The Future of Dwelling: Redefining Dwelling for the Anthropocene

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Abstract
Between 1970 and 2015, the average size of newly constructed homes in the United States, increased by 79%, from a size of 1,660 square feet (154 sqm) to 2,687 square feet (250 sqm). This shift has redefined our conception of the family unit and inherently, it has also redefined their habitation needs. With an estimated third of households in the United States, spending more than 30% of their income on housing, it is time for housing design to move in a different direction. It is the time for a housing revolution, designed to reassess the real habitational needs of the user to provide a better quality of life designed for the needs of the next decade. The future of dwelling requires homes that can coexist and live in symbiosis with their environment, develop mechanisms for human interaction and socialization, help the household financially by making the dwelling more self-sufficient and use technology and space planning to resize the space needed for dwelling in search for a typology designed for the purpose of right-sizing human inhabitation. These housing typologies will need to be versatile and adaptable, to accommodate the needs of all types of family unites and the transformations they suffer as they evolve in their spaces for living. In this paper, I will showcase work done to develop a live/work/farm inhabitation typology in search for proposals to start defining the future of dwelling.

Keywords: Habitation, self-sufficient, right-sizing, adaptable, live/work/farm

Introduction

It comes as no surprise that the average house has grown in size and cost over the last six decades, but have they changed much? In the 1950's, the average home was 1,232 square feet (114 sqm) [1], growing to an average size of 2,687 square feet (250 sqm) by 2017. But the space planning of a house has remained the same. In a world where social, financial and ecological structures seem increasingly tenuous, emerging technologies together with a diverse understanding on what constitutes a modern family unit are starting to reshape our design approach towards residential architecture. The idea of the traditional nuclear family has given way to multiple types of non-traditional family unions and living arrangements that are forcing residential design into a much more adaptable typological complexity. Adding to this, it is estimated that by 2020, 50% of the labor force of the developed world will be self-employed, turning their residences into micro-factories where they will make, package and sell products with the help of the internet and online marketplaces. In this new economy, the idea of the industrial zone in urban areas, which is a legacy of the twentieth century, will slowly be taken over by live-work residential design. In a similar way, the next generation habitat will be forced to reclaim certain elements of farming and resettle them in the city. Produce will be grown in house through hydroponics or other high-tech irrigation systems designed to help the household cope with the cost of living. All these technologies; mushroom production, grey water filtration systems, solar and wind energy, composting, and other passive and active advances will be dependent on affordability which will push residential design more and more into the realm of prefabrication to cheapen costs. As the future of dwelling is idealized, it presents an opportunity to reinvent residential living. This new design typology will need to get to a point, where sustainability is habitual to production, forcing smart technologies to be embedded in a systemic way through modularity and interchangeability in the new construction processes. These new dwellings will use an open plan approach as a way to create versatility. The resultant systemic interdependence will be the basis for the creation of the next generation of prefabricated habitation typologies which will be designed for transformational adaptability, production and filtration of water, generation of energy, urban farming and the capacity to sustain a live/work/farm environment in an affordable way that appeals to the middle class. Right-sizing will be an essential aspect of this process, as it develops dwellings designed to be versatile, adjustable, and user friendly. A housing typology re-designed for functional living, remote working and urban farming in a sustainable self-sufficient way will define the future of dwelling for the Anthropocene.

