Monotony and scarcity as elements for complexity as a gain – The Elemental case

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Abstract

People are moving towards cities quickly and massively. This, in principle is great news; cities are shortcuts towards equality and cities are the places where wealth and development is going to be created. So, the more people live in cities, the better.

But the scale and speed needed to accommodate properly these new city dwellers, requires innovative knowledge and particularly bold strategies. Until now, the complexity and difficulty of the challenge, has only found, unfortunately, reductive answers. The trend, in order to keep intact the richness of the urban phenomenon, is to try to develop complex responses, but that only generate complicated solutions that slow down efficient implementations.

This new, complex and difficult urban question will require extremely simple answers. In order to cope with the right way to build the future urban environment, we will need every single stakeholder (government and financial institutions, building private market, users and professionals) to keep acting within their own logic and not expect them to walk on other's footsteps. An open system will have to be designed with extremely scarce resources. But what would normally be considered an extra problem, namely, the lack of money, may be actually the ultimate solution. Not having enough money to deliver a complete, finished response, answers have been forced to be incomplete. If correctly formulated, incompleteness can lead to an open system. But there is still the problem of preventing an open system not to be chaotic or inefficient. The challenge consists in identifying all those components that require high levels of coordination and that can modulate future uncertainty and build them right away at the very beginning; then, the process will have to be completed on an individual basis allowing the energy of private uncoordinated performances to customize a generic beginning. A monotonous Infra and Supra structure will have to be designed in such a way that incremental self-construction can add value to the whole, allowing each party to contribute with its own capacity. Efficiency and economy of means will be achieved by a balanced combination of a closed, rigid, centralized initial construction giving way to open, incremental and decentralized interventions afterwards.

This paper is mainly about the concrete experiences we encountered with Elemental1 while implementing low-cost housing solutions and what we consider to be the key issues that we will have to deal with in order to make effective contributions to a relevant and difficult challenge.

[1] Elemental is a Chilean Do-Tank, a for profit company with social interest partnering with Copec (Chilean Oil Company) and Universidad Católica, which is implementing urban projects under existing political, financial and social conditions in the area of infrastructure, transportation, public space and housing, that can improve the quality of life of the poor.

1 Context I: An Urban World

2007 will be remembered as the year since which, for the first time in the history of humankind, there will be more people living in the cities than in the country.

In 1800, 3% of the world's population lived in cities; in 1900, 13%. In 107 years we crossed the 50% threshold; it is estimated that more than 3, 2 billion people live today in cities. And the trend is that by 2030, 5.000 million people will be urban inhabitants (from a total amount of 8.000 million people in the world by then). This urban growth is (still) mainly based in migration from country to town2.
The city has been a very efficient human invention to create wealth and improve the life quality of the population, particularly that of poorer people. It is more efficient to improve health by providing drinking water or sewer systems in urban concentrations than in the country. Providing energy to people so that they may cook or preserve food or boil water may be more efficiently managed if the people are concentrated in cities than if they are spread out all over the country. The same principle can be applied to providing health care, to teaching to read and write, to distribute food or public transport.

The fact that two-thirds of the growth population will happen in cities is, in principle, excellent news. However the problem is that together with crossing this threshold of a world which is mostly urban, we are also crossing the threshold of there being more damages than benefits for the city's inhabitants.

A first problem is caused by the extent and speed of the urban development process; the scale for which an answer must be provided is of an unprecedented magnitude. The capacity of providing an adequate response is being exceeded. This incapacity means that future urban development will be significantly done in slums. From the 3 billion people living today in cities, 1 billion is below the poverty line, living in slums; by 2030 it is foreseen that urban poor population will increase to 2 billion –40% of the total urban population. Actually the process of urbanization will mainly happen in the poorest countries in the world. Put in numbers, to provide an answer for urban growth from now until 2030, we must be capable to build, a city for 1 million inhabitants per week for the next 20 years, with houses worth $10.000 per family including urban services.

