‘Earthship’ as Model for an Urban Co-op Health Clinic?

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> What these kinds of houses are doing is taking every aspect of your life and putting it into your own hands ... A family of four could totally survive here without having to go to the store.
> Michael Reynolds on Earthships (Garbage Warrior 2008)
>
> …this clinic will provide community-based healthcare that is genuinely non-profit, preventive, humane and fun. It is a refuge for doctors and nurses who want time to heal patients. It is a refuge for patients who want to be treated with dignity.
> Patch Adams Free Clinic of Philadelphia Building Committee Project Statement, 2011
> (http://www.paulglover.org/patchadams.html - herein further referred to as *Client Project Statement*)

ABSTRACT: In Fall 2012, the Patch Adams Free Clinic of Philadelphia building committee (PAFCP) optioned a five acre parcel in a North Philadelphia disadvantaged neighborhood upon which they plan to build a co-operative health clinic offering care based on the ideals of Dr. Patch Adams. The desired building typology is an “earthship.” The committee teamed with the Philadelphia University Architecture Program to explore both the site and prospective clinic.[1] A two semester research and design exploration was completed by students as part of their fourth year comprehensive technical integration design studios. Programming sessions were conducted with the client to determine project goals, program needs and components. Design workshops were conducted with the neighborhood association and interested residents to determine community goals and interests. The charge of the studios was for the students, in groups, to explore and propose designs for an energy efficient, urban co-operative health clinic.

Design research explored the following typological categories: 1) The earthship as an energy model, 2) The earthship as a health clinic model, and 3) The earthship as a community building model.

This paper summarizes the student/ faculty research and the common approaches found in the seventeen group design solutions. Base-line energy modeling of a typical earthship is compared to a conventional clinic building type and basic student solutions to understand its performance and potential use. Conclusion will present the findings on the viability of this building typology as model for an urban health clinic.

Figure 1: View of Site North to Westmoreland Street. Source: (Google Maps; http://maps.google.com)

1.0 INTRODUCTION

The Patch Adams Free Clinic of Philadelphia is envisioned as an "open" medical facility operating outside of the insurance based, for-profit, healthcare system. To be supported by the surrounding community with the help of donations and public grant funding, the intent is to offer "free" on-going and preventive care delivered through a co-op model. Residents, by paying a yearly fee of $100-$300, will receive unlimited healthcare services. Emergency care responsibility will remain with the local hospitals. Expanded care such as optical/ eyewear, chiropractic, dental, acupuncture, and counseling services will be obtained through use of sweat equity "dollars" received when residents invest time and energy in the running and maintaining of the facility. The PAFCP goal is to create a self-sufficient facility "owned" and managed by members of the community itself.

After an exhaustive yearlong search, the committee found a suitable site in the Tioga section of North Philadelphia. The surrounding community is distinctly disadvantaged and has some of the highest rates of teen pregnancy, obesity, and diabetes in the city not to mention one of the lowest income rates. PAFCP estimates that upwards of 200,000 citizens lack some form of health insurance in Philadelphia. The property is a five acre industrial parcel where an abandoned manufacturing facility was razed in 2005. (Figure 1) It is bounded to the south by a busy east west artery in four lane Allegheny Avenue and to the north by West Moreland Street, a small two lane street traveled by local traffic and defined by archetypal Philadelphia rowhouses. A SEPTA rail line bounds the western side of the site while an eight story industrial building borders the east. The building committee found in the site the right combination of open space and disadvantaged community within close proximity to public transportation. An earthship built on this site would be the first urban version and one of its largest examples.

