

Generative and parametric design in Brazilian social housing production

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Abstract. This paper aims to present an on going research about the use of digital technology to improve the production of the Brazilian dwelling program so called “My Home, My life”, one of the majors current social housing programs in the world, which goal is to build about 1 million houses for low-income population located in areas of illegal occupation in Brazilian large urban centers where the high cost of the land and the specific characteristics of each area make unfeasible the use of the modernist paradigm, based on repetitive standards.

Keywords. parametric design; generative architecture; housing program; digital fabrication; immersive environments.

PRECEDENTS

Since March, 2009, it is being held in Brazil one of the major current dwelling programs in the world, so called “My Home My Life”.

The goal of this program is to build about 1 million houses for low-income population (0 to \$ 3,000.00 / month) divided into three subcategories:

1. 0 to \$ 300.00 – (90% of the deficit)
2. U.S. \$ 301.00 to \$ 1,800.00
3. U.S. \$ 1,801.00 to \$ 3,000.00

After a year of deployment, 408,000 units are already ready to be built, but only about 200,000 units will be destined for the subcategory 1 - 0 to US\$ 300.00 - located in cities and regions far from major centers where the deficit is greater.

According to Rolnik (2010), it happens due to the land price, which is much higher in large urban centers

causing a distortion that largely benefits the second income category - US\$ 301.00 to US \$ 1,800.00 - with the housing production in the edge of large Brazilian cities, repeating a wrong model of the past, which contributed to the fraying of the urban fabric of these regions.

The dilemma is that the greater demand comes from sub-category 1 (0 to \$300.00) and it is focused on large cities and metropolitan regions, situated in many cases in areas of illegal occupation, sometimes at risk, where the traditional building methods based on the modernist principles of repetitive standards aren't an appropriated solution.

Thus, in addition to solve the economic-financial variables, the policy of social housing in Brazil needs to rethink its technological base to face this specific challenge if the idea is really to address this serious social demand in the country.

In that case, advanced digital technologies, which are already being used in the production of sophisticated high-tech buildings, emerge as a possible solution.

With this goal, the main funding agency for research and projects in Brazil, FINEP, has built a research network comprised of seven Brazilian universities: MACKENZIE, USP, UNICAMP, UFPR, UFRGS, UFBA, UFC.

This research network defined some subprojects to be developed by the participants intending to explore particular skills of each one as BIM, Immersive Environments, 3D Scan, Rapid Prototype, Digital Fabrication and Generative and Parametric Design.

Thus this paper aims to present our specific task in this research network which is specially focused on generative and parametric design.



Figure 1
Typical Brazilian Slum

METHODOLOGY

The main subject of this research is the development of innovative solutions based on digital technologies to improve the dwelling program “My Home, My Life”, focusing BIM - Building Information Modeling and other applications to support the design process management, performance simulation and buildings operation.

In order to get it, FINEP sponsored about US\$1,561,636.74, being 60% for hardware, software and related issues purchases and 40% for scholarships. A research team has been created, by a selective process which elected seven universities.

This research network divided the main subject into 6 subprojects focused in particular aspects, considering the specific expertise of each institution:

1. Development of interoperability patterns for BIM use and the development of a special library of dwelling components;
2. Methods of conception and design development;
3. Production management;
4. IPD - Integrated Project Delivery;
5. Building operation management;
6. Management of the research network itself.

To develop these subprojects a general methodology has been defined as following:

- Documental and references revision,
- Cases studies;
- Definition of the state of the art framework of each subproject issue;
- Goals definition and respective tasks;
- Tasks development;
- Results evaluation;
- Revision and adjustments of by-products;
- Public information delivery of the research results.

Our university has been engaged in the subprojects 1, 2 e 4, as we can see below.

