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Toward complexity: participatory design out of disorder

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Toward complexity: Participatory design out of disorder

by

Rachel Beth Williams

A thesis submitted to the graduate faculty
in partial fulfillment of the requirements for the degree of

MASTER OF ARCHITECTURE

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Clare Cardinal-Pett
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This is to certify that the master’s thesis of
Rachel Beth Williams
has met the thesis requirements of Iowa State University

Signatures have been redacted for privacy
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CHAPTER 1. INTRODUCTION

Let us suppose there is an idealized form of housing, one which functions well for its inhabitants and the community. Architects have used the modernist ideal of order to approach this ideal, and recently they have realized that such order becomes more complex as it attempts to address the various individual needs of the inhabitants. In particular, these designs have often failed for the lowest income segments of the community.

Using complexity theory, the study of the border between order and disorder, I will examine the problem of designing towards this idealized form. Specifically I will be using the analogy of fractals, the visual representation of complexity, to investigate this. Many environments and organic systems which function well have been shown to have an organization approaching a fractal, so it is not a large leap to imagine our idealized housing as having fractal characteristics.

I will describe how two very different approaches, one from the side of order, the other from disorder, can be used to create fractals; and common characteristics that result. I will compare this to the approaches that have been used in creating architecture, and show some links as to why it has succeeded or failed.

Finally, this theory will be used to describe an alternative role for the architect, approaching the idealized form from a different direction. This will be illustrated with some speculation as to its possible effect in the design of a low- and middle-income housing cluster in Ames.
CHAPTER 2. COMPLEXITY, FRACTALS, AND ARCHITECTURE

Complexity is the border between order and disorder. Fractals are graphical representations of complexity. They are an idealized form that can be described, but never fully represented. Approximation is the best one can do. However, it is possible to approach complexity from both sides, both from order and from disorder. The choice of approach influences the methods used to create a fractal form.

Defining complexity from order

Qualitatively, fractals are easiest to describe from the side of order, and this is usually how they are explained to non-mathematicians. An example can be shown in the Sierpinski gasket, first precisely described in 1916 by the Polish mathematician Vaclav Sierpinski (1882-1969), but which can be seen incorporated much earlier in the art of several world cultures. The Sierpinski gasket is a solid triangle that has a triangular void removed from the middle. The process is repeated with each solid for infinitely many iterations.

![Figure 2.1 The first five iterations of the Sierpinski gasket.](image)

The common characteristics of a fractal can be easily seen in this example. One is multiple levels of scale, a pattern of solids and voids that repeats in many sizes. This example is particularly simple, so a gradient of these scales is obvious, from the largest to the smallest triangles arranged in a sequential pattern. The texture of this fractal can also be described as rough; there are no planes of solid surface, each is filled with smaller voids. Finally, and perhaps most interestingly, despite all this (or perhaps because of it) the pattern
can still be easily understood as a whole. This last characteristic becomes interesting and miraculous when applied to fractals of more unusual geometries.

Note that a fractal can never be precisely drawn, despite the ease with which it can be described. It will encounter the limits of our media for representation, the ink, or the pixel. Here, as we try to introduce greater levels of order, these limitations will instead give it a measure of disorder, or imprecision. Such small errors may seem insignificant at first, yet in our modern age of computing, encounters with the results of the butterfly effect are not uncommon; a small file error can sometimes create large problems in a system that relies on rigid order.

**Defining complexity from disorder**

The other approach to generating fractals is from the side of disorder. This is the approach most commonly used in mathematics, and was the means by which Mandelbrot first discovered these surprising forms. In this case a simple rule, or transformation, applied to random input can result in the emergence of order over many iterations. This is far from intuitive.

Again, to illustrate with a simple example: take a triangle of three points. Choose any point in the plane for the first mark. Then randomly choose one of the three triangle points (for example, by rolling a die). On the line between the first mark and the chosen corner, place the second mark. Randomly choose another corner and place a mark midway between it and the second mark. Repeat (infinitely many times). The figure shows the first few iterations of this method (with the lines drawn, although they wouldn’t normally).
Figure 2.2. First six iterations (Bourke)

At first it looks like a random scattering of dots. But after more and more iterations, a structure begins to emerge. The greater the number of iterations, the more detail is evident on the structure (shown on the right). Again we are approaching the Sierpinski gasket, but this time from a completely different source. Fractals generated in this way are referred to as “strange attractors”.

Figure 2.3 (right) Increasing iterations in the random generation of a Sierpinski gasket.

