Digital and Analog Aptitutes in Emergency Shelter Design and Fabrication

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"There are more refugees in the world than many countries have inhabitants." Stephanie Simmonds & Pat Vaughan – Refugee Community Health Care 1993

Increasingly, Architects flaunt the power of Digitally Aided Design, both as software and as hardware, interfaced at the front-end or conception side of a project, and ever more regularly on the production side - in the manufacturing of components or assemblies, and potentially via robotics, toward the construction industry itself, much as in the last twenty years of automobile production which relies heavily on the interface of computer driven assembly. That said, the notion of reflecting on societal, and particularly on our Professional and Academic Digital Aptitude, is an interesting moment having recently completed a third year Architectural Design Studio, where the larger curriculum asks students at this particular juncture in their development, to fabricate objects, details and space, with a direct emphasis on understanding the assembly, detailing and construction process, at some level beyond drawing or model making, so as to have a reverence for materials and methods of attachment, by having physically interacted or crafted them with their own hands.

Running parallel to this "hands-on" component, there is the desire to have these students survey current modes of Digital fabrication so as to expose them to the advantages of precision that these Digital methods can achieve, in shaping both traditional and avant-garde geometries. Concurrently, the Profession encourages this exposure, both toward students at varying levels of development and with the public at large. For the Professionals as well as for Academy, there is a mission for raising Digital Aptitude, be-cause Professionals understand that their means of practicing has changed and will continue to change, due to the exponential advancement of technological modes of representation / fabrication. With all this as a backdrop to a "hands-on" based design studio, what type of project might best challenge students to understand the unique position they occupy in the crisis of the changing landscape of a Profession they will one day enter? Toward an attempt to answer this question, an Emergency Shelter for crisis recovery seemed an appropriate scale, it offered a larger set of questions regarding the appropriate level of technology (Digital or Analog), economies of scale, and it was of a typology which could yield questions about content, site development, individual / group interaction (family and community), as well component design, fabrication, detailing and materials choices. Furthermore, it seemed relevant to query the notion of what is Digital Aptitude and does anyone in the throws of a disaster care? In all likelihood, they care very little when the ability to communicate with their family fails or when they cannot find food. At some point their more primal instincts move them forward toward survival. When logistical systems collapse and the supply and demand equation is out of balance, people pull together to get things done as the need to restore order and to secure shelter becomes primal – we might say that the Analog mode often replaces the Digital mode during a crisis. People who have relied on technology begin to adjust to the physicality of the crisis – as the disaster recedes the Analog runs parallel to the Digital and ultimately the Analog is put aside as the return to daily life approaches with all of its demands for daily Digital interface – such as banking, access to media, the ability to contact family via the internet, buying

food with debit cards, etc. These questions and their counterparts in the design process itself, such as the purity of Digital vs. Analog design approaches, or perhaps the truth that design has always has been a Hybrid[1] of the various modes used to develop it; formed the basis for the studio itself.

Figure 1.   3rd Year "Hands-On" Fabrication Studio Emergency Shelter Prototype – "Night"

THE CRISIS BACKDROP

> "Much of what we are doing is a question of changing the style of thinking." Ludwig Wittegenstien

Natural and Human-made disasters now occur with startling repetition. One Crisis eclipses another. The Media provides a continual drone of up to the minute news reports that circulate through the Internet, print, television, and now smart phone outlets, to countless spectators the world over. Hurricanes, tornadoes, floods, and tsunamis leave a wake of victims, many of whom are shocked into a world of utter and immediate reality, where the struggle for daily living becomes their premier occupation. In radical contrast to this crisis state, is a world of instant downloads, Hollywood Movies, television shows like American Idol, and advanced gaming environments, where images, words, information and statistics are immediately digestible and consumed as if the technology that provided them were simply so much air to breathe.

The high technology of the nearly invisible Digital realm, provides global citizens with the unique historical position, of being less prepared for crisis conditions, due to their perpetual interface with data systems that can provide services and information, and thus with less and less daily contact with the authentic environmental stimulus necessary for managing life needs in the wilderness of a power shutdown or worse. In a sense, the dual states of distraction and dependence co-persist and mediate how we adjust to the unexpected. How does Digital Aptitude aid in a crisis state when there is no access to power? How do people get the information they need to obtain food and water without media access? In most cases people default to word of mouth interaction with their community. It is from this perspective that a group of third year architecture students began an inquiry into the design and fabrication of an emergency shelter that would serve as the prototype for a community for disaster relief (Figure 1).

