Algorithmic Engineering in Public Space

Patterning strategies for a plaza paving

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Abstract. The paper reflects on a relationship between an algorithmic and a standard (intuitive) approach to design of public space. A realized project of a plaza renovation in Czech town Vsetin is described as a study case. The paper offers an overview of benefits and drawbacks of the algorithmic approach in the described study case and it outlines more general conclusions.

Keywords. Algorithm; public space; circle packing; optimization; pavement.

PUBLIC SPACE

Instead of the embodiment of a static order more and more a city is considered to be an ever changing organism. Over few decades, architects have to cope with new concepts of space imposed by global markets, the Internet, ballooning population figures, social isolation, and environmental crisis. Philosopher Peter Sloterdijk argues in his article “Foam City” that architectural designs have been always integral to establishing the society.

City vs. Society

The article focuses on the Fête de la Fédération of July 14, 1790, celebrated on the first anniversary of the storming of the Bastille. The author argues that the architectural staging of this spectacle served to generate an embodiment of the nation, enhanced by affective and acoustic measures. While the article is mainly concerned with the architectural technologies of politics related to the French Revolution, it also points beyond this specific historical case and briefly indicates how 20th-century fascisms used techniques that were prefigured by 18th-century French inventions. In both of these cases monumental and vast public spaces allowed the gathering of the crowd and assembly of a national collective.

Foam City

The current nature of the human environment is defined by the fact that nature and human action can no longer be separated. Technology and nature are considered to be all part of a network; a whole that cannot be managed by simple urban planning strategies.

Sloterdijk describes the city as a Foam City: ‘The co-isolated foam of a society conditioned to individualism is not simply an agglomeration of neighboring (partition-sharing) inert and massive bodies but rather multiplicities of loosely touching cells of life-worlds’ (Sloterdijk 2006).

In other words the idea of the collective society has disappeared and was replaced by the society that resembles the foam, where the individuals are clustered in co-isolated groups. In these co-isolated groups individuals share their interests and opin-
ions. Therefore the city and public space can no longer be designed for a massive collective but rather for an ever changing multiplicity.

**PROJECT GOALS**
Several years ago, we were approached by Moba architectural studio to collaborate on a refurbishment of a medium sized town in our country. The original design was based on Sloterdijk’s Foam City metaphor. We were commissioned to develop a method (algorithm) that would set out a layout of hundreds of concrete circles in the surface of the refurbished plaza while reflecting Sloterdijk’s observation of the society in his article “Foam City”.

The assignment consisted of two rather independent steps. The first step was the functional analysis of the square and development of a patterning strategy that would initiate various activities to happen in the public space. There was hardly any social interaction happening in the square beforehand and the entire space was used mainly as a communication corridor. By developing a right patterning strategy we aimed to invite as many social groups to interact in the plaza.

The second step was to develop the algorithm that would guarantee that all technical requirements are met. There were seven sizes of the concrete circles with diameter ranging from 1.2 to 4 meters. No two circles could intersect with each other and also with multiple other objects/obstacles. Furthermore the minimum continual asphalt area among the circles could not be less than 0.5 m² due to given construction limitations.

**METHODS**

*Input, brief*
Early in the process we realized there is a strong relationship between any algorithmic method and the designed pattern. The original design (an outcome
of an architectural competition) was based on a random distribution of circles with the highest density in the centre of the plaza (Figure 1). The paving pattern was created intuitively by the architects. Our task was to optimize the design with as little intervention as possible.

**Technical requirements**
We used a simple circle packing algorithm based on collision detection and an iterative approach. The algorithm ran through the randomly generated circles and in every round checked for several conditions derived from the brief (Figure 2).

1. If any of the circles collided with the boundary of solved space it was moved away in the opposite direction.
2. If any two circles were closer than 6 millimeters to each other both of them were moved apart in the opposite direction.
3. If the concave residual space defined by any three circles was smaller than 0.5 m² (gap smaller than 50 millimeters was considered as closed) all three circles were moved apart. The process usually took about one hundred iterations to optimize the circles. Visual aids to mark any possible collisions were scripted in to help to remove possible dead end suboptimal results.

**Functional analysis of the square**
Having met the technical part of the brief early in the work process, we started to question the functional quality of random distribution. The architects did not have any means of designing layout of almost five hundreds circles other than random distribution with intuitive gradient density. Our motivation was to propose a better way of working with such a high amount of design elements and still be coherent with the original design brief.
We analyzed the public space and defined several qualities of the pavement that we wanted to address in a new generator (Table 1). For example, spots with more and faster traffic would be defined by bigger and less dense circles (the asphalt is easier to walk and cycle on), spots that were supposed to become quiet rest areas were defined by a high density of the whole range circles, spots to slow down on (such as entranced to public buildings) were defined by a high density of smaller circles.

With such an approach we were able to compose a colored gradient map that served as a layout for the public space.
generator (Figure 3). However, this algorithmic driven design method was perceived by the architects as something uneasy to control and was not developed further.

CONCLUSION
Without an algorithmic approach it would not be possible to handle a project of this size within the short amount of time given to the project. The algorithmic approach not only helped to optimize the setting out of the circles but was essential for production of final project documentation and for laying out the concrete circles on site (Figure 4).

The failure of the approach was inability to change the rather simple definition of random distribution and gradient density of the circles. The designers were not comfortable with passing any control to an algorithm and with dual authorship (as described by Carpo (2011)). It is disputable whether there was any control (other than intuitive visual) at the first place.

In a general, yet similar, case (urban paving pattern), early design stage algorithmic tools capable of gathering and manipulating vast range of design information would help the team do devise a better and more functional design. In that case, an “information engineer” should play a substantial role in the design team similar probably to a role construction, civil or technology engineers play during a standard building design process.

REFERENCES
Carpo, M 2011,'The Alphabet and the Algorithm', pp. 126