Plug-In Design

Reactivating the Cities with responsive Micro-Architectures. The Reciprocal Experience

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Every city has under utilized spaces that create a series of serious negative effects. Waiting for major interventions, those spaces can be reactivated and revitalized with soft temporary projects: micro interventions that light up the attention, give new meaning and add a new reading to abandoned spaces. We can call this kind of operations “plug-in design”, inheriting the term from computer architecture: interventions which aim to involve the citizens and activate the environment, engage multiple catalyst processes and civil actions. Plug-in design interventions are by all meanings experimental, they seek for interaction with the users, locally and globally. Information Technology - with its parametric and site-specific capabilities and interactive features - can be instrumental to create such designs and generate a new consciousness of the existing environment. With this paper we will illustrate how two low-budget interventions have re-activated a forgotten public space. Parametric design with a specific script allowing site-specific design, materials and structure optimization and a series of interactive features, will be presented through Reciprocal 1.0 and Reciprocal 2.0 projects which have been built in 2016 in Italy by the nITro group.

Keywords: reciprocal frame, parametric design, responsive technology, plug-in design, interactivity, re-activate

INTRODUCTION
Plug-in design processes have been first formalized in the context of Sicily Lab in Gioiosa Marea, Italy, to define a bottom-up design process, strongly focused on Information Technology, aimed to the reactivation of public space through interactive participation of the citizenship. Although the very expression “plug-in design” is not common in architecture literature, it is still possible to retrace a class of projects that responds to the definition. Since, as said previously, plug-in design interventions are experimental by their own nature, illustrating specifics design processes is the best way to accomplish knowledge about their purpose, function and result. Therefore,
the paper will go through a definition of the methods and aims of plug-in design, a quick survey of most significant plug-in design interventions and finally an analysis of the design and building processes of two interventions, Reciprocal and Reciprocal 2.0.

**PLUG-IN DESIGN METHODS**

Project’s process is triggered by a crisis, which is seen as an opportunity to develop new and efficient methods to heal under utilized spaces, involving the citizenship and offering a new perspective on the public space, lighting up the qualities that are not perceivable. By their own nature plug-in design interventions seek for interaction, acting as catalysts to generate a new common way of living the city. They suggest a new dimension for urban spaces, in which both the public and private actors will be involved. In the last years many of these interventions have been realized all over the world, generating interest and pointing new paths for architectural research.

**DESIGN PROCESS**

Reciprocal is a plug-in design intervention, a light structure made of PVC bars each supporting the
"Water Playground along the Tiber" is the graduation thesis by Michela Falcone, developed in Rome “Sapienza”, advisor A. Saggio, within the chair project Tevere Cavo. The project, ignited by the crisis of the pollution level of the water, proposes a reappropriation of the river Tiber by its own inhabitants through several multitasking devices which provides, at the same time, leisure areas and decontaminating effects. The design consists in floating mobile structures, labelled as “water tools”, that recall instruments related to the history of the river itself and other in mutual relations of forces; the structure is temporary, dismountable and reconfigurable, aiming to the minimization of the used resources. From the constructive point of view, the structure has been built using the reciprocal frame model, first conceived by Leonardo da Vinci in the Atlantic Code, in which he details the functioning of the structure and its possible use for temporary shelters and bridges; it’s a class of self-supporting structures made of modular, linear elements supporting the weights just by mutual interlacing. Each element works both as a supporting and supportive module, discharging each other’s efforts. The minimum module structure consists of three elements, arranged in a triangle in which each element passes over the next and under the previous creating a concatenation of tension and compression stresses. While in Leonardo da Vinci reciprocal structures are following mainly “basket” and concentric geometries, Reciprocal geometry in our case is organic and free form. This is possible by the connection between parametric design and structural, reciprocal, test of the geometry. The Reciprocal 1.0 and 2.0 structures have been realized with a specific parametric software which allows the optimization of the geometry. The optimization process first allows the geometry to have a good structural functioning just by shape, then minimize the number of elements, reducing the quantity of used material. The employment of modular elements allows the structure to be reconfigured in many different shapes, generating a parametric but site-specific piece of design.