Crisis provides immediacy, Peoples' suffering is direct and not a synthetic set of equations or digital pulses – suffering is not a simulated environment, and for many the only suffering at the crisis scale that they are exposed to is via the film industry or the news media, where the space between them and the suffering is filtered by a soundtrack or an overdub. In the realm of architectural education a similar filter exists between the opposing worlds of the synthetic and real – between the imagined and the built. Can a student move from the realm of the synthetic[2] drawing, model or text toward the tangible and sentient world of materials and fabrication, and how do they adjust to this subtle transition in terms of design decisions, craft, economy and physical labor, in order to complete a built work of experiential / functional space? In the aftermath of Katrina and other disasters, much has been made of the emergency housing proposals from notable architects like Shigeru Ban who have developed various systems for crisis conditions that integrate paper or cardboard tubes along with reclaimed reinforced Billboard materials as rain screens for the roof.

The immediacy of programmatic needs in disaster relief housing provides a focus on simple and often taken for granted daily habits and routines – the need for storage, family interaction through dining, community order via the nurturing of relationships between neighbors and their exterior spaces, furniture for sitting, sleeping and for social exchange, and of premier importance, is the need to create a sense of the unique that can provide a feeling of place and ownership within what could,

if not handled properly, become merely a mundane modular and cost effective building system. How do students, who have in all likelihood just begun to live on their own, and may not, as yet realized the habitual nature of dwelling, jump from the development of abstract formal concepts[3] and the simple plan to section relationships of a small to medium building like a cabin, a church or a museum[4], with a placement only based knowledge of structure and a naive at best sense of environmental systems, that they have just recently been exposed to in their first and second year studios, progress toward the challenge of crisis architecture? First they must come to understand the level of dependence that they each have on technology both as designers and more importantly as human beings so that they produce realistic projects for a crisis situation as opposed to grandiose schemes that reflect only their current influences, material preferences and desires for the latest technological aids.

Studio conversations about disaster recovery unearthed logistical information that referred to ideal site locations for crisis relief communities – whether it would be best to locate just outside or within a major metropolitan area and how that location would be served in a time of crisis, etc, were all issues that were researched and found to have been discussed at great length by both larger and smaller government agencies, and that these plans exist in great specificity for various cities or regions. The studio discussed the transportation and infrastructural routes that allow both the delivery of housing units and the set-up of temporary water, sewer, and electrical hubs. Collectively, the studio began to understand that these conditions were studied in non-crisis times and that the results of these studies required that a plan be in place prior to a crisis in order to take advantage of networks/electronic systems that will more than likely be challenged in a state of emergency. At first the studio took for granted the complex system that exists between, power and other infrastructural grids, electronic hardware and software, competent network users, interlaced informational networks and government agencies that might collectively be called "the Digital and Analog Present"[5]. Community Emergency Prepared-ness is well suited to taking advantage of advanced planning through the interaction of local Sheriff, Police, Fire and the Red Cross, and the studio began to understand that their job was to focus on the development of the individual unit,

and the formation of community, such as to provide the possibility of variations in site planning configurations without sacrificing some of the key concepts that were emerging in the studio such as the importance of path, edge and district. More importantly, they began realizing the fragility of this combined "hybrid" system and understood that in a time of emergency that the "Analog" (hands-on) would become the premier condition of the immediate present in terms of people physically being able to get things done in a disaster.

Figure 2. Emergency Shelter Prototype Interior

It became a primary goal to create an architectural order that could manifest a recognizable difference between units that might result in the development of a communicable sense of 'home' for a family that resided there. While the studio acknowledged the need for mass-produced components and typical plan redundancy, they insisted on customizable conditions that might be the result of the random use of reclaimed materials that would provide identifiably at little to no cost. As is typical in a third year studio setting, there was a combination of research, prec-

edent study, statistical analysis that forecasted the average length of stay and average size of the family, the creation of physical and digital design models, and presentations were made by focus groups to the studio as a whole. In a way, the studio was business as usual – get an idea, produce a design and present it. The studio, like most good studios where performance is at high level, was in a state of synthetic euphoria; they had produced simulations that they mistook for reality. At their best these students substituted the materiality of their physical models for a "tangible materiality"[6]. In class discussions were delivered that attempted to liken this phenomena of substitution to the synthetic reality of television or other optic media (photography, video) where the viewer is positioned and can see only the completed pieces of the "set". To the naïve observer there is an appearance of a whole, but what they see is in fact a fragment – specifically the students would have a tendency to read the physical modeling materials as the real application of a material and not as facsimile that required further articulation as to both connection and coursing and environmental impact.