All the facts show that there will be an increase in the amount of people excluded from the benefits and opportunities of the cities in the urban development process, unless we are able to address it with scale and speed.

2 Context II: Political Framework and Market Reactions

In the last few decades, Chile developed an efficient and recognized housing policy, allowing the systematic reduction of the country's housing deficit[3]. In general terms, it is a property oriented policy, with subsidies to the demand, which is satisfied by the private construction market. In 2001 it consisted in a voucher composed by a direct subsidy of US$7,200 to an eligible family plus family savings of US$ 300, with which land had to be bought, infrastructure provided and the housing unit had to be built. In the best of the cases, assuming that the private building market was competitive, between 30 m^2 and 40 m^2 could be built.

Given the scarce resources available, the market reacted with the following approach: not enough money? Then make smaller houses and locate them where land is cheap. This created absolutely inadequate housing units in the outskirts of the cities, segregated from the opportunities (of jobs, education, transportation, health care and recreation) that urban settlements tend to concentrate. We could say that the market reacted to the lack of money by reducing and distancing.

These policy constraints are actually very similar in almost all the developing countries in the world, particularly regarding the fact that the amount of money is not enough for a unit of an appropriate size and to the fact that solutions are given where land is inexpensive, i.e. far away in the peripheries.

[2] The percentage of urban population in the developed world or even in Latin America has stabilized itself around 80%. In Asia and Africa, that percentage is still about 40%.
3 Chile is a country of 16 million inhabitants; 4 million families. The GDP per capita in 2007 was at 8,900 dollars according to the Chilean Central Bank. In the last decade the Housing Ministry delivered 1 million units. Of these subsidies, around 25% reduce the deficit. The rest satisfy the housing need of newly created families. At this rate, Chile hopes to reduce this deficit to 0 in 20 years more, or in 10 billion more.

3 The Elemental Approach: Reframing the Question

We have 2 points:

The first one: instead of considering 40m^2 as a small house, let's think of them as half of a good house. When the problem is reframed as having money to build half of a good house, then the key question is: Which half do we do? Our proposal was to do the half that a poor family will never be able to achieve on its own.

The second one: redefine a quality house, not as a bigger unit, but as one able to gain value over time. When buying a house, we all expect it to worth more with time. That is not the case in social housing. We designed our projects in such a way that we could expect value appreciation of each unit so that social housing could become a social investment instead of a mere social expense.

We identified a set of 5 design parameters that define that initial half of the house (due to the improbability to be done properly by families themselves) and that are exactly the same ones that can make a unit gain value over time. They are: enough low rise density (without overcrowding) that can afford well located plots, urban layout that introduces the collective space in between the public and the private one, middle income DNA design, strategic placing of the infrastructural core within the lot and structure for the final growth scenario. Given that this paper is focused on construction and technology, we are going to focus on those parameters that have to do with the built aspect of the first half, mainly the last one: structure for the final scenario.

4 Design Principles: Scarcity and Monotony as Virtues

In a conventional construction, a third of the cost corresponds to structure and rough work and two-thirds to finishes and cladding. In social housing, this relationship is flipped to where structure can claim as much as 80% of construction costs. Social housing is practically an inhabitable structure. So, if anything must be precise, strategic and efficient, it is the structure. A bull's-eye with the structure is a bull's-eye for the whole project.

The lack of resources is a direct consequence of the scale of the housing deficit. This normally compels a lower standard of finishes or even their elimination. But beyond a certain threshold in the lack of resources, the reduction in size and finishes is insufficient for the cost adjustment. In that case, 2 things happen: repetition and incrementality.

On the one hand, the standardization of social housing, desirable for responding quickly and at low cost, has been historically criticized for the incapacity for embracing the diversity of the users it serves. Homogenous solutions are incapable of responding to the different family, social and productive structures, differences in taste, diverse sensibilities and the natural need of the people to identify with their homes. There is a lot of evidence of design forces that seek to break the repetition, but in general this is done with arbitrary aesthetic operations and at the cost of the system's efficiency.

