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ABSTRACT
This paper describes the work of a team of architects, engineers, economists, sociologists, social workers, the city council and an association of homeless people, joining forces to create a pilot housing project as a model for the new loan system for housing in Brazil. The Ministry of Science and Technology of Brazil funded this applied research project with the intention to develop strategies of design, self-management, and sustainability for low-income housing. It describes the interdisciplinary approach of the research project and the participative design process developed for Residencial Serra Verde (RSV).

1. INTRODUCTION: THE SOLIDARITY CREDIT AS AN ALTERNATIVE HOUSING LOAN PROGRAM
In Brazil, until the 1980s, popular dwellings subsidized by the Government were built by private enterprise, totally excluding the participation of dwellers, as pointed by Lícia Valadares, Erminia Maricato, Nabil Bonduki, Alfio Conti, and other authors. This exclusion has in a way given incentive to popular movements demanding better living conditions and new forms of management in order to implement these conditions. According to Bonduki the proposed housing self-management—seen as a work of construction and management carried out by the future dwellers—appears in Brazil in the beginning of the 1980s lead by the popular movements in the fight for better living conditions. The proposals articulated by these movements were as follows:

- The creation of entities that represented the organized community, in charge of promoting and managing all stages of the housing enterprise (self-management);
- The attainment of land with the governments, at zero cost;
- Attainment of financing compatible with a household income of around a minimum wage, in order to buy construction material for a house of about 40 m2;
- The construction of houses incorporating the work force of the community, organized in the so-called mutirão (constructing bees);
- The attainment of subsidy for the execution of infrastructure; and
- The hiring of technical teams trusted by the community, to help it in the elaboration of projects, in the planning, control, and organization of the work and of the contracts with public organs.

In the beginning, one of the biggest difficulties found in this self-management idea was to legally form an autonomous co-op of the public government. This difficulty persisted until 2005, when the government, through the Ministry of Cities, created the Common-Interest Credit Program, to be operated by the Caixa Econômica Federal (Federal Economy Bank), whose objective is to “attend the housing needs of low income citizens by financing the final beneficiaries, organized in co-operatives or housing association”.

The beneficiary families—with an income of three combined minimum wages or less—must join in an associative manner to obtain credit. Families with an income above three combined minimum wages are admitted, but no more than 20% per enterprise. The Common-interest Credit Program admits the self-building regime of the beneficiaries themselves, self-help or constructing bees, or direct management, with the hiring of professionals or firms to execute the specialized services.

This program is the result of a long and intense struggle of popular movements and can bring significant improvements in solving the qualitative and quantitative deficit of popular housing in Brazil, as long as it is carried out properly.

2. RSV: THE CONSTRUCTION OF A SELF-MANAGEMENT MODEL
Since 1996 the School of Architecture of the Universidade Federal de Minas Gerais—EAUFMG—has developed research using advanced graphic computing resources to give support to the participation of the community in the planning and housing production for the low-income population.

Because of this accumulated experience the Financiadora de Estudos e Projetos—FINEP (technology innovation agency of the Ministry of Science and Technology)—hired with the Projects Department of EAUFG the elaboration of a model to enable the construction of housing of social interest in the self-management regime, incorporating principles of the common-interest economy, of community participation, digital inclusion and environmental, social, and economic sustainability (through job and income creation). This model is not abstract, since it is an applied research aiming to actually build housing for 76 homeless families, as a pilot experiment of the Common-Interest Credit Program.

The project groups professors, researchers, and undergraduate and graduate students of the Universidade Federal de Minas Gerais, the Pontifícia Universidade Católica de Minas Gerais (PUCMINAS), as well as Belo Horizonte City Hall technicians and leaders of the Associação dos Semi-Casa de Belo Horizonte (Homeless Association of Belo Horizonte)—ASCABH. Its main goal is to link technical and scientific knowledge developed at the UFMG and PUCMINAS with the current housing policy of the Brazilian government in attention to social movements for housing and urban reform. Its main result should be 76 dwelling units with 50 m2 each and a report with recommen-
ations for further development and improvement of the Common-

Interest Credit Program.

The self-management housing model resulting from the project should
be reemployed in similar enterprises, in order to consolidate the self-
management process and the public policies of social development,
with an aim to overcome the poor social and economic conditions of
a large part of the country’s population.

In order to develop strategies that not only cover the design of hous-
ing, but also enable common interest economy and a certain degree
of sustainability, two simultaneous research studies are of fundamen-
tal importance: first, the survey on community habits and vocation
devised by the Department of Economics, and second, the strategic
reuse of water and wastes, devised by the Department of Engineering.
The survey is set as an interview, containing both structured and semi-
structured questions, aiming to trigger in the community a discussion
process regarding possible vocations for future work arrangements.
These work arrangements range from women groups with handicraft
and culinary skills to more professional mixed groups willing to learn
and develop skills related to construction techniques or other issues
indicated as result of the interviews. As for the reuse of water and
wastes, the Department of Engineering has presented to the com-

munity some options and their benefits, ranging from traditional solu-
tions of dirty water and waste disposal to combining possible reuse
of water and waste showing the labor needed and the possible profit.
About 98 percent of the community members seem to be willing to
implement the strategies for treating and reusing water and recycling
waste. The final project and costs for implementing such a system is
now being studied for the final approval of the community.