Following these discussions, real materials were brought into the studio and teams of students began testing modes of attachment, and the various means of cutting and finishing, in an attempt to see beyond the cropped view of fabrication and assembly that most of them brought to the studio. The results were fascinating in that the length of materials available and the difficulty of moving an eight-foot long strip of wood or steel around a saw or grinder began to make the students aware of the fiction that they had been holding for the ease of fabrication itself. This was a milestone moving them from the Digital realm of Computer Modeling toward responsible thinking in terms of how refuges could set-up their units in a disaster setting. Questions such as, should a printed construction manual be provided or could the refuges use laptops with Digital models as an assembly manual – both modes seemed appropriate depending on the type of disaster – some students liked the idea of having volunteers lead the unit and camp set-up, and that as the refuges gained experience through the set-up of one unit they would become an expert and in turn teach others thus expediting the overall camp set-up. The students were beginning to see those things outside their immediate focus and were starting to understand how both complexity and the physical needs of building were mandating

simplification and redundancy as opposed to formal flamboyance and expensive materials.

An emphasis on the use of fabric or a fabric-like (reinforced plastic sheeting) material for the roof began to emerge as a means to screen water off the main area of the shelter. Several sheets of material were purchased in order to begin our discourse with the "Analog" reality of materials and their limits. This was the first link to the notion of full-scale construction for most of these students. The studio began to discover the reality of gravity and height as issues of reach and danger with regard to physical maneuvering, and bodily coordination in general with regard to working in close proximity with others while needing to maintain safe working conditions – all conditions that crisis victims would face in throws of camp set-up[7]. These realizations were discovered while unfolding and attempting to hold the fabric aerially, and where crosswinds began to interfere. This was a critical awakening and a moment of cross referencing of lessons and lectures heard, tests taken and projects critiqued – students were shocked to discover both the reality of materials and the sheer force of nature – conditions that they had previously understood in only a synthetic manner – because of these experiments, they became witness to a greater breadth of the environmental factors and the fabrication or production methods that they would be contenting with.

DESIGN ELEMENTS

The final design consisted of a series of elements that contributed to the system of the shelter in terms of structure, function, and concept. Notions of public and private were explored via the building envelope and this was complemented with an ritual emphasis on the components of the building having relationships with ideas of storage that came from a study of domestic furniture[8] as mode of meaning in the home. The primary material palette was an outcome of economy - OSB or Oriented Strand Board, dimensional lumber; some steel, and reinforced fabric and plastic sheeting were all used to fabricate the following shelter elements; the C-Section, The Drawer Floor, the Wall Bunk, the Louvered Wall, the Roof, the Porch and the Dining Table.

THE SITE PLAN

Research[9] indicated that Plumbing, Electrical and Food Hubs were typically set-up in refuge camps at

intervals. Designed to work with both centralized and linear site conditions, the notion of service hubs were maintained and accentuated as nodes within smaller neighborhoods or enclaves. These three to five unit enclaves (blocks) were set-up to promote small community interaction for play areas and for community dining. The resultant clusters were oriented to take advantage of the sun and to create a hierarchy of front, back and side yards/spaces, which were intended to minimize the feeling of repetition in the camp (Figure 5).

Figure 3. Full Scale Singe Bay Mock-up

THE C - SECTION

The C-Section structural bent allows for the quick set-up of the structural frame. This assembly derives from separate components that pack tightly for transport, and with the use of common tools can be quickly bolted together. The C-Section also allows for a clear definition of front and back, where the taller front becomes the solar-oriented interface with the other units and the rear of the unit becoming a privileged private area that serves as the designated sleeping area (Figure 3). The C-Shape was chosen to due to its ability to quickly shed water and based on historical research that indicated that some of the earliest human shelters were open-mouthed caves with large overhangs - the studio appropriated this proto-version of the C-Shape as a meaningful precedent. Fabrication methods were discussed for the C- Section that would utilize CNC technology and designs were prepared based on the limits of this technology. Digitally conceived the C-Sections were ultimately made by hand.
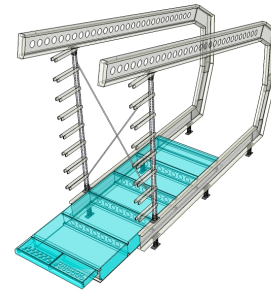

