Healthy Interior Environments in Haitian Orphanage Design

Amanda Krueger
THE FLORIDA STATE UNIVERSITY
COLLEGE OF VISUAL ARTS, THEATRE AND DANCE

HEALTHY INTERIOR ENVIRONMENTS IN HAITIAN ORPHANAGE DESIGN

By

AMANDA LEE KRUEGER

A Thesis submitted to the
Department of Interior Design
in partial fulfillment of the requirements for graduation with
Honors in the Major

Degree Awarded:
Spring, 2012
The members of the Defense Committee approve the thesis of Amanda Krueger defended on November 16, 2011.

______________________________
Jim Dawkins  
Thesis Director

______________________________
Dr. Christopher Coutts  
Outside Committee Member

______________________________
Laurel Harbin  
Committee Member
Table of Contents

Abstract ...........................................................................................................................  4
Introduction .....................................................................................................................  5
Haiti’s Conditions Pertinent to Interior Orphanage Environments ............................... 6
   Geography ...................................................................................................................  6
   Environment .................................................................................................................  7
   Society .......................................................................................................................  10
Review of Literature ......................................................................................................  13
   Overview: The Natural Step .......................................................................................  13
   System Conditions .....................................................................................................  13
   Summary ....................................................................................................................  15
Proposed Materials and Products Specifications .......................................................... 18
   Methods of Selection ................................................................................................ . 18
   The Criteria Matrix ..................................................................................................... 19
      Immediate Time Response. ....................................................................................  21
      Durability ................................................................................................................  21
      Local Availability. ....................................................................................................  22
      Third Party Certification. .........................................................................................  22
Proposed Solutions: The Criteria Matrix ........................................................................ 23
   Building Construction ................................................................................................ . 23
   Interior Finishes .........................................................................................................  24
      Floors ......................................................................................................................  24
      Walls .......................................................................................................................  26
   Furnishings ................................................................................................................  26
The Criteria Matrix: A Summary of Proposed Solutions ................................................. 27
   The Specification Process ..........................................................................................  27
   Product and Material Specification Resources .........................................................  27
   Application of Table 3.2 .............................................................................................  28
Conclusion .....................................................................................................................  35
References ....................................................................................................................  36
Images ..........................................................................................................................  38
List of Figures

Figure 1. Forest Area, 2000
Figure 2. Annual Deforestation, 1990-2000
Figure 3. Access to Sanitation, 2000
Figure 4. Life Expectancy, 2003
Figure 5. Infant Mortality Rate, 2008
Figure 6. Under 5 Mortality Rate, 2008
Figure 7. HIV/AIDS Cases in the Caribbean, 2004
Figure 8. HIV/AIDS Deaths in the Caribbean, 2004
Figure 9. Youth Literacy Rate, 2005
Abstract

Haiti’s 2008 hurricane season destroyed upwards of 22,702 homes and damaged another 84,625, for a total of 107,327 homes and 800,000 people impacted (DCHA & OFDA, 2009). Because of the intense rain fall, floods wiped out 70% of Haiti’s crops, resulting in the deaths of malnourished, newly-homeless children following the storms (DCHA & OFDA, 2009). These factors, combined with a 7.0 magnitude earthquake in 2010, have intensified the need to provide homeless children with a timely solution to the lack of orphanage facilities.

Swedish oncologist Karl-Henrik Robèrt, an internationally recognized leader on sustainable progress, developed an outline called, “The Natural Step Framework” in 1989, which considers the effects of interior finish material selection on human health. Within this framework, Dr. Robèrt suggests that multiple health problems, predominantly those of children, result from interior finish materials that we are exposed to every day (Robèrt, 2002). This framework is relevant as it relates to researching local interior finish materials in Haiti that have positive effects on orphaned children’s health, as opposed to products that will result in increased health problems.

It is the goal of this thesis to examine Haiti’s natural resources and existing labor situation, investigate opportunities for newer, more sustainable interior finish building materials, and together, how they can positively impact Haitian children’s health. The findings will add to the body of knowledge concerning interior finish materials that can aid in the healthy recovery of Haitian children and their orphanages from currently untenable conditions.
Introduction

This research explores the relationship between Haitian children’s health and healthy interior environments, and based on that relationship, proposes the most readily available healthy interior materials to provide homeless children with a timely solution to orphanage construction that can be established today with long-lasting positive effects.

Haiti’s need for a re-evaluation of current orphanage construction practices is rooted in the natural, social, and economic disasters of the past decade. The hurricane season of 2008 destroyed 22,702 homes and damaged another 84,625, for a total of 107,327 homes and 800,000 people impacted during this season (DCHA & OFDA, 2009). Because of the intense rain fall, floods wiped out 70% of Haiti’s crops, resulting in the deaths of malnourished, newly-homeless children following the storms (DCHA & OFDA, 2009). The startling statistics in the 2010 Human Development Report further exhibit the effects of agricultural loss creating intense malnutrition by an infant mortality rate of nearly 54 deaths per 1,000 live births, and children under five mortality rates of 72 deaths per every 1,000 live births (Klugman, 2010). The human tragedy played out in Haiti over the summer of 2008 continues to adversely impact children’s health. As such, the desperate need for environmentally healthy living options created by utilizing the most minimal amount of currently available resources is immediate amidst continually declining conditions.

This research is grounded in “The Natural Step Framework,” developed in 1989 by Swedish oncologist Karl-Henrik Robèrt. The Natural Step presents an outline, or structure, for considering the effects of interior finish material selection on human health. Within this framework, Dr. Robèrt suggests that multiple health problems,
predominantly those of children, result from interior finish materials that we are exposed to every day (Robèrt, 2002). This framework is relative as it relates to researching local interior finish materials in Haiti that have positive effects on orphaned children’s health, as opposed to products that will result in increased health problems. Moreover, “The Natural Step” provides the Four Systems Conditions, or basic principles, that are utilized in this research to mitigate the negative effects of materials practices on children’s health in Haiti (Robèrt, 2002). With this framework in place, environmental health characteristics will not be viewed as an add-on, but rather as a new method of informing design and building practices that unleashes creativity through transformative thinking.

This research combines the conceptual framework for healthy interior environments, available labor and natural resources, and new opportunities for interior finish materials, and how they impact children’s health. Existing and emerging construction materials that have a positive impact on environmental health characteristics are further explored to inform the selection of interior finish materials that can aid in the recovery of Haitian children and the rebuilding of orphanages.

**Haiti’s Conditions Pertinent to Interior Orphanage Environments**

**Geography**

According to the Federal Research Division, Haiti is approximately 27,750 square kilometers in size and located in the Caribbean between Cuba and Puerto Rico, occupying a third of the island of Hispaniola (U.S. Congress, Federal Research Division, 2006). The topography of Haiti, is dominated by the mountainous region Hispaniola, and incorporates five mountain ranges that divide the country into three regions – northern, central and southern. As a result, this landscape leaves only about 20 percent
of Haiti’s land suitable for farming, making cultivation extremely difficult (U.S. Congress, Federal Research Division, 2006). However, natural rivers travel through this mountainous region and provide the country with electricity, fertile soil, and catchment. The Guayamouc River splits the Central Plateau to provide some of the country’s most fertile soil, and the Libon River provides a majority of the country’s electricity while simultaneously functioning as a natural border with the Dominican Republic (U.S. Congress, Federal Research Division, 2006).

