EVERYONE IS AN ARCHITECT

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ABSTRACT

This project is an investigation into how the form and organization of single-family houses can become relevant in today’s tech-oriented society. It proposes a potential way in how to make technology a part of architecture in a manner deeper than creating touch-screen walls or a topical application of technology, but to apply the sensibilities of living virtually to our everyday life; to have virtual reality and the physical reality inform and react to each other.

The project answers our physical needs with virtual solutions and imagines a game or interactive platform which generates a house based on user inputs, allowing the user to test and modify the product, virtually, as they see fit, and then potentially translate their final outcome into a physical reality. User inputs are based on more ephemeral qualities upon which we base our lives, such as time and personal value, rather than physical factors such as gravity and distance. The program—Everyone is an Architect—combines this rationalization of personal lifestyles with site information and after a series of operations, produces an idealized, custom house. The last leg of this paper is a brief proposal of the program’s potential implementation in existing contexts.

1 Architecture showroom in Second Life of student who named his avatar 'Rem Koolhaas' (Ring)
INTRODUCTION

OVERVIEW OF MASS HOUSING SYSTEMS

The American Industrial revolution at the turn of the twentieth century spurned an entirely new way of fabrication and construction. The Ford assembly line deconstructed the Model T into a kit of parts; each member of the production line was responsible for the application of only one part, significantly speeding up construction time, lowering cost, increasing efficiency and accuracy. This process not only changed the way cars were manufactured but soon found applications in other fields, including architecture.

Borrowing from the assembly line model, Le Corbusier’s Maison Dom-ino and Jean Prouvé’s 6x6 Demountable House imagined the house as a formula consisting of a skeletal frame and interchangeable parts, forming a house-producing kit. The Maison Dom-ino expanded on Le Corbusier’s “Five Points of a New Architecture”: the use of piloti columns, the “free” façade which allowed for the use of ribbon windows, roof gardens, and free plan. In this scenario, the load-bearing columns allow walls, apertures, and furniture to be placed in a large number of different arrangements. Prouvé’s 6x6 Demountable House worked in a similar fashion, though in his version, the framework became an axial portal frame which could be partitioned into three rooms. The skeleton was light, prefabricated steel framing within which could slide wooden panels, some outfitted with doors and windows (Coley).

The kit-of-parts method also applies on a larger scale—to housing developments. Kurokawa’s Nakagin Capsule Tower and Moshie Safdie’s Habitat 66 were idealist projects which the constant skeleton was a communal framework onto which individual houses would plug-in. In the Capsule Tower, micro-apartment units were to be replaced every twenty years in order to keep up with technological advancements. Similarly, Habitat 66 prefabricated concrete units interlocked to create unique interstitial spaces; each of the units could also be customized to a certain degree. Both of these projects are upheld as imaginative speculations into the ‘future’ of mass housing, but failed in their implementation: the Capsule Tower went unmaintained and forgotten; Habitat 66 proved to be unlivable in its context as its design was more appropriate for a warmer climate than the freezing Canadian coast.

Larger housing projects like the Unité de Habitation also explored the idea of the single, universal unit, aggregated. While these units were efficiently designed, there was no variation between units and were completely un-customizable.

The Levittown model of postwar America expanded the universal unit into a catalogue of variants, which were prefabricated and, when aggregated, created neighborhoods with a strong, unified identity. The ability to pick from a selection of houses allowed its residents to have at least a small degree of personalization and foster a stronger sense of ownership. Homes were quickly and easily manufactured in order to provide housing for returning war veterans; the Levittown planned neighborhoods encouraged a tight-knit community united by the residents’ shared experiences, a visual identity, and the common American Dream. Levittown proved popular and created communities across the nation.

While these strategies in construction and design of housing expanded the field, ultimately they were all limited in number by some factor or another. The catalogue of homes a la Levittown is only as diverse as the number of different homes it offers, each of which the architect must invest a great deal of time designing individually. The aggregation of the supposedly ‘universal’ living unit must match the number of tenants who want or even can actually live there—a number which turns out to be less infinite than the utopian architect imagines. The kit-of-parts house has a finite number of viable combinations.

CAPABILITIES OF GAMING TECHNOLOGIES

As computing capabilities have grown, so have the abilities of computer gaming. Everything has expanded at an astronomical rate, from the depth of narratives to the intricacies of its visualizations. It is telling that the best-selling PC franchise of all time is The Sims, a virtual life simulation game. It lacks any concrete goals or endpoints. Players instead create custom avatars (“Sims”) and houses for them to live in, and play continues by directing The Sims to perform various tasks and interactions, affecting their moods or satisfying their desires.