On the other hand, lack of resources makes us inevitably enter into the field of progressive housing; given that there is not enough money to deliver the whole unit, families themselves will have to complete incrementally what can be afforded with the available resources.

However, when due to the lack of resources, the problem is framed as the chance to build half of a good house, this problem disappears. By only building half of the house, the second half finished by the families themselves functions as a personalization process or "customization" of the unit. If the structure has been designed anticipating spontaneous construction (generally seen as a deteriorating factor to both the building and the neighborhood) then the incrementality acts as an adjustment of the structures to the preferences of each specific family, domestication that gives vitality and diversity to the urban groups.

Under these conditions, the structure must respond to the following questions:

1. Save time.

In a conventional building, finishes are not only the most expensive part but also the slowest to execute. Social housing, on the other hand, for being almost pure structure should be, in principal, a quick construction. This is

important, because in social housing reducing costs tends to be associated with lower quality building. Shortening construction time reduces the contractor's general expenses and lowers operational costs without sacrificing building quality. These projects also tend to be urgent. Sometimes, housing solutions are provided on the same sites the families are informally occupying, meaning they must temporarily leave and move to an even more precarious situation. Other times, simply because the living conditions of the families are so bad that the problem must be resolved as quickly as possible. Reducing construction times is both socially and economically desirable.

2. Protect the harmonious growth of the complex.
When more than half the square meters of the complex will be self-built, the repetition of the components can be the only way of guaranteeing the quality of the neighborhood in the future. Unlike the cases where the whole dwelling is built, when only half is built the necessary repetition to reduce costs stops being a problem and transforms into a key factor for creating an organized frame for the individual extensions of an unpredictable quality. Efficient structures, even repeated monotonously, have a direct consequence in the dynamic appreciation of the home and introduce a regular support that protects the urban quality of the complex.

3. Take charge of the final state.
Structure is always an operation with level of difficulty requiring a specific professional knowledge that depends on the integrity of people. When working with progressive housing, the calculation and execution of the structure must consider the final scenario of the home with additions. The difficulty here lies in the uncertainty in how these additions will be built. This requires augmenting the security level of the building, certifying not only the calculations but also their execution.

5 The Reality Tests: The Iquique and the Monterrey Projects

Our first possibility to test this approach came when back in 2001, hired by the Chilean Government, we were commissioned a project that consisted in re-establishing 93 families on a 5,000 m^2 site where they had been squatting for the last 30 years with a budget of just US$7,500 per family, with which we had to buy land, provide the infrastructure and build the units. The answer was a low rise, dense, incremental housing project. To achieve this, we worked on parallel property scheme, with 36m2 houses on the ground floor and 36m2 duplex apartments on top, all of them with direct access to the collective courtyards and expandable up to 72m2 within the provided structure. The results? People were able to achieve the final expected unit size for only US$1.000 each. 5 years later, any house in the Elemental Iquique project is valued at over US$20.000.

Figure 1: Participatory process

A very relevant task during the design process was to socialize the project with the families, seeking the community participation far beyond the conventional information-delivery meetings. As the construction progressed, we developed workshops that dealt specifically with the grounds and logic of individual interventions. One of the key matters of this project was that it provided an "elementary" framework of restrictions and conditions to facilitate a harmonious growth with structural safety. We sought to create awareness in the future owners about their responsibility in the generation of added value. On the other hand, a progressive or "participative" building such as this, where almost 50% of the resulting façade was going to be uncertain, required special attention. The strategy was to transmit the idea that the initial building was an organizer of the diversity and therefore it should not assume the features of the individual expansions, but

preserve its homogeneous character. The regularity of the building, besides being good due to a cost factor, was desirable because it permitted to accentuate the individuality of each house by contrasting them.