Figure 2: "South and East Side of an Earthship Passive Solar Home." Source: (Author: Biodiesel33. Wikimedia Commons. 4 July 2011, http://en.wikipedia.org/wiki/Earthship)

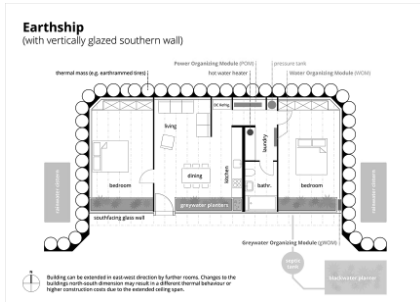

Figure 3: "Earthship plan with vertically glazed southern wall." Source: (Author: Muller, Felix; Wikimedia Commons. 20 August 2013, http://en.wikipedia.org/wiki/Earthship)

2.0 THE EARTHSHIP

> Because clean air and clean water are foundations of personal health, this building will exemplify green technologies. Building materials are regional, recycled, and hypoallergenic. The entire single-story building will be passive solar and earth sheltered to reduce heating and cooling costs.
> (Client Project Statement)

"Earthship" is term credited to architect Michael Reynolds and refers to a sustainable building typology developed initially in the southwestern United States after the oil embargo of the 1970's.[2] (Figures 2, 3, 4 & 5) 20,000 examples are claimed to exist around the world.[3] The earthship utilizes recycled materials and natural building techniques to create an energy efficient, solar powered, "off the grid", building which is purported to perform as net zero structures if properly designed and managed. "Earthships are buildings that capture and meet 100% of their energy and water needs, treat and recycle domestic wastewater, provide both indoor and outdoor spaces for growing food year round and use natural and recycled waste materials to construct energy efficient, durable structures." (Schlesinger 2013) They have become especially popular with environmental groups wanting to live apart from corporate sources of food, energy and our commodity culture. Earthships have tended to be marginalized by the architecture and construction communities due to their eclectic, whimsical language and perceived socio-political agendas.

Located primarily in arid rural sites, earthships are typically linear buildings recessed into the ground and bermed on three sides for greater insulation value. They generally oriented along an east/ west axis opening to the south/ southeast for solar harvesting. Interior functions are organized around open sun filled rooms with thermal mass floors and rear walls. Natural ventilation systems are integral to the envelope and shading devices are often incorporated to control overheating. The retaining wall structures are often earth filled tires with a cement parge finish exposed to sunlight as thermal mass heat sinks. The exterior walls tend to be made of recycled materials such as bottles and cans some of which are filled with water or oil for greater thermal mass qualities. The roof and remaining portions of the building envelope are super insulated with R-Values as high as 70 BTU/(h °F ft^2). Given the variables of thermal mass, ventilation and the sun, to live in an earthship requires an active relationship with the passive environmental systems to manage temperature and comfort.

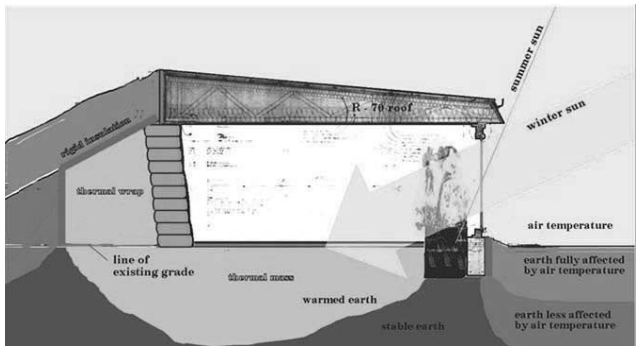

Figure 4: "Packaged Earthships. Earthship Cross Section." Source: (Author: Reynolds, Michael; http://www.greenhomebuilding.com/recyclematerials.htm)

Figure 5: "Earthship Tire Retaining Walls." (Source: Author: Paul Glover; http://www.paulglover.org/1006.html)

2.1 Earthship as Energy Model

As an energy model, the earthship is an earth sheltered, hyper insulated, passive solar building with thermal mass storage systems. For a building to be a good solar building, it must: a) collect the suns energy, b) store this energy and c) distribute the energy during times when the sun is not available. In the case of the earthship, the sun's energy is collected via large south glazing with storage primarily via thermal mass floors and walls; the energy is redistributed by direct radiation and convection offsetting the heat loss resulting from the south glazing. While many earthships employ active collection and redistribution energy systems, the basic energy model is that of a direct gain solar heated thermal mass which together with the constant temperature of the earth bridges the peak hi and low temperature internal building cycle. These structures are akin to the adobe rammed earth structures with high thermal mass envelopes.