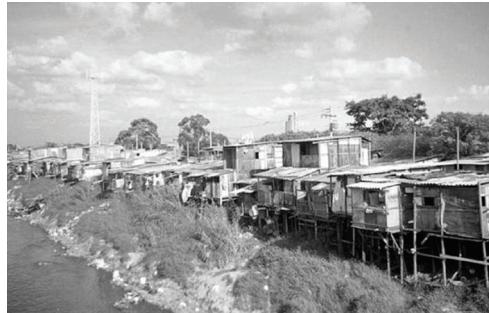


Figure 2
Slum at risk area

INTEROPERABILITY PATTERNS FOR BIM

The use of BIM technology in Brazil is emergent, very recent and we can count only a few relevant examples in the Brazilian construction chain nowadays.

Besides the expected difficulties of new technology implementation, the biggest challenge we have is the necessity to develop a background regulation for classifying all elements and components of this productive chain.

Indeed, the construction chain in Brazil has grown without a universal framework reference to classify services and products engaged in its production and now this has become a relevant obstacle in establishing a reference pattern to foster the application of the core mechanism of BIM process which is the interoperability of different disciplines and library components which take part in the design process.

This job has been done, since 2009, by a committee integrated by construction chain representatives, researchers from universities, suppliers representatives and members of govern agencies, like ABNT - Associação Brasileira de Normas Técnicas (Brazilian Technical Standards Association) and has already elaborated the Brazilian BIM standard, based on ISO 12006-2. Considering this background, this committee is now elaborating the necessary reference framework to classify the construction chain elements and components.

Anyway, this committee took as reference to its job the IFC pattern developed by smartBuilding Alliance and the Omniclass standard. Thus, it is already possible to start developing the necessary libraries of components to work with BIM.

Then, taking these patterns as reference, we are going to develop a special components library envisaged to social housing, focusing the program "My Home My Life". The first step is to check the work already done which is available at the website of MDIC - Minister of Development, Industry and Commerce of Brazil.

Actually, this work must be done in two different levels. One level must be dedicated to the current process and supplies already used in Brazilian dwelling programs such as structural and masonry components, doors, windows, etc. The other level must be dedicated to the new possibilities emerged

since the start of using of generative and parametric design technology to this kind of production.

This second level, off course, depends on the results of the development of subproject 2.



METHODS OF CONCEPTION AND DESIGN DEVELOPMENT

Traditionally the dwelling issue in Brazil has been faced under the modernist paradigm of serialization, repetition and standardization.

It means that to respond to the huge demand coming from low income people, official agencies responsible for the social housing programs, particularly since the second half of 20th century, have chosen wide lands far from the center of big cities, where the land price is less expensive to construct several large blocks of absolutely identical buildings which compose a clumsy urban landscape.

Besides this disastrous scenery this policy resulted in a big social cost, once those areas use to be far from the already existing urban infrastructure which imposes an additional cost to complement it.

And, what is amazing, the majority of these demands come from people who lives in slums built close to downtown of Brazilian big cities, in illegal occupations, near to medium and high class blocks, where they can find work in simple jobs, as maids, gardeners, etc., just in order to survive.

Recently, Brazilian dwelling policies tried to face this challenge starting programs to improve general conditions of these areas sometimes rebuilding the existing self-built precarious homes. But, still under

Figure 3
the result of modernist paradigm of serialization, repetition and standardization: clumsy urban landscape

the modernist paradigm of serialization and repetition, the results are not far from the disastrous urban scenery already known before.

The point is that instead of considering the specific characteristics of each site, as topography, surroundings and even the existing design of the slum, this paradigm needs to remodel the area transforming it into a plan terrain to build standard units.

Nevertheless, Duarte (2006) has already shown that, using the concept of shape grammar we can deal with this issue in a more creative and adequate way, facing the problem the right way, i.e., looking for a solution to the reality we have instead of changing the reality to shape it to the solution we have.

Then, this is the background of our task in this research network: to establish a method based on generative and parametric design, under shape grammar concept, to face the challenge of slums into the context of "My Home My Life" program.