Although these various rivers are critical in terms of transportation and electricity, they also pose a potential threat during Haiti’s wet season (April to November). During these months, the rivers often overflow, and compounding northeast trade winds cause extreme weather conditions as seen in recent hurricane cycles (U.S. Congress, Federal Research Division, 2006). Haiti’s 2008 hurricane season destroyed upwards of 22,702 homes and damaged another 84,625, for a total of 107,327 homes and 800,000 people impacted (DCHA & OFDA, 2009). Because of the intense rain fall, floods wiped out 70% of Haiti’s crops, resulting in the deaths of malnourished, newly-homeless children following the storms (DCHA & OFDA, 2009). These factors, combined with a 7.0 magnitude earthquake in 2010, have produced numbers showing about 12,150 million people affected per year by natural disasters, thus intensifying the need to provide homeless children with a timely solution to the current orphanage devastation (Klugman, 2010).

Environment

According to the Federal Research Division, Haiti has limited natural resources because of its small size and forest degradation caused by overconsumption for fuel.
However, it is the focus of this research to acknowledge which resources are available and can be utilized in orphanage construction and interiors. Of Haiti’s natural resources, wood, specifically mangrove forests, are considered the most abundant, but due to extraction, they will not be considered as a viable material for orphanage interiors. In addition to wood; gravel, limestone, clay, and sand are easily gathered to produce construction materials such as concrete, but fluctuating water volumes in the rivers often pose a problem in harnessing access to hydropower, which is needed to sustain concrete production (U.S. Congress, Federal Research Division, 2006).

As maintained by agronomic standards, the majority of Haiti’s land is too steep to provide the appropriate agricultural conditions for cultivation, yet 80 percent of the country functions as agricultural land, producing minimal and unstable yields (U.S. Congress, Federal Research Division, 2006). Exacerbating these adverse conditions is the severe deforestation problem. Statistics show that in 1923, 60 percent of Haiti was covered in forests; today they cover less than 3.2 percent as illustrated in Figures 1 and 2 (U.S. Congress, Federal Research Division, 2006).
Because most Haitians depend on wood and charcoal as their primary fuel source, a mass of negative secondary effects continue to accrue in which forests are expended, which leads to soil erosion, decreases agricultural yields, and ultimately results in deadly landslides and natural disasters (U.S. Congress, Federal Research Division, 2006). Moreover, these secondary effects lead to even greater negative externalities where landslides and natural disasters capture large amounts of trash and waste, disperse these amounts throughout the city, and as a result, many urban regions suffer from poor sanitation and slum areas, particular the capital of Port-au-Prince, are overcome with unsanitary living conditions (refer to Figure 3 below).
Energy alternatives are necessary to stop the source problem of deforestation, and will be considered in the development of healthy orphanage interiors to ensure proper sanitation for children.

**Society**

Haiti has about 10.2 million people with a declining growth rate of about 2.0 percent making it the second most densely populated country in the western hemisphere. Approximately 1.5 million people live in the capital, Port-au-Prince, but about 52.1 percent of citizens reside in one of Haiti’s other four smaller cities (Klugman, 2010). Plagued by political instability and a history of catastrophic natural disasters, the Republic of Haiti is designated by the United Nations as one of the fifty “least developed countries” in the world (Taft-Morales & Drummer, 2007).

“Least Developed Countries” (LDCs) [are] a category of states that are deemed highly disadvantaged in their development process…, and facing more than other countries the risk of failing to come out of poverty. As such, the LDCs are considered to be in need of the highest degree of attention on the part of the international community…the UN gives a strong signal to the development partners of these countries, and points to the need for special international support measures and concessions in their favor (UN Recognition of the Least Developed Countries, para. 1).¹

¹ “UN Recognition of the Least Developed Countries, UNCTAD, at [http://www.unctad.org/Templates/Page.asp?intItemID=3618&lang=1&print=1].
Haiti’s death rate ranks as one of the worst in the western hemisphere, as does its 2008 infant mortality rate of nearly 54 deaths per 1,000 live births (see Figure 4), and a children under five mortality rate of 72 deaths per every 1,000 live births (See Figure 5) (Klugman, 2010).\(^2\) According to the Federal Research Division, malnutrition is a heavy contributor to such high mortality rates among children, with 58 percent of the total population in 2004-2006 being categorized as “food insecure” and consequently underdeveloped (Klugman, 2010).

Life expectancy at birth is only 44 years, a statistic highly influenced by the fact that Haiti has the highest occurrence of human immunodeficiency virus/acquired immune deficiency syndrome (HIV/AIDS) outside of Africa (see Figures 6, 7, and 8).\(^3\) About 5,000 Haitian babies are born every year infected with the AIDS virus contributing to a fifth of infant mortality rates and 200,000 children orphaned. In addition to malnutrition and the prevalence of AIDS, children face an uphill battle against poor schooling. As illustrated in Figure 9 below, education standards are extremely low in

\(^2\) LDC: Least Developed Country  
\(^3\) LAC: Latin American and Caribbean region
Haiti with a literacy rate of about 61.0 percent of children 15 years of age and older, falling well below the 90 percent average literacy rate for Latin American and Caribbean countries (Klugman, 2010).

Haiti’s unique factors of geography, environment, and social disruptions, combined with a 7.0 magnitude earthquake in 2010, have since intensified the need to
provide homeless children with a rapidly available solution to the current orphanage devastation.

**Review of Literature**

**Overview: The Natural Step**

Swedish oncologist Karl-Henrik Robèrt, an internationally recognized leader on sustainable progress, developed an outline, called, “The Natural Step Framework” in 1989, which considers the effects of interior finish material selection on human health. Within this framework, Robèrt suggests that multiple health problems, predominantly those of children, result from interior finish materials that we are exposed to every day (Robèrt, 2002). This framework is relevant as it relates to researching local interior finish materials to be utilized in Haiti.

**System Conditions**

The Natural Step articulates Four Systems Conditions that are followed as guiding principles throughout this research with the goal to eliminate negative effects of interior finish materials on the health of orphans in Haiti. The Four Systems Conditions state that in a sustainable society, mineral deposits, products of society, and natural resources are used in the most efficient means possible to ensure that human needs are met worldwide (Robèrt, 2002). The Four Systems Conditions are listed below.

