

Architecture Narrative

West Virginia University and the University of Rome Tor Vergata have teamed up to create not only a house, but a home, through Sustainable Technology Integrated in a Learning Experience. Welcome to the future of green building. Welcome to STILE.

The overall design of STILE is linear and modern, using steel materials and neutral tones, with the design concept emerging from a blending of two cultures: Appalachian and Roman. This coalescence is most reflected through the design of the main house structure and the Arch. The house structure of STILE is referred to as the Box, and is designed as the American element of the cultural duo. Its Italian counterpart, the Arch, is designed as a modern interpretation of the classic Roman arch. Both components overlap each other, however instead of the Arch covering the entire Box, the Arch is offset to provide more of a contrast in form and space. This offset is not only aesthetic, it also reinforces the concept of merging the two cultures while still retaining the individuality of each.

While sleek and sophisticated, STILE still reflects a connection to nature with a band of vegetation which runs along 3 sides of STILE. This vegetated band brings biodiversity right to STILE's edge, with native varieties that are acclimated to the region's climate. The vegetation within the planters enhances the design of STILE, by contrasting the modern exterior with organic forms and materials. The wood planters span around the edge of the deck and create a smoother transition from STILE's sleek steel structure to the natural environment. The planters are made of a renewable resource with naturally rot-resistant qualities, and reflect Appalachian rustic character, while retaining the linear design concept of STILE. Not only are these planters aesthetic; they also act as an edging for the deck, securing the large, modular design in place.

The 1,854 square foot deck is designed with two ramps for smooth access to-and-from the carport at ground level. The deck not only doubles STILE's living area, but also gives the house a stronger connection to the surrounding environment. The wrap-around design gives the user several niches to choose from when enjoying the outdoors, and allows for ease of movement and maintenance around the Box and Arch of STILE. The deck was also designed to be modular and easily adjustable for the convenience of quick and simple construction. The deck substructure uses an adjustable pedestal system, similar to how the jacks are used for substructure under the house. These pedestals can be adjusted easily for quick and easy on-site changes concerning slope. The decking is made of 2'x2' hardwood panels that can be placed over any part of the deck's substructure grid, eliminating the need for specific arrangements and allowing for fast and simple construction of the deck. The wood used for the panels is Cumaru, a hardwood with durable properties and pleasant aesthetics which complement the houses exterior. These two modular components of the deck not only save time during the construction process, they also reduce the amount of resources needed to construct such a large exterior structure.

Partially covering the deck is the southern facing Arch, reminiscent of classic Roman architecture. By only partially covering the deck with the Arch, a more dynamic space is created, with various options for passive outdoor recreation available. The smooth angle of the Arch's face reiterates the sleek and modern design, while also providing a structure to which STILE's solar panels are set upon. The Arch's main structure is made of steel, which is strong, durable, and does not run the risk of expanding and compressing during shipping, as lumber would do in such a complicated form. By using steel, it is ensured the house can be built in any location, whether it be America or Italy, which allows easy transference between the two cultures.

involved in designing STILE. The secondary components of the arch, designed more simply and made of wood, provide the necessary structure for the solar array, while also being material conscious and affordable. Throughout the day, the Arch casts a shadow over STILE, shading the house, deck, and windows, allowing for a more comfortable living space. The shadow from the Arch also acts as an aesthetic interest throughout the day, and plays dynamically against the house's more boxy shadow.

The house itself, also referred to as the Box, reflects more of the American component of the dual-culture concept. The Box's main living area is open and easily transitions to the large deck, giving the user the feeling of a grand and expansive space. The structure itself is (40'x24') and is partially made of 3 shipping containers. These containers have been deconstructed and modified to create a fully functioning, aesthetically pleasing, and energy efficient house. Following with American practical design considering space, the interior is split with 1 container as the "core", and the other 2 containers creating the central living space. This divides the spaces conveniently for shipping, while also giving the user enough space with plenty of niches to live in. By using shipping container structures as storage during the transportation process, the modularity of the house is increased, and a more efficient and cost effective means of shipping is provided.

