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ENVIRONMENTAL OPPORTUNITIES TO MARKET CERAMIC TILE

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ABSTRACT

Environmental issues have never been as front and center in the US consumer's conscientiousness as they have been throughout 2007. Al Gore's "Inconvenient Truth" and its Oscar winning status is testimony to this observation. In fact according to Richard Fedrizzi, President, CEO and Founding Chairman of the United States Green Building Council (USGBC) responsible for the Leadership in Energy and Environmental Design (LEED) program, growth in sustainable concepts and architecture has moved far beyond the fringes and is one of the leading prime directives of the development industry. Fedrizzi stated in a recent seminar the "smoking gun which will propel Green Building initiatives is an overwhelming demand by users for healthy, safe and productive schools, hospitals, offices and homes".(1) Material selection and contributions from Interior Design can play a significant role in achieving this goal.

Previously, sustainable mandates have been focused on energy and water conservation as well as waste reduction. Emphasis has been placed on locally produced material and products with re-cycled industrial and post consumer content. Neither of these directives is especially favorable to assessing ceramic tile as a "green material". A new consumer driven focus on improved air quality and reduction of toxic by-products could substantially support the ceramic tile industry and bring a strong spotlight on the health and safety benefits inherent in natural clay tile. To date these advantages have been ignored or minimized by environmental authorities who argue the alleged high-embodied energy of tile, due to overseas transport and the lack of recycled content, restrict tile from inclusion as an environmentally friendly choice.

The ceramic industry has not refuted this statement nor mounted a substantial inquiry regarding the lack of comprehensive life cycle analysis (LCA). An assessment tool which would more accurately take into account the proven durability of tile compared to other non-durable surface materials. Up to now comparison of a products energy expenditure (embodied energy), not to mention resource extraction, is akin to the proverbial apples versus oranges analysis.

The ceramic tile industry needs to be pro-active in communicating its environmental position. Eco friendly construction materials are no longer simply part of a corporation's boutique business. They are a marketing necessity actively promoted by every other competing industry. Environmental information on the World Wide Web is prolific. Information regarding ceramic tile is astonishingly incomplete, fragmented, often misleading and at times inaccurate. It is the responsibility of the tile industry to present the sustainable, durable and health aspects of ceramic tile and educate the consumer and design professional.

This paper will identify: our current status; suggest areas where documented information is imperative; and highlight complimentary marketing strategies to reinforce the environmental opportunities and value propositions ceramic tile offers.

INTRODUCTION

I believe creating an environmental manifesto is paramount to the growth of the ceramic tile industry. Additionally while this paper focuses on impressions in the US marketplace, Green is not US centric, it is global. Tackling this issue with anything less than utmost diligence could prove to be very costly.

There is no question that the design community and consumers are interested and poised to receive environmentally candid messages. Genuine commitment and depth of information will nevertheless be aggressively critiqued by a suspicious public. Unsubstantiated "greenwashing" and superficial over-used eco-sentiments will be unceremoniously rejected. Currently ceramic tile has little or no ecological status in America. The industry must establish ceramic tiles *factual*, natural place in the hierarchy of environmentally conscious building materials.

"Given the growth in ethical consumerism and eco-consciousness and the availability of information in a knowledge age, brands that adopt values of authenticity, transparency and integrity, and that are aligned with the core beliefs and values of their audiences, will have a greater chance of succeeding,"[(2)]