1. “In the sustainable society, nature is not subject to systematically increasing concentrations of substances extracted from the Earth’s crust” (Robèrt, 2002, p. 65). Living organisms and ecosystems can only survive a short amount of time before they are adversely affected by increases in substances from the earth’s crust. Thus, the first
condition requires society to employ widespread metal and mineral recycling programs and decrease economic dependence on fossil fuels (Robèrt, 2002, p. 65). This condition is relevant to Haiti’s natural mineral deposits of bauxite, copper, gold, and lignite and applicable in selecting interior furniture, flooring, and finish materials that can be utilized to create healthy orphanage interiors (U.S. Congress, Federal Research Division, 2006).

2. “In the sustainable society, nature is not subject to systematically increasing concentrations of substances produced by society” (Robèrt, 2002, p. 65). In a sustainable society, humans will avoid generating systematic increases in products containing harmful chemicals such as DDT, PCB’s, and VOC’s. This is critical to orphanage construction and material selection in Haiti because persistent substances, such as volatile organic compounds, often found in paint, can remain in the environment long after application, causing negative, delayed effects to those exposed. The solution is to find ways to reduce economic dependence on continued man made substances, and start looking at alternative products with positive health effects (Robèrt, 2002, p. 65).

3. “In the sustainable society, nature is not subject to systematically increasing degradation by physical means” (Robèrt, 2002, p. 65). In society, individuals will avert taking more from the biosphere than can be replenished by natural systems. Consequently, humans will avoid encroaching, and permanently damaging nature by destroying the habitat of other species. Biodiversity, which includes the co-existence of animals and plants found in their natural state, provides the basis for ecosystem services that are essential to sustaining life (Kibert, 2005). Specifically related to
deforestation in Haiti, measures need to be established and implemented to ensure the replenishment of mangroves, which will consequently promote biodiversity, decrease erosion, and inversely improve sanitation standards. Society’s health and prosperity depend on the permanence of nature to renew and rebuild (Robèrt, 2002, p. 65).

4. In the sustainable society, human needs are met worldwide (Robèrt, 2002). Meeting the fourth system is a means of ensuring the first three system conditions for sustainability are met. Looking at the health, safety, and welfare of all requires the need to be efficient with regard to resource use and waste generation in order to be sustainable. Thus, to achieve this fourth condition, humanity must work to positively affect technical and organizational product production efficiency around the world, and thus live by fewer resources (Robèrt, 2002). The challenge to create safe and healthy products with fewer resources encourages innovation, and leads to increased availability of healthier interior products, which benefits product specification options for Haitian orphanage design.

Summary

The Four System Conditions can be applied to new building construction (specifically, orphanage construction), with a particular focus on building materials, to produce a matrix shown in Table 2.1 (Kibert, 2002, p. 277).
Table 2.1 Violation of Natural Step System Conditions in the Application of Construction Materials  

<table>
<thead>
<tr>
<th>Item</th>
<th>Violation Examples</th>
<th>System Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Durables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of less abundant mined metals and minerals (copper, chromium, titanium)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Use of heavy metals (mercury, lead, cadmium)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Use of persistent, synthetic materials (PVC, VOC, formaldehyde)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Wood from rainforests and old-growth timber that is harvested unsustainably</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><strong>Consumables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of petroleum-based products (solvents, oils, plastic film)</td>
<td>X X X X</td>
<td></td>
</tr>
<tr>
<td>Excessive packaging and other disposables</td>
<td>X X X</td>
<td></td>
</tr>
<tr>
<td><strong>Solid Waste</strong></td>
<td>Landfill disposal of construction and demolition waste, including toxic components such as lead and asbestos</td>
<td>X X X X</td>
</tr>
</tbody>
</table>

Table 2.1 Violation of Natural Step System Conditions in the Application of Construction Materials (Source: Sustainable Construction: Green Building Design and Delivery)

Table 2.1 indicates the relationship between the System Conditions and the types of materials used or generated in construction: durables, consumables, and solid waste. It also outlines what elements or practices violate system conditions. In practical terms, applying the Natural Step to the employment of building materials would result in the following materials practices:

1. Selected materials are nontoxic and produced from reused, recycled, renewable, or abundant (in nature) sources.

   (a) Reused means reprocessed or remanufactured in the same form, and in a sustainable manner.

   (b) Recycled means the produce is 100 percent recycled and can be recycled again in a sustainable manner.
(c) Renewable means a resource or good that is grown, harvested, and naturally regenerates at a rate greater than consumption.

(d) Abundant means natural supply flow is greater than human use, for example, aluminum, silica, iron, and so on.

(e) In addition, the extraction of renewable or abundant materials is accomplished in a non-encroaching manner, maintaining diversity of species, and utilizing the resource to utmost efficiency.

2. Building design and use of materials will occur in the following order of priority:

(a) Material selection and design decisions favor deconstruction, reuse, and durability appropriate to expand the life of the structure.

(b) Solid waste is eliminated by being as efficient as possible; however,

(c) Where waste does occur, reuses are found for it on-site; or

(d) For what is left, reuses are found off-site.

(e) Any solid waste unable to meet c or d is recycled or composted (Kibert, 2005).

The Natural Step asserts that, unless we are willing to accept poor human health, we need to eliminate the extraction of ores and fossil fuels mined and extracted to produce energy and materials. Additionally, synthetic materials, which accumulate in the biosphere, must be removed to avoid the drastic negative effects on human health. The Natural Step warns against the degradation of the biosphere by human extraction because it is the only available resource to sustain life, and lastly it addresses the social aspects of sustainability by noting that the amount of available resources must be utilized to meet all human needs in the world (Kibert, 2005). Overall, the message of
the Natural Step is to eliminate resource extraction, increase reuse and recycling, and minimize emissions that effect both ecosystems and humanity.

**Proposed Materials and Products Specifications**

**Methods of Selection**

Utilizing the Natural Step as a relevant means of interior environment evaluation, and taking all existing physical conditions into consideration, this section outlines the requirements used when assessing materials and products appropriate to designing and constructing healthy, interior environments in Haitian orphanages. The resulting evaluation is then compiled into a more formal Criteria Matrix; a set of guidelines for designers and builders alike that can aid in the selection of suitable materials and products.

When looking at specifying materials and products for orphanages, a few terms and concepts must be defined and explained for the purpose of this research. The first critical term to review is “biobased materials,” which generally means that some percentage of a biologically renewable source has been used (Chambers & Muecke, 2010). According to ASTM E2114-2004, a renewable resource is one “that is grown, naturally replenished, or cleansed, at a rate which exceeds depletion of the usable supply of that resource” (ASTM E2114, 2004). The amount of time needed to replace a renewable source varies among products, for example, it may take a tree 30-100 years to mature, while bamboo can fully develop within 10 years. For the purpose of this research, rapidly renewable resources will refer to those that can be replenished within 10 years.
To ensure continued availability, renewable, biobased components are typically derived from a plant or animal, and managed in a sustainable fashion. This biobased component or piece may then be utilized within a product in several forms: in an unchanged state, it may undergo chemical or physical alteration, or it may be combined with other products and employed as an intermediate constituent in the manufacturing process (Chambers & Muecke, 2010).