Contrasts and Applications

To relate these approaches to complexity to applications in building, it is important to note the differences in effort and energy required by each. The first method, of increasing levels of order, is a hierarchical system, requiring each iteration to be done in order and exponentially increasing detail and energy is
needed at each successive iteration. In contrast, the second method, although far more iterations are needed before the order emerges, requires exactly the same amount of energy for each. The one-millionth iteration is just as easy as the first. This process can be efficiently handled by a network because the first point chosen was arbitrary, so the summation of calculations from different starting points should approach the same figure, hence work can be done separately by many computers towards the same goal.

**Complexity in Architecture**

Complexity and fractals have a variety of characteristics and while mathematicians have often used examples from architecture that show fractal qualities, architects have chosen very different examples to emphasize other characteristics. Mathematicians look to fractals to make evident a rhythm or pattern in a system that seems to have no particular reason to be ordered. In particular, a fractal pattern will be repeated at all (or at least many) different scales, from the largest form to the smallest details. For this reason, they choose examples such as Louis Sullivan, Frank Lloyd Wright (Salingaros 2001), Gaudi (Lesmoir-Gordon 164), as well as the details of the classical orders and the structure of gothic cathedrals (Bovill 155 and 184).

Architects, in contrast, see architecture as ordered by default, and therefore attempt to use fractals as a generator to introduce an unpredictability or disorder to the structure. This is usually done through the use of irregular shapes. Thus the examples chosen are Venturi for his studies of the “decorated shed”, Gehry’s forms, and some deconstructionist in the fad of “fractal architecture” during the 1990s. In the case of Gehry, Taylor describes the experience of the Guggenheim Bilbao as:
Wandering through the museum’s circulatory circuits, its structure seems to change repeatedly in unexpected ways. Instead of preprogrammed or permanent, the order of this structure is emergent and transient. It is as if the flow of the space follows the swirling eddies and turbulent whirlpools of the Nervien rushing nearby. (44)

The important phrase here is “seems to change”, when it is static. Although the irregular shapes might surprise a newcomer, I would guess from my experiences of his other buildings, that after being there for a weeks or even hours, the shapes would become familiar and unsurprising, and the details (or lack thereof) would become boring. The large curved panels used to create his building lack fractal qualities at the smaller scales, leaving them merely unusual and irregular geometries.

![Image of Mies van der Rohe's Seagram Building in New York City contrasted with Frank Gehry's Guggenheim in Bilbao, Spain.](Taylor, 22)

Both architects and mathematicians have looked to vernacular architecture as an example of complexity, but see different things. While the architects make note of the
irregular shapes and lack of alignment, the mathematicians will notice the order that exists despite that, how groups of buildings echo each other in different sizes, how groups are contained within groups, and that there is a rhythm and distribution without rigid regularity.

Figure 2.5 Aerial photo of a village in Cameroon. (Lesmoir 166)
One thing that both groups do agree on is that an ideal example of architecture that is not fractal is a building by Mies van der Rohe because of its planarity, regular grid, and lack of detailed ornament.

**Causes and Effects of Complexity**

Complexity can be seen in systems that grow (trees, ancient cities, clouds, etc.). The rules that create complexity can be described as an iterative process over an extended time period. It is also characteristic of a grass-roots organization, rather than a hierarchical one. Each element (house, person, cell, molecule, etc.) that interacts with the system, does so through multiple factors at the local level. This allows the system to work much more effectively with the variety than would a system dictated externally through principles derived from considering the averages of elements (since considering every variation within the system is almost always impractical or impossible).

Many fractal studies look at how existing cities have developed over time. Generally they have found, on systems at several scales, that the success of a city correlates with the measure of its fractal or complex nature. (Salingaros 2003; Crompton 2001; Alexander 1965; Turner 31) An efficient system is one that is structured as a network rather than as a hierarchy.
Complex environments have multiple solutions to problems (for example, a network of streets offers multiple routes to a destination). This redundancy not only prevents partial failure from becoming total failure (Levy and Salvadori, 81), but also works as a buffer to handle change as well as a springboard for new and better solutions. (McDonough)
Complexity is healthy. Being exposed to complex systems encourages human cognitive development through recognition and interaction with these patterns. (Salingaros 2001) Most systems of nature are relatively complex.

**Pros and Cons of Standardization**

Standardization does have definite advantages. The predictability can allow for new components that fit neatly into an existing system. Components of this system can then be mass-produced at a reduced cost. Such a system is designed to relate to a specific (though it may be large) set of criteria. Problems arise when such a system is asked to handle criteria beyond its predicted parameters. Adaptations that are introduced to bridge the gap between needs and capabilities are often obviously outside the established system and appear odd or ill-fitting. For example, standard foundation construction requires some steps up to reach the raised floor height. To make the first floor accessible, a ramp or altered landscaping is used, which makes the house appear different from its neighbors.