A brief history of dwelling sizes in the United States

In the 1950's a 1,232 square feet house would cost around $8,545.00 dollars (figure 1). This house would be composed of; three bedrooms, a kitchen, a living room, a dining room and a garage. The adjusted value of this house for 2015 dollars would be around $44,600. And although it's natural for prices to rise over time, the issue here is that home values are outpacing inflation, making it nearly impossible for new and young buyers to enter the market. This partially happened because the size of a house has changed in two opposing manners: According to the US Census Bureau [2], the average house built in the US increased from 1,660 square feet (154 sqm) in 1973 (earliest available housing-size information from the census) to 2,687 square feet (250 sqm) in 2015. This is an increase of 1,000 square feet (92 sqm). During the same period of time, the average household size has decreased from 3.01 to 2.54 persons per household, a reduction of one-half person per household. With the average number of people per household declining, the percentage of households of people living alone has climbed dramatically. In the past 6 decades, the percent of households of people living alone has risen from less than 10% in 1940's to 25% in 2000's. Even as the number of people per household has been declining, houses are still growing in size. This means these houses have more bedrooms and bathrooms. The percent of housing units with 1 and 2 bedrooms have been steadily declining, while the percent with 3 and 4 bedrooms has been increasing. The number of bathrooms shows a similar trend. Housing units with a single bathroom have declined from being almost half of new construction in 1973, to a little over 10% as of 2001. During the same period, the number of housing units with 2 or more bathrooms has climbed to over 80% of all new construction. This trend has ended up with more expensive houses which are partly why the typical homebuyer today is 44, whereas in 1981, the typical homebuyer was 25 to 34. In 2016, home prices rose twice as fast as the national inflation. And in nearly two-thirds of the country (USA), housing price growth exceeded wage growth.