The complete factual documentation our industry requires is not found in this paper as I am not an environmental scientist or a ceramic engineer. I do not sit on committees devoted to collecting data on: emissions; waste stream strategies; resource efficiency; production inputs/outputs; contribution to greenhouse gases; or recycling programs. What I have done, as a ceramic tile specialist, over the past twenty years is research, investigate, analyze and question environmental data from as many resources as possible. My original goal as an educator was to discover whether records existed regarding the positive or negative ecological impact of ceramic tile production and use. With the aid of the internet almost any topic imaginable can be accessed. However, my search for information on ceramic tile has been frustrated by the limited data produced by the industry. In many cases I have formed opinions by attempting to verify or disprove competitors' claims. My investigation is certainly open to scrutiny and I'd welcome scientific input although I am convinced the information suggests a very strong positive position for tile. Admittedly, without empirical information to defend industry claims and hypothesis, I have often felt like David opposing Goliath. In spite of the efforts to advance ceramic tile benefits to the powerful environmental organizations in the United States, they repeatedly pan on promoting the material and fundamentally consider virgin, imported, ceramic tile as a "persona non grata" in the list of sustainable materials.

Logic has driven me to question and even suspect the position taken by these councils as having a political and economic consideration in addition to their goal for environmental sustainability. Only definable and defendable data regarding ceramic tile will ultimately reveal the facts or fiction of my uncertainties. I sincerely hope this paper motivates ceramic tile's academia to conduct an environmental assessment of the industry and publish the facts about the product.

WHY CERAMIC TILE IS EXCLUDED FROM GREEN MATERIAL LISTS

- Purportedly, ceramic tile possesses prohibitively high embodied energy due to contributions from kiln firing and over-seas transportation.
- Purportedly, the ceramic tile industry consumes prohibitively high volumes of water in production processes.
- Few ceramic tile programs utilize post-consumer or pre-consumer post industrial recycled content.
- Ceramic tile is not biodegradable or recyclable at end of life stage. Therefore, it is not a cradle to cradle product but a cradle to grave (landfill) material.

The only ceramic products that have been endorsed by environmentalists in America are the few programs utilizing recycled glass content or niche distributors who market re-claimed ceramic tile floor. In the past year, one American manufacturer has successfully certified a tile program by verifying 40% of the tile mass originates from diverted manufacturing waste stream reclamation, or pre-consumer ceramic recycled content. With this certification the product qualifies for points under the USGBC's LEED rating system.

The LEED system is the "nationally accepted benchmark for the design, construction and operation of high-performance green buildings." [3] Bearing this in mind, if the reasons ceramic tile is currently excluded from qualifying under LEED are indeed ecologically defensible, one can assume that no imported virgin tile will ever be certified by USGBC.

At this time points are awarded within the LEED rating system to the following products:

- Low-emitting Materials: Carpet Systems.
- Rapidly Renewable Materials. Suggested flooring materials referenced are: bamboo, linoleum and cork.
- Other materials can qualify if they are either locally manufactured or contain recycled content such as the ceramic tile program noted above.

Qualification within the LEED rating system is a virtual environmental stamp of approval for a product. Acknowledgement in LEED has a tremendous influence on design professionals, consumers and the entire "Green Building Industry" & media. Conversely, a product's exclusion from the rating system is synonymous to an ecological guilty verdict.

EMBODIED ENERGY

Therefore, a definitive answer is whether the alleged high embodied energy of ceramic tile exceeds alternative flooring choices.

In simple terms, embodied energy of a material is the total energy consumed in acquiring the raw materials, manufacturing the components and constructing the building on site. It includes the energy consumed for transportation within and between each of the stages leading to the completed building, as well as the human energy, transportation of workers to the factory or construction site and attributable portions of the energy used to manufacture and maintain the machinery and the factories that house them.

Understandably, the complexity of embodied energy calculations is frustrating even for scientists and it is easy for the individual homeowner, builder, designer or government specifier to become discouraged at the difficulty of obtaining accurate figures.

To further obscure a precise answer, there is not a complete Life Cycle Assessment (LCA) or verifiable list of assessed embodied energy (cradle to grave or cradle to cradle) for all flooring products. There are many partial lists, all using different protocols. However, one LCA reference which is often cited is the BEES program developed by the National Institute of Standards and Technology (NIST). The software and data was specifically compiled for designers, builders, and product manufacturers in order to select cost-effective, environmentally preferable building products. Only one ceramic product is included in the list - a 75% recycled glass content option. Even with this limitation, a few preliminary observations can be made and the embodied energy of ceramic tile can be compared to competitive material choices at least from this listing. According to the BEES environmental data, Figure 1 shows the results of four of the most common flooring materials.