The first step in that direction has already been done two years ago with the experiment "Parametrics in Mass Customization" (Vincent, 2010, 236), when we start to consider the parameters and tools in order to get our approach.

Summarily, this experiment took as reference the work of Terzidis (2006), Arvin (2002), Cheng & Lee (2005) and Shaviv (1986), and tried to develop a script programming to generate the plan of dwelling units, using as tools Rhino+Grasshopper connected to Excel spreadsheets to get to a more sophisticated generation matrix.

Next step is to elect a real case, in which we'll identify the main variables in terms of topography, weather conditions and cultural references of the community, to build a generative matrix to get a unique solution to this case study.

Off course, we know that we'll be working with a very complex issue in different terms, since the forms and patterns that we are going to generate till the interface that we'll need to discuss this complex solution with the existing community and, maybe, the official players engaged in the experiment. So, we presuppose the use of special

tools to support the experiment, such as CNC machines for rapid prototyping models and digital fabrication and an immersive environment, such as a CAVE, to present and discuss the proposals with community representatives.

IPD - INTEGRATED PROJECT DELIVERY

This experiment is not only related to systems, software and tools but, mainly, to the process, i.e., the methodology of design development. Then it is an excellent opportunity to check and review the current methods and practices to do this.

Thus, we are going to develop the research based on the concepts of IPD - Integrated Project Delivery for Public and Private Owners, AIA (2010), in order to check its adequation for this kind of entrepreneurship and possible revisions needed to make it feasible in this specific case.

In few words, the current AEC business model will change profoundly when we'll adopt these new production process based on digital technologies.

Certainly the DDB Model (Design Bid Build) contract method, where the architect follows a series of phases, like schematic design, design development and contract documents and then hires consultants to support the other disciplines as designing structural, MEP, etc, will be replaced by DB Model (Design - Build), where a complete team is hired together to develop an already defined building program and a schematic design, working in collaborative process rather than competitive one.

Indeed, as it has been shown by Eastman (2008) the use of BIM systems will anticipate the main constructive decisions to the conception design phase anticipating the demand for specific technical consultants.

But it is not only in the contract method that we expect to have big changes, also in the relationship between client and architect in terms of the design development method, especially if the client is a low income community.

Nowadays, in Brazil, the architect is hired to develop dwelling projects since a pre-defined standard

of repetitive series. He works far from the community, focused on low cost, high density of units and, last but not least, real short time to do the job with quality.

Digital technology, anticipating the construction definitions, will make available to work close to the community, allowing them to participate in design conception phase. It means that we need to develop the method that we shall work with them.

In that case, undoubtedly, the interface resources will be the critical issue once the architect has to communicate his abstract ideas, things that don't exist yet, to ordinary people who, in many cases, have never had the opportunity to decide anything in their lives...

Actually, this is an enormous opportunity to evaluate the performance of digital technologies such as rapid prototyping and immersive environments to support the process of design conception together with the community.

FINDINGS

Brazil is living a special time in its History, after about 25 years of democracy and 17 years of economic stability, period that allowed the reduction of poverty and raising the purchasing power of low medium class. This new scenery in parallel to the recent huge world financial crises turns the country as a relevant target for international investments.

It happens at the same time that four special events are going on: the dwelling program "My Home My Life", the beginning exploration of the huge oil reserves so called "Pré-Sal", the World Cup and the Olympic Games. Events that need advanced technology to be faced because of the complexity of their demands.

Thus, it couldn't be a better opportunity to develop a research like this one, exploring all the possibilities of digital technologies to deal with complex issues.

The research emerged in a rare connection between academy and the real state market, in order to make feasible a technological turn point in that branch and so many efforts have already been done also by official agencies and private players.

The first steps have already been done and we have a horizon of two years to finish this research when we expect to have changed considerably the technological references in the Brazilian construction chain.

During this time we'll be publishing partial results that we'll get in order to allow the debate and the revisions that sometimes shall be done.

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