All productive components of The Sims come from extensive kits. Avatar choices, housing elements, and even actions, such as “Talk to...” or “Play with...”, all come from a catalogue which is large enough to provide unique combinations nearly every time but manageable enough in size for both the computer capacity and player usability. Subsequent expansion packs further multiply this number by adding items to the different catalogs.

A similar game, Second Life, was launched about a decade after The Sims and follows a similar model but places it online. Here, customized avatars called “residents” each have their own buildable property and interact with each other in communal “grid” zones. The online component allows for communicative capabilities as extensive as the human language—INEF. It has also encouraged commerce, group activities, relationships, which often blur the lines between online and offline, virtual and reality.
DIGITAL LIFESTYLE

The smart-phone is having a profound effect on the way we think about communication, information, and daily living. 80 per cent of the world’s population owns cell-phones, and although the number of smart phones is currently relatively small, this number is steadily growing and will continue to rise as technology becomes cheaper and more widely available; Moore’s law, roughly stated, loosely predicts that technology doubles in power and its capabilities approximately every two years.

Some fear the growing reliance on technology. Folkloric habits tell us not to stare too long at a screen, that it is a waste of life to stay inside too much, to be too sedentary. According to *Time* Magazine, 80 per cent of US schools report that they have already or are on the cusp of including touch-screen and portable technology elements into their permanent curriculum, insisting that early acceptance and adaptation to technology will stimulate student’s learning. However, *Time* polls also show that parents across the nation are still split 50-50 over belief that technology in schools will do more good than harm. Research at MIT shows that, on average, “students can remember only 10 per cent of what they read, 20 per cent of what they hear and 50 per cent of what they see demonstrated. But when they’re actually doing something themselves—in the virtual worlds on iPads or laptops—that retention rate skyrockets to 90 per cent.” (*Time*, August 2013)

Beyond the smart-phone’s specific capabilities, it represents a part of a movement which is making technology more democratic and accessible. With its seemingly endless and growing app store, it is not unlike 3D printers, CNC-machines, Arduino boards, and open-source based technologies which enable the average citizen to pursue his or her dream.

As we become increasingly attached to our smartphones, we become connected and isolated at the same time: we may be surrounded by people—even people who are very meaningful and familiar, like family—but are wholly absorbed, alone, in our individual electronic screens. This dichotomy presents a somewhat philosophical quandary of who are we with and where, for example, are we here with our family or in another place with some friends or are they here with you? etc. Not only are lines of privacy and public space completely invisible, but so is presence itself.

We no longer need rooms for privacy, as we can tune out with portable entertainment on our smartphones; we no longer need public forums to gather and meet, as we have every desirable type of social media at our fingertips.
Now that architecture is not necessarily required for regulating human interaction, what is architecture’s new role in privacy and communication?

“EVERYONE IS AN ARCHITECT”

*Everyone is an Architect* is a gaming system and design process which aims to revitalize the design and construction of homes by exploiting modern technology and our use of it (Figure 3). Computer technology has facilitated the construction of housing, reducing cost and time. It has also shaped how people interact and function as a society, changing the role of the house itself. *Everyone is an Architect* re imagines the house in terms of this new, tech-driven twenty-first century lifestyle and uses gaming as a way for clients—now players—to explore and test their designs first-hand. It facilitates a continued dialogue between virtual and physical realities, within which balances the house, a continuously evolving and dynamic middle realm.

**METHOD:**

**ROLE OF THE ARCHITECT**

In this frame of working, the architect is responsible for structuring the “rules” of the game. Because he/she must input certain limits to appease the player, the architect can sway the results to a certain aesthetic or outcome. In this case, a very basic Levittown-like model and look has been chosen so as to recognize and make clear the social experiment that is occurring. Although Levittown is shorthand today for a thoughtless, monotonous suburbia, it was ultimately successful in providing well-functioning and affordable housing as well as creating communities, ideal for a distraught, post-war society.

This project suggests that Levittown could be expanded by using today’s technology and access to computers and games combined with advancements in prefabrication.

**RATIONALIZATION OF NON-SPATIAL LIVING**

The sophistication of Internet and games has created a duplicate, complex alternate universe of how people interact with technology and each other. Phones, computers, tables, and gaming devices are ways to escape reality. There is a sharp divide between real life and the virtual world. These two parallel universes compete for attention and seem to be equally important in the lives of many—physical life experiences are almost less important than its digital documentation on social media sites. Both are now equally real, at least in value.
The mapping of non-physical lifestyles

In order for the physical, built world to remain relevant in context of a burgeoning tech-driven society, architecture must be re-evaluated in the new terms of the modern lifestyle. Namely, that many lives are no longer defined by concrete terms or physical measurements, but rather are characterized by temporality and interconnectivity. Whereas staid architectural programming relies on the discrete compartmentalization of different activities, a more appropriate response for the modern lifestyle would reflect these newer contemporary priorities.