	Ceramic-75% recycled glass content	Linoleum	Nylon Carpet	Wool Carpet
Life Span	50	30	11-15	11-25
Water Used (L)	15.1	44.636	224.33	349.69
Air Emissions (g)				
Carbon Dioxide (foss)	2400.0	1142.66	4744.64	13468.07
C Dioxide (bio)	66.09	-401.0	0.3790	-5888.96
Carbon Monoxide	3.2	2.5039	10.57	44.80
Ammonia	0.00671	0.61617	0.58532	120.52730
Indoor Air Quality (g)				
IAQ (q)	0.037	0.12	6.350	3.17
Nitrogen Oxides	7.97	7.42	17.06	353.63
Sulphur Oxides	12.50	4.84	26.37	57.00
Radioactive substance (kBq)	463.0	1485.83	1521.24	4488.20
Methane	4.43	2.94	16.71	722.04
Water (g)				
Chlorides	42.70	16.08	29.64	200.97
Suspended Matter	1.73	2090.58	3.94	84.30
Radioactive effluent (kBq)	3.	9.64	9.85	29.09
Chloronated Matter	0	0	52.60	5077
Dissolved Matter	55.50	19.44	105.50	251.32
Energy (MJ)				
Feedstock Energy	8.63	12.20	44.21	27.55
Fuel Energy	23.6	16.07	65.93	91.29
Non-Renewable Energy	30.8	17.52	108.82	118.14
Renewable Energy	1.41	10.77	1.21	0.70
Total Primary Energy	32.2	28.25	110.04	118.84

FIGURE 1 [4]

The environmental data is product specific to each type of floor material and quantities are expressed in terms of the product's functional units, 1 square foot of product service for 50 years. I have assumed this to mean that replacement frequency has been calculated into the environmental and economic calculations to reflect a 50 year life span for 1 square foot of each product type. I have also assumed that energy required by the kiln would be equal regardless of the recycled content of glass in the body of the tile.

Clearly, in looking at the data in Figure 1, ceramic tile does not possess the highest embodied energy, water consumption, or emissions. Furthermore, I am truly shocked that any carpet product achieves status on environmentally sustainable lists if the above data is indicative of carpets environmental performance. The fact that low-emitting carpet systems enjoy the opportunity to earn points under the LEED environmental building certification system without qualifying cautionary remarks regarding: carbon dioxide emissions; fuel dependency; as well as water consumption is misleading at best.

Based on the data, the only possible reason I can imagine is that carpet is considered a necessary, irreplaceable component in all buildings and Eco-councils such as USGBC are sincerely trying to mitigate the environmental impacts of a material that they believe will inevitably be specified. If I accepted the necessity of carpet, I could even judge this strategy as prudent- rewarding designers for specifying carpet systems which are *less environmentally offensive*. No matter what USGBC's reasoning may be, I find it distasteful that imported ceramic tile has been given such a black eye when a locally produced material seems to have been granted an ecological free pass

It would be instructive to see if informed, environmentally conscience designers and consumers would agree that carpet is a fundamental building requirement? Certainly it has reliable thermal and acoustical advantages but, how did society deal with these issues before, considering wall-to wall tufted broadloom has only been available since the 1930's? Without doubt there may be many other ways to interpret the data in Figure 1. The opportunity for the tile industry lies in challenging the image others have assigned to ceramic tile - to open the debate and let the market decide the merits of each flooring material.

TRANSPORTATION ENERGY

While the computations found in Figure 1 include various transportation energy inputs, they do not reflect the energy required to ship ceramic tile containers by sea. Because of the weight of tile and the considerable distances involved in its transport to markets, these two factors are consistently raised by tile critics who insist transportation energy raises the total embodied energy of tile by such a significant amount to warrant it's exclusion from the lists of sustainable product choices.