Although there has been a recent interest in biobased materials, most interior finish materials and products are still typically produced by use of non-biobased materials, which can yield potentially negative circumstances and adversely affect the environment and those exposed to the product. For example, various products and material ingredients can negatively affect the interior environment through the release of indoor air pollutants such as volatile organic compounds, commonly known as VOC’s. These compounds are of great concern within an interior space, especially housing children, because even after the initial release of compounds, other substances and surfaces within the room can harbor the toxic chemicals and re-release the compounds back into the environment where they will be absorbed by the occupants a second time (Chambers & Muecke, 2010).

**The Criteria Matrix**

Utilizing the strict criteria and requirements discussed earlier, a Criteria Matrix (Table 3.2) is proposed to guide the evaluation and selection of materials and products with the goal of creating healthy interior environments. As stated above, the methods to meet these goals can be found in biobased products containing low to zero emissions that promote healthy indoor air quality for children and adults occupying the
These requirements are necessary because children are extremely sensitive to environmental factors (See Table 3.1 below). Their bodies and brains are still developing, and they breathe faster, which consequently means they receive a higher dose of indoor pollution per body weight (Kopec, 2009).

<table>
<thead>
<tr>
<th>Developmental Stage</th>
<th>Biological Vulnerabilities</th>
<th>Exposure Pathways</th>
</tr>
</thead>
</table>
| **Newborn zero to two months** | Brain: cell migration, neuron myelination, creation of neuron synapses  
Lungs: developing air sacs  
Bones: rapid growth and hardening | Food  
Water  
Indoor air  
Mold  
Chemicals |
| **Infant/Toddler two months to two years** | Brain: creation of synapses  
Lungs: developing air sacs | Food  
Water  
Indoor air  
Floors  
Chemicals  
Stimulation from television |
| **Preschool child two to six years** | Brain: dendritic trimming  
Lungs: developing air sacs, increasing lung volume | Food  
Water  
Indoor air |
| **School-aged child six to twelve years** | Brain: specific synapse formation, dendritic trimming  
Lungs: volume expansion | Food  
Water  
Indoor air  
Toxins in arts and crafts supplies |
| **Adolescent twelve to eighteen years** | Brain: continue synapse formation  
Lungs: volume expansion  
Reproductive system: maturation of ovaries, testes, ova, and sperm; development of female breasts | Food  
Water  
Air  
Occupational hazards |

(Source: *Health, Sustainability, and the Built Environment* by Dak Kopeck)
The three most critical requirements relevant to Haitian children and product and material selection for healthy interior orphanage environments are immediate time response, durability, and local availability.

**Immediate Time Response.**

The immediate time constraint following a natural disaster calls for relief that is readily shipped and quickly constructed. Products and materials following the Natural Step Framework that can be shipped directly upon response are ideal for disaster relief in Haiti, because they can offer displaced orphans a rapid, yet long-lasting solution to orphanage construction. If, however, a product is not available to be shipped for immediate relief, another option is to send products over with the first wave of emergency relief teams that can be added to local Haitian resources to begin orphanage construction and promptly provide safety.

**Durability.**

Due to a sudden and immediate time constraint, products need to be selected for quick setting properties and optimum durability. For example, an additive to decrease the required time to dry and increase water resistance used in combination with any remaining concrete following a disaster that is easily shipped, or brought over with an emergency relief team would not only allow the foundation, walls, and ceiling to be quickly built, but also improves strength against future water saturation, thus extending the life of the orphanage structure. Products and materials with excellent durability are also in keeping with the Natural Step’s Four System Conditions by decreasing mineral extraction and increasing efficient use of existing resources.
Local Availability.

The final requirement in selecting interior finish products and materials for Haitian orphanage design is the possibility of utilizing what is already available at the existing site. Considering Haiti’s limited natural resources, this requirement is significant because it not only saves the fuel necessary to ship a product, but it also conserves the existing Haitian resources. Local availability is key in maintaining the Four System Conditions, especially the last statement concerning efficiency in utilizing products to ensure enough remain for worldwide human needs.

Third Party Certification.

In combination with the above requirements, GREENGUARD, a third party certification program, has accounted for inhalation exposure in younger children, and applied a body burden correction factor to their current GREENGUARD Indoor Air Quality Certified allowable levels. They have also developed a program specific to children and schools, which requires products to meet lower allowable emissions criteria along with limits on chronic reference exposure levels and phthalates. Products certified with the GREENGUARD mark and recommended on GreenSpec, a database that combines top performing green building products and materials, are utilized to recommend a list of available specified materials with respect to constructing healthy Haitian orphanages.

---

4 Body burden correction factor is a term coined by GREENGUARD that specifically takes into account the greater inhalation sensitivities among children; Moreover, body burden correction factor has been applied to current allowable emission levels from indoor materials and furnishings.

5 Recent research indicates that inhalation is an important route of exposure to phthalates (harmful chemicals), and that these chemicals have been associated with endocrine disorders, reproductive and developmental toxicity, asthma and allergies. See Greenguard.org for more specific requirements and information about GREENGUARD Children & Schools Certification Program.
Proposed Solutions: The Criteria Matrix

Building Construction

The most reliable and readily accessible building material in Haiti is concrete. Traditionally, concrete is composed of aggregate (sand), cement, water, and various additives, that contribute to many positive qualities such as high strength, thermal mass, durability, and high reflectance. In Haiti, concrete is generally available from regionally local materials, and can be used without interior and/or exterior finishes. Moreover, it does not offgas and affect indoor air quality, is readily cleanable, and is impervious to insect damage and fire.

The main concern surrounding the use of concrete is the CO$_2$ emitted during the production process. Second to coal fired utilities, cement yields one ton of CO$_2$ emissions for every ton of power produced (Kibert, 2005). However, 20 percent of the initial CO$_2$ emitted during the manufacturing process is reabsorbed during the materials’ life cycle, at least partially alleviating this associated effect. Strategies to combat these emissions include minimizing the quantity of cement in a concrete mix, or partially substituting cement with flyash and ground-blast furnace slab, both of which have cementitious properties (Kibert, 2005). The recycling qualities of concrete are generally satisfactory, making recycled concrete aggregate high in demand and price. Furthermore, crushed concrete, which after recent natural events is generously located throughout Haiti, can be used as sub base for roads, sidewalks, and parking lots.

The benefit of using concrete in Haitian orphanage construction is that it is resistant to harsh climates. As a result, concrete can be utilized as the material of choice for the building shell and floors. This is the common practice currently seen
throughout Haiti, and can be supplemented with additional concrete sealers and weatherproofing agents that prevent moisture from entering the building envelope without solvents that emit VOC. This selection of concrete is again, following the Four System Conditions, which requires that orphanages in Haiti utilize products that avoid increasing concentrations of persistent, hazardous substances.

