Development of parklets by using parametric modeling

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Abstract. The lack of urban planning has made the recreation areas increasingly smaller in the cities. Parks and squares gradually gave way to streets and avenues to try to accommodate the growing number of cars and motorcycles. An alternative that tries to balance recreation areas and urban roads was found in the city of San Francisco (USA). Parklets are temporary extensions of urban sidewalks that occupy a few parking spaces. This article aims to demonstrate the potential of parametric modeling in the development of parklets. Thus, anthropometric studies, amount of parking spaces and types of benches were used as input parameters. Rhinoceros and grasshopper programs were used for modeling, while 3D Studio Max was used for rendering. With this study it was possible to verify that when the project is parameterized the processes of creation and modification became faster, reducing design and implementation time.

Keywords: Grasshopper algorithm editor, parametric model, parklets.

1 Introduction

The Industrial Revolution was a breakthrough for society because the production form went from a handcrafted scale to an industrial scale. Thus, the demand for jobs in factories caused a lot of migration of peasants to the cities.

The pace of growth of most cities could not keep up with all the needs that this new reality presented. The streets, which were former exclusive areas for chariot circulation, started having the circulation of cars. In favor of urban mobility, public leisure spaces were being gradually replaced bystreets and avenues. [1]

However, the solution for urban mobility is not associated with the increase in the number of roads, but with the way people move. Stimulating the displacement by collective or non-motorized means of transport (bicycle, for example) is indicated in the guidelines of the National Policy on Urban Mobility (PNMU) established by Law No. 12.587/2012. [2]

Initiatives that aim to rethink the space of circulation have already been taken in some cities. In London, there are signs that indicate the walking distance from the main sights. In Philadelphia and New York, street space is being turned into multipurpose spaces: bike paths, sidewalks and squares. [3]

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The creation of squares in urban centers is a problem because there is a lackoflargepublic spacesincentral areasof big cities.To try tochange this situation parklets, or mini-parks, originated in the city ofSan Francisco (USA)[3].

Parkletsconsist ofthe extension of temporary public footpath (sidewalk) occupying some areas which, until then, were dedicated exclusively to parking vehicles, through the implementation of a platform equipped with benches, tables and chairs, roofs, exercise equipment, or other street furniture having recreation function [4]. The great benefit in implementing parklets is increased awareness and coexistence between people and transport vehicles, both conventional (cars and motorcycles) and alternative (bike, skateboard). Parklets,because of their ephemeral construction features, give cities a significant aesthetic movement, regarding the perspectives of the cities, which are full of static buildings in the urban scenario. Parklets are dynamic, constantly changing the visual of the city and in a healthy way, the population. The parametric design concept applied to parklets contributes to the excellence in a contemporary character design, taking into consideration the essence of project design and manufacturing.

This projectaims to meetthe current demand forpublicspacesin the form ofparkletsand considersanthropometricdimensionsfor the design of a set of street furnitureitems, chairs and loungers, besides the development of a roof.

Using the paradigm of parametricdesign,this furniturecanbe manipulated togeneratealternativesthat meet the needs ofdifferent available public spaces. Thus, the purpose of this study is to investigate the potential of parametric modeling for the development of parklets.

2 Methodology

To verify the potential use of parametric modeling we opted for the development of parklets whose main function is to provide the user with a rest area. For this purpose, a chair composition and a covered area were created. That definition was based on the design time (3 months) and on the size of the available staff.This research was carried out in a course of the Post-graduate Program of Design at the Federal University of Rio Grande do Sul in 2014 with the objective to verify the development process of parklets by using parametric digital modeling.

The research wasorganized in two phases: exploratory literature review andthe virtualand physical simulation ofparkletprototypes.In the exploratoryphase, theobjective was toverify which design requirementsshould be consideredin developing a parklet. These requirements were used as input parametersin the algorithmto be created in the Grasshopperprogram.

