Urban Projects Database Based on Alexander’s Pattern Language: The Case Of Favela-Bairro
Erivelton M. Silva and Rodrigo C. Paraizo
This paper describes a system for searching and retrieving urban design drawings developed or contracted by public or governmental entities. We assume that in governmental public programs with similar goals recreating solutions is a daily action, which is, clearly, an unnecessary waste of time and resources. The system presented in this paper aims at concentrating and organizing this information in order to allow urban planners and designers to search for existing solutions to their projects and answers to their current needs.
1. INTRODUCTION

This project was built upon the observation that it is difficult to access information concerning urban projects contracted or developed by public or governmental entities in Rio de Janeiro. This access is of special interest when private architecture offices are hired to develop these projects, and end up facing design problems that are similar to past experiences from others. Even when they are aware of previous solutions, usually the only way to get this information is searching through several different archival departments, public and private, whenever they exist, and learning their archiving methodology, which not always corresponds to the intentions in the new designs. Thus developing new recreating solutions becomes routine, and a clear waste of time and resources. The urban environment needs constant interventions, either because of obsolescence and the sheer need of renewal, or due to new demands. Previous solutions can and should be reapplied, readapted or recombined into new ones, and may even lead to the development of new solutions.

Favela-Bairro is a program intended to integrate poorer areas by the physical and institutional transformation of Rio’s slum areas (‘favelas’) into neighborhoods. It has been developed by the municipality of Rio de Janeiro for more than ten years now, resorting to public competitions in which private architecture offices design a methodology that is later developed by the office in the interventions. By analyzing the resulting designs, we can see how different professionals deal with similar problems, generating a wide array of solutions. City planners should profit from this widely varied accumulated knowledge in order to enhance the development of future solutions.

The objective of this research project is to develop an online database to serve as a public channel of communication of the accumulated knowledge represented in the design drawings of urban interventions such as those analyzed as part of the Favela-Bairro Program. Online databases and multimedia technology allow an efficient organization, as well as the update and continuous availability of these vast resources. With the help of the Internet, these ideas may facilitate future designs, making their development faster and more reflective on past experiences, therefore having an active and hopefully positive interference on the creative process of offices and professionals using the tool. In a later phase, these professionals may also be able to provide feedback to the system, evaluating solutions and even providing their own design solutions and original patterns.

This project originates from the M.A. thesis by Erivelton Silva on the use of hyperdocuments as a memory of urban projects [1].
2. THE FAVELA-BAIRRO PROGRAM AND THE DATA GENERATED

The Favela-Bairro Program started in 1993 as part of the housing policy of Rio de Janeiro for low-income residents in irregular settlements in the metropolitan area. Its key objective is to improve these settlements, mainly by building urban infrastructure and providing access to urban facilities. These measures provide social benefits that should ultimately integrate a favela into the urban fabric and transform it into a neighborhood [2].

In 1994, as part of the Program, the Housing Secretariat promoted a public design competition for a methodology to develop improvements in eighteen medium-sized favelas (between 500 and 2,500 dwellings). The winners, among which were young architects as well as older and prestigious ones - many of them working for the first time in favelas - presented new ideas and had the opportunity to unfold their methodological approaches, developing them in actual design interventions.

This competition generated a plethora of solutions to many of the recurrent problems in favelas. The Program’s line of action has been changing over the years to favor in-house designing, but the need to intervene on these areas still exists, and anyone involved in designing these interventions might benefit from past experiences, if not for finding a precise solution, at least some help for envisioning it.

The original nature of the competition, dividing the design among fifteen teams, generated data scattered throughout many offices, both private and public, that were never standardized nor centralized. The purpose of this work is to help gather this information and provide organizational scaffolding that allows users to retrieve it meaningfully, in order to employ them when thinking about new designs.