Figures 2-3: Iquique – initial and with expansions

Two months after the families had moved, almost 60% of the expansions had been successfully executed from a technical point of view. Out of these expansions, approximately 95% were done according to the recommendations they had received in the workshops. There were 3 cases of owners who made their enlargements with inadequate materials, 2 of them were demolished and one of them faced a lawsuit in the trial court for non-compliance with joint ownership regulations. The three previous cases were of users that had not participated in the workshops. These cases provided us an excellent opportunity to put to the test the legal tools available to them, due to which the case was specially monitored and publicized.

Since Iquique, we have worked in about 20 projects throughout Chile, under very different geographic, climatic, urban and social conditions, completing around a 1,000 units and with other 2,000 under design process. Our first chance to test these principles abroad came during 2008, when the Government of Nuevo León in México commissioned us to design a group of 70 homes on a site of 0.6 hectares in a middle class neighborhood in Santa Catarina. The required density suggested the application of the typology we developed for Iquique. However, the climate in Santa Catarina is very different from the northern dessert climate of Chile. The 600 mm of annual rainfall required us to adapt our proposal to this new question.
We were asked to develop this middle class neighborhood with a financing of US$20,000 per dwelling (almost double the funds we had for the housing projects built by Elemental in Chile). However, the construction standards and building codes significantly raised the construction costs, to the point that there was no project of this kind in Monterrey which cost less than $35.000 per house. In this case, it was pertinent to use the strategy of investing state resources to build “the difficult half” of the house, especially given the capacity of do-it-yourself building observed in Mexico, ensuring a promising future for the expansions.

Figure 4: Elemental Monterrey

As in Iquique, given that almost 50% of the m2 of the complex will be self-built, this building is porous so that the growth can occur within the structure. On one hand we want to frame and give rhythm (more than control) to the spontaneous construction so as to avoid deterioration of the urban environment over time, and also make the process of expansions for each family easier. The proposed continuous roof above the volumes and voids protects the expansion zones from rain and ensures a definitive profile of the building toward the public space. This project demonstrates the adaptability of the design criteria abroad with the added result of empowering the local building associates with the knowledge to take these same innovations and apply them themselves.

6 Prefabrication for the 3S: Scale, Speed and Security

Given than as much as 80% of the final cost of construction can be the structure, any structural efficiency, whether on account of its possible repetition or the time reduction, is very welcome. By prefabricating construction, both goals are met. First, a prefabricated structural system saves time in that instead of being built, it is simply assembled. Second, because in prefabrication, the more repetitive the system, the better it protects the harmonious development over time. In the specific framework in which we are working, where more than half of the housing complexes will be self-built, the repetition of the components, chain production and process repetition, instead of being a negative outcome, may be the only way of ensuring the future quality of the neighborhood. Very arid and repeated, even monotonous pieces, may be a key factor for providing an ordered framework for the sum of individual interventions of very unpredictable quality. Both factors combine themselves to explore the manufacture of prefabricated structural components. And lastly, because prefabricated constructions can make the quality control of the components in their place of origin allowing the certification not only of the structural calculation, but also the fabrication and installation.

Figure 5: Prefab: Assembly Process

6.1 The Milan House

These concepts were implemented for the first time at the beginning of 2008, when Elemental was invited by the Triennial of Milan to participate in the “Case per Tutti” (houses for everyone) exhibition and a prefabricated prototype of an Elemental House was built. We used the typology built with conventional technology in Lo Espejo, Chile, which consisted of 2 superimposed properties within a 6 m. bay. The entire house was reduced to 10 concrete panels, which were mounted in 24 hours. The thickness of the panels (20cm for the walls and 25 cm for the slabs) allowed us to eliminate beams and augmented the structural module from 3 m. 6 m.