In Brazil,themunicipality is responsible for the creation of regulations for operating parklets. During the research,it was found thatfew Braziliancitieshavethe operating regulations.The city of SãoPaulo, for example,has already createda handbook with regulations for those whowant toimplement a parklet. [5]

These regulationsare divided into six categories, namely:

types of parking spots-if it is anobliqueor parallelparking space;
distancefrom thecorner - parklets cannotbeinstalledless than 15meters from theedgeofthealignment of the street cross section;
limitations- parklets cannotobstructcurb cuts, bus stops, taxi stands, pedestrian crossingsand elderly and handicapped parking spaces;
accessibility – they must meetthe technical standardsestablished in Art.5 ofDecree no.55.045/ 14;
drainage -the installationshould not occuronmanhole covers orin areas withoccurrenceof floods;
sloping streets- parkletscan onlybe installed onroadswith up to8.33%oflongitudinal slope.

Asinput criteria to create the algorithm the type of parking space was selected (Figure 1) whichdefines themaximumspace of occupation inparallel parking spaces positions2.20 m wide starting from thealignmentof the street curb and 10m long. Regarding perpendicular or oblique parking spaces, the alignmentshould be 4.40m wide and5m long.

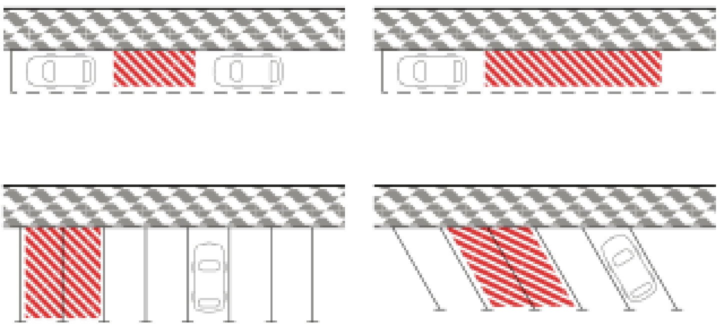


Fig. 1. Graphic representation of the maximum space for the implementation of parklets in the city of São Paulo. [5]

Accessibility criteriaandslopeof the streetswerenotused in this study because they would increasethe control variablesand, as a result, thecomplexity of the algorithmto be created. However, this implementation is recommended for future studies. As for the othercriteriapresented(distance from the corner and drainage), they are not considered input parametersthat influencethe projectdesign.

Otherdata usedin this project arethe dimensions of benchesand ceiling. For these data,we used theresultsof the master's thesis by AnaClaudiaVettorettientitled "Benches to readand talk: Design parametersforgenerativedesignsystem" [6].

In her thesis, Vettorettisurveys the several posturesusers ofpark benches adopt while reading and chatting. Taking this information into consideration, the author checked the postural tendencies adopted while performing those activities and developed a guidelinefor the designof these types ofbenches.

To verify the input parameters 9 bench profiles were selected (Fig. 2), where the user can keep their legs extended or flexed.

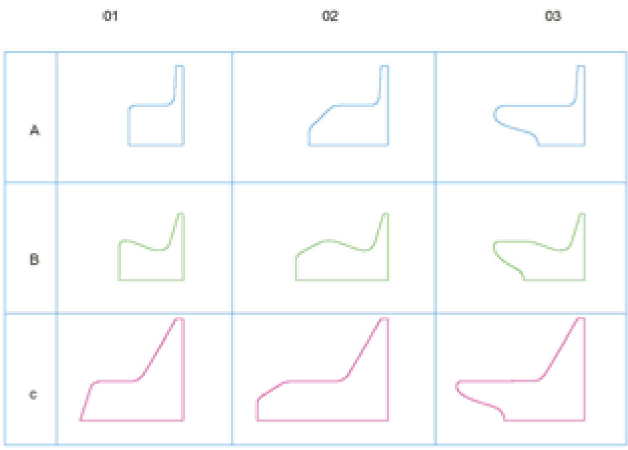


Fig. 2. Profiles selected as input parameters in the algorithm

Because this project is based on digital manufacturing, the wood sheet thickness and the distance between sheets will be considered, as this information will be essential for the generation of parts for laser cutting.

For the second phase of this study, which consists of virtual simulation, the program Rhinoceros was used to visualize the object generated from the algorithm developed in the Grasshopper program. Since the focus of this research is to verify the potential for using parametric modeling when designing parklets, a full-scale prototype was not developed. Instead, a physical scale prototype was developed and a 3D Cliever printer (type Black Edition) was used.