The southern half of the Box contains floor to ceiling windows. These windows open up the house's interior to the outdoors and create a smooth transition between the Box and the deck. In keeping with the modern style of the house, the windows span the entire southern half, and wrap around the sides, acting as a "glass wall". The windows are not only aesthetic; they are also an important component to the energy efficient design of STILE. By opening up the entire southern half of the house with glass, the design welcomes natural sunlight into the house, reducing the need for lighting during the day; during winter months, the southern facing windows will also allow sunlight to enter the home for longer periods during shorter days. The windows are double paned and include a layer of gas and an insulating layer in between the glass panes; this further improves the energy efficiency of the house. Just as some materials of STILE come from the Appalachian region, these windows are specially made in Italy. This further connects the Italian culture with the design and construction of the house, and reflects the quality material Italy has to offer to sustainable and modern design.

These specialty windows can reduce some of the radiation coming through, however in order to have a significant impact to the energy efficiency, solar shades were implemented for STILE's resource conservation. These shades are located along the southern side on the exterior of the house, and wrap partially around the sides. When not in use, the shades can be pulled up and stored within the overhang of the roof, thereby respecting the linear aesthetic of the house; the simple design also reflects the modern character of STILE, and provides a streamlined means for privacy when needed.

The main living area of STILE is a mixed-use space that accommodates the kitchen, dining area, living room, and a passive relaxation nook. While these areas are all located within a small parameter, the open floor plan and large windows make the space feel so much larger. With floor-to-ceiling windows, the edges of the Box extend past the steel wall structure and into the surrounding outdoors. This main living area fully reflects the American design features of large and open living, while also maintaining the functional aspect of American home design.

Located above the center of the main living area, is another key component in the energy efficiency of STILE, the Solar Chimney. The Solar Chimney passively ventilates and cools the house by using the differences in pressure due to change in temperature. While the Chimney heats up on the roof, cool air from under the house is pulled up through vents in the floors. The cool air slowly warms and rises, and then reaches the top of the chimney. This change in temperature also causes a change in pressure, which causes more cool air to be pulled up from under the house and constantly replaces the warmer air inside, in a positive feedback loop. This system allows for a passive cooling of the Box, further reducing mechanical cooling needs and energy consumption. The solar chimney also adds aesthetic appeal by acting as a skylight through which natural light can enter, and further opens up the main living area.

The Core of the house contains the bathroom, bedroom, and a mechanical room. The Core is designed at an individual level, and features small spaces for personal use. While the main living area is large and open, reflecting more the American style of living, the smaller, more intimate rooms of the Core reflect a more European living style. These smaller spaces suggest a less materialistic lifestyle, using less resources, and therefore needing less storage. The Core is also the structure that will contain many materials during shipping, and will further improve the efficiency of the spaces created. By shipping the Core as a fully constructed piece, construction time is decreased and an initial construction reference is created.

The interior concept of the house is Appalachian texture meets contemporary Italian design. Both flooring and cabinets within the house are laminate, which are scratch resistant and durable - meaning the sleek look of STILE will remain throughout many years of use. The light and neutral shades chosen for flooring and cabinets also enhances the contemporary design and open floor plan of the house. The laminate also requires no sealant, which means zero VOCs and no off gassing, making the interior a healthy place to live as soon as construction is done. Both surfaces can be installed and maintained easily, adding to the efficiency of the homes construction and maintenance. The house will also feature a very low VOC paint, with light neutral tones for the walls. The remaining furnishings play off the modern, neutral colors, reflective of Italian contemporary design, with several decorative items adding splashes of color in blue and gold related tones - reflecting the origin of the houses construction in West Virginia.

Moving through the house, located at the back of STILE is the Vertical Garden. The vertical garden is a conceptual continuation of the Arch. Reiterating the material design choice, the vertical garden's structural support columns are made of steel, ensuring support for the large amount of vegetation being grown. Continuing the materials choice, the horizontal slats of the green wall are made of 1x6 wood beams, and provide the necessary support while also being cost effective and material wise. Just as the solar array along the Arch provides energy for STILE, so does the vegetation along the northern wall. The planting schedule includes various species which are useful in cooking and home remedies. Not only does this reduce some grocery costs, but also promotes a healthy lifestyle and provides a means of personal outdoor connection. The vertical garden uses a felt pocket system, with each individual plant wrapped and placed in pockets, which allows for easy redesign and maintenance. The fibrous material also allows water and nutrients to wick through and reach the plants as needed. This further reduces the water needed to grow a garden, while what water that does manage to drip down, is caught in a trough and sent back through as greywater to irrigate the rest of the landscape.