It must be said that this is the first time we are able to join all dis-
cussions, critiques, and techniques developed in previous research,
and also to test some as yet unexplored tactics of participation in a
real situation of housing development. As far as we have already
come, it has proven very successful. It has been legally approved by
the city council and by the loan program, and is now in the beginning
of the negotiation process of self-management. The community will
now decide how to proceed with the building of its housing: whether
some of its members will work as self-builders or if they will contract
a third party to do it (contracting). The technical team is already work-
ing on the best structural solution to guarantee that construction can
be done without any heavy instruments and with non-specialist labor.
With regards to labor, any contracted labor would need some training,
so it is important to give the training opportunity to those members of
the community who are unemployed and willing to improve or learn
new skills for further jobs, as indicated in the research of the Depart-
ment of Economics. Section 3.3 describes further the concept of open
design applied to the constructive system, employed to make it easier
to accommodate different structural systems at the time of construc-
tion, considering the huge fluctuation of prices of ordinary building
materials in Brazil.

2.1 The characteristics of a self-management model

The housing production process in a self-management regime has its
peculiarities: the hiring of technical consultants that elaborate the
projects and technically manage the work and the mixing of special-
ized labor with unskilled labor, recruited in the community.

A self-managing model, therefore, involves the following activities:

I. After the partnership between the government (which
makes the land available) and the dwellers association for
the execution of an enterprise is defined, a package of ar-
chitectural and complementary projects is provided. This
package is elaborated by the technical consultants with the
participation of future dwellers.

II. As soon as the architectural project is concluded, the
technical assistants take care of its approval and registra-
tion with the relevant authorities.

III. Once the complementary projects are concluded and
coordinated, budgeting and planning actions are taken with
the objective of physically and financially executing the en-
terprise, with the participation of the community and co-
ordinated by the technical consultants.

2.2 Preparation of the users to the participation in the project
and construction activities

The evaluations carried out in self-managed housing settlements re-
veal that the main problems of such a management model are due to
the lack of participation of the community in the decisions about the
project, planning, and execution of these enterprises.1 This lack of par-
ticipation is due to two basic factors. The first is excessive tutelage of
the government that subsidizes the enterprise and consequently takes
control of the decisions. The second factor is the lack of formal knowl-
edge—technical and administrative—of the beneficiaries, which in-
hibits and even impedes their full and effective participation in the
process, for they are left impotent in front of the supposedly technical
arguments that are presented to them. In fact, excessive tutelage
takes place exactly because poor communities have little argumenta-
tion power when faced with technical elements and find themselves
in an extremely fragile political position because of the financial help
they get from the government. The tutelage of the government gener-
ally gives rise to authoritarian actions, while the community’s tech-
nical and political frailty results in subservience. Authoritarianism and
social frailty make a circle that needs to be broken. Among the actions
that can be developed to enable people to make informed decisions
and encourage their participative attitudes, breaking this circle, is
education. Thus, the process of project and construction of dwellings
must constitute an opportunity for learning.

Another question highlighted by previous research is related to the
role of independent technical assistance, hired directly by the commu-
nity association. A well-conducted technical assistance was observed to be extremely relevant for the success of a housing program managed by the community. However, the technical assistance must not manipulate the decision-making process.

The technical discourse is intimidating and seductive at the same time. It is seductive because of the mystery it holds: the technician (or specialist) is taken as a person that has the key to access all compartments that normal people do not understand. Projective drawings, for example, are too intricate for a housewife or a man who washes cars that never finished primary education. A cost table is enigmatic for both of them. In a constructing bee both are “consulted” and take part of the decisions that are suggested to them. They do not challenge these decisions because they cannot understand everything about them. They are vulnerable, therefore, to any sort of manipulation. This problem can only be minimized—and even eliminated—if the community has total access to the technical and financial information of the enterprise. To access it fully it will be necessary to know it fully. The role of the technician is to generate the possible alternatives of solution, be they technical or financial. To decide on the alternatives generated, the community needs to understand and evaluate them autonomously. This is the big question to be solved in self-managed enterprises. The evaluative studies available—including the ones we carried out—do not indicate any technical, building, sociological, political, administrative, or legal problem to which the solutions are not known and tried, be they in our or in similar contexts. On the other hand, a little-explored field is that of the interaction between the community and the enterprise, like the practical and democratic action and exercise of citizenship. A high degree of interaction between the participants of the enterprise and the free circulation of information seems to be a fundamental element for the improvement of the cooperative systems of construction, and here we include the constructing bees. The individuals involved in the creation process—architects, engineers, technicians and especially the final users—may, with the support of computers, be asked to participate in a more effective way in the work process.¹

Thus we arrive at the idea of combining educational action with the development of new participatory processes in the work project and execution, using computer technology.

With this strategy we could enhance cooperative management procedures, enabling a better communication between the work site and the technical backing, and employing effective mechanisms to educate personnel, in which the teaching and learning activities take priority over mere training. Our hypothesis was that the situation itself—the effort of a community to make its own housing—was extremely propitious to the development of innovative actions in the systems of cooperative housing construction. Besides, the incorporation of cutting edge technologies in the computer science field could enable people in the community to move past their lack of technical knowledge and lack of experience.

