | Based on professional software, it is used to drawing accurate size vector plan, which can be printed in any proportion. |
| | Hand-painted Effect Expression Technology | By using the professional software, it is used to transform the master plan into hand-painted effect plan. |
| | Digitized Typesetting Technology | By professional software, it is used to fast typeset texts and pictures, easy to be changed and replaced. |
| 3D rendering technology | Light Scene Rendering Technology | It is used to express architectural lighting, architectural sunshine and light changes by tracking ambient light to form a real light environment scene. |
| | Architectural Scene Rendering Technology | By professional software, Simulate the real scene of the building and render the scene picture as a real scene. |
| Multimedia technology | Multimedia Expression Technology | Making the report file in multimedia form, combined with sound, images, animation and special effects, it can avoid multiple reports or off-site reporting of trouble, and to avoid embarrassment of the tender project judges and reporters. |
| | VR technology | By establishing the real 3D scenes, it makes people get immersive feelings with special equipment to well experience the real planning effect. |

6.2. **Technology application case: Digital hand-painted expression practice of urban space**
Digital hand-painted expression has the biggest advantage to grasp the relation between blankness and actuality in the overall atmosphere of the city. In the practice of a city, in order to highlight its characteristics of the water system and the port, we emphasized the structure of the relationship of the water system, vividly drew the prosperity of the port, and weakened the building, not expressing as key point, only expressed the gradation of space for the environment, by using more uniform ways and colours. Through planners carefully drawing by hand-painted software PAINTER powerful artistic processing functions, there was formed a rich gradations of urban landscape where river linked to port and water vein was clear (Figure 5).

![Image 4. The development pattern of virtual-real framework space](image)

7. Conclusion

Through the detailed analysis of the urban design technology cluster, it can be seen that the digital technology has the continuous growth while the technology progress and the urban design understanding develop continually and in depth. Under the background of the rapid development of the current disciplines and the era of digital age, a new topic appeared in urban design teaching is that how to grasp the development context more accurately and meticulously and make a more scientific and rational design by applying relevant urban design technology. Combining with the characteristics of procedural and stage of urban design, with a number of technical clusters as the carrier to put it into the main line of urban design teaching, there is a significant meaning for the establishment and development of the technical structure of urban designers. It is hoped that through the targeted technology cultivation structure, urban designers gradually improve the knowledge and technology structure, and have a good technology innovation and application capacity.

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