Standardized systems also lack the ability to adapt to opportunity, such as might be provided by recycled building materials, windows, plumbing, etc. Although these components might still be fully functional, they are discarded as not worth the effort to make them fit, when comparable standardized components can be so cheaply made. This is an instigator of our throwaway culture that prefers to replace a part or whole rather than to repair or reuse it. (McDonough 97) This is an environmentally disastrous attitude towards materials.

A neighborhood with complexity will only be built when there is motivation that outweighs the motivations of the current trends in housing. Those motivations begin to be
evident in the 19th century as a result of the industrial revolution and increasing technology. Specialization, as well as speculative investment in housing, has lead to the increase in housing initiated by economic concerns and built to a standard formula by builders, long before the users are even identified. (Wright 200)

The alternative I propose is to return to the motivations of earlier vernacular architecture, namely community and need for shelter. The structures must react in relation to those neighboring it and the people using it. For these reactions to take place there must be collective knowledge of the history of the community, as well as means for altering the structures. For this reason, education about construction methods, recognizing that the residents are not specialists in construction, and ease of alteration become concerns in the design development. Also, since the form of the buildings and the site will be partially determined by the residents at many stages, it will not be possible as a designer to fully describe the end results, but merely to make educated guesses towards several possibilities.
CHAPTER 3. PRECEDENTS

Of course affordable architecture has been tried many times. I am only suggesting another alternative because I believe that a wider choice will enable affordable housing to be successful in more settings. Some examples I will highlight have been very successful, but perhaps because they are unique to their location. Since complexity is so highly dependent on and responsive to influences at the local level, merely copying an example from another area to solve the problem here will not produce the same results. However, this does not exclude being able to learn from how and why these examples have adapted to their sites.

New Urbanism

Many New Urbanist developments from Celebration, Florida, to Somerset, Iowa, are designed to be economically diverse, but end up gentrified, only offering options to the narrow upper range of the economic spectrum. Owners do not have design input on the communal space, nor much control over their own spaces with only a few chosen acceptable styles of houses, enough to prevent monotony. The standardized model houses are designed to satisfy an average resident, not to respond to their individual differences.

In attempting to increase the density of its housing and commercial districts, Somerset in particular has fallen victim a common problem in this system. Although it tries to create a pedestrian focused neighborhood, it has given in to the demands of users for a place to park. Hence the core of the neighborhood is a large void in the form of a parking lot. The other alternative, to force the parking to the perimeter makes the neighborhood a pedestrian island, discouraging interaction with neighboring communities.
Cohousing

Many examples of cohousing projects are not only dense and diverse, but also involve the residents in the design process and are inclusive of a few lower income households. Case studies show the completed design as determined by those who live there, perhaps constructed in one or a few phases. This is an illusion. The turnover in any group of housing is greater than zero, and it is not unreasonable that it would be even greater during the unsettled time of agreeing on a design. What would be more fascinating and relevant is a longitudinal post occupancy study, showing how new residents and relationships have influenced change on the built structures.

Lucien Kroll

Kroll’s efforts towards community involvement in design are a large step in the direction pointed by this research. He has developed a superstructure with varied infill influenced (and sometimes designed to be modified) by the residents.

His work also shows some of the constraints such a system is likely to encounter. For example, in his residential complex, he limits floor to ceiling heights to one of two dimensions. Likewise the grid of walls, although the original concept was irregular and he acknowledges that dimension choices should be ideally be in increments of 1-2 cm (Architecture 59), the built form ends up as a rectilinear grid in increments of 10-20 cm due to practical constraints, shown in figure 3.1.
The inhabitants are to choose different sizes of windows depending on their personal preferences and personality, yet he describes in the construction of the building the architect decided on the placement of the panels in the façade, determining that pure chance (drawing cards) did not make it look “random” enough, and that an architect “does not make mistakes”. (Architecture 56) It is not evident that the owners themselves have the ability to change the windows from within nor, if it is difficult, that the effort would be worth it.
The limitations that Kroll is running into are the remnants of the modern role of the architect in a hierarchical system as the intermediary between the user and builder, coordinating wishes and taking responsibility. By limiting the choices available, particularly in terms of dimensions of components, and predetermining others, such as the exterior façade, it brings the number of decisions overseen by the architect within reason. If however, the coordination took place locally, and was not the responsibility of an overall figure such as the architect, then standardization would be less necessary. This would also allow for the use of components, perhaps recycled, that are not designed specifically for the standardized system.
Christopher Alexander