We are convinced that only the incorporation of new technologies to the self-management process will make it develop technically and administratively, while remaining a participatory process. From a technical perspective the self-management construction regime is a construction like any other. It involves the same operational procedures required by other forms of construction. To generate products of good technologic, architectural, urban, and environmental quality, the constructing bee has to be organized technically and administratively like any other means of production that has these same objectives. In a constructing bee, the execution of a brick wall must obey regular procedures, whether the executor is a professional builder or not, for the wall needs to be a well-built wall. A finished house is a building like any other.

The difference between the cooperative construction system and the construction enterprise (construção empresarial) resides in the involvement of the human resources and in the type of management of these resources. In the construction enterprise (construção empresarial) the human resources are specialists, except in those activities in which unskilled labor may be used (as is the case of transporting the materials from one place in the construction to another). On the other hand, the human resources available for constructing bees are very heterogeneous and vary from case to case. And each case will be unique. However, the involvement of the people with the act of building their own houses is always intense, and that makes the qualitative difference between the cooperative systems and the systems of contracting.

According to Antônio de Pádua, president of the Estate Union for Popular Housing, the appropriation of the housing—dwelling units and collective spaces—is much more successful when community participation happens from the beginning of the design process. The sooner people get involved with the decision process the better becomes their knowledge and understanding of the limitations and possibilities of their housing. Consequently their sense of “belonging” is enriched when appropriating the space, be it during or after construction.

To participate is to decide, and to decide one needs to understand what the object of decision is. The participative design process must include the community in all stages of decision, and at the same time empower its members to understand and negotiate each one of the stages. In the case of RSV, we were able not only to create and test a participative design strategy with some community members, but also to evaluate it critically, correct the errors found, and try again in new workshops.

After this comprehensive explanation of the project we focus on the design strategies used to guarantee low cost and high value of use in housing. This takes into account that the more empowered the community is to make decisions, the better involved the community will be in the whole process, from designing to building and appropriating.
3. PARTICIPATIVE DESIGN STRATEGIES
The participative design strategies developed for RSV aim to include the community in all stages of the design process. The design process is developed in three steps: First, the digital inclusion of the community, which aims not only to make community members familiar with computers but also to make them familiar with the basics of architectural representation and to get involved with the design process. The main objective of this digital inclusion is to enable the community to negotiate their spaces among themselves and with the design team. Second, the participative design process of the dwelling units aims to define which features are of collective and individual decisions, and also those that are unacceptable and wished for. The main objective of this process is to define what can be taken as fixed and what can be taken as flexible in order to guarantee low cost and high value of use of all dwelling units. Third, the design of the housing itself takes into account the results of community participation in the previous stages. In the case of RSV, the housing is a vertical building fully accessible, whose units are embryos fixing those features collectively decided and leaving open to dwellers half of the floor area of each dwelling unit, so they can decide individually on their living spaces without making the housing more expensive. It must be said that these stages are not so strictly divided, they happen simultaneously, informing each other. The design team was already working on the building site and studying possible building locations simultaneously with the first workshops for digital inclusion. Nevertheless, we divided the three steps as clearly as possible for purposes of description and further research.

1. Screenshots of the form with digital keyboard with two different fonts and the animation of the digital keyboard into Qwerty keyboard

3.1 Digital inclusion
For the digital inclusion of the community—almost all of its members are computer illiterate and some of them completely illiterate—we have criticized and improved the digital-inclusion strategy developed in previous research by Flávia Ballerine and José dos Santos Cabral Filho. We designed a set of interactive digital interfaces, using Macromedia Director, to enable community members to learn the basics of computers with content related to the housing. This educational process is not one-way, as the technical team also learns a lot from the families about their preferences, wishes, and dislikes, which informs the design process. Each of the 76 families has at least one representative taking part in the workshops for digital inclusion.

The first digital interface is designed to introduce the use of the mouse, which is a difficult task for most uneducated people. Ballerine had already indicated that one of the greatest barriers to start using the computer was the difficulty to find the letters in the keyboard, which makes people quite uneasy. This first interface is then a simple form (Image 1) with family data to be filled using only the mouse to choose the letters placed in alphabetical order in a digital keyboard. People are required to interact several times with the movement of the mouse, as they need to make the form fields active by clicking on them, and later clicking on the letters to fill in the fields. As the task—filling in the form—is quite important, as this is their official registration to start the participative process of designing and building their homes, they focus on the task, and not on the use of the mouse, which seems to facilitate the use of the mouse.

The second digital interface (Image 2) is set to give continuity to the use of the mouse and to introduce the keyboard, making people more comfortable with the computer. This is used after the animation of the letters from the digital keyboard into Qwerty keyboard, which makes them more at ease with their lack of knowledge of the position of the letters. This interface regards users’ environmental preferences, and it is designed to stimulate people not only to repeat the use of the mouse—but clicking and dragging—but also to start thinking about their preferences regarding the place they will live in. Instead of providing a set of images to be chosen, the interface has fields in which users are required to write that which comes to their minds. If the word written matches the range of things we have already thought of, then a symbol of it appears, if the word is misspelled or if it is something we have not programmed, then a generic symbol appears with the word on it. In both cases users are required to drag the symbol and place it in order of their preference in one of the five squares on the bottom of the page. Though this is a very simple interface, it is effective because it not only introduces the use of the keyboard quite naturally, but it also starts a process of participation in which people are not required to choose among predefined things—rather they need to think independently and inform the technical team about their wishes.