According to the National Renewable Energy Laboratory, (NREL) and its Life Cycle Inventory Database, 2007, emissions and embodied energy of transport per Ton-Mile for freight is as follows:

	Energy Use MJ/ton-mile	GWP Lb CO_{2e}/ton-mile	Reference
Ocean Freighter	0.28	0.05	NREL US LCI, 2007
Locomotive	0.37	0.06	NREL US LCI, 2007
Barge	0.54	0.09	NREL US LCI, 2007
Cargo Plane	1.15	0.17	NREL US LCI, 2007
Combination Truck	1.54	0.26	NREL US LCI, 2007
Single Unit Truck	3.29	0.56	NREL US LCI, 2007

FIGURE 2 [5]

It is interesting to note, ocean freight is 32% more efficient than rail. Rail is four times more efficient than combination truck and nine times more efficient than single unit truck. Once again our question is: exactly how much energy is added to each square foot of tile from ocean transportation? The calculation is shown in Figure 3.

Destination Spanish Sea Port to New York City & San Francisco	Kg Weight/ ton	Distance-miles	Energy MJ/ton-mile (from Figure 1)	Total Energy For container	sq. ft. per container = 11458 Total Energy per Tile
Castellon-NYC	21770/ 21.77	4128.5	0.28	25165.68	2.19634
Castellon-SF	21770/21.77	9220.7	0.28	56205.69	4.90536

FIGURE 3

According to the above charts, the energy required to transport tile by sea over the maximum distance would raise the Total Energy of tile to just over 37 MJ / square foot. (32.2 MJ from Figure 1 plus a max. of 4.90536 MJ from Figure 3) Therefore, the poor sustainable rating of tile including the embodied energy associated with ocean freight can only be in relation to other hard surface materials and not to all types of flooring. While this is not the most advantageous position for tile from an energy or emissions point of view, it is a conclusion based entirely on one list only. It is a comparative analysis of the limited flooring choices included in the BEES program. These include Vinyl Composite Tile (22.75 MJ), Cork Plank Flooring (19.08 MJ) and Linoleum (28.25 MJ). No data is available on sheet vinyl flooring, bamboo, natural stone, stained concrete or other popular hard surface materials.

RELIABILITY

It is more than reasonable to question the quality and consistency of current databases and LCA programs. The information available to the marketplace and on the internet is literally a mine field of confusing and perplexing data. One such example can be found in the BEES database with regard to the figures stipulated for Cork Plank flooring. According to the description of this type of flooring it consists of recycled cork, laminated to an oriented strand board (OSB) backing layer. The energy required to produce one square foot of OSB as stated in BEES is 24.8 MJ. However, the total energy attributed to one square foot of Cork Plank floor is only 19.08 MJ. Contradictory data such as this is likely never seen by the end user of the BEES program. Users simply select a variety of choices and the software computes a summary report ranking selected alternatives from lowest value to highest value based on a blended environmental and economic performance scale. An example of the summary reports are shown in
Figures 4 & 5