Alexander is famous mostly for his Pattern Language where he describes hundreds of named configurations of space, which he asserts as positive or beneficial. In his latest work on the nature of order, he attempts to describe the principles underlying these patterns he had found earlier. He narrows these down to fifteen principles that he describes and sketches: levels of scale, strong centers, boundaries, alternating repetition, positive space, good shape, local symmetries, deep interlock and ambiguity, contrast, gradients, roughness, echoes, the void, simplicity and inner calm, and not separateness. The interesting thing about these is they can be seen equally well as qualitative descriptions of fractals or complexity although those terms have not been used at all in his text. Figure 3.3 shows four of his illustrations that appear particularly fractal-like and whose concepts are included in the design ideas following.
Unlike Alexander, who views these abstract patterns as static examples, the findings in the previous description of fractals tend to indicate that growth and change are an integral part of, and even cause of, the structures he has observed.
CHAPTER 4: AFFORDABLE HOUSING IN AMES

In the area surrounding the site chosen for study, several different attempts have been made at affordable housing. The houses on Franklin Avenue are small in size compared to those on newer streets, and they have undergone many changes over the years. These homes have a notably strong connection to the street, often with sidewalks extending straight from the front door to the street. More recently built houses tend to shift this focus to the driveway instead.

There is a development of houses to the south of the site at 3514 W. Lincoln Way, built in the 1970’s that attempts to economize by standardizing the housing into identical units. These units lack a connection to the exterior, instead facing each other and reducing their privacy. Although the existing mobile homes on the site have similar proportions on a smaller scale, they have more variety in window and activity orientation, thus allowing for more privacy.

Another group of apartments a block to the west, gives each apartment a pleasant view to a shared green space. This affect is achieved by a long wall separating the green
space from the street. This lack of connection greets the numerous pedestrians drawn to that location because of its convenient bus stop and island in the center of the street, which makes it easy to cross even without a streetlight.

![3801 West Lincoln Way](image)

*Fig 4.2. 3801 West Lincoln Way*

A series of low-income duplexes, built in 1970, is a little further west on Lincoln Way. These use a different method to separate themselves from the street, that of a parallel access road. The median between the two roads is planted with evergreen trees to provide a sound and visual barrier throughout the year. Because these houses are grouped together, they maintain a stigmatizing identity, where they might individually blend in with a more typical residential neighborhood. The yards and driveways of these houses, though not well maintained, are at least well used, perhaps evidence of adaptation to small interior space.
The latest homes in the neighborhood are large apartment buildings built behind the Hy-Vee supermarket. These attempt to consolidate the construction to achieve an efficiency of scale. The result is a building surrounded by a large parking area, in disproportionate scale to the surrounding neighborhood housing. The only green space is a pond and fountain at the corner of the parking area. Although it may be used as geothermal sink to help control the temperature of the building, it is more likely to be merely ornament and a required basin to collect the storm run-off from the vast parking lots.

The mobile home park itself will be described in detail with the design description.
In Ames, the need for affordable housing is often hidden. Most of the new construction is in relatively high-cost apartment buildings for students on the outskirts of town, beyond public transportation. At the same time, the wait list for houses from Habitat for Humanity in Story County is three years, and government subsidies for Section 8 housing has been closed because the list was longer than two years. The government’s limited funds towards low-income housing leads to the dilemma of giving a small subsidy to many slightly poor families, or to give large subsidies to fewer very poor families. Due to real estate pressures, the subsidized houses are not likely to stay as low income residences; within a few years they are often sold back to speculators where they re-enter the market at a rate comparable to standard housing in the neighborhood. For Ames, that standard housing price is beyond what is affordable to salaries in many respected and necessary professions.

To consider what housing price is affordable for a given salary, the asking price alone is both intimidating and deceptively low, particularly for those without cash resources available. Not only is the price tag high, but even a subsidized mortgage at a very low rate of 5.375% will have a total cost of over twice the principal if paid off in thirty years. Even though the monthly payments are enticingly lower than an equivalent place to rent, surprise costs such as utilities, major repairs, and closing costs of 3-5% or health problems can quickly threaten foreclosure on a mortgaged home. So merely eliminating the interest and other mortgage related payments could significantly increase the affordability as well as flexibility in paying for a place to live.

Considering the long-term life of a building when designing it not only enables investment in sustainable technologies, but it conserves building resources. It can save
money on energy costs and create a building that doesn’t deteriorate within a few years and earn a stigma as “cheap” housing.