The carport is the structure which protects STILE's electric car, and is designed as a reflection of the Arch and Vertical Garden. The elements of the carport, steel columns and wooden slats, continue the materials choice of the Arch and Vertical Garden. The steel columns, follow the modern design of the rest of STILE, while also providing a strong structure for the canopy plane. Meanwhile, the wooden slats are layered on top, providing shading and weathering protection. The carport is located at the base of both ramps, and creates a convenient circulation loop between the car, deck, house, and surrounding grounds.

Night Architecture Narrative

Transitioning through the evening and into the night, the house continues to offer a myriad of spaces through the design of the lighting and thresholds. Moving from the carport up along the ramps, the pathway is well lit for safe passage to the house. Lighting runs along the ramp and gives the deck an aesthetic glow, while also maintaining ADA guidelines. Ramps along the deck provide smooth and easy travel to the house, without the worry of stumbling over rocks or stairs. The wrap-around deck also provides easy access to any threshold of the house, and allows the user to enjoy the outdoors at night with the security of still being at home. Similarly, the large windows of the house provide a great view of the nighttime landscape, from the comfort of the main living area. Solitude indoors can also be achieved through the use of the solar shades, which can lower and act as a privacy screen during the night.

Market Appeal Narrative

STILE house's unique blend of architecture, engineering aspects, and livability combine to create the ideal living space for an empty nester couple in their 50's or 60's. Our world and society is growing and changing rapidly, and STILE provides older couples with an ideal learning and living environment to experience these new technologies firsthand. Many older couples look to downsize their living space after their children move out, and STILE provides them with this opportunity by creating a space with a smaller square footage, while still maintaining the space efficiency and comfort unique to the floor plan of STILE. The small size and open floor plan is ideal for the mobility of individuals of this age, eliminating any concerns for the future about whether the house will still be suitable for when the couple ages. Another essential element that aging individuals need is plenty of vitamin D, which is necessary for strong bones and preventing osteoporosis; the large window wall makes this possible by letting in plenty of sunlight. This large wall of windows shows the outdoors to promote one to engage in outdoor physical activities, which helps one's overall health as well. Our team's motivation, innovation, and collaboration have built a house that applies to homebuyers in any location. STILE promotes simplicity, outdoor engagement, healthy living, and energy efficiency; these qualities could attract any homebuyer.

STILE's innovative home automation system is appealing to the target market because of how user friendly it is. An overbearing amount of technology tends to make some skeptical, but STILE's system combines just enough automated technology to make the living space interesting and easily accessible from all aspects. For example, the automated exterior shades allow the inhabitants to adjust the levels of sunlight that filter into the room, as well as adjust the privacy of the living room, kitchen, and dining area. Motion detectors and security systems help to ensure that the homeowners will be kept safe, which will aide in providing a level of comfort particular to the house. Automatic light switches provide the homeowner with the ability to create whichever atmosphere they need in their home just with the touch of a button. Even if the homeowner leaves the house and realizes that they have left a light on, they will be able to switch the light off with the touch of a button saving time and energy.

The aesthetic design of STILE is appealing to the aging couples because of its unique bridge between modern, clean, minimalistic design and the coziness that results from creating a unique space that's your own. The hardwood-like laminate flooring of the living space lends a homey feel to the overall atmosphere of the home. Even though the floor appears to be made of hardwood, the laminate is made out of 74% pre-consumer recycled wood chips and fibers. The floors are also low VOC, which is beneficial for the overall air quality of the house. One of the main purposes of the floor plan of STILE is to keep the private areas of the house contained within the core container, while keeping the main living space, like the kitchen and living room, in the larger, windowed area of the house. The shades for the windows are located outside so that the size of the living room will not be compromised by interior curtains. The windows aid in keeping the living room bright and open, which helps the room seem bigger by not limiting the room with walls. The denim insulation housed in the interior walls aide in this purpose, as it is an excellent sound barrier to keep the sounds of the common area out of the bedroom and bathroom areas. Denim is sustainable in that it is free of VOCs and is made from 80% post consumer recycled denim fibers. Because it is easy to install, is it also easy and safe to maintain, as there are no health risks or typical fiberglass itch.