3. IMAGES, DATABASES AND URBANISM

The organization of knowledge that is based not only in words, but also in drawings, has been for a long time an important question for architects. In architecture offices, images, especially drawings, are usually indexed by projects alone, even when it would not be difficult to sort them by type of image (reference and building photographs, sketches and presentation drawings, early stages and detail drafting, for instance). Richer relationships between drawings and the design philosophy they represent, as the reasons to favor one housing typology over another, the pros and cons in a particular design detail or the path of development of a structural solution, are passed from one generation of practitioners to the other by word of mouth or rely on very generic documentation. When someone retires without completing this transference, some of these relationships are lost and the drawings lose part of their meaning. The resultant lack of knowledge is called epistemic failure [3]. This means that not only the actual piece of
information, that is, the drawing, should be preserved, but also the knowledge surrounding it - how to use it, how does it fit in a given framework of thought -, in order to be able to understand it.

Different approaches to catalog design solutions are seen by architectural handbooks such as Neufert’s Architectural Data [4] and Schneider’s Atlas of housing plans [5]. Structured as reference works, envisioning the reuse of information, they provide useful structural organization and indexes. Their digital counterparts, however, have not contributed much to improve data retrieval, something that can be changed if we approach them not only as catalogs, but as digital databases.

The term database is herein used as a structured collection of data, as well as the software that handles this data in order to search, order and produce subsets of it. Manovich envisions databases as one of the two main forms of new digital media, the other being virtual worlds [6]. They can be developed in many programming languages - Oracle, Postgre, Access, MySQL, MSQQL, Paradox - proprietary and non-proprietary, and they can sort and search large amounts of data using very refined filters. From Google and Altavista, with their collection of websites, to word processing software with digital dictionaries and thesauri, many applications we use regularly have databases in their cores.

When it comes to image databases, though, in spite of many improvements over the years, the possibilities of image data retrieval is mostly text-based. One of the few examples of content retrieval using images can be found in the research for color restoration of the Dunhuang Fresco Preservation project [7]. Only recently software such as Google’s Picasa has been offering color-based image retrieval, for instance, but still as an experimental feature. Therefore, most image databases have to rely mostly on additional interpretative information, stored either in the database or within the file. Metadata schema and information standards related to art and architecture include the reference model OAIS (Open Archive Information System), Dublin Core and Getty’s CDWA (Categories for the Description of Art Works), just to mention a few, witnessing the complexity of the task of classification; as Mason points out, such information standards for semantic classification of cultural data depend on social negotiations and specific community needs of information retrieval [8].

In general, architecture public database resources reference complete works and their references. Perhaps the widest known is Great Buildings Online [9], and its wiki counterpart, Archiplanet [10]. They both attest the difficulties involved in the classification of architecture works; date, for instance, refers to the construction period - it is not clear whether it includes or not the period of conception of the design, and to explicit or even record this period is a discussion worth having in some cases. Other fields, such as “style”, might generate whole debates for themselves. What is
clear is that a human operator must reflect and make a decision in order to make this classification, and that the clearer the guidelines are, the more consistent are the ulterior classifications and more relevant the possibility to compare and group records, especially when there are many operators involved.

On the other hand, when it comes to the urban scale, there are specific difficulties for the delimitation of the objects to be sorted, as the delimitation of an urban intervention in space and time is not always clear, making these judgments even more subtle. Research projects using databases as main resources or as a core that allows for the creation of more complex interfaces include BADU (Urban Database on Urban Projects) [11] and Rio-H [12], both developed in the Post-Graduation Program in Urbanism of Federal University of Rio de Janeiro (PROURB/FAU-UFRJ). The first organizes information about articles on urban interventions, and its fields “theme” and “keywords” show the careful reflection that must be done not only when designing the forms, but also when filling up the database. It also does not present fields for information such as total area, nor the duration of the intervention, nor its year, precisely because they are difficult to determine in many cases - and even the very elements that constitute an urban intervention vary greatly from one another. The second project is a database of spatially referenced historic texts and images of downtown Rio de Janeiro. Users can navigate using the metadata on each historical document that also associates each document with specific areas of the city.

The proposed database of design drawings therefore provides enough metadata information in order to appropriately sort and retrieve drawings; and its interface allows the visualization of the drawings, to speed up the access to the information.