Suburban sprawl is a problem because of its unsustainability. It has a large impact on the environment, and the increasing distances required to produce the overly ordered environment are achieving diminishing returns in efficiency. The uniformity (monotony, conformity) of the suburban environment is leading to its eventual collapse. (Salingaros 2003) The pattern of such collapses has been recorded in other similar social systems. (Tainter)

When the value of their labor is small, it is difficult for wage earners to work the extra hours needed to save the money needed to pay for materials and skilled labor of builders as well as their heavy equipment. Another alternative, one of the primary ones of which Habitat for Humanity makes use, is to instead let the future owner invest their time into their home, using money to pay only for materials. This, although slower than the rate at which skilled labor could build the same house, is still much faster than the rate at which the owner would be able to save towards the costs of skilled labor. During the Great Depression, when materials were expensive and hard to come by, but labor was relatively cheap, it was common practice to spend the time to salvage usable parts from all sorts of waste. But now with labor costs generally high, that behavior is considered a “waste of time” and it is just more “efficient” to buy things new. The choice of trade-offs between the relative costs of time and money is up to each owner, and therefore decisions based on those choices should also be individual. But the structure needs to be one that enables participation in order for those options to be open.
CHAPTER 5. DESIGN

Introduction

I do not mean for this section to be proscriptive of the only way to solve the dilemmas of sustainability and affordable housing, in the context of complexity. It is rather the description of an exploration into one possible solution to the problems. The conclusion will describe further directions of exploration that have opened up in the process of this thesis.

Site

Selection: Part of the site selection criteria was that it is a place that I walk past frequently. It gives me a perspective that is closer to the future owners of that site, rather than one that I only know remotely and from published data.

The site was chosen because of its connections to pedestrian routes as well as public transportation. Within walking distance are schools, especially elementary and middle schools (older students can make use of more transportation options, such as public transit and carpooling), several businesses that could provide potential jobs, a major grocery store,
and green space in the form of a forest preserve. The public transit adjacent to the site is a primary route with buses every 5-20 minutes depending on the time of day. The buses connect to the high school, major areas of entertainment, and larger shopping areas including downtown, the mall, and big-box stores on South Duff Ave.

Besides the connections to the neighborhood, the site offers many qualities within its boundaries. Slight to moderate slopes in the topography are sufficient for easy drainage without creating challenges to the construction process. Mature deciduous trees throughout the site allow for plenty of sunlight in winter, but a thick shade in summer, assisting the passive solar qualities of the buildings and mediating the negative effects of paved areas for parking.

Existing permanent structures on the site are somewhat old and in disrepair. Some of the methods suggested for new construction on the site could be applied to these buildings by stripping away some of the cladding materials and utilizing the core structural members. The current residents of these buildings as well as the mobile homes on the site could be the first ones to build by purchasing the land on which their homes currently rest and building alongside while continuing to reside there.
Description: The site selected for this project is the mobile home park located at 3503 W. Lincoln Way. The site has space for 36 standard mobile homes, but currently houses only 24-26 mobile homes with the other lots vacant. Also on the southeast corner of the site is a turn-of-the-century house facing Lincoln Way with many extensive additions on its back side. In the middle of the site, on the border between the rental lots and the forest preserve, are two small, low-quality houses that look post WWII, but are definitely present on a topography map from the 1960's.
Figure 5.3. View from forest preserve to north end of residential part of site. Entrance to forest preserve on West Street.

The infrastructure of the site consists of gravel drives that are mostly used one way—entering from Lincoln Way, and exiting out the rear through adjacent commercial parking lots and alleys. There is a paved pedestrian sidewalk along Lincoln Way, and there is a well-used footpath through the forest preserve connecting Story Street and West Avenue. It is connected to the city’s infrastructure of electricity, telephone, and sewer. There are no fire hydrants visible on the property.

To the south, the property is bordered by Lincoln Way which is four lane and undivided at this section. There is a large drainage ditch on the opposite side before a medical clinic. The clinic has a gas station and strip mall parking on either side.
To the west, there is a large restaurant and bar. The northern half of the property is surrounded by detached residences with access through smaller backstreets. On the east side there is a restaurant in a renovated residence and a newly constructed video store.

**Economics:** The existing site is currently zoned as highway oriented commercial (with a secondary usage as residential low density) with an annual (2003) property tax burden of $23,514, based entirely on an assessed land value of $830,600, with no buildings included in the assessment since the mobile homes are usually owned by the occupants. The forest preserve located on the back half of the property awards the owner a tax exemption value of $56,600. No credit was awarded for low-income housing.