Additionally, the large window walls serve as a to the outside world, providing an unobstructed view of the surrounding environment, while still maintaining the level of comfort that the homeowner feels from being inside. Natural light is very beneficial for a living space, as it greatly reduces the amount of electricity needed to light the house, as well as improves the moods of its inhabitants, and STILE works to integrate this natural light to become a vital part of the house as a whole.

The windows that provide the interior lighting to the house form the front side of the rectangular shaped house. The contrast of the rectangular shape with the curved steel arch provides the viewer with a house that's different, never been seen before, and aesthetically pleasing to the eye, while still maintaining a homey look. STILE is unique from other houses because it combines unique features that are both aesthetically pleasing and functional into an exceptional living experience.

In addition to the overall user friendliness of STILE, the appliances lend a hand in keeping the house as efficient as possible. These carefully selected appliances and fixtures ensure the homeowner that they are receiving the highest quality possible. The appliances have been selected for their energy efficiency qualities as well as aesthetic design. The lighting fixtures have been chosen for their energy efficiency and aesthetic look, which coordinates with the style of the house. These fixtures make a difference in how much light is presented to the given area. For example, track lighting was chosen for the kitchen to highlight the different sections and appliances of the kitchen. The sinks and shower in the kitchen and bathroom are equipped with low flow faucets to ensure that water is conserved. Because of the limited amount of space in the kitchen, it is important that storage space is used as efficiently as possible, which is why we have selected the cabinets that we did. These cabinets fit nicely around the appliances, such as the fridge, so that storage space can be maximized. These cabinets are Kitchen Cabinet Manufacturers Association certified and meet the standards for the Environmental Stewardship Program. They were chosen for the company's dedication to sustainability, responsible forestry, and general care for the environment. The genuine craftsmanship of these cabinets is distinct and unique.

An important and vital feature to the overall design and function of STILE is the passive cooling system made possible by the solar chimney. The solar chimney is located in the central part of the house, right in the living room, and resembles a skylight. This chimney is more than skylight, however, as it works to keep the house cool without using electricity. Hot air rises in the house and is allowed to exit through the chimney. As the chimney is heated by the sun and the escaping heat, cool air from under the house flows through the vents located on the floor flows and into the house via the natural air currents created by this passive system. This system truly makes STILE unique as a house because of its use of natural, physical systems that already exist in nature. True to its roots of being a natural, minimalistic house, STILE is able to integrate fresh air from the outdoors into the living space, creating a healthier living environment for its inhabitants. This naturally ventilated air eliminates the stale air that can occur within the house, creating a more comfortable area for the homeowners.

STILE's unique design philosophy combines some of the best aspects of both Roman and Appalachian architecture. The Roman inspired arch, housing the solar panels and providing the house with power, shade, and aesthetic design, creates a distinct focal point particular to STILE. The arch is a design aspect like no other that demands attention and piques interest. The overall

coziness of the house, along with features like the wood laminate flooring, creates a familiar feeling of Appalachian design. The two designs combine into a one of a kind style. Stemming from the minimalistic design of STILE is the idea of modularity that makes the house unique. The flooring of the house is built from three recycled shipping containers, each with a subfloor on top of them. The modular roofing system, composed of insulated wood panels, allows for quick ease of construction. Keeping with the theme of the Roman steel arch, the house focuses on a steel structure to support it. This different but modern idea works to interest the target market with its natural resiliency, as steel is considerably more durable than wood. This steel structure, complete with steel wall studs as well, aids in the overall ability of the house to be easily taken down and transported if the need be. Steel is also fire resistant, which is appealing to older couples concerned about safety.