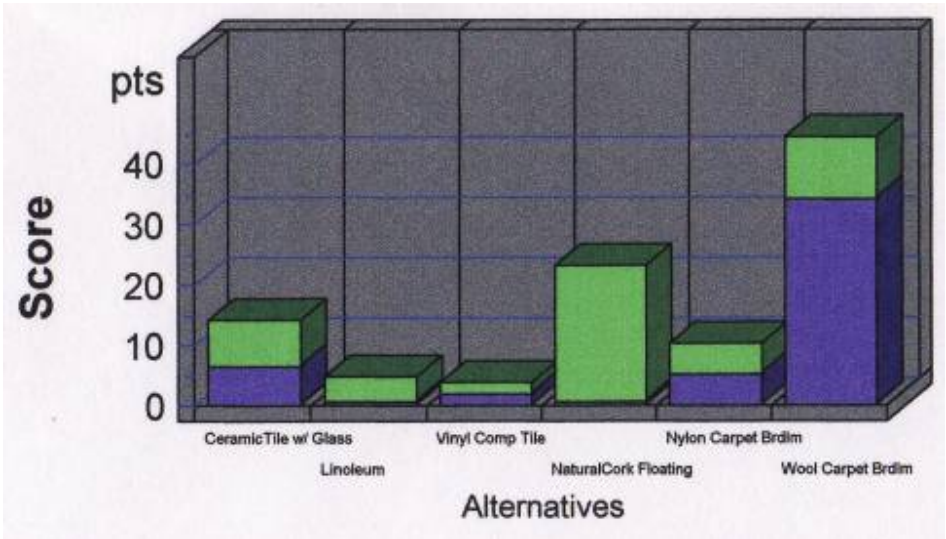


FIGURE 4: OVERALL PERFORMANCE [4] Note: Lower values are better

Category	Tile/Glass	Linoleum	VCT	Cork Floating	Nylon Broadloom	Wool Brdlm
Economic 50%	7.5	3.8	1.7	22.3	4.7	10.0
Environment 50%	6.5	0.9	2.1	0.7	5.4	34.3
Sum	14.0	4.7	3.8	23.	10.1	44.3

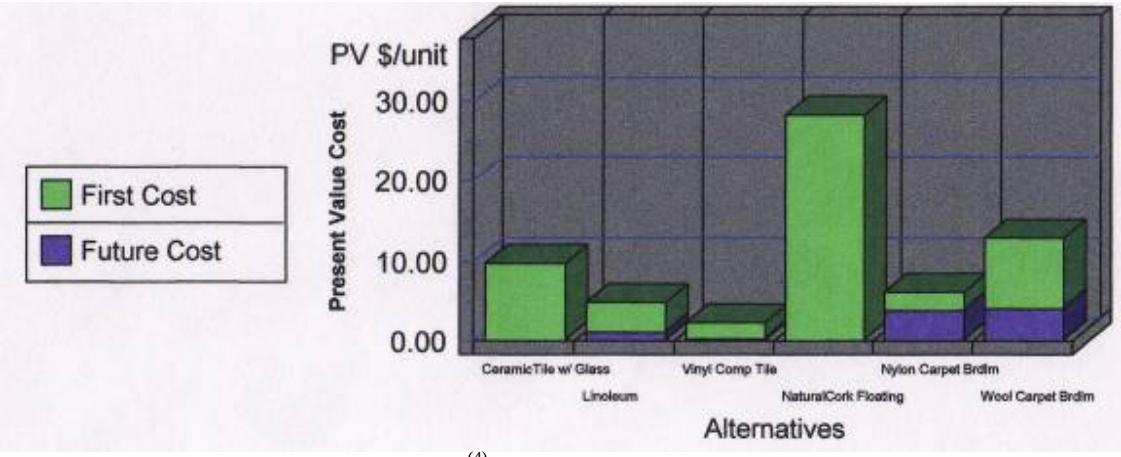


FIGURE 5: ECONOMIC PERFORMANCE [4]

Category	Tile/Glass	Linoleum	VCT	Cork Floating	Nylon Broadloom	Wool Brdlm
First Cost	9.55	3.56	1.88	28.20	2.13	8.58
Future Cost-3.0%	0	1.20	0.25	0	3.81	4.10
Sum	9.55	4.76	2.13	28.20	5.94	12.68

A third report on Environmental Performance (EP) is also supplied to the user. I have omitted it due to its length. However, the results rank ceramic tile 5th behind: Cork Floating Floor; Linoleum; Vinyl Composite Tile; and Nylon Broadloom. In my opinion it is incredulous that ceramic tile achieves a poorer score than nylon broadloom carpet economically, environmentally and in overall performance values. However, I also cannot claim to be a computing wizard. Hence the results shown on Figures 4 & 5 remain beyond my level of comprehension. Based on the data in Figure 1, I cannot grasp how broadloom carpet production is helping to realize a reduction in fossil fuel and water consumption, or limiting landfill waste or reversing global warming. What I am absolutely certain of is, designers and consumers select product based on these reports and they trust the recommended material will meet their environmental objectives.