The park is at less than full capacity, and appears to be going downhill, both in the number of residents and in the condition of the mobile homes situated there. At some point the park will reach a point when the rental return on the lots will not cover the tax burden of the property.
One possibility is that the owner of the mobile home park will sell or convert the property to other commercial interests. This is not likely because there are multiple other commercial properties within one or two blocks, with unoccupied existing commercial structures of various sizes and infrastructure.

At this point the city may be forced to get involved, or the owner may request the assistance of the city. The city may re-zone the property to residential or mixed commercial-residential and lower the property tax burden because of this changed use. The difference between the old and new tax burdens can then be invested into the initial infrastructure needed in a permanent residential area. This new residential area could be administered under the city’s housing department or under the current owners. Conditions that will be necessary are that there should be at least enough units to replace the existing mobile homes so that the current residents are not displaced. Also, home ownership should be encouraged, and this should include the land under the detached homes at least. Ownership of the shared facilities and rental units could be shared as a cooperative, the local government, or a private owner under contract with restrictions established by community representatives.

The units are designed to be built in multiple stages, so that the owner may, instead of a mortgage, simply build as he or she can afford to do so. If someone with limited resources can make do with less space, they have more options open in how to spend or save than if they are forced to stretch their budget to get a “better” house. One of these choices may be a location that gives access to various social support structures that can provide much needed help during periods of difficulty and opportunities for improving the situation. (Turner 53)

Buildings can be built to last a lifetime, but they can also be intentionally temporary and recyclable. Mud huts in Africa have to be rebuilt every 5-10 years because of erosion
from the rains. All the materials are readily available and cheap, and the knowledge of how
to build the structures stays fresh in the collective memory of the community. One advantage
is that it is then not such a disaster if the hut gets washed away in a severe storm or burnt
down, as it was scheduled to be rebuilt anyway. Modern homes similarly have parts that are
expected to be replaced after 5-15 years, but the old parts are merely thrown away, and the
cost of replacing them can be an unexpected burden on a homeowner with limited income.

The benefits of owning a home include not only the security against raising rents or
changing landlords, but also a sense of pride and control in one's surroundings. Ownership
motivates maintenance and improvements to a property. For affluent homeowners, this is
often a choice of expenditures of money. But for low-income homeowners, whose financial
situation is already stressed, paying someone else to do the work is often not an affordable
option. However, if there is building knowledge within the community, those same effects
can be accomplished through expenditure of time and effort. Collective skills were more
common in a time before specialization, and so buildings today can be designed for some
simplification and reduction in the building skills necessary, at least initially while the skills
are being re-discovered. More advanced projects and systems are always a possibility once
the resident has the desire and confidence to engage them.

Finally, another economic advantage of living in a community that is continually
being built and rebuilt is a collective knowledge of home maintenance. According to one
Habitat for Humanity owner: "The [sweat equity] I do is worth it because I am learning to
take care of my own home."
**Infrastructure needed:** The site planning will be pedestrian dominant but it will recognize the presence of vehicular traffic (though, because it is low-income and near public transit, we will argue that fewer parking spaces per unit than usual are needed). The parking will be dispersed throughout the site to reduce its visual as well as environmental impact. As much as possible will be shaded by trees or be permeable paving material.

The pedestrian crossing of Lincoln Way will include a wall of vegetation perpendicular to the traffic flow to encourage a reduction in speed. The proposal also includes a slight deviation of the traffic and an island created between the traffic flows, both to slow the traffic and to create a refuge for pedestrians crossing there at the mid-block. Sound abatement will be achieved through a combination of grading, building placement vegetation, and speed reduction.

The public pedestrian access to the forest preserve will be strengthened by clearing and building a more weatherproof walking surface such as a boardwalk, as a link between this enclave and the other residential neighborhoods to the north. A clearing at the border between the site and the woods provides an opportunity for a picnic area. The commercial activity on Lincoln Way may encourage some small commercial ventures on the southern perimeter of the site.

Towards the center of the site common facilities such as laundry, daycare, and a large meeting room can be located. This is also a good place for a play area for younger children, where they can be supervised from many units. Older children seeking more independence can use a paved area on the west side of the site. This is adjacent to the service entrances of the neighboring businesses. This is a good place for louder games, such as basketball and skateboarding, where they are not likely to disturb others.
The green spaces within the site can include wetlands to help in the greywater treatment of drainage collected from paved surfaces. Towards the northern end of the site, the density of trees can increase, transitioning into the woods as well as providing some privacy to the neighboring residences. The smallest and most temporary units, apartments, will be concentrated at the noisier and denser end of the site near Lincoln Way. The larger, freestanding units will be interspersed amongst the trees towards the north end. These are ones more likely to have children residing in them and would benefit from the quieter atmosphere.
Dwelling distribution: For buildings so close together, with unusual and changing wall conditions, the issue of party wall conditions becomes particularly important. This is resolved through the position of shared circulation space between units as well as directionality to the units determined by their passive solar use. Solid party walls can also be
used to house plumbing and other utility cores, however this limits the directions in which units can expand and contract.