2. Screenshots of a sequence of use of the interface of environmental preferences
At this point in the workshop we have a break from the computer, as people have already taken more than an hour with the previous interfaces to get familiar with the use of mouse and keyboard. During this break, we ask them to use a set of cardboard modules measuring 1 m x 1 m and build a room. We then require them to organize cardboard tiles on the floor and discuss with them notions of area and volume.

After that, they return to the computer to use the next two interfaces, which pertain to architectural representation and require of them a more precise use of the mouse (Image 3). These two interfaces are reproductions of the cardboard room they have created. The first deals with organizing tiles on the floor, so users are required to experiment with the abstraction of the concrete space they had just created to its representation. This deals with scale and notions of area in architectural representation, both plan and perspective. The second has the same room as its basis, but this time users are required to organize a furniture layout. In both cases users can operate in plan and perspective simultaneously, as everything done in one is automatically represented in the other.

Since having people really involved and knowing what they are deciding on is crucial to the success of this work, we needed to find the best way we could possibly use for architectural visualization. We then decided to apply the techniques of “usability test” to check which way would be the most useful to communicate with the community the design of their housing. We redesigned the interfaces of spatial representation as a test with different kinds of architectural representation, ranging from physical to digital models, used in different ways, as we also wanted to check how the community would feel more involved discussing their own spaces.

From a series of six workshops with different groups using different approaches, we noticed that the more successful was the manipulatable three-dimensional digital model, with which people got more involved and seemed more able to visualize as an abstraction of a real space. Our observations made us speculate that perhaps people tend to see physical models and printed drawings as concrete objects, which makes it more difficult to start the abstraction process. With the digital model, due to its lack of fixed scale, people are already working with abstraction from the beginning, and this is perhaps the advantage of this kind of representation. Another point we have observed is that when given a bit of time alone to play with the model each user was able to get much more involved and bring more ideas to the discussion process.

3.2 Participative design of dwelling units: collective and individual decisions

The second step of the participative design process is the design of the dwelling units. Though participative design process is not new, we developed a new approach due to recurrent problems. In order to apply for a loan the design needs to be legally approved by the city council, which means that before having the final dwellers defined (approved by the loan agency) it is necessary to have the design. Another problem is that the community has in common only the lack of money, their demands are not the same, which means that more space with lower cost is welcome instead of a fixed space with predefined size and number of rooms. This, among other reasons explained below, made us rethink the ideal of individual participation. Our approach implies a workshop based on the strategy of focus group, with randomly chosen homeless persons in which several design proposals are shown and they are able to criticize and change them in real time according to the group’s negotiated demands. From this we are able to define which features are of collective and individual decisions, as well as those that are unacceptable and wished for.

For this participative process our starting point was the idea of “open
design,” borrowed from product design, which according to Ronen Kadushin is “based on the principles of the already successful Open Source method that revolutionized the software industry, and gave birth to a social movement that is cooperative, community-minded and seeks legitimate ways of sharing creativity.” Both open source and open design are participative processes that enable different degrees of participation.1

According to Carole Pateman there are three types of participation: pseudo, full, and partial.2 Pseudo-participation is the most common in architecture: users are called to participate in the design process only to legitimate the imposed proposals of architects. Pateman says that “pseudo-participation ... covers techniques used to persuade employees to accept decisions that have already been made.” This needs to be distinguished from architecture. On the other extreme full participation is defined as “where each individual member of a decision-making body has equal power to determine the outcome of the decisions.”3 This would be the ideal, but due to its very egalitarian definition it is not possible in architecture, as architects would be always in advantage with the power of their technical knowledge, which differentiates them from other participants. So, in architecture we can only think of partial participation, and this can be directed towards pseudo or full participation. Nevertheless, we need to bear in mind that the knowledge of architects is an instrument of power, and this can be regarded not only as a negative attribute, but as a powerful instrument in benefit of participative design; that is, it can be used to help people to understand their lived spaces and to interpret their demands, so the design of spaces can be produced as to meet people’s demands without imposing ways of living.

In architecture partial participation is not new. Architects such as Lucien Kroll, Ralph Erskine, Christopher Alexander, Yona Friedman, Walter Segal, Cedric Price, and many others, have already tried it in different ways. Some of them would approach participation as a means to personalize buildings according to their users, as is the case of Kroll’s La Meme, and Alexander’s Nagoya and Mexicalli housings. The problem with such an approach is that the space is personalized, designed as to accommodate the demands of users in a specific time, becoming as difficult as other buildings to accommodate future changes. An attempt to solve this problem is to use modular systems, such as those developed as SAR (Stichting Architectural Research) and Open Building, working with the idea of support and in-fill, setting the fixed and the flexible parts of the building.4 Unfortunately, this in Brazil is not easy as our building industry is not developed according to modular coordination, and our building regulations do not help. As an example, it is not possible to have a building approved by the city council and change its facade (nor even change the place of windows in the facade).

Other architects, such as Friedman, bring the user to play the role of architects. Friedman’s ‘Flatwriter’ would enable users to design their own flats. In this case, the architect creates a sort of interface to help users decide on their spaces, but the design is still completely pre-defined before building and use, making it difficult to accommodate future changes due to different demands of use.5

In the cases above, participation is facilitated by letting the user work with the architects or replace the architects. The designs produced, even if with a certain degree of flexibility, are of finished spaces, with little or no change in the traditional design process based on representation, in which the stages of design and construction are completely separate.