Another industry concern regarding the information used by any LCA database including BEES is the age of the data. The National Contractors Association of America supplied some of the current data but there is no indication of the date.

It is reasonable to question whether new technological advances in production such as water filtration, co-generation of electricity, sludge waste diversion, emission reduction or waste stream re-cycling have been reflected in the figures being used.

With the millions of dollars the ceramic tile industry spends each year in research and development, a prudent decision would be to assign an annual budget to ensure that a reliable account of environmental improvements is documented and available for public review.

RECYCLED CONTENT

The qualified representation or misrepresentation regarding embodied energy, fossil fuel depletion and water consumption is the first issue challenging the growth of ceramic tile in the environmental arena. The second debate is a similar qualification regarding virgin material containing no recycled content. The predominant message in the United States endorses any material with recycled content over materials lacking in it. Recycled content is an easy and somewhat convenient flag to wave. It is easily understood and measureable. Does this imply that all products with re-cycled content are automatically more environmentally conscientious than 100% virgin product? It is another controversial dilemma. Is a non-durable product which lasts less than 10years that is partially made from post consumer recycled product a better environmental, energy efficient choice than a 100% durable virgin product that will last a life time? How much energy is expended in the collection, extraction, re-production and transportation of the diverted waste or re-cycled material? How does it reduce landfill burdening if the new re-cycled content material is disposed of in the land fill every decade?

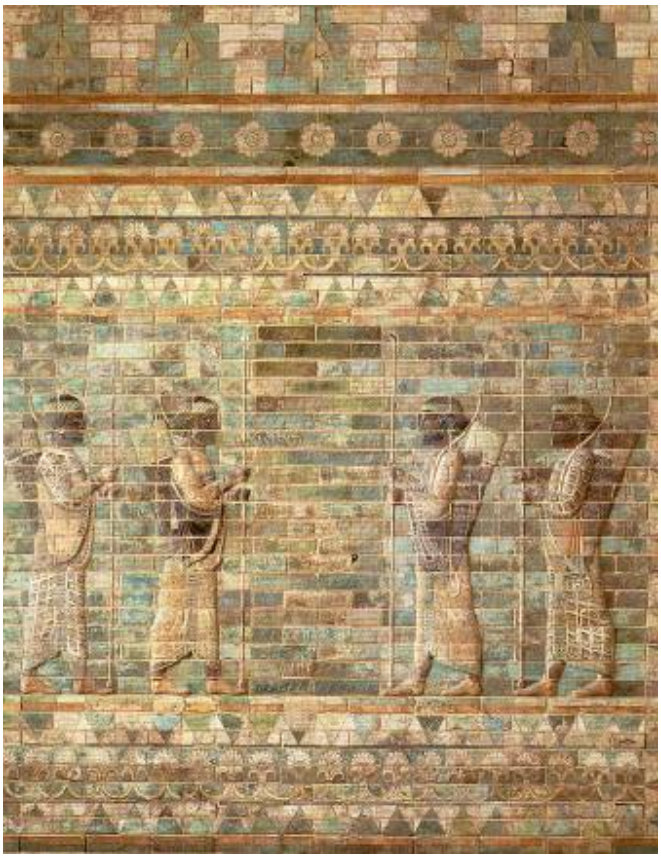
While re-cycling is certainly a vastly important goal in order to divert as much waste from municipal landfills as possible, I believe it cannot be held up as the “Rosetta Stone” to solving the complex problem of defining the most sustainable material selection. “Building for Life” with durable materials that require minimal maintenance, remain aesthetically attractive, and are healthful alternatives must also be considered for their beneficial status among design solutions.