Another feature of the structure is related to sound. Reciprocal creates a proper “sonorous environment” thanks to Mogees, a device developed by the Italian entrepreneur Bruno Zamborlin, capable of converting any object into a musical instrument. Mogees is a kind of endoscope that allows to retrace the secret throb of music in common objects or environments, involving the materialization of all those traces that permeate our environment but which go unnoticed. The music produced by the structure is
Albula is an interactive urban device that deals with the pollution crisis of the river Tiber. The installation by Deltastudio (D. Pompei, V. Galeone, S. Massaro), was designed for a young architects competition in Rome and evokes the old roman tradition of watermill along the river. The device generates a reverse ecology taking advantage of water flux, in order to purify the Tiber and giving it back to its citizens. The design proposes a suspended phytoremediation system and generates, at the same time, a new civic space for leisure and play.
TreeIT is an installation designed by nITro in 2013 (Design team: A. Saggio, V. Galeone, D. Pompei, L. Bregni, G. De Francesco, G. D’Emilio, A. De Pasquale, R. Faralli, V. Galeone, D. Motta, D. Pompei) in the historical city of Ronciglione (Vt). This piece of plug-in design consists in a harmonious boardwalk which spreads in several directions, dynamizing the space and outlining its potentialities. Along the boardwalk more than a hundred artificial trees take their place, evoking a natural environment. The trees enlighten through the activation of interactive technologies when people pass nearby: they are mute without the civic action but they light up the environment when the citizens are involved.
Wunderbugs is an interactive installation curated and designed by Francesco Lipari and Vanessa Todaro in Rome. It is a wooden pavilion, realised with simple and repetitive modules, inspired both by the shapes of the Roman Baroque and the geometries insects can generate. Inside the wooden structures six spherical ecosystems host living insects and a number of sensors for motion, humidity and temperature. The data collected by these sensors interact with an audio installation modulating its musical composition.
also connected to a light source: the system is regulated by a set of Arduino boards connected to a microphone and a relay system able to discretize the sound wave in acoustic bands of different frequencies. Each acoustic band was matched with a set of LED lights arranged on the top of the bars and spread all over the structure. Aiming to employ the shortest length of cable, a minimal-path algorithm has been developed to identify the optimum path between the light source and the electric board. Therefore, the structure can not only provide shelter for performers, musicians and citizens, but create new “informational” relations between space and sound.

EXPERIMENTAL RESULTS

The paper is not only a description of the software development and the scriptable processes that have created specifically for this project but also a report of the construction experience, the feedback of the citizens and of the performers. In relation to economical analysis and workflow description, nITro group decided to concentrate on the experience of Reciprocal 1.0, since it represents the beginning of our investigation and the first step of a repeatable methodology. The project has been developed in two main phases: the initial research was conducted inside nITro studio in Rome, the second one in the spaces of Sicily Lab in Gioiosa Marea. During the first phase the team developed the detailed algorithm, realized the models to test the reliability of the structure and of its assembly process using different materials and wrote an assembly manual which allowed to optimize the construction phases, guaranteeing its accuracy. Since the beginning of the software development the estimated time of work has been about a month of a team of 10 people, considering standard work days. It is important to underline that the phase of algorithm design is only needed once, because when the software is completed it can be used on different type of surfaces.

During the second phase the group selected, in accord with local administration of Gioiosa Marea in Sicily, the site of the intervention, which has been measured and digitally reconstructed. The next step regarded the site-specific design, during which we designed the basic surface to be algorithmically processed. This phase took us about a week. The assembly has been organised in several phases: measuring and cut of the PVC bars in homogenous length (2 work days); assembly of sections of the structure to be joint in-situ (2 work days); in-situ assembly (1 work day). At the end of the exposition the structure
Figure 7
Reciprocal 2.0
digital model and
internal view,
Ronciglione (Vt)
2016 by nITro
group. Design
team: Antonino
Saggio, Matteo
Baldissara, Valerio
Galeone, Davide
Motta, Valerio
Perna, Gabriele
Stancato,
Alessandro
Perosillo, Silvia
Primavera, Manuela
Seu, Michele Spano
has been dismounted recovering all the PVC bars in 3 hours. The estimated costs for the material amount to 500 € (200 € for the PVC bars, 90 € for the plastic strips, 125 € for the Mogees). The local administration has also granted a contribution for the amount of the 60% of the total cost.

The feedback from the same administration with the mayor dr. Eduardo Spinella and the Deputy to the Environment ing. Maria Grazia Giardina Papa, has been very positive: in addition to the economical contribution, the local authorities took part in the inauguration of the structure with a public event, showing support and enthusiasm for the initiative. On the other side the citizens interacted with the structure since its assembly phase, exploiting its social potentialities and also showing a certain disappointment knowing that the structure was to be disassembled. The local press and television have reacted very positively to the event, giving room to the initiative and interviewing the design team.

**DISCUSSION**

Despite its character of event-related report, it is still possible to deduce a strategic approach to plug-in design, methods and goals to reactivate the public space with low budget interventions, using the IT as a crisis solver tool. Investigating and promoting new ways to operate in the stratified city using a parametric, interactive design is the main goal of this paper. The authors are also involved in academic work at Sapienza, University of Rome, with the role of PhD candidates, and PhD Program Coordinator. Teaching deals with the impact of Information Technology in architecture. The example of Reciprocal is fit to show not only the theoretical and algorithm aspect of parametric design, but also to involve different layouts and even changings in the algorithm itself due to interaction with students. The project is also scheduled to be built within the MAAM (Museo dell’Altro e dell’Altrove) in Rome, Reciprocal 3.0 will involve the inhabitants that live in this very peculiar environment.
that is at the same time a museum of contemporary art and a community of eleven different nationalities.

REFERENCES
Converso, S 2010, Il progetto digitale per la costruzione. Cronache di un mutamento professionale, Maggioli Editore, Santarcangelo di Romagna
De Finis, G 2017, Maam - Museo dell’Altro e dell’Altrove di Metropoliz_città meticcia, Bordeaux Edizioni, Roma
De Francesco, G and Saggio, A 2016, Tevere Cavo, una infrastruttura di nuova generazione per Roma tra passato e future, Lulu.com, Raleigh, USA
Popovic Larsen, O 2007, Reciprocal Frame Architecture (500 Tips), Routledge, London
Da Vinci, L 1478, Atlantic Code