The participation processes proposed by Segal and Price differ from the above. Segal developed a self-building system, which includes the user in the actual production of space, and Price proposes value-free spaces, or flexible spaces, in which users are expected to complete the spaces with their appropriation.6

The intention of RSV’s participative process is to acknowledge the power of architects without reproducing traditional practices, without moving toward pseudo-participation. We are inspired by the idea of support and in-fill, and also by the self-building processes of Segal and the flexible spaces open to users’ appropriation proposed by Price. We developed an approach to join these strategies taking into account our local building regulations and the very low budget of the Common-Interest Credit (each dwelling unit needs to be R$ 20,000,00, which is about US$ 10,000.00).

We already knew from previous research that low-income communities in Brazil modify residential spaces much more frequently than the middle classes because their houses tend to be much smaller and they have to extend or adapt them over time due to changes in their family composition.7 Another point is that their dwelling units are small, so any change needs to be accommodated in the space, which generates refurbishment. With this in mind we started to discuss with the community a series of design proposals for the dwelling unit, ranging from 40 m2 to 50 m2, with different articulations of internal spaces. These proposals were supposed to raise discussions and inform the design team about what can be taken as collective, thus can be fixed in the design solution, and what is taken as individual and so need to be left open in the final design solution. These discussions were done in workshops with the community, sometimes with focus groups (12 to 15 people), sometimes with groups of more than 20 people. At all times we used 3D models. In the smaller groups these models were manipulated in real time by a technician using the software Sketch Up, which provided an easy and quick way for the community to criticize and change the design proposal. In the big groups the models were used to show the community they demanded changes in the design proposal so they could approve them. We also used printed drawings of plans to be modified and criticized individually, in both big and small groups, and also used a combination of strategies—3D models and 2D drawings.
The strategy adopted in the workshops with small groups was to show three different models of the dwelling units for discussion and modification (Image 4). None of these models were intended as the final design, they were only means to raise varied discussions concerning the relationship of the members of the community with their dwelling space. One of the models was a finished two bedroom dwelling unit, with all walls and rooms defined, and with very little possibility for future change, as the bathroom determined the two bedrooms and the living-room. The only possible change people could make in space was to open the kitchen to the living-room. Another dwelling unit presented was an open floor with the kitchen/service-area and bathroom defined. People were able to try and place two or three small bedrooms and the living-room, and also to change the size of the kitchen/service-area. The other alternative to the dwelling unit presented was a three bedroom with little possibility for change.

After the first discussion groups we were able to understand that the community had equal thoughts regarding the wet areas and one master bedroom. This means that they wish a big kitchen with separate ventilation from the service area, a very tiny toilet, and a master bedroom able to accommodate a double bed, a wardrobe, a drawer and two bedside tables. Most of them also wish they could have some privacy separating the bedrooms and toilet from the living space. There was no consensus regarding the number of bedrooms and the size of bedrooms and living room, nor was there consensus concerning the possibility of keeping the kitchen open as an extension of the living room or closing it. From the discussions with the community, and the changes they made, we learned enough to start working in other dwelling units for future big group discussions (Image 5). So we defined as collective not only that which Habraken calls support, but everything that seems to be consensus, including most of the in-fill (wet areas); and defined as individual the living spaces, that which should be open to each family to decide upon.

The final design of the dwelling units tried to contemplate all these, and at the same time take advantage of the fact that we have a very low budget to build the best space. The community has opted to have a 50 m² flat even if this implies not having their flat completely finished. We are still trying to sort out a way to enable them to finish their flats according to their different demands for their living spaces. But this is not only a matter of budget, but also of building regulations, as the unit is already approved by the city council and the loan program, and any change needs to be approved again.

The participative process used in RSV borrows from Price the idea of leaving the space undefined for users’ appropriation, as half of the space designed is left empty for future divisions when appropriating. The architects work not as authors or advocates of one design or idea, but as observers showing different possibilities for the community and learning from and with them how to interpret their demands. Our interest was always turned to hearing the community and learning from them as much as we could in order to empower them for discussing their demands and spaces. The workshops were always conducted by a group of architects and at least one economist and one engineer. The technical team works more as mechanical hands for the community and less as authors of a finished design. The final design of the dwelling units is a collective product.

Partial participation and open constructive system tend to take to the extreme the possibilities of accommodating different life-styles. This is what we call “open design,” which aims to enable partial participation of users in the conception, building, management, and appropriation of the building; always taking into account that in order to produce mass housing we need to open the possibility of participation as much as possible without affecting building costs.

3.3 The final design of the housing
The third step of participative design is the design of the housing itself. The architects’ team already knew from previous research1 some requirements of Brazilian low-income communities as far as the housing settlement is concerned. These requirements are:

I. While doing the housework, the mothers must be able to have their kids playing under their possible surveillance;

II. Bedroom windows should not face one another, to ensure pri-vacy;
III. The housing should not have unsafe areas (hidden places), that is, all places should be easily watched by dwellers;

During the workshops other requirements were put forward by future dwellers:

IV. The use of lift should not be compulsory, because of their high operational costs;

V. People should be able to access their houses without ascending more than one or two floors.

After knowing all these requirements the architects’ team was able to develop a housing design and submit it for the community appraisal. First we studied the terrain, which is quite steep (Image 6), and the possibilities available for it. Then we opted to use the declivity to guarantee direct-level access for all pavements to be built. The most adequate solution to attend most of the requirements was a variable high terraced housing, forming a horseshoe, with a large collective area inside it (Image 7). The part higher up in the terrain is composed of two floors. The part lower down in the terrain is composed of five floors. It had already been determined that the housing units would be semi-detached and would have the door and one window facing an area of circulation, and the other windows would be facing the outside. The length and depth of these units, as well as the positioning and articulation of the rooms were then defined in a participative process aiming for open design.