Thermal performance studies have shown that southeastern US earthships tend to perform well in balancing heating and cooling loads tracked over the period of a full year. (Ip & Miller 2009) In consideration of the weekly or daily trends, though, the basic earthship is subject to peak overheating and underheating depending upon the season and climate as result of the large solar collection glazing area. In summer they tend to overheat requiring shading and greater ventilation while in the winter they require supplemental heat due to heat loss. (Grindley & Hutchinson 1996) These peaks are often offset by constant interaction of the inhabitants in deploying sunscreens or insulating devices, adjusting ventilation, controlling amount of exposed thermal mass, and introducing supplemental heating in winter. This on-going interaction with the thermal envelope without question results in an emotional

attachment to the buildings which is part of the earthship's allure. Similar to the wind sensitivity a yachtsman develops, earthship residents must have a keen awareness of the exterior environment and corresponding adjustments needed to maintain their thermal comfort.

Earthships are predominately houses and the most efficient range from 1,000 to 2,000 sf. Initial programming for the Patch Adams Clinic concluded that 17,500 sf was needed. The earthship's ability to maintain constant temperatures is most successful when the air volumes are low and thermal mass high. When compared to a similarly sized, conventionally framed structure with punched openings on all four sides, basic energy modeling found the earthship generated roughly the same total heating loads as the conventional envelope in the Philadelphia climate.[4] As a small volume, initial heating sketches found the thermal mass adequate to offset the heat losses resulting in performance similar to conventional construction – but no better. For total cooling loads, though, the earthship runs hotter and generates twice the cooling loads – a factor of the heat gain from the solar glazing array which can obviously be improved by careful shading. In doubling the sizes of both the earthship and conventional structure while maintaining a similar 40% solar aperture size to air volume ratio, for sake of argument, basic energy modeling found the earthship performed roughly fifteen percent better for both heating and cooling load standpoints overall. As we add fenestration to the other sides of the earthship enclosure for proper daylighting, though, and consider the amount of air exchanges required for healthcare facilities, a Philadelphia earthship does not generally offer significant building performance advantages over conventional construction with elevated insulation as air is the primary thermal delivery medium and there is simply too much air to heat and move in a passive and even active delivery format. Both will need supplemental heating and cooling with this aperture percentage in roughly the same amounts and as the conditioned spaces approach 17,500 sf, they perform similarly. Obviously, as the solar aperture becomes proportionally larger, the earthship will tend to perform worse than conventional punched opening construction due to the high heat gains and losses.

2.2 The Earthship as Health Clinic Model

> For a small annual fee, members will own this clinic, gaining diagnosis and referral, dentistry, chronic and urgent care, counseling, pediatrics, birthing, hospice care, massage, family planning, chiropractic, acupuncture, and other therapies. (Client Project Statement)

As a healthcare facility, the earthship can create a series of spatial and functional challenges. With an open space around which spaces are organized, ancillary functions operate best when open to the solar space for daylighting, ventilation and thermal transfer. For proper healthcare functioning, though, clinics require a series of layered zones of public and private spaces separated by security thresholds. Patient privacy needs result in acoustically and physically separated program zones. Secondary waiting areas for the ill tend to be located outside public circulation zones to minimize infectious contact. Exam, office and support spaces tend to be small, private isolated rooms. Security thresholds separate areas of clinics for the protection of information, assets and personal safety. Areas of the facility must be locked down when not in use especially in a community based clinic where hours of operation may extend beyond normal business hours. In short, clinics tend to be a collection of multiple, non-communicating rooms and spaces most of which do not want to open onto large or public spaces. The earthship with its large open communal sun space(s) does not tend to fit the basic clinic typology – especially when approaching 17,500 SF.