Figure 4.   C – Section with Drawer/Floor

THE DRAWER FLOOR AND WALL BUNK

Responding to a need for ample storage and the transformation of the interior in order to accommodate a wide variety of programmatic conditions – the basic floor unit was conceived as a drawer that was pushed into position between the C-Sections and functions as a storage vessel for not only the dining table and the bench/shelves but for components of the shelter itself during transit. The Billboard roof can be folded and stored here along with other assembly hardware etc. Once assembled the floor also serves the occupants as overflow personal storage for clothes etc. Next the Wall Bunk is set in place at the rear of the shelter – this provides critical lateral stability and the sleeping bunk design continues a theme of play on the historical role of furniture in the domestic realm (Figure 4). There is also a system for air flow from the exterior to the interior via cavities in the floor system that operate in tandem with the Louvered Wall and the Wall Bunk modules, that facilitate the exit of this air at the back of the unit. Like the C-Sections, the Drawer Floor and Wall bunk units were designed to utilize CNC technology but were made by hand.

THE ROOF

The use of reclaimed Billboard material was derived from necessity and from a desire to build variation into a repetitive system. The material is available in most regions, is easy to modify and can be repaired with duct tape. The benefit of local and corporate logos and the wide array of color and graphic variation of this reclaimed material enabled the potential for legibility between shelters. The roof is installed

like a tent just prior to the finalization of the other interior components – occupancy is immediate.

THE LOUVERED WALL

Derived as the light giver and the public/ private interface with the greater community at large, the Louvered wall mediates light and privacy through the use of operable panels that are fabricated from the same Reclaimed Billboard material that make up the roof. Outboard of the louvers there is a removable clear weatherproof rain screen and operable Floor / Drawer lids promote airflow through the floor and along the wall into the unit itself (Figures 1 and 2).

THE PORCH

The addition of an extra structural bay that is outboard of the interior living space provides both a porch and an entry ramp. The ramp adapts to the various elevation changes while the porch acts as a social incubator with neighboring units and as overflow for the occupants (Figure 5).
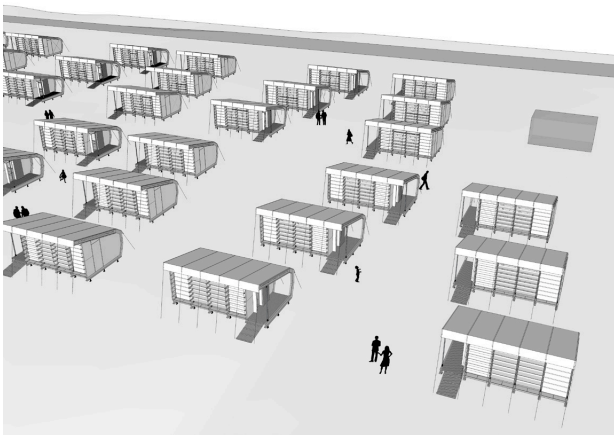

Figure 5.   Site Development – Unit vs. Enclave

THE DINING TABLE AND THE SEAT/SHELF

From a cultural perspective, dining tables have played a premier role in the domestic realm as a place for social interaction and family development. The table maintains this key role in the shelter as expandable within the unit and as deployable from the interior to the exterior, where it can be set up between the three to five units that make up an enclave. The adaptability of the Dining Table and the Seat Shelf are intended to provide the opportunity for accommodating multiple family meals, and social interaction that contribute to a feeling of "normal daily life" and for the celebration of special occasions such as birthdays, etc. The Seat/Shelf and the Dining Table were designed to utilize CNC Technology, but were built by hand.

REFLECTIONS

"Shelter is by far the greatest single item among man's requirements in point of physical volume, weight, cost and longevity of tenure. Yet it is among the last to receive his scientific attention…Even the newest and most publicized skyscrapers are decades obsolete in terms of what science and industry have rendered attainable." R. Buckminster Fuller – Nine Chains to the Moon, p 17, 1963