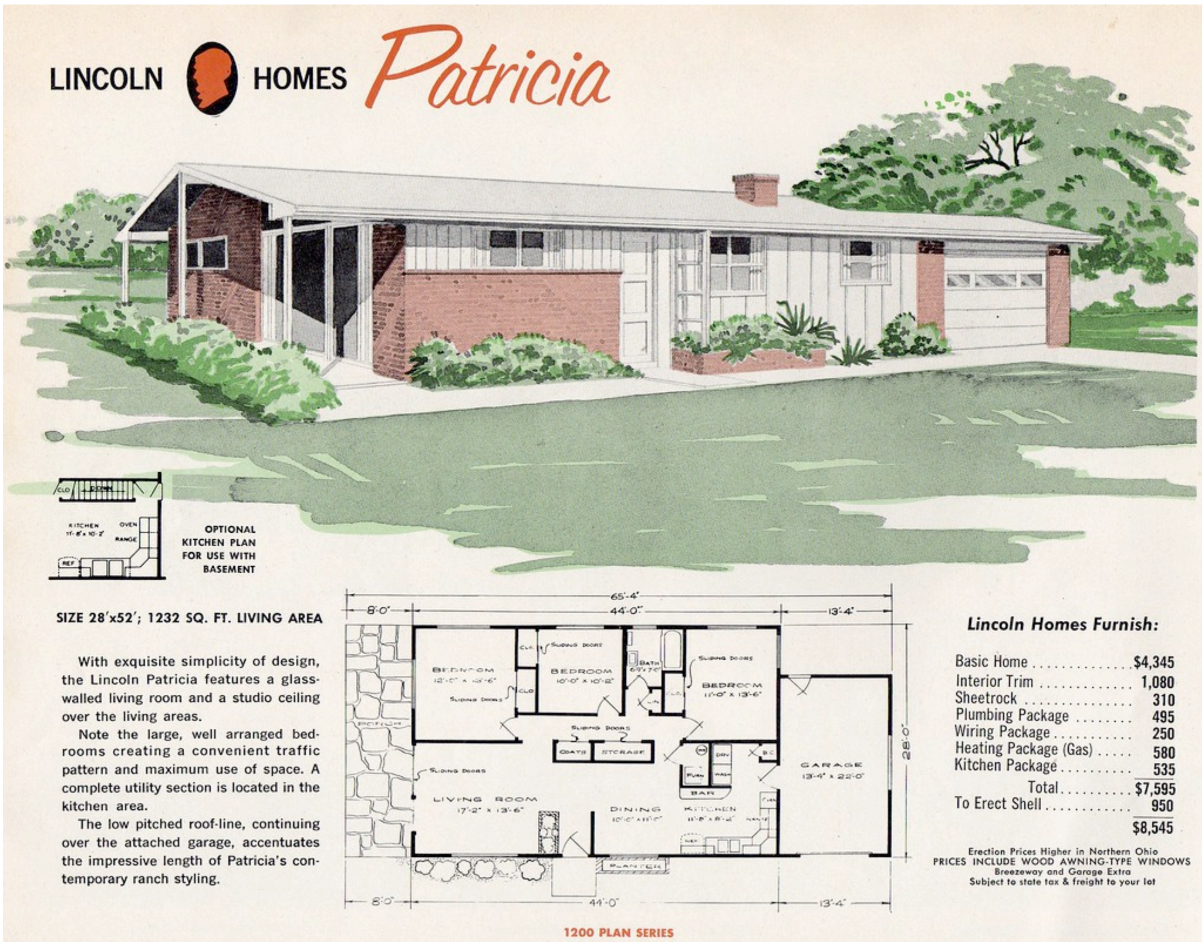

Figure 1: Lincoln Home-Patricia, 1950's

Is bigger better?

The reality is that bigger is not better. Because, better is better! And let's be clear, I am not talking about tiny homes. Right-sizing means not as big as you thought you needed, but designed and built to suit the users long term way of life. But how are smaller homes better:

•*Easier maintenance and less time cleaning:* Anyone who has owned a house knows the amount of time, energy, and effort it takes to maintain it. Fewer rooms means less time spent on cleaning and fixing things. A large house encourages you to have more "stuff" in it, which is more "stuff" that needs to be cleaned and cared for. All things being equal, a smaller house requires less of your time, energy, and effort to accomplish that task.

•*Money savings and less debt:* Because a smaller home typically costs less, this frees up money every month to spend on other things. It's not just the lower mortgage payment that will save you money. Smaller homes are less expensive to purchase and less expensive to maintain (insurance, taxes, heating, cooling, electricity, etc.). That adds up to major savings over the years. Another aspect of savings we need to talk about are taxes. Our property taxes are determined by assessed property value, and value is partly determined by square footage. Though a number of other important factors also affect assessed value, all things being equal, smaller homes equal cheaper property taxes.

•*Freedom from stress:* Just as important as the monthly savings, is knowing that you're living below your means. This gives you peace of mind if you have a major financial setback like being unable to work, losing a job, or having a serious medical problem. A small house also encourages you to get outside more often.

•*Freedom of time:* Along with buying less stuff because you have no room for it, you will also avoid the time costs of maintaining all that stuff, as well as the time cost of keeping your large house clean and well maintained. Living in a small house means that the needs for your home will require less of your free time, allowing you to have free time for other activities.

•*Closer family and neighborly bonds:* Unlike the often gigantic rooms of a McMansion, small homes have small rooms. This gives each room, as well as the entire house, a feeling of coziness and intimacy that larger homes lack. In turn, this forces family interaction, not allowing it's members to hide from each other ensuring social interaction. When you live in a small space together, you learn to work around each other and diffuse problems before they happen. That is internally, but externally a small house forces you to be more extrospective putting you in touch with your neighbors and community. Small houses are often set closer together. Spend an afternoon sitting on your porch, and you'll have the chance to see your neighbors children playing on the sidewalk, people doing yard work, and the walking their dogs.

•*More energy efficiency:* Smaller homes are often more energy efficient because they have less space to heat and cool, which means they have a lower ecological footprint. They also use less materials in the building process. But in addition to these environmental benefits, small houses are also generally built in more walkable areas, which means you don't need your car every time you need to run an errand.

•*A small house is easier to customize:* A large house can be very expensive to furnish. When you live in a smaller house though, having your space set up and decorated exactly how you want it is pretty easy! Space limitations challenge our creativity and drive innovation. Also small living changes how you view making new purchases. In a large house, there's always room for more, which adds to our consumeristic mentality.