Because of STILE's focus on being integrated with nature, it was important for the house to have plenty of outdoor living space in addition to the indoor living space. The large, spacious deck is perfect for older couples who enjoy sitting outdoors to relax, entertain, or just enjoy the scenery around them. The many facets of the deck provides the homeowners with many options, such as the large, expansive arch providing shade to the deck if the weather is too hot. On the back side of the house, the large greenwall that houses dozens of plants provides the homeowners with a pleasant, natural view. This green wall is visible from the bedroom window and has the ability to house many different kinds of plants, including herbs, vegetables, and other useful and edible plants. The green wall encourages a good relationship with nature through gardening, and promotes being self sustainable. Older couples will enjoy this easier form of gardening because of the vertical, modular system. The plants are easy to maintain because of their vertical location, which is helpful to older people who may have trouble bending over for long periods of time. This green wall brings the surrounding nature even closer to the house, while still keeping with the design aesthetic of the arch and house in general. The planters located around the circumference of the deck coordinate with and reflect the wood-like appearance of the flooring inside the house. These planters allow for plenty of space for older couples to garden and customize their outdoor deck space for their enjoyment. The carport, located on the west side of the house, provides the homeowners with a secure place to keep their car and keep it in the shade. The simple but attractive carport ties together the core design elements of the arch, the green wall, and the carport itself.

STILE emphasizes ADA compliance because of the importance of accessibility for all people. The house is laid out so that there is plenty of room for wheelchairs to be comfortably navigated. The spacious deck and main living area aid in preventing any discomfort from occurring. The level of ADA compliance will provide reassurance to an aging couple because they won't have to worry about whether the house will still be suitable in the event that one of them or a visitor might need a wheelchair at some point in their life; doorways and hallways were designed to be 3 feet wide to leave room for wheelchairs. STILE was designed with the comfort and accessibility of everyone in mind, and is an optimal choice for an empty nest couple looking to downsize their living space while still maintaining the prime level of comfort.

Engineering Jury Narrative

We believe in a world where one day every building will effectively utilize the sustainable resources offered by the surrounding landscape, minimizing its environmental impact. Stemming from this concept, we've designed STILE to ensure that the complete energy needs of the house are satisfied using solar energy, thanks to the use of monocrystalline PV panels that represent the greatest performing solar technology available today.

Our team didn't stop with simply using solar energy captured by PV panels; we wanted to optimize our system for complete solar energy dependence and conservation. Our uniquely stylish solar panel array has been oriented at the optimum direction and angle for maximum light absorption and is supported by our house's overarching design. This arch functions as a multipurpose feature that is not only aesthetic and provides structural support for the PV array but also minimizes energy demands for the house by shading the house from direct sunlight exposure.

We also wanted to provide a secondary method of maintaining our house's temperature that does not depend on money or electricity. This simple system that we implemented utilizes basic thermodynamic principles in an innovative way to reduce the cooling load on our house. We are excited about this incredible system that has never been previously brought to the Solar Decathlon Competition- until now.

Total energy consumption had to be calculated considering the usage of an HVAC system, heat pump, laundry machine, television and several other electrical devices that are typical furnishings for a common house. In addition to powering the internal equipment, the contest requires that we must charge an all-electric car using the power produced by the photovoltaic panels. Thus, the energy analysis has been one of the main steps in addressing the project goals given the restrictions that are imposed by the contest's rules.

In order to estimate the total energy consumption, we had to calculate the exact amount of power used in all devices during operation while ensuring that these systems are efficiently and effectively designed. Our goal has been to choose suitable, low cost technologies, while guaranteeing comfortable conditions in the house during all seasons.

Structure

STILE features a unique steel framing system which solves many of the issues that the team anticipated facing within the competition. Steel is a medium of construction that small scale buildings typically avoid, due to the greater attention to detail and planning required to make a steel structure feasible. Our team's efforts to design and build an effective, reliable house were made possible by the competition's time frame.

A primary benefit that steel offers is the inherent rigidity of a steel framed system. While wood will break and unalign, steel can be erected multiple times without fear for the structural integrity of the material. Bolted connections do not break apart the material, but rather reinforces the overall structure.

Additionally, steel has a greater overall longevity than other framing systems. Due to the modular design of the house, STILE's frame needs to survive multiple climates, as well as the potentially rough cross-country transit from WV to California. Steel will be able to better survive a several thousand mile transit without worry of damaging the structure.