*Everyone is an Architect* evaluates program on a person-to-person basis, rationalizing customized inputs with more sensitivity and complexity than simply a compartmentalization of activities. The user answers a survey, evaluating different priorities in their life (for example, playing with the dog, working, spending time with friends, playing video games, etc.) in relation to the personal value they assign to it and the time they dedicate doing the activity. Loose thematic “types” (communal living, infrastructure-dependent, and personal space) are assigned to each of these visualized activities in order to later highlight certain commonalities and relationships which aid in the later physical realization of the house. The bubble diagram created by these rules is then clustered using digital physical simulators, thus bridging the gap between virtual and physical. The resultant clustered diagram maps living in a way makes physical the non-specific activities of the modern lifestyle, but provokes new relationships in the overlapping and proximity of seemingly unrelated activities (Figure 4).

Although this method of programming may not be unequivocally definitive or produce a singular truth, it provides an insight into how virtual life can have physical implications. The clustered diagram recognizes that today’s way of life is often erratic and non-sequential. Reflecting this sensibility back into housing updates tired and irrelevant housing tropes.

**COLLECTION OF EXTERNAL PARAMETERS**

The user-informed program diagram is combined with external parameters to produce an idealized outcome tailored to both the user and the house’s context. Digital databases are a treasure trove of site information. Equipped with zoning regulations, local codes, traffic patterns, and other information, a building envelope is generated. With further detail, such as environmental conditions and neighborhood typologies, a more specific, building shell can be produced.

It is within this shell that the program diagram divides the space using a voronoi pattern, allocating each program activity space of appropriate size. A voronoi diagram is a method of dividing spaces dictated by a series of points, or seeds. The regions produced consist of all the points that are closer to the specified seed than other seed in the region. The result are faceted shapes, which, when used in the three dimensional boundary of a house, create folded surfaces, oftentimes none of which can immediately be occupied.

In order to translate the voronoi diagram—the three-dimensional realization of the previously two-dimensional clustered program bubble diagram—into something which can be used as a house, it must be interpreted and translated into inhabitable surfaces and spaces. For example, in voronoi divisions, the lacking of any flat surface, floors must be somehow inserted, and then stair-cases must be added as necessary in order to connect different spaces. Considerations into performative qualities must also be considered, such as privacy and circulation, further manipulating the interpretation of the generated diagrams. This procedure of interpretation, manipulation, and editing has countless possibilities which, if not guided carefully, can make the design of the house in this scenario impossible.

**FROM DIGITAL TO PHYSICAL**

Digital physics simulation provides the key link for the transition from virtual, non-physical ideas to a concrete design. Using *Rhinoceros 5.0*, *Grasshopper* plug-in for *Rhino*, and *Kangaroo* for *Grasshopper*, adaptive lifestyles are mapped into two-dimensional diagrams, given physical features, and translated into three-dimensional space.

Circles and spheres are a way to give initial equivalence to different user-directed inputs. They convey three important factors of virtual-to-physical information—virtually, they represent the user-defined
activity, time spent performing those activities, and personal value assigned to the activities, respectively, these are defined by physical characteristics of the definition or title, the radius, and distance from center point, \(c_{center}\) to central clustering point \(c_{center}\). A series or cluster of circles gives each circle (activity) an equal relationship to each other, meaning that each circle behaves and reacts similarly to all the others, not favoring a certain errant geometry. There is no geometric favoritism in the haptic description of the activity via shape itself, but the circle’s physical behaviors are dictated instead by the other two factors it describes.

The circles are then clustered to a central point using springs, a physical simulation using Kangaroo for Grasshopper for Rhino which realizes spring force laws along an indicated line.\(^1\) This motion translates to activities of more personal value to be closer to the “heart” (\(c_{center}\)) of the home and to be in closer proximity to each other.

The radius of the circle—the time spent doing the activity—also has an effect on its resultant distance from \(c_{center}\) post-spring application.\(^2\) Although the equation of the periodic motion of mass on a string does not immediately yield the final resultant position of the circles based on their mass, it acknowledges that mass has an effect on its spring motion, which then has an effect on its final resting position. Here, the “mass” correlates directly to the size of the circle’s radius (i.e. all circles of equal radius have equal mass, those of larger radii have larger masses).