2.3 The Earthship as Community Building Model

> The Patch Adams Free Clinic therefore offers healing, learning, play, food and work….The facility will contain meeting rooms, quiet rooms, cafeteria (local foods), musical instruments, art materials, clown costumes and health library.

> These spaces face a central circular atrium featuring plants, mosaic paths, and acoustic concerts. The waiting areas offer ergonomic chairs, cushions, cots, playpen, board games and health literature. (Client Project Statement)

Early in programming workshops, the students and clients collaboratively arrived at the shared goal of creating a place where "people can hang out all day." This realization drove the exploration of a spatial character for the clinic charged with framing a social system. The earthship model of open central shared spaces does satisfy this goal even if it offers little advantage from energy use and clinic standpoints. As described in the initial client statement, the central space(s) provides the platform for social performance and community interaction. Many of the functions listed in the Client Project Statement have little to do with the health operations of the clinic but everything to do with educational, inspirational and social needs of the neighborhood. For the committee, the primary vision is to create a unique place which the community can control and take ownership of. Mentioned repeatedly in programming sessions was the importance of child care, elder care, job training and education – all functions which would operate outside of the administration of the healthcare organization. It became clear that the Free Clinic is intended to be a center whose foundation lies in physical and mental wellness and not just pragmatic healthcare.

2.4 Tioga United Neighborhood Association

The success of such a place lies squarely on the buy-in from the neighborhood. Initial presentations by the PAFCP building committee to the Tioga United Neighborhood Association unfortunately focused on the earthship building typology surrounded by orchards and gardens rather than first and foremost a place of health and wellness. (Figures 6 & 7) The association spent years wrestling with the industrial owner over a plethora of issues pertaining to the blighted site eventually persuading him to demolish the dilapidated buildings. New issues then arose as the open site became a favorite dumping ground for used tires and construction waste which, in turn, created health risks for the neighborhoods. Discussions of an earthship made of recycled materials and used tires immediately alienated a majority of the association members derailing the deliberations. The new Philadelphia Zoning Code requires formalized meetings with registered neighborhood associations and without the blessing of Tioga United, the project would not be realized. Dr. Patch Adams met with the association in support of the project alongside a number of the student design proposals. Dr. Adams is 6'-6" and dresses in clownesque garb which only further complicated the situation and led to a spirited community meeting with a long list of distrusting questions and accusations. (Figure 12) As a result of unfortunate circumstances resulting from the best of intentions, the Philadelphia University students entered a contentious situation as they began work. While the initial presentation/workshops with the association tended to get sidetracked with questions of tires, compost, urban farming and smells; the students were able to assist in repairing the bridge between the committee and association through continued focus on differing energy efficient buildings strategies – the earthship being but one version.

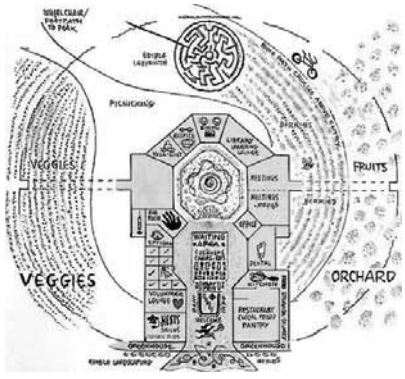

Figure 6: "Patch Adams Free Clinic of Philadelphia Original Sketch." Source: (Author: Paul Glover; http://www.Patch.org/Patch Adams.html)