3 Results and Discussion

For the generation of the 3D models the program Rhinoceros (Rhino) was used with plug-in Grasshopper (GH) by drawing all geometric elements of the base curve of the structure to be projected. Although this method allowed a total mastery of design variables such as height, width and length of the roof, height and depth of the bench, whether there are curves or not in the layout of the bench, wave effect on the height and top of the bench, it provided a very poor result and did not allow an ergonomically proper design. Figure 3 shows an example of the first result obtained.

Fig. 3. Concept study

Since the first results it was easy to identify GH potential to assist in the development of complex models, test several concepts of product design, try new approaches and allow the designer to develop a relational and adaptive design. [7].

In search of a better definition to the model in terms of shape, visual design and ergonomics, it was decided that the project would start with a set of previously defined curves, instead of generating the curves in the GH. A set of projects of benches ergonomically designed by Vettoretti [6] was then taken as a basis and it was added a more organic and fluid form, based on the concept of the "Great Wave off the coast of Kanagawa" painted by Hokusai, which served as inspiration, for example, for the construction of the Yokohama International Marine Terminal in Japan by FOA (Foreign Office Architects) [8] as shown in figure 4 and 5.

Fig. 4 -The great wave

Fig. 5. Reference curves developed

The definition of the curves increases the degree of project control and makes it possible to generate different models of parklets with the addition of new geometries. When a new curve is inserted, it is projected and added to the model base set, which regenerates and accommodates to the new geometry.One of the positive aspects in the parametric adjustment of curves is the transition control between them, because this is one of the ways to ensure that the predicted ergonomic aspects will not change (Fig. 6).Therefore, when this control is used it is possible to ensure a smoother transition between curves.

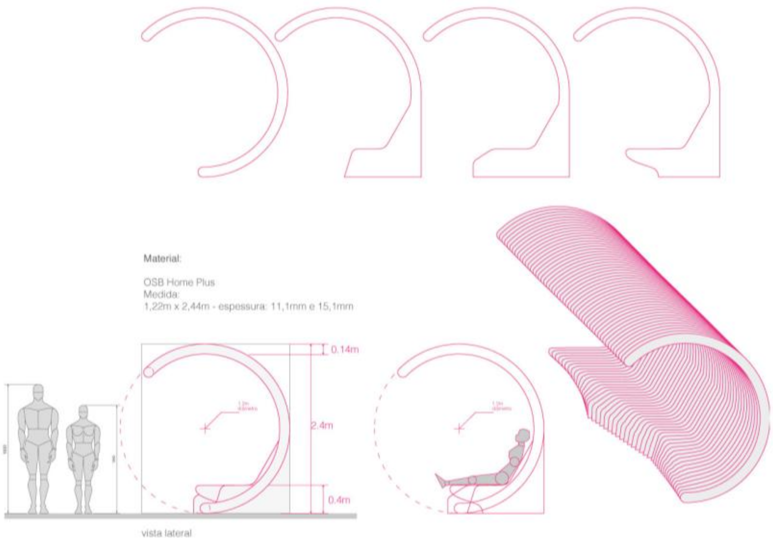


Fig. 6. Reference curves developed and ergonomic aspects

The algorithm developed in the GH consists of some building block models. Figure 7 presents the parameter block, both of the sheet to be considered for the production and of the curves that will be used as a basis for building the model.