**Interior Finishes**

Interior finishes can give character to any environment and can also be a factor in creating a negative or positive environment. Chemicals, such as formaldehyde, which are associated with negative health impacts, have led to efforts that measure and control product emissions so that today there are zero or low-emitting options available in all finish categories. Finish materials not only affect those in direct contact with the product, but also the environment before they’re installed, due to raw material extraction and impacts from manufacturing. Wall and flooring materials are the most frequently replaced items in an interior space, so selecting products relative to their daily impact can minimize the cumulative environmental impact.

**Floors**

For orphanage construction in Haiti, concrete can be utilized as the best option of a resource that uses structure as finish for both floors and walls, which will reduce material use and environmental impact. Concrete can further be covered with cosmetic layers, such as Ashford Formula by Curecrete Distribution, Inc., which makes beneficial use of otherwise industrial waste, and simultaneously reducing the quantity of CO$_2$ associated with concrete production (Kibert, 2005). An optional flooring product such as vinyl, which does have substantial durability properties, was not selected for Haitian

---

6 See Images 1 and 2.
orphanage environments because it contains various synthetic materials which not only compromise healthy indoor air quality, but also violates the Four System Conditions.

Although carpet has been associated with emissions that negatively impact interior spaces, measures are now taken to ensure carpet products meet the NSF/ANSI 140-2007e Sustainable Carpet Assessment. This voluntary, point based standard certifies carpet products to three levels (silver, gold, and platinum), based on information such as material selection or carpet recycling. Carpets meeting the NSF-2007e Platinum level must contain 10% post-consumer recycled content, be certified by the Carpet and Rug Institute’s Green Label Plus program or California’s 01350 for indoor air quality, and must contain no polybrominated diphenyl ether (PBDE) flame retardants. The carpet must also undergo a life cycle assessment (LCA)⁷, and the manufacturers have to meet Carpet America Recovery Effort (CARE) recycling goals⁸ (Guidance Manual Task Group of NSF Joint Committee, 2009). Also, modular carpet tiles, such as Infinity RE Modular Tiles by Mannington Commercial can ship quickly and are packed tight, consequently illuminating excessive packaging. Therefore, in addition to finished concrete floors, modular carpet tiles meeting the NSF 140-2007e Platinum level can be utilized in the interior of Haitian orphanages to provide ease of replacement, comfort, sound absorption, and the ability to trap contaminants such as dirt, mold, and dust mites which negatively impact indoor environmental quality.⁹

---

⁷ According to Kibert, Life Cycle assessment is, “a method for determining the environmental and resource impacts of a material, product, or even a whole building over its entire life” (Kibert, 2005, p. 43).
⁸ See BuildingGreen.com for more information and specifications concerning carpet.
⁹ See Table 3.2 Concrete and Related Products for additional carpeting specifications.
Walls

Zero VOC paint, such as Akzo Nobel/Devoe Paint Wonder Pure or Glidden Professional Lifemaster No VOC paint, can be applied directly to concrete walls and ceilings to create a cheerful and friendly environment. These products not only follow the Four System Conditions, but are also a timely solution, because they can be easily packed with emergency relief troops to save the fuel necessary for shipping.

Furnishings

Furnishings incorporate many different materials and components, each having its individual impact on the surrounding interior space. As a result, indoor air quality can be compromised by the even the smallest component that is added the entire piece such as binders in wood composites like particleboard, sealants used on the products, and adhesives and finishes applied to give the product a finished look. Even fabrics chosen for seat cushions and the cushion materials must be considered because they can capture dirt and debris and later emit these particles into the air. Thus, furniture selection for Haitian orphanage interiors should refrain from utilizing persistent synthetic materials and instead use biobased materials, which have lower manufacturing processes resulting in a reduced negative effect on interior air quality. This is particularly essential in the specification process because selecting a product that contains even the slightest amount of VOC's, for example, can disrupt the entire “clean” environment. Relative to orphanage design, furnishings such as cradles, twin beds, dressers, chairs and play tables should be considered under the continued strict
conditions discussed herein and selected based upon positive health effects for orphanage interiors\textsuperscript{10}.

The Criteria Matrix: A Summary of Proposed Solutions

The Specification Process

To ensure healthy interior environments in Haitian orphanage design, the specified products and materials (listed below in The Criteria Matrix) were measured against the following three criteria: immediate time response, durability, and local availability. Products and materials that can be shipped directly upon response can offer displaced orphans a rapid, yet long-lasting solution to orphanage construction. Moreover, due to a sudden and immediate time constraint, products were selected for quick setting properties and optimum durability. Lastly, interior finish products and materials for Haitian orphanage design were selected with the possibility of utilizing existing materials in Haiti.

Product and Material Specification Resources

Third party resources were referenced in addition to the above three criteria to ensure that products and materials promote healthy indoor air quality for children occupying the orphanages. The GREENGUARD mark and GreenSpec, a database that combines top performing green building products and materials, assure that selections in The Criteria Matrix are manufactured in a sustainable fashion, and are truly composed of biobased materials. These website databases can additionally be used for further commercial and residential projects.

\textsuperscript{10} See Table 3.2. Source: Greenguard.com and Buildinggreen.com. Additional information and specifications (relative to other site sources) can be found on these third party websites.
Application of Table 3.2