The geometry, dimensions and topology of these ground plans are translated into words and sentences, and are therefore made searchable by engines such as Google. And with no small success! We can now enter a fragment of a ground plan as a search term in Google, and entire ground plans containing that fragment - or similar fragments - will be returned as search results. What would happen if we used this indexing machine upon the entire building stock of Switzerland, and if we - as in project CRB online - make it available to every architect? New methods of working, new methods of teaching and learning, new business models, and new architectures would, undoubtedly, result.

6.2 The E-House

A second prefab prototype that we have been working on is called the E-House. It consists in a nucleus of basic infrastructure 1.5x7m in 2 levels containing the bathroom, kitchen, stair, and acts as a physical support for the future expansions, firewall and acoustic isolation among neighbors.

Given that the massive installation of people in cities principally occurs in the poorest cities in the world in the tropics, housing will have to respond to a hot climate. It might be dry or rainy but we know that it will be hot.

So the problem for the 2 billion new urban dwellers will be cooling not heating. Since air conditioning is not an alternative (due to excessive cost and energy consumption), the only strategy left is to avoid undesired energy gains and there are 2 ways to do that: shading and crossed ventilation.

Shading uses overhangs to avoid direct radiation over the vertical faces of the house, especially windows. Through cross ventilation we understand the possibility of creating a fresh air current in the rooms acquired by means of having at least two openings in each room.

Evidence shows that self-construction is able to provide appropriate answers for shading, but not for a free flow of air over time. Elemental will include crossed ventilation as part of the initial half of the houses. The infrastructural core is in itself a ventilation device that guarantees appropriate exhausted air elimination for kitchens and bathrooms (internal domestic pollution is by far more significant than urban air contamination) and that provides the second air source necessary for crossed ventilation into a scheme that due to its density has a 2-rooms-built-bay-depth and only 2 facades exposed to the exterior.

In its most radical version the E-block can be implemented with only the infrastructural cores placed at a strategic distance between each other: big enough for reasonably sized rooms, small enough for unskilled labor and low-tech operations. The measure of the void is a module of the most common and standard building materials and panels, so material waste during self constructions is reduced to its minimum.

In this case we decided to provide also the roof as part of the initial half, because it is an element difficult to be built properly and because it is ranked very high in a building's good environmental performance. Besides that, one of the most common complaints about the urbanization process and the act of building itself is that, because of streets and roofs, it turns the soil impermeable. So, instead of fighting this fact, we decided to take advantage of it. Roofs are a natural water collector; we just need a place to storage it. The roof of the infrastructural core then, is a watertight thickened slab, a flat cistern that collects the water of the rain (in humid tropical regions) and uses it mainly for toilets, which generate the biggest domestic consumption. They also work as buffers to regulate intensive rainfalls preventing to some extent the collapse of urban rainwater collectors. A separated part of the cistern is for tank drinkable water that can be fed by trucks in case of problems with the urban water network (something quite common in the underdeveloped world)

7 Integral Systems: Open and Inclusive

Solving the housing equation of the world's poor requires such a massive response maybe contradictory systems will be operating simultaneously. Just to give an example: it is known that the housing is an activity that has big influence on macroeconomic country balances. It is used to activate the economy, to help the private market in times of crisis, to lower unemployment rates, etc. So sometimes building efficiencies are not politically desirable. And we can expect that the countries with the greatest housing needs face exactly this kind of dilemma. So, building systems will have to able to embrace both goals: technical and economic efficiency compatible with political and social agendas.

Figure 6: Elemental Prefab Type

If the available amount of resources allow to deliver only partial solutions, e.i. have to be based on incremental housing strategies building systems will have to self explanatory. Technical obviousness will be a must. We will have to a knowledge that building systems won't be open only in the sense that they are not finished, but also in the sense that they will have to accept almost any known building technique afterwards. Any building system which efficiency is achieved only if specific and proscriptive operations are implemented will fail. Building systems will be integral in the sense that will have to be able to integrate uncertainty. We have to consider as a fact, that no matter how High-Tech the solution we provide might be, it will be finished and achieve its final form through Hand-Tech interventions.