This solution stood up under the community scrutiny; it was very well accepted and approved. A few people seemed to be worried about the circulation in front of their sitting room and would prefer a high sill window there. Nevertheless, the majority opted to have low sill windows with curtains to protect the view from people passing by. The area of the plot is 6.367 m². There are 76 dwelling units of 50 m² each, more 100 m² destined to a telecenter for the community (funded by the Ministry of Science and Technology), plus an open area (200 m²) we call “pilotos” for legal approval purposes, which will be used by the community for economical purposes (common-interest economy or rental for needed shops). There are 27 parking spaces, as most of the dwellers have no car and also the city legislation only requires one space for each group of three flats.

We have used the open design concept to inform the open structural system. That is, we designed the building to enable distinct possibilities of material and components without losing spatial quality. This is crucial in Brazil, because the prices of products in general are not stable, and so the prices of building material usually fluctuate. For example the price of cement decreased almost 50 percent last year, and the price of iron is more than twice its value a couple of years ago. This makes iron structures almost impossible, as also the use of ferroconcrete. However, the use of concrete is encouraged by its low price. At the moment, the best alternative seems to be concrete structural brick walls. This example only shows that in Brazil we need to have options for the time of construction, and not define the structural option which seems to be the cheapest at the time of the design. Different motivations make the prices of material change and the design must take this fact into account. To enable such a flexible choice of materials and constructive system, the design we propose can be built for example in iron structure, ferroconcrete, or structural brick walls. When using structural brick walls, the design generally is done so as to create indentations that guarantee structural stiffness. H-shaped buildings with small indentations on each face are very common in Brazil, built with structural brick walls. When using iron structure or ferroconcrete, this H shape with indentations turns out to not be very rational, as it demands a lot more structuring than a non-indented building. In the case of RSV (Image 8), we proposed the joint of perpendicular walls as a series of T-shaped structures to avoid the need of indentation and to guarantee flexibility and quality of space, taking advantage of any structural system employed.
Another advantage of the design of RSV is that if built with structural brick walls it can employ bricks of both families available in the Brazilian market. This is another interesting point for research as in Belo Horizonte, and also in other Brazilian cities, brick producers usually make them 39cm x 14cm (39 family), which means that if the pagination of the walls are right we need to use a few bricks measuring 14cm and a few measuring 54cm (which is a bit heavy if the workers are first timers or women for example) in order to create the T-shaped structural system. Nevertheless, recent research has already indicated that it is much easier to paginate and to build walls using smaller bricks (29 family), which are also cheaper to produce, making the final cost of the square meter even cheaper. The problem we have is that on the one hand it is easier to find and buy the 39 family, but on the other hand we should at least try and push the market to change to the 29 family. This can only be done if we have a design to fit both situations (Image 9), as is the case of RSV, so we can test both scenarios and the community can understand the advantages and disadvantages of all cases and decide what to do.

We are now preparing the complementary projects (electrical, hydraulic, and structural) to start the discussions with the community concerning the self-management of the building. The site was already donated by the city council, and the building process will start this year. As already mentioned in section 2, the design was already approved by the city council and by the loan program. However, the families are not yet all approved, and the last notice we have is that only half of them were able to fit the requirements of the Bank. This means that the homeless association needs to replace some of the members applying for this program, or to review their applications. So, we cannot say precisely the demographics of the future residents, but from the 76 families we have up to now we can have an idea of the residents’ profile:

- 86 percent of the heads of the families are women and only 14 percent men. According to Antônia de Pádua, president of the Estate Union for Popular Housing, this is due to women’s role as mothers and their need to have more stability and fixity than men (this is particularly the case with low-income families). Their family income varies from two to three minimum wages, (the minimum wage in Brazil is R$ 350,00 month, about US$ 160).

- 19.7 percent of the families are composed of two members, 26.3 percent composed of three members, 21 percent of four members, 15.8 percent of five members, 10.5 percent of six members, and 6.6 percent have their composition varying between 7 and 10 members.

- 65 percent of the heads of the families have already lived or worked in rural areas, which characterizes their skills for rural activities such as growing fruits and vegetables, cooking fruit and vegetable conserves, and other related activities.

- The age of the head of the family varies from 22 to 77, and the age of other members ranges from newborn babies to grandmothers and grandfathers in their 80s. We can perceive a predominance of school aged children and teenagers.

- 26.3 percent of the heads of the families are single, 47.4 percent are married or have a stable union with a partner, 14.5 percent are divorced, and 11.8 percent are widows.

4. PREPARING FOR THE WORK: THE GAME STRATEGY

In order to increase participation of the community in the discussion of construction questions, we raised a daring hypothesis: the incorporation of cutting edge technology in the computer science field, using the seduction of a video game associated with the didactic and pedagogical approach of Paulo Freire to teach adults.