•*Easier resell value:* By its very definition, a smaller, less expensive house is affordable to a larger percentage of the population.

An American home built in the last three decades, is forcing us to pay all the time for a lot of space that we only use some time. And while a big home may still be a dream for some, a smaller home may be a smarter and more flexible choice for those who want to save money, energy, time, and relationships.

What is Right-sizing?

As McMansions start to become a thing of the past, the National Home Builders Association stated that, the average size of a new home was expected to shrink to 2,575 square feet by 2019. Post-recession home buyers are seeking practical and functional space over surplus square footage. Right-sizing then is a design approach that uses emerging technologies, combined with research on the future needs of residential living and environmental changes due to global warming to propose sustainable dwelling designs for the up and coming future. It proposes homes that can coexist and live in symbiosis with their environment, develop mechanisms for human interaction and socialization, help the household financially by generating passive income and use technology and space planning to resize the space needed for dwelling. Finding the right home size for the user's needs will be an essential aspect of this process, as we develop dwelling units designed to be versatile, adjustable, and user friendly to accommodate to the needs of all types of non-traditional and traditional family units and the transformations they suffer as they evolve in their spaces for living. A process aimed at producing a housing typology re-designed for functional living, remote working and urban farming while providing dwelling solutions that allow for smart growth, shaping the way urban density will manifest in the future.

Smart house technologies in systemic interdependence

Systemic interdependence requires that both active and passive technologies work together to make in this case the house more self-sufficient and sustainable. The goal is to go past designing a green building and move both the design and build process to result in a net positive dwelling. An important part of that process has to do with how emerging technologies are being used interdependently to achieve our goals. In this section, I will cover some of this technologies and how they function:

•*Energy:* When talking about energy in residential living, I am normally thinking of it in two ways: Sustainability and the potential for self-sufficiency. In all our projects this quest starts with solar panels or tiles on the roof of the structure. This roof will be designed to a pitch that works well both in the summer and winter. The solar panels will be maximized to produce the required amount of energy which will be stored in a Tesla battery (solar battery) which will be stored on an equipment closet somewhere within the dwelling. The energy stored will be used in appliances, the working of the different systems and illumination. To save on energy during the day, illumination of the residence will be aided by the use of solar tubes where possible. This system can be over designed in places where the government buys your extra energy creating a source of passive income. Which is a financial incentive and one way of making your house net positive. Solar heaters on top of the house will provide warm and hot water as needed.

•Water: The water systems are divided into active and passive. The passive ones comprise; water catchment systems and storage tanks while the active ones have the potential to make the dwelling water self-sufficient. It all starts with atmospheric water generators, turning the moisture in the atmosphere into drinkable water. This water is used for showers, toilets, drinking and farming. The grey water produced in these processes is filtered and sent to a tank for storage and reuse while the black water goes into the sewage. At this point we can change the toilets from water based to composting and not need water at all. This option will be covered further down on this section. The water can be held on tanks under the house until needed, when solar pumps would then bring the water up into the residence.

•Food production: The kitchen is provided with a couple of farming technologies. Drawers with mushroom farms will produce year around. Also in the kitchen, hydroponic vertical farms will produce a portion of the produce for the dwelling. These systems together with seasonal farming on the exterior garden and terraces will provide the family with fresh produce reducing their food cost. Any excess on the food production can be sold within community markets in the neighborhood.

•Composting: This process starts in the kitchen also, where worms will eat all the organic waste and produce liquid and solid compost to be used in the seasonal exterior farms. To achieve full plumbing self-sufficiency, the possibility of using composting toilets would remove the need for the dwelling to be dependent on the city sewage system. The human compost should not be used on the external farm but can be used in none edible gardens.