When clustered, the circles of larger radii pull towards the central clustering point \(c_{center}\) while smaller ones fall between the larger ones, filling in the gaps created by the varying curvatures. Because circles of larger radii translate to activities which consume more of the given user’s time, the result is that activities which the user spends a lot of time doing are located in proximity to one another in their final spatial clustering outcome. Practically, this means that spaces bend towards being realistically multi-purpose and actually relevant in its duplicity of functions. Thematically, it reflects the increasing habit of quick, non-sequitur actions that are presented by the virtual world—flipping between internet tabs, having multiple computer applications running simultaneously, the immediate accessibility of any and all information imaginable, etc.

It is important to note that the combination of these two physical motions results in a complex clustered result. In either of the aforementioned physical laws, if all components in the spring system are equidistant in their distance from \(c_{circles}\) to \(c_{center}\) and are equal in mass/size of radius, the result would be a wholly symmetrical cluster which resembles the outcome of circle packing of identical circles. However, the inequality and variation of the user-defined inputs guarantee a unique clustered result in every case. This is why each house is a unique ‘snowflake’: users’ lifestyles are different, and this vital difference is preserved in the rationalization process from two-dimensions through to three, starting with the ability for the physical simulation to maintain these differences, rather than to simplify them.

While the physical spring-force clustering motion of the original bubble diagram can be regimented and systematically employed, the rendering of the circles themselves in their original placement is somewhat less constant. In other words, there exist multiple bubble diagrams which describe the same “lifestyle” as dictated by the values of the spheres (their size, their distance from \(c_{circles}\) to \(c_{center}\), but do not result in the same clustered result. One way to resolve this issue is to devise a tertiary physical descriptor which would create a relationship between each of the spheres. That way not only would the sphere location be defined at least in one direction in relation to \(c_{center}\) but to all other \(c_{circles}\) contained within the system.

The use of Kangaroo to simulate the physics of spring motion revealed a shortcoming in the program itself, which was eventually used to benefit the design of the home: with certain circle and sphere combinations, the components would not only cluster but, in fact, intersect and overlap. There exists a certain, indiscernible threshold where a sphere will entirely consume a smaller sphere. This happens despite each sphere and circle being specified a defined boundary consisting of all the points of a certain distance (radius, \(r\)) away from their center points (\(c_{circles}\)). Theoretically, the spheres should not breach these boundaries in their clustering motion. For the most part they do, and bounce and settle in predictable, logical manners. However, in some cases, mostly at points where the radii of neighboring spheres are very different in size, they begin to overlap in their final position. This is accepted within the Everyone is an Architect program as interesting and potentially productive. Following the clustering process comes the opportunity to “interpret” the resulting, clustered bubble diagram whence the overlapping of circles may be translated programmatically in three ways: a negation of either (or none, in the case of an overlap of more than two circles) circle, an additive combination of the two circles, or a new, emergent condition. This third interpretation is the primary manner selected as generally providing the “best” final house outcomes as it suggests that the previously described non-sequitur-like behaviors promoted by virtual living result in a tangential or divergent relationship between components, not a simple additive or subtractive one; that multiplicity or overlap of seemingly unrelated items can combine to create a new emergent result or behavior.
CROSS-EVALUATION OF POTENTIAL OUTCOMES

The process by which the program determines the “best” outcome is a complex genealogy of variations which is cross-compared and evaluated on spatial and performative scales. At every stage of design, from the generation of the program diagram to the way the clustered diagram is realized in physical form, there are a myriad of different possibilities (Figure 5). To avoid running through a lengthy process of design and testing of each possible outcome for each house required, a small selection of house scenarios have been evaluated in order to determine the series of operations which generally yields the highest number of desirable results. The factors considered are many and relate to: how the initial program diagram is visualized, the clustering of the program bubble diagram and its interpretation, the manifestation of the program diagram within the voronoi boundary, various manipulations of the program diagram, the voronoi boundary to produce usable and appropriately-sized spaces, circulation through the house and accessibility of services, and the balance between privacy and visual unity.

After the primary algorithm produces a suggested house, the user can subsequently tune up their given outcome as they see it. To accommodate different levels of technological savvy, this user-directed design input can range from varying levels of ease, from nearly full automation or complete manual control. All of the opportunities for change open to the user for alteration are already groomed by the system to ensure their logistical viability (ex. floor-to-ceiling heights, spaces of appropriate sizing, etc).
TESTING AND CONSTRUCTION PHASES

After a house scheme is settled upon more or less, it becomes live within the virtual “game” component of the program. Clients now become players and are able to explore and test their house first-hand through means they are often times already aware of—virtual life simulation (Figure 6). Depending on the depth and scope of the game developed, players can not only explore their generated house but even its surrounding context. The social aspect a la Second Life encourages the forging of community ties even while the community is still under construction in real life. Gathering players of common interests in the virtual world improves the likelihood of a tight-knit neighborhood of like-minded residents in real life, later. In this way, Everyone is an Architect helps build communities too.