The idea of the games was a strategy to transform the teaching/learning into a sort of child’s play, using electronic games with all their seductive potential. Hans George Gadamer notes that a game is not something serious for those who play it, and that is why one plays it. The seriousness of the game is exactly in that it is taken seriously as a game and not as something serious. The game has its own essence, independently of the players being conscious of it. The players are not the subject of the game; but through the players it is the game itself that is represented. Hence its power of seduction and the force it has to fix learned points.

A series of games is already being developed with three games completed, and another three under way. The games will be used as soon as the community decides on the management strategy, defining who will take part in the construction process. The first game to be played is the building-site game, which is described bellow as an example of the game strategy.

4.1 The building-site game

The building site game deals with the organizational aspects of a building site, regardless of the type of enterprise—whether it is self-managed or contracted—but taking into account its size and technological profile. The objective of the game is to allow the discussion
of several important factors in the assembling and organization of a conventional building site, using the video game strategy to commit contents to memory and discuss them. The structuring elements of the building-site game were conceived with reference to a building-site for a popular housing enterprise of medium size in which conventional technologies are employed in the construction, in which supporting and sealing elements are made in loco.

According to the technicians that have already worked in aiding constructing bees, one of the main problems found in the organization of the building sites is to make personnel realize that there is a need to keep the building-site organized and clean. This is surely due to the fact that the conventional construction activity is in itself a generator of dust and debris, giving the impression that disorganization and dirt are inherent aspects of construction. Because of this it was decided that a basic educational message of the building-site game would be that a building-site must be well planned, furnished with all the infrastructure of support to the work, to the storage and distribution of material and tools; and it must be kept organized and clean to enable good production development.

To make the learning of these contents more effective, the game would be played first, and then discussions related to the elements of organization of the building site would be conducted. The contents would be evaluated and the eventual distortion of information would be corrected. Thus a group of the constructing bee would freely play the game and then a technician (of technical assistance) evaluates it. In the instruction about the game a small script is presented that might lead to discussions with members of the bee as an evaluative task. Even if a member of the bee does not become interested by the discussions, she will still have attained certain general concepts from the game, allowing her to understand some matters related to building sites more easily.

4.1.1. João Expedito organizes the building site
To fulfill the educational objective of the game, a story was created in which the characters were members of a constructing bee. João Expedito (Expedito John) is a young man who wishes to build his house and joins a bee, at the heart of a homeless association. Zé Palpite (Opinion Joe) is an idle fellow who roams around the building site trying to get in the way of João Expedito’s task. The game presupposes that the player will side with João Expedito, trying to protect him from the actions of Zé Palpite.

Initially there is an introduction to the game, which aims to contextualize the story and present the characters. In this introduction João Expedito looks for the technician Teresa (Tetê) and asks her what is necessary to start the bee. Tetê explains that, among other things, it is necessary to build some provisional installations called “building site” where the houses will be located. After that, Tetê observes that the preparation of the site requires four basic places: one for storing tools, one for material, one for an administration office, and one for a refectory. She adds that electrical installations and water/sewage installations will be necessary, as well as a rain-water drain which protect against possible flooding.

With this information the player takes on the role of João Expedito and goes to a building site where other members of the bee are, among them Zé Palpite. The tasks João Expedito has are: collecting objects that are strewn around the site and putting them in their proper places; turning on the water mains and fixing an electricity post. However, while João Expedito tries to fix the site, Zé Palpite walks around taking things out of their proper place. To every object placed correctly by João Expedito, the player gets a point and the game ends when the player scores ten points. There are ten different levels, through which each element taken by Zé Palpite corresponds to a loss of one point. At higher levels Zé Palpite removes objects more quickly.

The objects chosen to appear in the video game are those that can be easily identified by the people who have little familiarity with building processes: a post-hole digger, a sack of cement, office papers, a plate for food, and a tool box. These objects, after João Expedito stores them, reappear on the building site floor when Zé Palpite goes past in the background; in that case, João Expedito must place them back on the appropriate places so that the player can score points. The post-hole digger must be placed on the tool shed, the sack of cement on the material shed, the papers in the office, and the plate must be placed on the refectory table. João Expedito still has to turn off the water mains and fix the light in a lamp post, but he will need to hear the complaint of a member of the bee who is next to the bathroom, and take the toolbox to fix an improvised wiring.

4.1.2. A brief technical description of the game
The game was technically conceived to be executed in a very basic configuration and accessible in community telecenters and public schools. The minimum requirements for the computers are K6 II 300 megahertz, 8 Mb RAM, 10 Mb video card, and a multimedia kit. The game was conceived in Shockwave Flash Macromedia and may be played in a browser (Internet Explorer, Netscape and others) on-line, or it may be downloaded and played. The size of the video game is 1.2 Mb, and its download over the internet takes 5 to 6 minutes at a speed of 46 Kbps. The video game may be played without the web browser and offline, after it is downloaded, using the player stand-alone of Shockwave Flash Macromedia.
The building-site game asks the player to use the mouse in the introduction and the keyboard in the development. The only element that is controlled by the player is João Expedito, with the use of keys and arrows of the keyboard, which move the character so he can perform his tasks. To move him right, the right arrow (→); to move him left, the left arrow (←); to make him jump, the arrow up (↑).

The original game font allows changes in the following visual components without altering the ActionScript programming (and adapting them easily to the type of bee in which it is applied): the types of objects and their position, exchange of scenery (backgrounds and provisional constructions).