•Prefabrication: Prefabricated construction is the practice of assembling a variety of components of a structure at a manufacturing site and transporting those sub-assemblies to the location of the construction site. Since prefabricated sub-assemblies are constructed in a factory, unused materials can be recycled or re-used in-house. Also, the controlled environment of a factory allows for a more accurate construction, tighter joints and better air filtration, which in turn allows for better wall insulation and an increase in energy efficiency. The modules are commonly delivered by a flatbed truck to the construction site. Once there, cranes and trucks are used to assemble them in place. The foundation is the only aspect of the build that is done on site.

Net positive design: Creating regenerative buildings

Regenerative-design buildings go beyond typical green construction by seeking to achieve a net-positive impact on both the environment and the quality of life for its users. Architects take a systemic interdependent approach that considers; materials, cyclical systems, health, and building inhabitant usage. Net-positive performance can be achieved by spilling over to the community, the benefits derived from regenerative buildings, which may, for example, sequester more carbon than is emitted by the production, transportation, and installation of building materials; self-produce energy instead of taking it from the grid; generate, catch, store and purify all potable water and treat, compost and recycle all grey and black water; operate carbon-free; produce a percentage of the produce consumed by the dwelling; and include interiors that improve human mental and physical health, deliver day-lighting and natural ventilation, and provide flexibility and adaptability of use with transformative potential looking to the future.

Methodology

The act of designing in architecture is complicated. Because a lot of it is intuitive, some people tend to think that it is not a well-structured process. But intuition which grows from research and experience is not only easily structured but also quantifiable. With that in mind, I developed the following methodology:

•We started by looking at statistics from the American time use survey provided by the Bureau of labor [3].
•We looked at the work presented by a UCLA team on the book Life at Home in the Twenty-First Century: 32 Families Open Their Doors [4].
•An analysis of architectural precedent composed of residential design measuring between 400 square feet and 2000 square feet was stablished to provide case studies for the different interior and exterior elements of the dwelling. From this analysis a prototype kitchen was produced which won the research and development award at the Reinventing Home Kitchen Design Competition, by Mia Cucina and Archiparti in Hong Kong, China.
•An analysis of type was produced to generate through it a design methodology.
•A design process was stablished with the aim to produce five distinct prototypes to address the live/work/farm typology.
•Designed a construction system to be prefabricated and easily installed in site.
•Researched new construction materials suitable for the project, assessing; Cost effectiveness, sustainability, carbon footprint, local availability and close loop potential.
•Researched different sustainable technologies to design the smart systems of the dwelling. This included: Hydroponics, aquaponics, mushroom farming, composting, energy production and storage, grey water filtering and reuse, water production through atmospheric water generators and sustainable thermal insulation.
•Presented a project based on this research for a dwelling competition sponsored by eleven magazine where we won an honorary mention.
•Designed a proposal for the inner city that uses the research on right-sizing to develop a town house to address the question of density.

The biggest problem we are anticipating is being able to produce a product that is versatile enough for different possible users. To address this issue, we are working with modularity and open plans. The modularity will allow us to resize the house cheaply and the open plan will give the user a level of adaptability and control of their interior space. All proposed prototypes will then be able to right-size to the needed footprint. Growing vertically will allow us to deal with density were we are looking in triplicating the present population of a specific urban block.

Design proposals

The following designs were produced and developed over the course of the last six years, and have been written and presented extensively.