Do it once – do it right – build it to last. It is one of the most sustainable concepts known. Excluding virgin imported ceramic tile from sustainable lists when it can be proven to be a better economic and environmental choice than other materials containing recycled content is the second area of discussion the ceramic tile industry must tackle.

OUR FOOT MUST BE IN THE DOOR

As I have stated several times in this paper, my expertise is not centered on ecology, nor am I even very gifted at chemistry or math. My strength over the years has been to familiarize architects and consumers with some of the more easily definable attributes of ceramic tile. Many of these straight forward characteristics have helped me develop my own environmental story on ceramic tile. However, no matter how many people hear the seminars I've created, it is a monumental struggle to have them believe the information. While it may make sense at the time, there is no authoritative voice re-enforcing or corroborating the concepts. There is a cacophony of opposing sentiment advising them differently. Should the ceramic tile industry be successful in getting their foot in the door of sustainable design, all of the other environmental attributes of ceramic tile will garner much more attention and credence.

ENVIRONMENTAL OPPORTUNIES



- Ceramic tile dating back to 575 BC survives. There is no building material with such a proven track record for durability. In fact ceramic shards are so immutable they are used by archeologist to date civilizations. Without ceramic relics we would know much less about past civilizations.
- Ceramic tile is a hero of disasters. It is inert and inorganic. It survives fire and flood. Premature replacement of the original floor and substrate are often avoided even in the face of these occurrences.
- Tile can be easily spot repaired if damaged without noticeable patches as ceramic tile does not fade or deteriorate when exposed to ultra-violet light. Similarly, sections of tile that have experienced unusual traffic wear can be restored without replacing the entire floor. All of these characteristics reduce construction waste in landfills.
- Tile can be installed over existing tile, saving construction waste disposal and the replacement and disposal of substrate material such as plywood.
- Ceramic tile installed with Portland cement mortar contributes to good air quality. Tile is neither an original nor a secondary source of indoor air pollution.

- Ceramic tile is not a sink for other pollutants, irritants, or contaminants. It will not absorb odors or trap particles.
- There are no fibers, gases or toxic by products associated with ceramic tile.
- Ceramic tile is chemically inert and inhibits the growth of mold, mildew, fungus and other viruses.
- Ceramic tile is 100% natural and mimics nature using heat and pressure to produce man-made stone.
- Ceramic tile should be considered a superior performance based specification in specific areas where alternative natural materials have been traditionally used such as:
  -Nature stone applications in environments susceptible to water or moisture vapor. Natural stone is porous and requires periodic sealers to maintain the finish. Quality glazed ceramic tile is not porous, is aesthetically comparable, and does not require any topical chemical protectorate;
  -.Solid or veneered hardwood in environments susceptible to water or moisture vapor. Wood is porous and requires periodic stripping, sanding and re-sealing/staining in order to maintain the finish. Wood is detrimentally affected by water causing warping, curling and de-lamination which can cause premature disposal. Quality glazed ceramic "wood" is not affected by water or vapor, is aesthetically comparable, will not burn, and does not require any re-finishing or topical chemical protectorate.
- Ceramic tile has been proven to be the most economic floor and wall covering material when replacement frequency and maintenance cost are included over a 50 year life span.
- Quality glazed ceramic tile requires no detergents, soaps, wax, or sealants. The most effective cleaner is hot water or PH neutral cleaners. No toxic chemicals are flushed into the eco-system in order to maintain ceramic tile.
- The ceramic tile industry has invested millions of dollars in research and development in order to reduce their environmental footprint. Technologies such as water filtration, co-generation and emission control have all contributed to an on-going commitment to enhanced corporate stewardship.

I am passionate about the potential and future possibility available to the ceramic tile industry. I believe in it aesthetically, technically and environmentally. Like many others who are keen on making informed sustainable design decisions for our world, I depend on balanced complete information. I genuinely hope the ceramic industry has the wisdom to recognize the inadequate resources available today and makes the commitment to filling this void.

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