4. PATTERNS

In any case, these schemas are not enough to provide useful information on the role of a specific image or CAD drawing in a given design. As described by Ozel [13] they embed the information about the object, but not the knowledge it represents, which means that they focus only on the classification, and not in how the objects in the database connect to each other and how they represent a design world view. In Ozel’s analysis, patterns can be used to represent this knowledge. They try to describe their objects in a value-free, impartial way, while a record of a design should incorporate also the values that constitute the design view.

Besides non-hierarchical relationships, the information on design should also allow for the formation of groups and subgroups. This draws us to the work of Christopher Alexander, and particularly to pattern languages, a theory described in “The Timeless Way of Building” [14] and further developed in “A Pattern Language” [15], where patterns are actually
detailed, and “The Oxford Experiment” [16], containing a case study of the application of the language in the expansion project of the University of Oregon.

Alexander’s theory was developed in a context in which Modernist architecture and urban planning were being questioned by critics such as Jacobs [17] and Krier [18] in the 1960’s-70’s. These critics were especially addressed to single-functional zoning regulations and the abandon of continuity and tradition in the city. Alexander, as some other architects in that time, acknowledged vernacular forms and traditional techniques as potential sources for design solutions, frequently overlooked and underestimated by professional designers; he also suggested that the community processes should be enhanced by participatory design.

The theory of patterns presents an attempt to code and structure in an intelligible way generations of architecture knowledge in order to address changing social needs and produce new spatial configurations. Perhaps its most successful intellectual feature is the structure of the language itself. In 1965, Alexander stated that, from the organizational point of view - and here we may add from the informational one as well - the city is not a tree [19]. The organization of a city is not structured as ramifications where each node has one single origin or branch. The tree structure provides a very simple navigation throughout the information, but does not hold more complex relationships among the objects that compose its nodes [20].

A pattern can be a part of as many other patterns as needed. The way patterns relate to each other, both horizontally and vertically, without single-parent constraints, combining in order to achieve more complex objects, is one of the strongest features of the language. This allows for a greater experimentation with a greater range of possibilities, answering to varying degrees of interest a designer may have in applying the language to arrive to a solution [21]. The structure proposed for the patterns has some similarities to rhizomes, as described by Guattari and Deleuze [22], in the sense that the ramifications and connections are multiple and virtually endless. A node is more important as it becomes more connected, just like a pattern is more relevant as it is more referenced. Unlike rhizomes and network structures in general, however, there is a sense of hierarchy in the pattern language, at least in the sense that relatively simpler (or “smaller”) patterns compose more complex ones.

The possibility of organization of complex information has found echoes far beyond the architectural field. The interaction among the context, the forces within the problem-space and its solutions, or actualizations, makes this notion fit for other practices that are project-based, such as Object-Oriented Programming, in software engineering. This growing interest that might be attributed to the influence of the book “Design Patterns” [23], and the number of scholars working in the creation and review of programming languages based on this notion has grown, as can be verified by the increase

Even if there are differences among Alexander’s patterns and how they were appropriated by software engineers, Ozel [13] argues that the confluence of meanings can lead to prolific solutions for Building Information Model, with the conscious incorporation of the qualitative and philosophical aspects of Alexander’s proposition, such as the rationale of the process, the relationship among patterns and the overarching qualities in design as patterns themselves.

Salingaros [24] identifies in pattern language a way to understand and possibly control a complex system through a coherent structure that could benefit even human-computer interface design. Human activity itself describes patterns, therefore they are also present in human interaction with the computer; and indeed many programmers and hyper-document authors have been trying to explore this approach in their interface designs and representation techniques, especially for the Internet [25].

Alexander does not provide a formal definition for the term ‘pattern’, considering it a pre-formal notion that describes the interplay of forces in the world and the relation among these forces. Each pattern describes a recurrent problem in our environment, as well as the solution to that problem, in a way that this solution might be applied any number of times without ever repeating. This description also implies a critique to the use of standardized models and components, highlighting the philosophical as well as the technical and social aspects of patterns and their relation to an open ended design structure.