**Components**

For this scheme to work, it is important for owners to be directly involved with the modification of their living environments. This is so that variations as a response to conditions can be made as directly as possible. In historical times, when family members built their own dwelling structures, the ability to individually modify their own dwellings was a natural result. With modern technology, the skills of building have become specialized and concentrated within a small portion of the community. Thus, any building technologies that can be expected to significantly involve the owners in our current society need to be simplified so that the occupants do not need to acquire the larger body of building craft knowledge, in addition to their own personal specialized knowledge, in order for the technology to be applied successfully.

One characteristic needed in this technology is a base infrastructure that can be “plugged into” for whatever building design is required at that location. This infrastructure may be installed in stages as the site fills in, but it should be provided by the community rather than as the responsibility of an individual homeowner. The reason for this is that initial costs are one of the biggest hurdles for low-income homeowners, and infrastructure represents a large proportion of that. If the costs can be spread out over all members of the community who use them, as well as over the long lifespan, this will reduce the initial cost impact on groups wishing to begin homeownership here as well as encourage the use of sustainable technologies with longer lifespans and reduced operating costs.
Foundation: Although it is easiest to create a slab on grade foundation, the Iowa climate awards several advantages to those who make the effort of creating a basement with their house. Its temperature is geothermally stabilized: cool in summer, and relatively warm in winter. It also provides much needed tornado shelter. However, in considering structures that will be built in several phases, it is not unreasonable to have a slab on grade as the foundation of the first iteration. (It would then be recommended to have accessible tornado shelter in nearby community buildings.) A later phase with a basement could be constructed nearby, and the original foundation used for part of the house, or as an outdoor patio area.

For a basement, it is structurally easiest to do a sloped or terraced foundation that follows the natural slump of the local ground. Excavation can be done with little or no equipment if one side has a slope gradual enough to form a ramp, or the ramp can be made to go up along one side (as the inverse of the Egyptian pyramid constructing technique). Underneath the foundation should be well drained to avoid having the foundation float like a boat. Gravel or recycled broken glass can work well as fill leading to a drainpipe at the bottom. This then makes the bottom surface of the foundation. As the foundation is poured in terraces, wood can be recycled to make new formwork at each level, and reinforcement cast into one level can connect it with the one above.

Functionally, a terraced foundation does not seem the most obvious choice, but it can serve well two of the main functions of a basement: storage and tornado shelter. Habitable spaces can also be formed from it by building mezzanine floors that connect across terrace levels.

A more standard foundation can also be built with standard vertical walls. These walls do need to be reinforced against the weight of the backfill behind them. This can be
done either by reinforcing bars contained within the wall itself, or as wing walls that extend a few feet into the basement area, perhaps separating it off into different spaces. Here the options of building formwork for cast in place concrete, as well as creating walls from concrete masonry units are both reasonable, depending on the preferences of the owner.

![Foundation section detail](image)

*Figure 5.6. Foundation section detail*

To connect the foundation to the walls above, one option is to integrate wood columns into the final pour of concrete. These will be structurally stable, but difficult to change later. Otherwise the bolts can be included in the concrete, which can be later attached to the structure as desired. With either method, it is difficult to later return and add a connection to the foundation where there wasn’t one originally. Here the options could include: drilling holes into the concrete for screws or to epoxy a bolt in place, or if the span is small enough, to connect the new structure to neighboring walls and allow it to merely rest on the foundation without attachment.
Wall structure: For this I propose an unusual attempt at a solution. The outer wall of a building is usually the area with the highest concentration and smallest tolerance for error (as well as the greatest source of owner-architect litigation) because of the multiple roles it must fill. The components of this system allow the separation of the functions of shading, rain screen, structure, and insulation. Thus spaces can be created between the layers of these functions that are sheltered but unconditioned. The microclimate of these spaces can be quite tolerable for much of the year in Iowa, yet they are much lower cost to construct in addition to the savings on conditioning the space. (Such sheltered places can also protect building alterations that are in progress.)