•*Micro-houses:* The micro-houses (figure 2) are adaptable extrusions designed to assume the size needed by the user. The single extrusion allows for the space to grow in two directions, increasing the size of both interior and exterior-covered space as needed. In the interior, the long sides of the volume get built-in furniture, designed to maximize functions and storage. Within this built-in elements, we house; shower, toilet, closet space, kitchen, pantry, open shelves, drawers, a murphy bed and storage cabinets. The exterior has two terraces which add covered space to the interior by being accessible through two accordion glass doors at each short end of the volume. When the weather allows it, the accordion doors can be left open to enlarge the interior space, and when not the visual link to that exterior space remains through the glass doors. Inside, the kitchen pierces through the wall with a window that mirrors itself on the wall behind it creating a built-in dining area that uses the extruded window as a sitting area. The roof is accessible and meant to be used as a seasonal garden and leisure space. The house uses all the technologies previously mentioned to function as a smart house. And it is prefabricated and brought to the site as a whole, to be placed on top of the structure. The structure is the only element built on site, and it is composed of a spider footing system, designed to adapt to different topographies and to interact in a minimal way with its environment. This house has been designed for one or two occupants, but can be expanded for more if needed. Following the same parameters, we have designed five micro-houses of which another example of a dwelling for four people has been added below (figure 3). This houses have been designed to stand on its lots, whether in the city or suburbia, allowing for the maximum possible green space around the house. The idea is to use greenery to create privacy and to give space for urban farming to occur. Later on, when we talk about density, we will touch on the idea that by greenifying the blocks we are contributing also to better air quality for the community. In this way the lot and the dwelling work in symbiosis adding to the quality of life of the individual and the neighborhood simultaneously.

Figure 2: 350sqft [32sqm] of enclosed space 518sqft [48sqm] of open terrace

Figure 3: 600sqft [55sqm] of enclosed space 160sqft [14sqm] of open terrace

•*Trailer home redesign:* The trailer home is a housing typology prevalent in the United States due to its adaptability and low cost. With this in mind we have designed an upgrade to this classic (figure 4) where prefabrication allows us to produce the dwelling in sections, all of each housing a different function. The user, then can choose from the different functional modules to put together the house she/he needs. Each of the specific modules can then be designed in different styles to give the user options and to allow for diversity within the interiors. The modules have been designed to fit together allowing for compositional freedom longitudinally. There are multiple profiles designed for the base extrusion to give the used a variety of house front elevations to choose from. Some of them, adding a terrace above the house. Just like the micro-homes presented before, this proposal uses all the smart technologies covered on this paper and similar design ideas to add quality of life to the dwelling in a sustainable way. The modular prefabrication allowed us to explore a different type of adaptability and versatility for the dwelling, following right-sizing ideas. This project won an honorary mention in the Eleven Magazine, micro-living revolution competition in 2018.

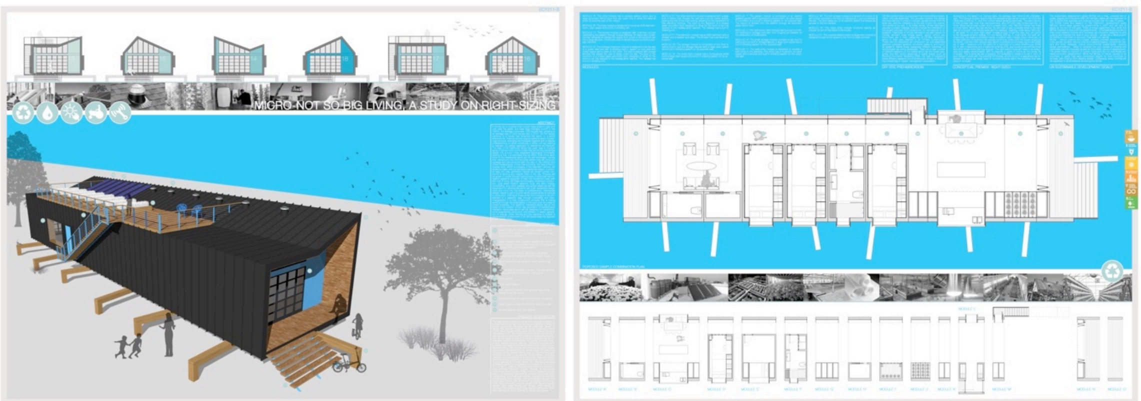

Figure 4: Eleven Magazine: Micro-Living Revolution Competition | Winner of an honorable mention

•*Low-income housing:* On this project, the same parameters are followed but in a system that is starting to consider density. To lessen building cost, this proposal uses shipping containers. The first floor uses 20’ containers to generate a commercial zone, followed by 40’ containers on the second, third and fourth floor. The containers are set, side to side, generating a 745 square feet floor plan, with a central core for an open kitchen, bathroom and storage, and two pop out volumes on the back, housing the bedrooms. Each apartment has been designed for four to five people. The fifth floor is designed to be an urban farm, to be cared and maintained by the occupants of the building.