A relevant methodological device employed by Alexander is the graduation of patterns according to their conceptual stability, as perceived by the researchers involved in its definition throughout a number of cases. This implies that patterns are not a given, but are actually constructed notions, and therefore can be modified, created and excluded at any given time - and that different pattern languages might correspond to different societies.

Each pattern should not be seen as an isolated entity. Its existence is supported by the connection with other patterns, from the scale of entire regions and cities to buildings and to constructive details. Alexander’s “A Pattern Language” accounts for 253 patterns, working as a pool of multi-purpose design solutions that attend many different scales. A pattern’s description is composed of five sections:

- Name: a descriptive name or phrase, short and familiar, synthesizing the solution instead of the problem or the context. Example: ‘Alcove’, ‘Main Entrance’, ‘Parallel Roads’.
- Example: one or more figures, diagrams and/or descriptions that depict an experimental application.
In the next section, we will examine how this structure was adapted to the information available for the Favela-Bairro Program.

5. THE SYSTEM

Even if we use as proof of concept only some of the designs developed for Favela-Bairro, we acknowledge that this kind of databases have constant and dynamic feed throughout the years, being more useful as their records increase - if the methodology employed to fill those records is clear and well constructed. Making this methodology explicit is essential in order to have others continue the work consistently on a later stage. Inadequate archiving can render the data useless no matter how well stored, making it difficult to retrieve and understand it, avoiding epistemic failure.

The methodology for building the prototype [26] can be described as the following set of actions:
- Choice of objects to be analyzed.
- Cataloging the information on these objects.
- Definition of preliminary design patterns from the information gathered.
- Design of user interface.
- Conforming the information to the chosen media format.
- Publishing the prototype for usability tests and debugging.

From the variety of projects that compose the Favela-Bairro Program, we focused on four design propositions to help elaborate the system prototype and its underlying pattern language draft. Although originated in the same architecture design office, Fabrica Arquitetura, they represent different aspects of Favela-Bairro, for they were developed for different community profiles: Quinta do Cajú, located at the shores of the Guanabara Bay, in the docks region, in lands that once belonged to the Federal Government and then legally transferred to their dwellers; Favela do Andaraí, in the North zone of the city, that served as a prototype for the Favela-Bairro Program itself, and is located on a hill; Parque Boa Esperança, also in the North zone, which is located on a plain and limited by two
avenues and a canal; and Divineia, located in Campo Grande, in the West zone, surrounded by many other low-income communities.

The communication of an urban design happens through many different media and techniques, resorting to photos, technical drawings, sketches, texts and notes. The methodology adopted should provide support not only for the textual information, but also for the visualization of graphic information. Besides, it should emphasize the relationship among the various parts of a given design proposition.

The system was developed with the focus on the technical drawings. They were considered as the main source for the database because they document a wide range of design scales while their precision and constructive information makes it easier to reproduce and adapt the documented solutions. This phase of the project focused on the analysis of this kind of document. This decision reduced the initial set of files from 2352 (comprising 1.75 Gb of information) to 1.764 and later to 1246 after removing backup files and duplicates. From those 101 drawings were chosen to build the prototype, because of their significance of representation and clarity in the identification of problems they addressed. The other 1145 remain to be later added to the system.

Once defined the universe of study, the drawings and their related data were cataloged using Microsoft Office Access, a relational database management system used to feed an object-oriented representation of the pattern language. Even though other database models could be more appropriate to describe the pattern language, Access was chosen for its availability for end-users and, more important, for its capacity to send information to Adobe Macromedia Flash via ASP, which was crucial for the development of the graphic interface. Other combinations of database managers (even with abiding by other database models) and interface design packages could be used with similar results.

Entry fields were determined by the validity and universality of information that could be extracted from the documents, and refined during the development of the prototype:

- **ID**: automatically generated, exclusive number to identify the drawing file.
- **Project**: the favela for which the project was originally designed.
- **Type**: the kind of file being cataloged (although initially focused on vector-based technical drawings, the system was designed to also incorporate graphic bitmap files, such as sketches and photos, as well as text files).
- **Original name**: the original name of the file in the architecture office structure.
- **Code name**: name by which the file is going to be referenced in the prototype. The need to create a code name comes from the ultimate impossibility to prevent duplication of file names across different projects or inside the same project but in different disciplines and
aspects. The code name is based on the name of the community, plus an alphanumeric index.