Players may continue to make alterations to their house as they wish, and once a final design is decided upon, it can then be submitted for construction. Constraints are placed on the design of the house at all stages of the process in order to ease its translation into real life construction. As much of the house as possible is made from off-the-shelf parts to reduce cost. Custom elements are optimized to allow for standardized joints and details and are pre-fabricated to expedite on-site assembly.

Changes to the house made in the game—say, adding new light fixtures or re-painting—can be sent as “work orders” and almost instantly change in real life too. Similarly, changes made to the house in real life can update immediately in the virtual version.

APPLICATION CAPABILITIES TO WORK WITH EXISTING TYPOLOGIES

Specification of a building exterior “shell” is required in order to generate a house. This becomes an opportunity for either the input of a new typology or a selection of an old one. If the house is being planned in an existing neighborhood with an already established language, the client and designer may opt to borrow the prevailing language of its context. After running through the primary algorithm, the selected building exterior is often times affected by the three-dimensional voronoi spaces created inside. The result is an exterior which parses the neighborhood typology through the aesthetic language of the program itself (Figure 7).

Everyone is an Architect houses have both a visual connection to its context but also to the program. Everyone is an Architect has been “played” in Detroit, a city which has unfortunately suffered dramatically following the recent economic downturn. The neighborhood of Brightmoor, in particular, has an astoundingly large number of lots which are deemed “Vacant, Open, or Dangerous” by the City of Detroit Parcel Survey organization. Everyone is an Architect uses the selected primary algorithm with common traditional or existing Detroit housing typologies to generate new housing possibilities. These outcomes can begin to regrow the decaying city, imbue the new houses with a new, contemporary sensibility but also with at least a visual connection to its past.
Using Detroit as testing grounds provides a context within which a house can be generated, but further research must be done into the economic viability of such a project. Ultimately, however, the intent is that this program could not just work in Detroit, but in cities across the world in a variety of different situations. In this way, Everyone is an Architect joins the intents of many ideas before it—Levittown, Archi-techtonics’s Flex-City, NYC, Work AC’s Nature-City, amongst a myriad of others—as an investigation into typology.

TO INFINITY AND BEYOND

Everyone is an Architect broadly seeks to demystify and simplify the design and building process and reach out to everyday people. Because of the numerous variables involved in the process, the current state of the program still has far to go in terms of refining the chosen algorithm and its potential deployment. Small changes in the process have a large effect on its dependent clauses, and the simplification is not always simple.

Although everyone may be an architect, the architect is not disposable. Instead of designing a singular building, the architect designs the rules of a microcosm of possibilities. The power of computing, guided by the authoring architect, combined with the user-friendly platform of gaming technology allows design to be infinite yet bespoke and accessible.
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NOTES

1. When springs forces are applied to the circle diagram, the circles react in a way which pulls circles of shorter distance from circle center points c\text{center} and leaves circles of greater c\text{circle} to c\text{cluster} distance along the periphery. This is essentially an enactment of Hooke’s Law:

\[ F = kx \]

where the force required to compress a spring (F) is dictated by the spring stiffness factor (k) multiplied by the distance, x, the spring is displaced. Because c\text{center} is considered as (0,0,0), F would essentially result in the resultant displacement after the springs are enacted. In this scenario, the equivalent equation would read:

\[ c\text{circle}_2 = k \times |(c\text{circle}_0 - c\text{center})|, \]

where c\text{circle}_2 is the resultant circle position according to its center point, k is the program-defined spring stiffness constant, c\text{circle}_0 is the initial circle starting point according to its center, and c\text{center} is the central clustering point coordinate.

2. This motion can be somewhat described by the physical law describing the periodic motion of mass on a string:

\[ T = 2\pi \sqrt{m/k}, \]

Where T is the period of the motion, m is the circle’s mass, and k is the program-defined spring stiffness constant. The springs in this program do exhibit periodic motion—the circles bounce because of the springs and off of each other’s surfaces and eventually settle into their clustered position.

REFERENCES


IMAGE CREDITS


Figure 2. “Mod The Sims–My screen is glitchy when the screen moves - and is freezing.” Mod The Sims - My screen is glitchy when the screen moves - and is freezing. N.p., n.d. Web. 7 Apr. 2014. <http://modthesims.info/t/234306>.

Figure 3-7. Author’s Original Content.

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