In an age where the highest aspirations for a fully integrated "Digital Aptitude", as it might be manifest at the front, middle, and end of the design process, via drawings, models, images, mock-ups, and the production of architectural space, are all ideals we can cling to or strive toward, how are designers dealing with the lag time and disconnect that Fuller acknowledges above? Both our means for conceiving design and certain programmatic constraints ask us to live in a hybrid of flux between the realms of the Digital and Analog. Crisis Conditions ask their survivors to become "hands-on" when the Digital Domain shuts down and when architectural design studios strive for Digital explorations before the Analog environment is more fully understood or appreciated by students, or when a design is prepared for one method of fabrication and due to time allocation or a lack of resources must be manually fabricated – will we find true Digital Aptitude – is there such a pure state – nature through disaster reminds us that there may not. Physical Fabrication as a studio directive asks us to consider whether or not the means that made a project are as important as the outcome – until such time as there is a guarantee of resources, networks, power grids and means to preventing significant disasters, then it seems as though the Analog of the physical will hold it's own in the slower than expected transition toward a more fully integrated Digital Aptitude. In an academic setting, perhaps the means is more important – and the means of the studio as outlined above, moved in parallel between the Digital and Analog. In the end one can only wonder, if it had not been pointed out them, would the students have realized the difference between these

realms and continued forward in their lives design-ing and interfacing with technology, without know-ing they were the children of a hybrid aptitude? It would seem that with all do respect to Buckminster Fuller, that Crisis Recovery does not care about the latest science and technology, it's victim's only care about one another and finding shelter. The students who designed and fabricated this Emergency Shelter gleaned much with regard to advanced technology, architectural detailing and crisis recovery as a form of community and individual unit design, they did not however have the chance to learn whether or not their larger ideas about site organization, Digital vs. printed instruction manuals, digital fabrication vs. hands-on fabrication, or whether their ideas about team led unit set-up would work in a Crisis setting – The studio ultimately fell back to it's own Crisis state, fixated on the completion of the unit Prototype itself and left the larger ideals of community interaction in a time of Crisis to be tested at later date.

> "The site for all of this – at least in the near term – is likely to be the seam between virtuality and physicality. [10] Michael Sorkin – VR The World

ENDNOTES

1   Hybrid as used here refers to a representational image or model that began in one media, a sketch for instance that is scanned and brought into a digital platform and then modified in some manner as a continuation of the design process, and not merely as a means to facilitate a more current output for the original image – this could also operate in reverse where a digitally created image was outputted and modified physically in order to propel a design notion forward.

2   My use of synthetic here assumes that a hand drawn image, a computer drawn image, a hand crafted model or a digitally crafted model, are all equal as simulations or projections of a future built object that is not as yet in the world – I consider these media to be equal.

3   Abstract formal concepts as developments from textual or poetic intentions are critical and a necessary part of an Architect's education but often leave program and physical materiality out of the equation for the students despite the best intentions of the critic.

4   All of these program types are useful exercises but most projects of this nature which are completed at this level in a curriculum result in a final state that is not detail or economically based, and thus serve little use in preparation for small scale intensively budget driven projects.

5   It seems unlikely that a 100% "Digital Present" currently exists – thus the true network is a hybrid of interfaced systems.

6   For example a wood model is a wood building, a metal model is a metal building and so forth. Many students fail to grasp all of the components, assemblies and detailing required to realize even a small project of 100 or 200 square feet, particularly in terms of the physical labor involved when moving between the time required to build a model and that of the actual building that the model represents

7   During the set-up of the C-Section full bay mock-up just prior to Final Production, the students made a video recording of a few crisis victim stand–ins led by a sole designer during the assembly – the students soon noted that all references to the computer model that was accessed via laptop, were superseded by intuition and the test fitting of components – prior to this test assembly there was an assumption that users would prefer the digital interface as a way of seeing the larger final object.

8   The studio's study of furniture began simultaneously with the very first conceptions of the shelter form itself. The studio examined the historical variations, styles and materials of domestic furniture and went so far as to consider the idea of an heirloom. They brainstormed and collected memories of important family events that had occurred around the kitchen table, etc. - much was made of the fact that the furniture provided would be devoid of character, or would be stylistically invisible when compared to the context of the shelter itself – it was decided that over time character would emerge, or rather that it would be embedded on the pieces by way of surface stains, scars, etc. and that this would be a means of making them meaningful.

9   Numerous refuge camps were studied from around the globe – these were cataloged and were studied for typology and scale. The results were assembled into a database and many of the precedents were averaged together through overlays in order to recognize patterns and scale for application in the final site enclave proposal.

10   Michael Sorkin – VR The World, The Edge of the Millennium: An International Critique of Architecture, Urban Planning, Product and Communication Design, Whitney Library of Design, 1993 p 234.