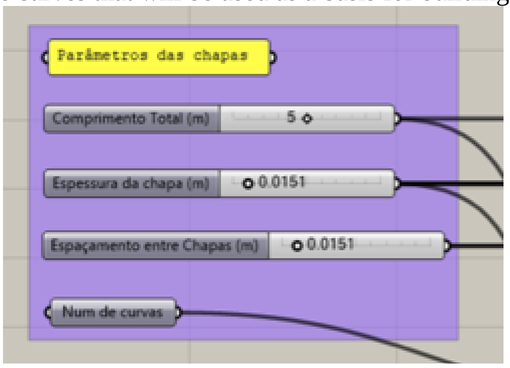
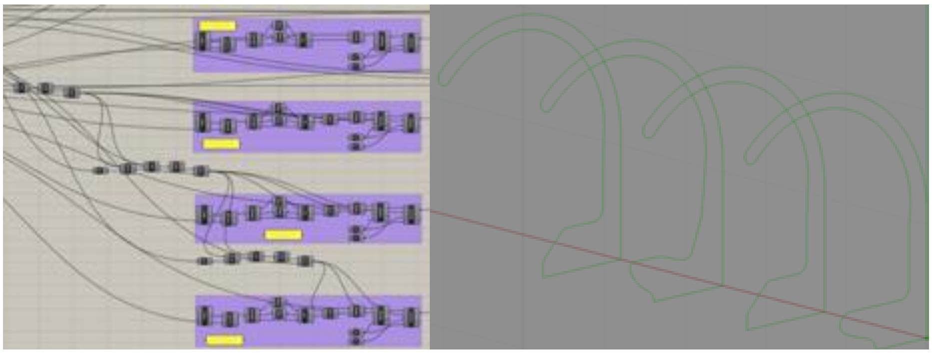


Fig. 7. Model parameters

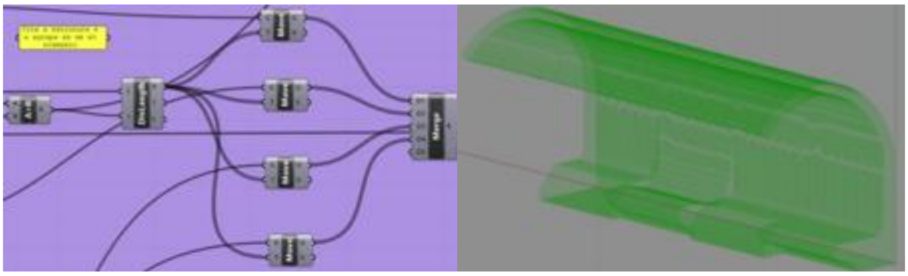
Once the curves are defined, whether the same or different, and the dimensions of the project, the project itself was developed. It consisted of 4 geometry modules, which was defined by the fixed number of curves that would be used. The correct curve positioning was reached with the fractions of codes shown in Figure 8a.



(a) Algorithm in Grasshopper (b) Positioned curves

Fig. 8. Positioning modules of reference curves

Following the method of successive copies of these curves it was obtained the skeleton of the model structure, as shown in figure 9a, the code and in 9b the structure.



(a) Algorithm in Grasshopper (b) Virtual simulation

Fig. 9. Positioning modules of reference curves

We decided to generate a large number of intermediate curves to ensure a smooth transition between the curves, and, thus, ensure that there was no distortion of the ergonomic baseline study.

To ensure that the same orientation of the curves is achieved when generating the lofting of the model, the guide curves were generated in a controlled process and not at random by the grasshopper function. This attention was necessary in order to eliminate fouling in the resulting model, generated by differences between the geometries of curves and misalignments and their number of constructing points. Figure 10 shows the code and the result of this operation.