- **Description**: short text with basic information about the file.
- **Year**: when the drawing was executed. It may provide the user with an overview of the evolution of the project, or even of one of its phases. It may also serve as a basis for comparisons of designs from a single office in a given period.
- **Pros**: analysis of advantages of the solution, as in a post-occupation evaluation, in order to help the user decide whether the solution fits his or her needs.
- **Cons**: analysis of the problems found in the solution, also post-occupational, trying to identify the origins of problems in the solution or in its implementation. Understanding what has and has not worked in each case seems to provide better grounds for evaluating a solution and the necessary steps of adaptation in adopting it, guiding the development of improved versions of it.

Another table, *padroes2*, links different drawings that depict a single solution (as plans, sections and details of the same object, for instance). In the prototype, all data was entered by a single person, with thorough knowledge about the research objectives. Even unintentionally, this made it easier to deal with more subjective information, such as “Pros” and “Cons”. In spite of the database being centrally managed right now, its forms were designed envisioning future use by others, maybe even in a collaborative Internet-based environment, and future developments might include mediation between the perspectives of researchers and those of users, designers and post-occupational evaluations.

Once the data was gathered and analyzed, the next step was to create, from the observation of the database, a pattern language that could describe the transformation of a favela into a neighborhood. It was possible to identify the recurrence of some subjects as well as some designs that clearly answered to similar problems. Dwelling issues led to the development of a pattern called “multi-housing residences”, as well as water drainage led to the perception of a pattern to deal with “water ways”.

After that, it was necessary to identify the relationships among patterns, as well as to establish some intermediary patterns to articulate others; and their level of relative hierarchy. This was when the pattern language as such began to emerge. In the end, 37 patterns were identified and 50 relationships were established among them in different levels.

A table was created containing the definition of each pattern; and another recorded the relationships between them, as well as the level in which they occur. Macro-patterns, that is, high level patterns that deal with larger areas or more global problems, were created to group patterns that addressed similar needs. A last table links the patterns created and the registered files using their ID values, in such a way that several patterns can be linked to a single drawing, as well as several drawings can refer to a
single pattern. Even if the forms were designed with a larger user group in mind, this part of the process is bound to be more specific, probably destined to a specially trained agent, for its subjectivity implies a good knowledge of the philosophy that surrounds the concept of patterns.

The next step was to design the actual interface to exhibit patterns and their relationships, as well as their definitions and related drawings. A combination of Adobe Macromedia Flash - to build the graphic user interface - and Active Server Pages - to access the database - was chosen. Flash presented a good flexibility to satisfactorily display bitmap and vector images, and its scripting language, ActionScript, allowed communication with databases using ASP. The design strategy adopted has some similarities with semantic clouds, but in this case the relationships between patterns are reinforced; and their meanings are graphically designed to convey the idea that they are more stable concepts than tags in a tag cloud. The intention was to provide a graphic translation of the structure of a pattern language (Figure 1).

The application starts by presenting the highest level pattern, “Favela-Bairro”, as a floating circle in the center of the screen. Clicking on the ramifications icon on the pattern opens the lower-level patterns that are directly connected to it (Figure 2). Next to this button there is another that hides the patterns and their connections. If lower level patterns have connections to patterns other than the higher level one that caused it to appear on the screen, these connections are also shown. An eye icon appears on the lower center of the circle in every pattern other than the initial one, leading to the second screen, where the pattern definitions and linked drawings are shown.
This first screen is completed by the Search button (Figure 3), where it is possible to go directly to a pattern searching it by name. The option for floating and squashing circles reflects the intention to translate the inherent instability of any language: in spite of an overall stable structure, its elements gradually change and oscillate. Also, the circles can be freely rearranged on the screen by the user, to help him or her visualize specific connections.