In the several tests we carried out, some bugs were identified. Sometimes, in the development of the game, the character of João Expedito manages to simultaneously carry the sack of cement and the post hole digger (which does not happen all the time) and depending on the computer processor used (if faster or slower) the character may float (which made the game easier) and slow down the Zé Palpite passing by on the background. None of these bugs, however, interferes with the development of the game. A faster processor allows Zé Palpite to pass by more times, because it is a random function that activates his passing (Image 10).

4.1.3. Step by step on how to win
The game file comes with step-by-step instructions to allow the instructors to be familiar with the rules and the best sequences for the player to score points and, consequently, the scoring of ten points that are required to complete the building-site organization. On scoring the tenth point the player is saluted and given incentive to play again in order to improve his or her time. The objective is for each player, in competing to improve his or her performance, gets the message (the point the game is trying to teach).

4.2. Suggestions of discussion after the game
The conception of the games took into consideration the possibility of errors in the representation of the reality in which the actions take place. Thus, before we started the storyboard of the games about the processes of construction, we were already conscious that we would make mistakes of representation to get our message across. The following were anticipated:

Generalization—It was necessary to set criteria for generalizing images, techniques, and procedures with the intention of holding the players’ attention and keeping actions fast paced.
Selection—It was necessary to set criteria for selecting game information, giving priority to the sequences that could be learned coherently and with technical correction.

Distortion—The distortion of images and information should not interfere with the conveying of information. They were studied and designed in relation to their expressive capacity.

To complete the learning process we suggest a discussion script with the players right after the game is played. We suggest that the following questions be raised:

I. Explain the fact that João Expedito is a fictional character who can carry out many simultaneous activities in the game and can also do somersaults and float. In reality it is only possible to develop one activity at a time in a building site, because ordinary people are not capable of doing those pirouettes.

II. Note that men are more commonly present in most building sites (and that is why the characters are both male), but that women take active part in the self-managed processes, and that they lay bricks, work in the hydraulic installations, and perform other tasks usually performed by men.

III. Note that the characters do not wear helmets, but that helmets are indispensable in a real building site. In the games, only Tete wears a helmet because she only appears in the introduction, outside the fictional action.

IV. Note that there are empty places between the provisional constructions, indicating the space for the construction of houses.

V. Note that rainwater drains are not present, but that these are important to avoid flooding, as recommended by Tete.

VI. Note that the animations only show essential aspects of each step, and explain in detail what was omitted and what might be interesting for the bee in question.

At last the complementary script can be elaborated from the necessary errors of the game, inferring the idiosyncratic characteristics of each place and community.

5. CONCLUSION
So far we can conclude that community participation should start from the beginning of the design process: the more they understand, the more they get involved, the more successful is the next step of participation. It is a cumulative process. As for the best means of visualization and negotiation of space, 3D digital models have been the best instruments so far. People’s ability to abstract is much more encouraged with manipulatable 3D digital models than with other media tested such as drawings, physical models, and 3D still images of digital models. With regard to the negotiation process, the 3D manipulatable digital model enables people to quickly change and propose new ideas for their spaces. This facilitates their involvement and consequently also their ability to discuss their opinions concerning the space with others. The discussion process becomes less a matter of speech and leadership, and more a matter of action (people acting on the representation of space).

With regards to the participative process, our approach shows that
instead of personalizing each dwelling unit to the taste of the dweller, bringing the user to the place of the architect, we can work with even more constraints and reach a great degree of satisfaction. This process has proven to enable the design team to learn from the group which features of space are collectively acknowledged by all as necessary, and which features should be regarded as of individual decision, and so appropriated in different ways, even though the dwelling units are the same and cost the same. This will certainly improve value of use. In unstable economical circumstances, as that of Brazil and other similar countries, designs need to be open not only in terms of use, but also open to different structural systems and materials, while also guaranteeing spatial quality, flexibility and low cost. This can only be done if the design takes advantage of the most usual systems. To achieve low cost and high value of use in housing, all these steps described above should be regarded. However, these steps are not guarantee of low cost and high value. The careful work and enthusiasm of the design team and the involvement of the community members in the design process, from the beginning, are essential for the success of the whole process, including, we believe, the self-management of the housing construction. We can only hope that the self-management will work well after the degree of involvement of the community with the design from the beginning of the participative process.

We also propose the open design as an open source to be freely distributed, used, and adapted by any other low-income development with no cost. Everything we design has no copyright and can be freely appropriated by anyone, from the interfaces for digital inclusion, to the design of the dwelling units, to the training games. This should encourage other similar low-income housing enterprises to take advantage of our pilot research project.

BIO
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ACKNOWLEDGMENTS

Architects, Economists and Engineers
Alfio Conti, Bruno Berg, Carlos Augusto Chemicharo, Fernando Batista Pereira, Lisete Celina Lange, Magarete Maria Silva Araújo, Mateus Moreira Pontes, Mônica Bedê, Renata Alves Siqueira, Renato César Ferreira de Souza, Roberto Luiz de Melo Monte-Mor, Samir El Aouar, Silke Kapp, Valter Pádua.

Students of Architecture and Economics

Community Leaders
Antônia de Pádua, Guilherme França, Vanilda Aparecida de Jesus, Norma Lucia da Rocha Barbosa.

ENDNOTES
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7 Ibid., 68.
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