Table 3.2 is a compiled summary of currently available products and materials suitable to create healthy interior conditions in Haitian orphanage design and construction. Due to the beneficial properties of resisting the harsh, wet climate in Haiti, concrete is a viable material to be utilized for the building shell and floors and can be supplemented with additional concrete sealers and weatherproofing agents that prevent moisture from entering the building envelope without solvents that emit VOC. Concrete can then be covered with cosmetic layers to positively increase environmental factors and financial costs over the lifespan of the structure. Related to flooring, modular carpet tiles can be utilized to provide children with the ability to personalize their own space. Other benefits include ease of replacement, comfort, sound absorption, and the ability to trap contaminants such as dirt, mold, and dust mites, which negatively impact indoor environmental quality. Finish materials such as zero VOC paint can be applied directly to concrete walls to create a cheerful and friendly environment. Furthermore, all furnishings listed contain low emissions to provide homeless children with a timely solution to the current orphanage deficiency in Haiti.
<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
<th>Sustainable Properties</th>
<th>Durability</th>
<th>Health Considerations</th>
<th>Certifications/Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>GranCem Cement by Holcim (US), Inc.</td>
<td>Finely ground granulated blast-furnace slag (GGBFS); replaces portion of the portland cement in mixtures.</td>
<td>Pre-consumer recycled content; exceptional durability or low maintenance</td>
<td>Increased compressive strength and durability</td>
<td>Less CO₂ Emissions</td>
<td>LEED Credits: Recycled Content MR Credit 4</td>
</tr>
<tr>
<td>TXActive by Essroc Italcementi Group</td>
<td>Uses a hydraulic binder with photocatalytic properties; self-cleaning and ambient pollution-reduction</td>
<td>Reduces pollution or waste from operations; exceptional durability or low maintenance</td>
<td>Discoloration prevented; exceptional durability; low maintenance; resistant to sulfate attack and alkali-silica reaction</td>
<td>Uses light energy to accelerate natural oxidation processes that break down CO, NOₓ, SOₓ, certain VOCs, and more.</td>
<td>LEED Credits: EQc4.1 and IEQc4.1</td>
</tr>
<tr>
<td>Industraseal by US Mix Products Company</td>
<td>Sodium-silicate-based coating; creates a clear, water-resistant seal; allows vapor to migrate through it.</td>
<td>Releases minimal pollutants; reduces impact from construction or demolition; zero VOCs.</td>
<td>Exceptional durability or low-maintenance; improves abrasion and chemical resistance of the surface</td>
<td>Water resistant; no VOCs</td>
<td>LEED Credits: EQc4.1 and IEQc4.1</td>
</tr>
<tr>
<td>Ashford Formula by Curecrete Distribution, Inc.</td>
<td>Permanent, penetrating concrete hardener, densifier, dustproofer, and sealer for new or existing concrete.</td>
<td>Releases minimal pollutants</td>
<td>Becomes watertight; remains breathable; develops a shine; locks in salts; eliminates concrete dust formation</td>
<td>nontoxic, nonflammable, and releases no VOCs</td>
<td>LEED Credits: EQc3.1, EQc3.2, EQc4.1, IEQc3, IEQc3.1, IEQc4.1</td>
</tr>
<tr>
<td>Penetrating Waterstop by American Formulating &amp; Manufacturing (AFM)</td>
<td>Zero-VOC</td>
<td>Releases minimal pollutants</td>
<td>Increases water-repellency on concrete foundations</td>
<td>Nonflammable; free of formaldehyde and hazardous ingredients</td>
<td>LEED Credits: EQc3.1, EQc3.2, EQc4.1, IEQc3, IEQc3.1, IEQc4.1</td>
</tr>
<tr>
<td>EnvironOxide Pigments by Hoover Color Corporation</td>
<td>Eth-tone pigments made with natural iron oxide product recovered from abandoned coal mine drainage.</td>
<td>Pre-consumer recycled content; reduces material use</td>
<td>Nonbleeding and weather resistant</td>
<td>Pigment is nontoxic</td>
<td></td>
</tr>
<tr>
<td>EcoPath Entryway Track-Off Systems by ECS EcoPath Division</td>
<td>Indoor air quality benefits.</td>
<td>Post-consumer recycled content; blocks introduction, development, spread of indoor contaminants; rapidly renewable</td>
<td>Different abrasion levels provided</td>
<td>Underlayment 100% post-consumer recycled PET bottles; EnviroCel layer of soy-based polyols and fly ash constituent Face fibers: virgin polypropylene or nylon.</td>
<td>LEED Credits: EQc5, IEQc5, MRc4, MRc6</td>
</tr>
</tbody>
</table>