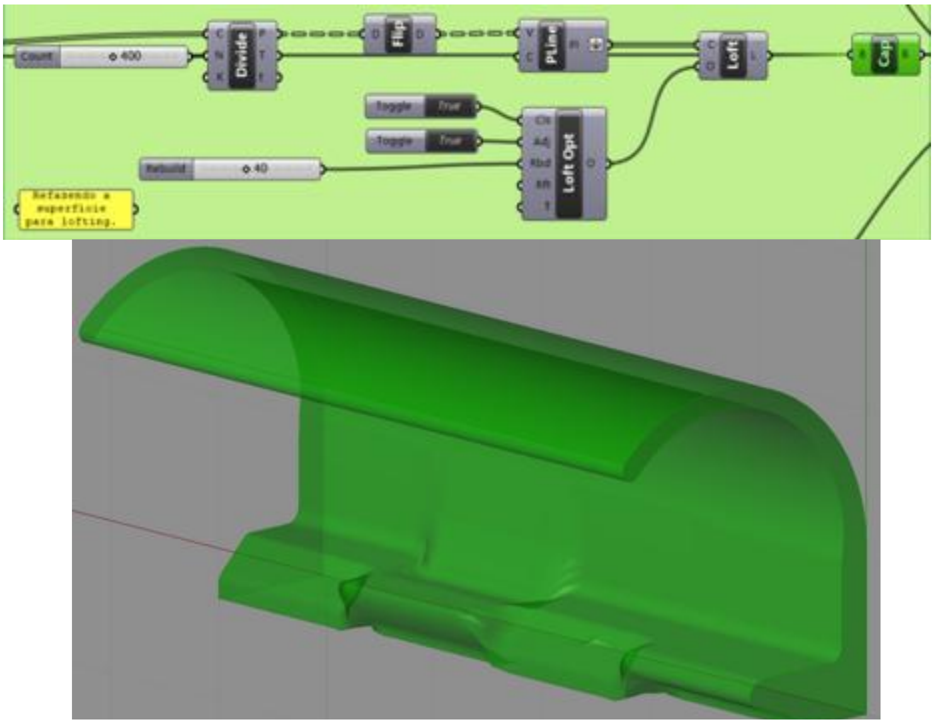


Fig. 10. Lofting control algorithm and virtual model

With the generated lofting the structure for the slicing and generation of the final model to be manufactured is obtained. Considering the initial parameters of wooden sheet thickness and distance between sheets the sections of the model were created.

Once the final model is a set of sheets separated from each other, a support was developed to be placed between the sheets, without changing the visual design of the model. This support is said to be universal since its dimensions allow its use with any geometry of curve chosen to set up the Parklet model.

Finally, the sheets and brackets are united in one element, thus concluding the desired Parklet model.

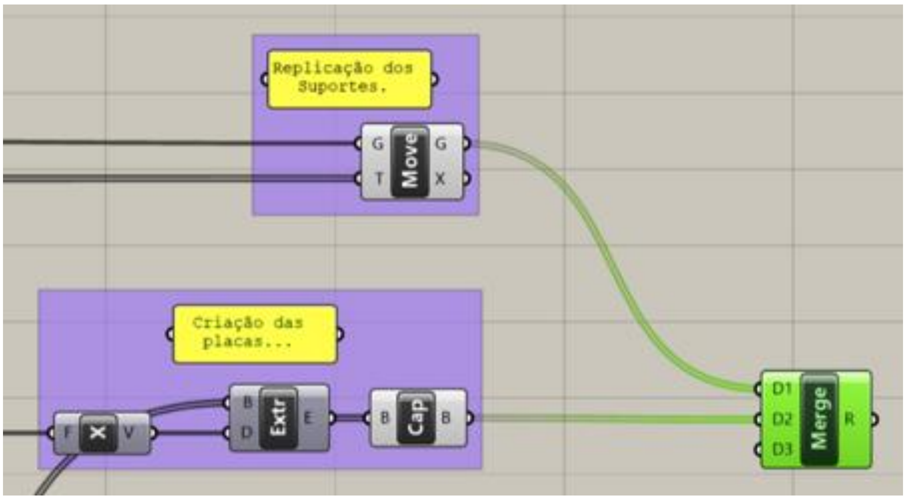


Fig. 11. Algorithm of sheet bonding

One of the advantages of using a tool such as Rhino/Grasshopper is the possibility of generating the cross-sectional profile for a nesting algorithm, and, thus, materialize the constructive elements of the model.

In this study, physical prototypes of one of the parklet variations developed were printed in 3D printers, as illustrated in figure 12.

Fig. 12. Prototype made in a 3D printer.

With the virtual model generated by Rhino / Grasshopper the file was exported to 3D Studio Max in order to create the final rendering of the project that can be seen in Figure 13.

Fig. 13. Final model of parklet

4 Conclusion

Whena project is parameterized there is designtime optimization, which can be seenduring the phase ofgenerating alternativesandin the manufacturing process, which makes its use a major competitive differential.The use ofparametric modelingwas efficientin developingparklets, because for eacharea of a citythere can bedifferent design requirements(inputs). Thestudy also showed that in theproject scopephase it is necessaryto definethe variables involvedand their relationshipsto create theparametriccode ingrasshopper. However, ifthere is aneed to includea new parameterduring the project thiscan be donewithout affecting what has already been performed.

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