Figure 5: 745sqft [70sqm] of enclosed space 85sqft [7.9sqm] of open terrace

The center of the block has been designed as a public green area for pedestrian traffic. This park, is flanked at the two longitudinal sides of the block by buildings, that have their commercial level open to the inner and outer sidewalk, creating a directional continuity and permeability through the ground level. This openness adds a level safety to the area, since you are being watched all the time by someone. At the urban level, the urban farm at the top of the building and the park/garden at the ground level are adding a green component to the city capable of purifying the air and generating local grown produce. All the previously presented technologies and design ideas are also part of this project.

•*Micro-apartments:* Similarly to the last project, the micro-apartment is a building composed of a built on site structure, designed to receive prefabricated units. This units are height ceiling lofted spaces that follow the same parameters of the micro-houses presented before. The units are designed to house one or two people. Also like a previous project, the building has a commercial space on the first floor and residential above. And just like the last project, this proposal is looking into ideas that deal with density but trying to preserve the quality of life of the future user. This balance is, I believe, the basis for a successful urban strategy for the future of cities.

The goal of this research is to identify; emerging technologies, construction techniques, human social tendencies and smart design, that can allow us to re-size our residential requirements and change human habits to better our quality of life and lessen our foot print in the planet.

Density: Smart city

Urban density refers to the number of people living in a particular urban area and is an important aspect of how cities function. The response of a neighborhood to its density in terms of accessible services is what makes a city successful. A good neighborhood should serve all its population's needs within the neighborhood itself, preferably at a walking distance of your home. However, when cities are allowed to expand from the center out without the benefit of smart growth planning, they can become relatively unsustainable. Cities operate more efficiently when residents live in denser urban surroundings, with services at a walking distance and good public transportation. And an efficient city is more sustainable. Through this paper we have concentrated on right-sizing but I want to end with some ideas in terms of urban density, because these two ideas work side by side. So once the right-size of a dwelling gets resolved, we need to think about the block and the neighborhood around it. Following are some ideas that have informed our density based proposals. The following are the urban ideas we are working with while designing our projects that can help turn high-density city into a smart city:

•Plan for long-term growth and renewal.
•Embrace diversity and foster inclusiveness.
•Greenify the neighborhoods, starting with the dwelling itself.
•Develop affordable, mixed-use self-contained neighborhoods.
•Activate public spaces.
•Prioritize green systems.
•Visual overlap (eyes on the street) adds a sense of safety and security.
•Forge public-private partnerships.

Conclusion

The aim of these projects is to develop a new typology of residential design that re-educates the population towards a more affordable, sustainable and energy efficient future. From the beginning, the project has attempted to increase the quality of life of its inhabitants. To do so we have stablished an interdependent series of system designed to help the dweller by:

•Producing in-house some percentage of their food necessities in a healthy, organic and fresh way.
•Producing their own electric power and using natural light to minimize energy consumption.
•Cleaning and storing, rain and grey water for future use and re-use.
•Defining the appropriate size of the dwelling in terms of its users.
•Providing an affordable alternative to the housing market by the use of prefabrication and the minimizing of dwelling's area.
•Creating versatile spaces that allow for personal adaptability.
•Providing spaces for the development of self-employment.
•Creating community by breaking the trend of the introspective residence and forcing the dweller to re-engage with his neighborhood.
•End the life-long slavery to the mortgage by creating an affordable home.

The next step is to implement this ideas on our next residential project, which (it seems) will take place in 2020 in Woodstock, New York.

Acknowledgments

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