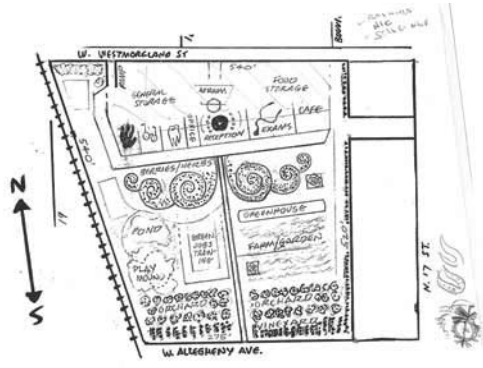

Figure 7: "Patch Adams Free Clinic of Philadelphia Site Sketch." Source: (Author: Paul Glover)

3.0 STUDENT DESIGN STRATEGIES

In introducing the project to the students, the PAFCP committee presented their intention for an earthship and the above plans (Figures 6 & 7). The students were required to complete a tectonic proposal for a building which strove to generate as much energy as it consumed – but not necessarily in the form of an earthship. Of the seventeen student projects, only one group undertook the strategy of organizing their program elements around a large central passive solar space. This team elected to incorporate a minimally insulated, translucent panel roof with periodic clear solar apertures (Figure 8). As the project developed, the high heat gains and losses of this roof led to proposing only minimal conditioning of the community space negating the passive solar potential and comfortable year round use. The heating and cooling loads to fully condition the atrium were large and would result in excessively high operating costs. The space was simply too large to adequately perform from a passive solar standpoint. The clinic functions adjoining the atrium developed into individual thermal enclosures limiting the ability to directly activate the community space. It became clear that if a central space is indeed provided it will be a difficult to economically condition limiting activities at times other than during temperate days.

Figure 8: Atrium Solar Space, Student Design Proposal (Authors: Ryan Doll, Taylor Klemm & Brandon Runnels)

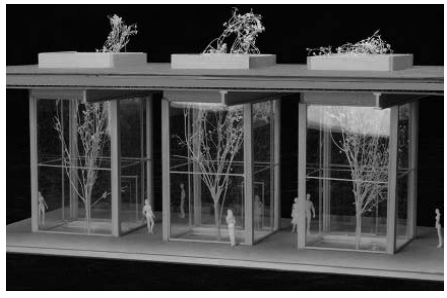

Figure 9: Interior Solar Gardens, Student Design Proposal (Authors: Marika Mavroleon, Sean Tiche & Natasha Trice)

As a challenge to the client's initial intentions, the majority of the other students proposed smaller passive solar sub-centers which framed individual clinic components and offered more efficient means for solar heating assistance. While losing some of the symbolic qualities of a central realm, the sub-center schemes began to align the thermal mass/ air volume proportions closer to those found in an earthship house resulting in a greater chance of thermal and energy success (Figure 9).