**Table 3.2 The Criteria Matrix:**

**Specifications for Healthy Interior Environments in Haitian Orphanages**

**Concrete and Related Flooring Products**
<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
<th>Sustainable Properties</th>
<th>Durability</th>
<th>Health Considerations</th>
<th>Certifications/Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infinity RE Modular Tiles by Mannington Commercial</td>
<td>30% recycled content by weight; 24&quot; x 24&quot; tiles; variety of nylon 6,6 face fiber options; 100% post-production yarn</td>
<td>Post-consumer recycled content, pre-consumer recycled content, minimal pollutants, reduces pollution or waste from operations</td>
<td>Collect worn-out tiles at no charge, for projects over 2500 ft²</td>
<td>Applied with Mannington’s CRI Green Label Plus-certified zero-VOC adhesive.</td>
<td>CRI Green Label Plus, NSF-140 Platinum; LEED Credits; EQc4.3, IEQc4.3, MRc4</td>
</tr>
<tr>
<td>ESP Cushion Back Carpet Tile by Milliken Floor Coverings</td>
<td>Open-cell polyurethane backing: 25% pre-consumer and 10% post-consumer recycled content minimum</td>
<td>Post-consumer recycled content, pre-consumer recycled content, minimal pollutants, reduces pollution or waste from operations</td>
<td>Backing absorbs shock; minimizes fiber wear; prolonged life by as much as 50%.</td>
<td>Zero-VOC, high-friction coating</td>
<td>NSF-140 Platinum; LEED Credits; EQc4.3, IEQc4.3, MRc4</td>
</tr>
<tr>
<td>ERS RS Modular Tile by Tandus</td>
<td>Dense, low-pile nylon fiber; 100% post-consumer recycled-content backing made from the PVC carpet backing and nylon fibers</td>
<td>Post-consumer recycled content, minimal pollutants, reduces pollution or waste from operations</td>
<td>Peel-and-stick installation using Tandus’ C-14E, a Green Label Plus certified low-emitting adhesive; long service life.</td>
<td>The RS system eliminates wet adhesives so indoor air quality is minimally affected; no antimicrobial treatments</td>
<td>CRI Green Label Plus, NSF-140 Platinum; LEED Credits; EQc4.3, IEQc4.3, MRc4</td>
</tr>
<tr>
<td>AkzoNobel / Devoe Paint (Wonder-Pure paints) / Devoe Paint® Wonder-Pure® Interior Finishes</td>
<td>Premium quality, no-VOC</td>
<td>Free of odor and less likely to cause allergic sensitivity.</td>
<td>Durable, long-lasting, beautiful finish. Excellent coverage and application properties</td>
<td>Premium quality, no-VOC</td>
<td>GREENGUARD Children &amp; Schools Certified, GREENGUARD Indoor Air Quality Certified</td>
</tr>
<tr>
<td>Concrobium Mold Control by Siamons International</td>
<td>Surface-applied product; inhibits mold growth.</td>
<td>Blocks introduction, development, or spread of indoor contaminants</td>
<td>Generally prolongs life; applied by hand-spray, paintbrush, roller, immersion, or airless sprayer</td>
<td>Odorless and colorless; no bleach, ammonia, acids or volatile organic compounds</td>
<td></td>
</tr>
<tr>
<td>Eco-House Mineral Silicate Paint by Eco-House, Inc.</td>
<td>Potassium silicate binder dissolved in water; petrifies when chemically reacts with lime.</td>
<td>Minimal pollutants; reduces impacts from construction or demolition; exceptional durability or low-maintenance</td>
<td>Used on plaster, concrete, and other mineral surfaces; not suitable for wood, metal, or any flexible surface.</td>
<td>No VOCs; solvent-free; odorless after 1-2 days; made from widely available materials, naturally antimicrobial, noncombustible at any temperature, and extremely durable.</td>
<td>LEED Credits: EQc3.1, EQc3.2, EQc4.2, IEQc3, IEQc3.1, IEQc4.2, MRc3, SSC2</td>
</tr>
<tr>
<td>EonCoat by EonCoat LLC</td>
<td>Water-borne, two-part, ceramic coatings; set almost immediately; form a dense, protective barrier</td>
<td>Minimal pollutants; reduces impacts from construction or demolition; exceptional durability or low-maintenance</td>
<td>Durability of ceramic; zero flame spread without flame retardants.</td>
<td>No VOCs and no hazardous air pollutants (HAPs)</td>
<td>LEED Credits: EQc4.2, IEQc4.2, MRc3, SSc2</td>
</tr>
<tr>
<td>Product</td>
<td>Description</td>
<td>Sustainable Properties</td>
<td>Durability</td>
<td>Health Considerations</td>
<td>Certifications/Standards</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
<td>------------------------</td>
<td>------------</td>
<td>-----------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>EverKote 300 by Edison Coatings, Inc.</td>
<td>Waterborne, inorganic mineral-silicate coating made with &quot;waterglass&quot;; forms chemical bond with suitable substrates.</td>
<td>Minimal pollutants; Reduces impacts from construction or demolition; Exceptional durability or low-maintenance</td>
<td>Appropriate for calcareous materials; durable; nonflammable; UV-resistant</td>
<td>Breathable and naturally antimicrobial</td>
<td>LEED Credits: MRc3, SSc2</td>
</tr>
<tr>
<td>IdeaPaint/ Tabrasa ULTRA by IdeaPaint</td>
<td>Solvent-based, commercial-grade dry-erase paint. Lifetime warranty. Assortment of standard and custom colors.</td>
<td>Solvent-based</td>
<td>Commercial-grade dry-erase paint</td>
<td>Solvent-based (See GREENGUARD certification standards)</td>
<td>GREENGUARD Children &amp; Schools Certified, GREENGUARD Indoor Air Quality Certified</td>
</tr>
<tr>
<td>Keim Mineral Silicate Paint by Keim Mineral Coatings of America, Inc.</td>
<td>Available in both exterior and interior products; 370 standard colors and over 38,000 custom colors.</td>
<td>Reduces minimal pollutants; Reduces impacts from construction or demolition; Exceptional durability or low-maintenance</td>
<td>&quot;Waterglass&quot; binder combined with inorganic fillers and natural earth oxide to produce an inorganic &quot;liquid stone&quot; finish. Durable; Used on plaster, concrete, and other mineral surfaces.</td>
<td>Solvent-free, odorless, nontoxic, vapor-permeable, naturally resistant to fungi and algae, noncombustible, light-reflective, resistant to acid rain, and extremely durable.</td>
<td>Keim Mineral Systems carries ISO 14001 certification. LEED Credits: MRc3, SSc2</td>
</tr>
<tr>
<td>Pro Industrial by Sherwin-Williams Company</td>
<td>For interior or exterior, commercial or industrial applications; all colors; gallon covers 140-225 square feet.</td>
<td>Releases minimal pollutants; Reduces impacts from construction or demolition</td>
<td>Brushed or sprayed on for a durable, chemical-resistant finish; high early moisture resistance.</td>
<td>Pro Industrial 0 VOC is a low-odor, zero-VOC, HAPs-free, single-component acrylic gloss or semi-gloss coating.</td>
<td>Certifications: California Section 01350, GREENGUARD Indoor Air Quality, GREENGUARD Children &amp; Schools. LEED Credits: EQc3.1, EQc3.2, EQc4.2, IEQc3, IEQc3.1, IEQc4.2, MRc3, SSc2</td>
</tr>
<tr>
<td>Silacote Mineral Silicate Paint by Silacote USA LLC</td>
<td>Made from natural inorganic compounds such as quartz, other minerals, and mineral colorants with a potassium silicate binder.</td>
<td>Releases minimal pollutants; Reduces impacts from construction or demolition; Exceptional durability or low-maintenance</td>
<td>Suitable for coating inorganic substrates; water-based product; life expectancy of 25 to 30+ years; microcrystalline structure reflects light and heat.</td>
<td>Breathable, nontoxic, noncombustible, zero-VOC (including colorants), and will not support mold growth.</td>
<td>LEED Credits: MRc3, SSc2</td>
</tr>
<tr>
<td>Product</td>
<td>Description</td>
<td>Sustainable Properties</td>
<td>Durability</td>
<td>Health Considerations</td>
<td>Certifications/Standards</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>------------------------</td>
<td>------------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>Furnishings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Climatex Lifecycle by Designtex</td>
<td>Natural-fiber textiles designed by William McDonough.</td>
<td>Rapidly Renewable</td>
<td></td>
<td>Fibers are blend of wool and organically grown ramie—totally compostable biological nutrients, designed to turn back into soil at the end of their useful life.</td>
<td>LEED Credits: MRc6</td>
</tr>
<tr>
<td>Foxfibre Colorganic Fabric by Vreseis Ltd.</td>
<td>Selectively bred and grown to produce cotton in shades of green, brown, and natural off-white.</td>
<td>Rapidly Renewable</td>
<td></td>
<td>Naturally flame-retardant, though chemicals have been added to meet most commercial standards.</td>
<td>Organically grown cotton LEED Credits: MRc6</td>