The second screen (Figure 4) is divided in five sections. The upper part holds the title of the pattern and the navigation button that conducts the user back to the pattern navigation screen. Just below it, on the left, lies the pattern description. It ends with a list of drawings related to the pattern, grouped by the favelas for which they were originally designed. The area below the description shows the pattern connections to other patterns,
both above and below it in the hierarchy of the language. It also represents another form of navigation, avoiding the need to return to the first screen. On the right side of the screen are the thumbnails of related drawings, with the visualization screen just below them. Once selected, the drawing is “zoomable”, and clicking in the printer icon on its left opens another window containing its PDF version.

Here we must stress that reusing a solution or drawing does not mean one should not adapt or modify it. The intention is simply to provide references and a knowledge base from which to start, and always respect the context of application, as well as the designer’s own will to leave his or her mark.

The system so far is only a functional prototype, because it has a relatively low number of records. Future plans include increasing this number, which might eventually lead to review and adjust the interface. Other possibilities are the development of forms for the online addition of records to the database and also the creation of feedback mechanisms that allow users to evaluate and even suggest patterns, as well as their connections and the drawings associated to each one.

6. CONCLUSION

When the pattern language was presented, it described how to build a human environment, from a city to a small house. It caught the attention of many researchers in the field of software engineering because of its potential for the description and control of complex objects. In this project, it was again used to describe a city - or at least part of it - and the efforts to improve it; this time using computer software. This pattern language focuses in favelas, which are areas where public institutions have more difficulty to represent and in which to be represented. A pattern language
concerning these areas was developed and coded in a database, with a graphic interface that allows users to retrieve the written and graphic descriptions of each solution, as well as the relationships among the different parts that constitute the solutions. The system navigation is based on the visualization of the underlying pattern language, and this feature allows the user to perceive more easily the relations among elements of the language.

One of the goals of the project is to prevent the knowledge waste that comes from lots of effort and thinking from various attempts to deal with the city’s problems. This is even more important when those problems affect the poorer citizens that almost never can resort to professional help. If those who can help have some form of aid, the effort can be improved. Such a system should not substitute the designer; only help him or her to work more efficiently. Design teams could use the system to evaluate and restructure their own assessment of an architectural program of necessities, as well as perceive unexpected connections.

Although the goal of this project is not to evaluate how the system might affect professional practice, we would like to believe it should have a positive impact on design methodologies and in future public initiatives. The system’s architecture allows for the future implementation of a user-driven definition of pattern languages, in order that it could easily be adapted to new contexts and contents. The sole imposition it does, and it is not a small or meaningless one, is the use of a pattern language to describe it. Using patterns as a design reference should make the designer more aware of the relationships among the several elements in a project. The simple act of browsing through related solutions may lead to unexpected connections and discoveries.

It would be interesting to see an evolution in the designs, to see solutions evolve into new designs and even in new patterns, and to see a more collaborative approach in this area too. The system itself should evolve over time and use. It should be on the best interest of public institutions to provide feedback on the system, in order to develop and record urban design knowledge. The system might also help to visualize social changes by tracking responses to design problems over time. Urban design can be understood as connected modules; but these, once connected, ought to produce a result greater than the sum of its parts.

**Acknowledgements**

The authors would like to thank FAPERJ, CAPES and CNPq, for the funding and scholarships that made this research possible; their advisors, José Ripper Kós and Rosangela Lunardelli Cavallazzi; the Graduate Program in Urbanism of the School of Architecture of the Federal University of Rio de Janeiro; and the fellow researchers at the Laboratory of Urban Analysis and Digital Representation in PROURB.
References


Erivelton M. Silva
Federal University of Rio de Janeiro
School of Architecture - Post-Graduation Program in Urbanism
Rua Barra Mansa, 595 - São João de Meriti, RJ - 25555-760 - Brazil
eriveltoms@gmail.com

Rodrigo C. Paraizo
Federal University of Rio de Janeiro
School of Architecture - Post-Graduation Program in Urbanism
Av. Roberto Silveira 349/1006 - Niterói, RJ - 24230-152 - Brazil
rparaizo@gmail.com