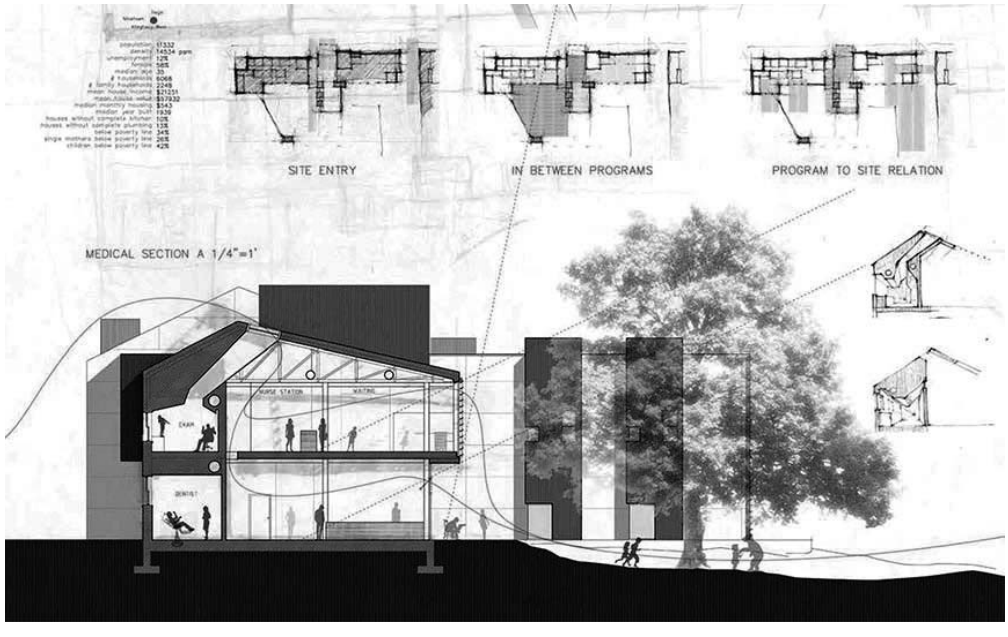

Figure 10: Student Design Proposal (Authors: Thomas Burghart, David Trapp & Daniel Silberman)

Emanating from initial passive solar design research, the remaining sixteen student design proposals oriented their facilities along an east west axis open to the south for solar harvesting same as for an earthship. As programming unfolded, the inherent differences between the clinic and community functions together with the need for secure thresholds led to their physical separation. It was a unanimous conclusion that the programs would operate

individually and interact by their adjacency. A number of the proposals split the clinic functions around community spaces with the goal of greater social interaction but majority of the schemes either "barbelled" the two prime functions on either side of an "arrival" space or layered them side by side or on top of each other. (Figure 10) These organizations were consistent across the schemes and could be concluded as inherent responses to the program.

Figure 11: Southern Solar Exposure Allegheny Street, Student Design Proposal (Authors: Kenneth Roposh, Melanie Whedon, & Michael Rothman)

Relative to the site, there were three primary organizations equally proposed by the students. Facilities located to the north part of the site tended to be organized as individual expressions of program components resulting in a scale more akin to the adjacent rowhouses. While appealingly "village-like," the downside of these organizations is the vehicular traffic and drop offs required of a clinic that will be difficult to achieve on a two lane, quiet back street. The proposals, by being to the back of the site, also did not have the larger identity requested by the PAFCP – the building wants to advertise its mission and program to the average passerby. Proposals locating the facility to the south side and center of the site tended to be organized into larger massing arrangements scaled more in keeping with the four lane east/ west arterial Allegheny Avenue and want for greater image. Vehicular and pedestrian access is direct and opportunities for street presence more available. For the students locating the facility in the center of the site, the distance to either street averaged 75 meters, a tough distance to comfortably negotiate for pedestrians – especially in a challenging neighborhood. This distance imbibed the schemes with a suburban quality complete with automobile roadways, turnarounds and drop offs. To maintain the urban character and pedestrian access so important for community ownership, it became clear to the majority of students that the facility was best located in close proximity to either Allegheny or Westmoreland streets. (Figure 11)

CONCLUSION

> The Patch Adams Free Clinic offers healing, learning, play, food and work. Designed and decorated whimsically in the spirit of Dr. Patch Adams, our clinic reminds that true healing touches the soul.
> (Client Project Statement)