</tr>
<tr>
<td>FSC-Certified Maple Furniture and Toys by Community Playthings</td>
<td>Manufactures furniture using solid FSC-certified maple harvested in the Northeastern U.S. and, for some products, a high-quality, low-emitting imported birch plywood.</td>
<td>Releases minimal pollutants; Certified wood</td>
<td></td>
<td>Many products are certified Indoor Advantage Gold by SCS and all come with a ten-year warranty.</td>
<td>The company uses UV-cured, waterborne lacquer finishes on all furniture. Certifications: California Section 01350, Forest Stewardship Council (FSC), Indoor Advantage Gold. LEED Credits: IEQc4.5 (Low-Emitting Materials – Systems Furniture and Seating), IEQc4.5 (Low-Emitting Materials – Furniture and Furnishings), MRc6, MRc7</td>
</tr>
<tr>
<td>GreenPlay by Skyline Design</td>
<td>Products made with environmentally responsible and healthy materials and finishes, including post-consumer recycled plastic, sunflower hulls, and wheat straw.</td>
<td>Post-consumer recycled content; Pre-consumer recycled content; Releases minimal pollutants; Rapidly renewable; Agricultural waste material</td>
<td></td>
<td>Take-back policy in which they accept outgrown GreenPlay components to repurpose and donate.</td>
<td>All paints and coatings zero- or very low-VOC; adhesives entirely avoided in favor of mechanical attachments. LEED Credits: MRc4, MRc6</td>
</tr>
<tr>
<td>Mod Green Pod by Mod Green Pod</td>
<td>Produces 100% organic cotton upholstery fabrics; silk-screen printed by hand with water-based paints without chemical finishing agents.</td>
<td>Rapidly renewable</td>
<td></td>
<td>100% organic cotton</td>
<td>Silk-screen printed by hand with water-based paints and without chemical finishing agents. LEED Credits: MRc6</td>
</tr>
<tr>
<td>Product</td>
<td>Description</td>
<td>Sustainable Properties</td>
<td>Durability</td>
<td>Health Considerations</td>
<td>Certifications/Standards</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
<td>------------------------</td>
<td>------------</td>
<td>-----------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>Natart Juvenile / Allegra &quot;4-in-1&quot; Convertible Crib (80003-05) (90287-00)</td>
<td>Made in Canada. 100% Solid European Beech. Converts into a toddler bed, daybed, complete double bed, or double bed headboard. Optional upholstered headboard panel for crib and double bed.</td>
<td>See GREENGUARD Certificates</td>
<td>See GREENGUARD Certificates</td>
<td>See GREENGUARD Certificates</td>
<td>GREENGUARD Children &amp; Schools Certified, GREENGUARD Indoor Air Quality Certified</td>
</tr>
<tr>
<td>Natart Juvenile / Avalon &quot;4-in-1&quot; Convertible Crib (50003-60) (90287-06)</td>
<td>Made in Canada. 100% Solid European Beech. Converts into a toddler bed, daybed, double bed or double bed headboard.</td>
<td>See GREENGUARD Certificates</td>
<td>See GREENGUARD Certificates</td>
<td>See GREENGUARD Certificates</td>
<td>GREENGUARD Children &amp; Schools Certified, GREENGUARD Indoor Air Quality Certified</td>
</tr>
<tr>
<td>Natart Juvenile / Avalon Double Dresser (50036-60) (90287-18)</td>
<td>Made in Canada. 100% Solid Canadian Birch. Slow-motion, self-closing, anti-pinch drawer glides with safety locks.</td>
<td>See GREENGUARD Certificates</td>
<td>See GREENGUARD Certificates</td>
<td>See GREENGUARD Certificates</td>
<td>GREENGUARD Children &amp; Schools Certified, GREENGUARD Indoor Air Quality Certified</td>
</tr>
<tr>
<td>Natart Juvenile / Bella &quot;4-in-1&quot; Convertible Crib (70003-60) (90287-25)</td>
<td>Made in Canada. 100% Solid European Beech. Converts from a crib into a toddler bed, daybed, double bed or double bed headboard.</td>
<td>See GREENGUARD Certificates</td>
<td>See GREENGUARD Certificates</td>
<td>See GREENGUARD Certificates</td>
<td>GREENGUARD Children &amp; Schools Certified, GREENGUARD Indoor Air Quality Certified</td>
</tr>
<tr>
<td>Natural Fiber Bedding and Mattresses by Vivetique</td>
<td>Vivetique natural-fiber mattresses available in three types: standard cotton, organic cotton, hemp, and an organic cotton/wool blend.</td>
<td>Rapidly Renewable</td>
<td>Organic cotton/wool blend contains naturally fire-resistant wool; organic cotton pillows and wool mattress covers and comforters also available.</td>
<td>Organic cotton mattresses made without fire-retardant chemicals; require doctor's prescription showing chemical sensitivity to purchase.</td>
<td>GREENGUARD Children &amp; Schools Certified, GREENGUARD Indoor Air Quality Certified</td>
</tr>
<tr>
<td>BeautySleep Naturally Refreshing Glow Baby &amp; Toddler Mattress by Simmons Kids (90302-10)</td>
<td>Comfort &amp; Support - Soy enhanced foam core. Dual purpose Sleep-4-Years design adds years and value.</td>
<td>GREENGUARD &amp; CertiPUR-US certified, chemical free fire retardant. Meets or exceeds all Federal Safety Standards. Size: 51-5/8&quot; x 27-1/4&quot; x 6&quot;</td>
<td>Cover - hypoallergenic, water and stain resistant natural fabric.</td>
<td>Health &amp; Safety - Natural latex layer is hypoallergenic, resistant to dust mites, mold and mildew.</td>
<td>GREENGUARD Children &amp; Schools Certified, GREENGUARD Indoor Air Quality Certified</td>
</tr>
<tr>
<td>Product</td>
<td>Description</td>
<td>Sustainable Properties</td>
<td>Durability</td>
<td>Health Considerations</td>
<td>Certifications/Standards</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Textus by Momentum Group</td>
<td>Offers environmentally responsible options including Terratex 100% recycled</td>
<td>Pre-consumer recycled content; Releases minimal pollutants; Alternatives to hazardous</td>
<td>Minimize water pollution, use vegetable oil lubricants rather than mineral oil, and environmentally friendly dyes.</td>
<td>The company’s Eco Wool fabrics are processed without pesticides, using biodegradable detergents</td>
<td>Certifications: Cradle to Cradle Gold. LEED Credits: MRC4, MRC6</td>
</tr>
<tr>
<td></td>
<td>polyester (from pre-consumer sources), and MBDC Gold-certified fabrics</td>
<td>components; Rapidly renewable. Company claims 72% lower CO2 emissions, compared with</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>conventional wool products.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TULIP Juvenile / Domino</td>
<td>Made in Canada. 100% solid Canadian Birch &amp; Ash. Converts into either 1</td>
<td>See GREENGUARD Certificates</td>
<td></td>
<td>See GREENGUARD Certificates</td>
<td>GREENGUARD Children &amp; Schools Certified, GREENGUARD Indoor Air Quality Certified</td>
</tr>
<tr>
<td>&quot;Crib to Twin&quot; Convertible Crib (TU5005-62) (90287-03)</td>
<td>twin bed with storage trundle or 2 twin beds; <em>peek-a-boo</em> Plexiglas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>panels to let light into crib and provide child interaction.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Young America / 650-0035</td>
<td>BED - Myhaven 3/3 Twin Low Post Cottage Panel</td>
<td>See GREENGUARD Certificates</td>
<td></td>
<td>See GREENGUARD Certificates</td>
<td>GREENGUARD Children &amp; Schools Certified, GREENGUARD Indoor Air Quality Certified</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Conclusion

This thesis proposes a conceptual framework for healthy interior environments in Haitian orphanages utilizing available labor and natural resources. In addition, the research explores new opportunities for interior finish materials, and how they impact children’s health. Geographical, environmental, and social conditions were explored to better understand the needs of Haitian children and the problems facing orphanage construction. “The Natural Step Framework”, created by Swedish oncologist Karl-Henrik Robèrt, further informed product and material specifications leading to the following three criteria relevant to Haiti: 1) immediate time response, 2) durability, and 3) local availability. Based on the established relationship between Haitian children’s health and healthy interior environments, the most readily available healthy interior products and materials were selected to ensure a positive recovery of Haitian children and their orphanages from current deficiencies and future natural disasters.
References


Images

Image 1. Showing current construction practices utilizing concrete as the main material.

Image 2. Again, showing that concrete is the general means of construction in Haiti today.