This is somewhat similar to the rainscreen cladding technologies that are frequently used on modern skyscrapers. The standard for “efficient” housing construction currently is trying to seal every gap in the building – contributing to many problems with mold. Rainscreens have interlocking cladding to drain the majority of the water, but acknowledge that some wind-driven water will get into the insulation layer. Their solution is to also allow free air movement to that layer such that it can dry out as easily as it gets wet.

The structure will be a combination of wood structure with a variety of infill units – compatible with straw bale. Because of the double layer construction, recycled single-pane windows will be more effective than in standard construction, when newer expensive windows are not available within the resident’s budget. The structure can be erected using light equipment, but the majority of the labor should be from the neighborhood to increase the sense of community. The infill panels can be installed by fewer people (1-2) with simple connections, recognizing the owner’s lack of specialized skills.
Figure 5.7 Insulating wall and rainscreen.

The outer rainscreen can be of a light material, but should be well secured against high winds and able to support snow loads, (which only add to the insulation on colder days). A system for collecting the snow and using its insulating properties can be used.

Utilities: Heating will be from some passive solar, but as much floor based geothermal as possible. The cost of drilling to establish the system can be shared amongst units to make it reasonable. Cooling is primarily from the strategic shade, ventilation and preservation of large trees. These techniques when applied carefully can make almost all of the Iowa summer tolerable if not pleasant.
Figure 5.8 Thermal control of the living environment.

Plumbing will need the assistance of an experienced plumber to install. It is therefore reasonable to include the basics within the core of the first phase of building. More luxurious plumbing such as a laundry room and second bathroom could be saved for a secondary core in a later addition.
CHAPTER 6. CONCLUSIONS

Further research

To develop them further, the ideas presented in this thesis could now be tried at full scale. Although some replica of these ideas could be tested using models (as was done by Kroll in the development of The Social Centre), there are two major obstacles this must overcome. First, a user may or may not interpret the model environment into an accurate image of a full-scale environment. Because the design is so dependent on the owner’s perception and decisions within the space, this can cause large inaccuracies in its predicted development. Secondly, a model is often significantly easier to build than the actual building. Decision choices may then be overestimating the scale of spaces that would be feasible to build with the technology and labor available.

Projected impact on suburban development

This method of building is intended to help owners and residents of all income levels see the possibilities available in re-inhabiting the urban areas, where an advantage of proximity to services can reduce transportation costs and others. Homes may perhaps no longer be seen as static to be placed on a pristine lot, but rather as a dynamic and ever-changing space to be created and re-created by its owner(s). Ownership of land need not be in large blocks but rather to be system of movable borders, so that small pieces can be added and divided as necessary.
Marketing

Houses are currently marketed featuring the number of bedrooms and bathrooms, the square footages, as well as the dates of the latest major improvements. This alternative construction method could be advertised by describing its location, as well as the spaces between its core and neighbors, and the community skill base, in addition to the structure that exists. Perhaps a more likely lifecycle of a building is that the building would start small, expand as needed, and then either consolidate back to a smaller form, or become subdivided depending on the needs and relations of the owner. Eventually the land surrounding a shrinking building may be absorbed by its neighbors in need of additional space to expand. Or perhaps a retreating building will provide the space for a new dwelling to be started adjacent to it. Buying and selling of property will take on much more variety, hopefully including more affordable options.

Another option would be to operate the site as a land trust, where the land itself is held in common as a cooperative, but the homes on it are individually owned. Here each person only pays for as much as they use. This has been tried on isolated sites by the Story County Community Land Trust, which operates as a non-profit organization. Their contract uses 99-year leases to ensure affordability and stability to their projects. Although this method may work well in some locations, there are as yet no studies comparing its effects to those of standard homeownership.

A new role for the architect

The result of this thesis is less a finished product, than a method of thinking. It proposes to change the role of the architect from producer to an educator. The analogy
works as such, the best teachers, although they have their own idea of what the finished product should be, do not impose this predetermined result on their students. Instead they supply the students with the tools to investigate and create on their own. More often than not, the students will surprise their teacher with un-thought-of possibilities, and even better solutions. The transition to this type of student-centered teaching, from teacher centered rote learning, has been difficult, and not implemented by all teachers, and methods are easier to find for some subjects than others. Similarly, it is difficult for an architect to give up imposing his idea of the “correct” solution, and step back to allow the users to try, and sometimes fail (and learn from their mistakes), but sometimes to come up with a better solution.
REFERENCES

Complexity and Fractals


**City and Neighborhood Planning and Affordable Housing**


Cross discipline and Precedents


Sustainability and Building Technologies


Local