From a winter heating and thermal comfort standpoint, earthships perform ideally in the arid southwestern U.S. where diurnal temperatures fluctuate as much as 30–40'F overnight. The sun is powerful enough to charge the building thermal mass during the day to maintain comfortable temperatures overnight until recharged early the next day. The solar radiation/ days in this climate are strong enough to provide a steady and reliable heat source. The small size of the buildings and corresponding air volumes together with large thermal mass heat sinks and a high R-value envelope all create an ideal balance for consistent temperature control. Unfortunately, when transplanted into northern climates the earthship performs less well due to the limited solar time and consistently low winter temperatures. While the passive solar glazing component does offer heat assistance, the energy stored struggles to overcome the evening heat loss. While the additions of an interstitial glass "sun" room between the solar glazing the inhabited space (a thermal buffer zone), double skin facades and insulating glass curtains can help offset the heat loss, the earthship as a passive solar volume cannot provide adequate winter heating without assistance from active HVAC systems – especially when it is expanded beyond the size of a house – a common problem with passive solar buildings. The claim that this typology can capture and meet 100% of its energy needs is presumptive in northern climates. While it can be argued that the detrimental heat loss occurs during the overnight hours when public buildings are closed, the amount of solar energy needed to recharge the thermal mass the next morning is difficult to attain. As the earthship model is enlarged from the house scale its thermal performance drops to levels similar to conventional construction. Add the clinic requirement for greater ventilation and loss of infiltration control due to the arrival and egress of many visitors, and the performance quickly drops below that of conventional construction.

The earthship model does provide a unique spatial environment for a community health building. The model develops awareness for, and exemplifies the importance of, a respectful relationship between users and the natural environment. These buildings can educate and demonstrate the ease and availability of passive solar/ ventilation systems, waste processing, storm water management, recycling, the growth and preparation of foods, urban agriculture, and overall wellness – especially in a disadvantaged neighborhood unfamiliar with many of these opportunities. In this specific case the earthship also embodies the "whimsical spirit of Dr. Patch Adams" who believes that "laughter, joy and creativity are an integral part of the healing process." (www.patchadams.org) There is no question that the earthship here is as much a symbolic and metaphoric building typology forwarded by an organization wishing to distance itself from standard forms of healthcare and its subsequent institutions. The architecture here is a direct expression of counter-culture political and social ideologies – a fringe building strategy for a fringe healthcare provider. At a time during which the American healthcare system is in full upheaval, alternative delivery models cannot be discounted and in this case, the architecture can support and frame the larger social ideals of the client.

While the earthship model offers positive sustainable attitudes and expresses well the character of the client, the community continues to be at odds with the project. The student proposals for energy efficient versions of the clinic have helped temper the discussion but the neighborhood is unfamiliar with the tectonics, language and presence of this building typology. Unfamiliarity breeds distrust and the earthship is distinctly alien to the surrounding residents most of whom have spent generations housed in traditional northeast US rowhouses. As such, the project has stalled in its attempts to find financial and community support similar to

Patch Adams's twenty-plus year campaign to build his own hospital in Pocahontas, West Virginia - also based on the earthship model.

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ENDNOTES

[1] Patch Adams Committee Team Leaders: Paul Glover and James Wurster. PhilaU Team: Faculty: David Kratzer (Coordinator), Brian Johnston & Daniel Chung. Fall 2012 Students: Logan Dry; Kevin Peters; Michael Opdahl; Amber Freedman; Stephanie Geraghty; Lauren Arrington; Jared Bilsak; Ryan Doll; Thomas Frank; Sean Tichy; Muzalier Gaussaint; Brandon Runnels; Daniel Rich; Taylor Klemm; Erik Tsurumaki; Austin McInnis; Robert Garcia; Stephanie Smith; William Brostowicz; Marika Mavroleon; Natasha Trice; Eike Maas. Spring 2013 Students: Sara DeMuth; Matthew Anderson; Nathan Ellenberger; Timothy Schaefer; Fatema Kanji; Joshua Voshell; Matthew Ziemba; Nicole Boris; Marian Jony; Philip Rivera; Kenneth Roposh; Dylan Wilson; Melanie Whedon; Thomas Burghart; Tristan Emig; David Trapp; Michael Rothman; Brandon Lansing; Kyle Burke; Ellen Wright; Daniel Silberman; Darpan Patel; Phillip Luu; &Brandon Saiz.

[2] http://www.earthship.com

[3] Others have placed the number as low as 3,000 as of 2009. (Ip & Miller 2009)

[4] Energy modeling was completed utilizing IES software (Integrated Environmental Solutions, LTC)