Beneficial to the competition, the time requirement to construct steel is faster than a wood structure. Whereas wood requires connection points every 16 inches with multiple screws, steel can be designed to only need a few connection points. Also, steel can span much greater distances than wood, with far fewer supports.

Mechanical

To heat our water we used the energy star rated AO Voltex Hybrid Electric water heater which is more than twice as efficient than a standard water heater. This water heater reduces water heating costs by up to 71% by pulling heat from the environment, while simultaneously cooling and dehumidifying ambient air. The Voltex water heater is equipped with four operating modes. The Efficiency Mode uses only the heat pump to heat water. Though the Hybrid mode mainly uses the heat pump, it uses the element to quickly heat water after use. Additionally, the Electric Mode uses only the electric element to heat the water, and Vacation mode keeps the water heated to 60 °F.

Another point we thought crucial for our plumbing was conserving water. STILE is equipped with a filtered greywater system, which along with rainwater collection, is used to water the plants on the deck. In addition, our house provides a drinking water purification system. This reverse osmosis filter has a semipermeable membrane that extracts particles from the water making it pure and refreshing to drink. Drinking from this filtered water removes any unpleasant tastes that are caused from chemicals and contaminants that can get into the water. This filter provides quality water that will minimize the dependence on bottled water, which can be expensive and wasteful.

As the concept of the house, modularity plays a key role in the plumbing. Indeed, the main system is installed in the core container and it is composed by a manifold water distribution and a main pipeline that brings the water from the plants room to the kitchen and bathroom. By doing so, this enables pipe connections to be mounted in WV and hold secure for California allowing for minimum work during competition time.

Electrical

For our panels our team has chosen to work with a company called Solar World. These efficient panels produce 285 watts of power during peak conditions. We engaged in a cooperative design with Tor Vergata from Rome to design of our roof, carport, and unique arch. The arch, our energy system housing, has the spacious capability to install 36 solar panels above the roof. Most solar panel arrays in America typically are mounted directly to the roof. This can cause hazardous conditions for firefighters if a fire was to ensue the house, preventing them from putting out the fire in a safe and efficient manner. Since our panels are suspended above the house on a steel structure, the firefighters will have nothing to fear and they can treat the house in a similar fashion to every other house fire they have come accustomed to. The wiring of our panels will consist of two branches of 18 panels. The two branches will be combined in a Solar Edge Inverter in which the captured solar energy will be transformed into the AC power.

The Solar Edge technology is new to the market and is quickly outpacing the old methods of DC/AC conversion. Typically, micro-inverters are attached to every panel in the array limiting the amount of panels on one string. Additionally, if one panel was to become shaded in the day the panels further down the line would suffer the same power loss that the shaded one was

subjected to. With the Solar Edge technology this is not the case. Solar Edge uses optimizers on every panel allowing for the current and voltage to vary itself in accommodation to the weather or shading of a single panel in the string. String voltage is fixed, regardless of the temperature, string length, or shading. Also, string voltage is fixed at the optimal voltage of 350Vdc at 240v for DC/AC conversion. Besides the ability to monitor the output of all the panels and receive the most power from the array, Solar Edge system also allows for longer strings which means less wiring and components, a more affordable inverter, increased design flexibility, and an app that allows the homeowner to monitor the production from the panels on a phone.

The STILE house will incorporate Z-Wave technology in the receptacles, lighting, and other appliances. One of the perks of Z-Wave is that it allows for users to wirelessly control small appliances, lighting, the temperature of the house, and the locks on doors from anywhere. This is useful because it can lead to efficiency and power saving good habits of turning things off that aren't being used. Also, Z-Wave has a corresponding app for the user's phone that allows them to access everything it controls with ease.

One of the key features included in Enel's Smart Car Charger is the smart grid integration, which lets the consumer delay recharging for off-peak hours. This is the long run will save the consumer money and put less strain on the grid. The control center provides details on energy consumption, which makes calculating the bill for energy use easy and efficient. Finally, there is remote monitoring station of the status and level at which recharging process is at, providing another level of convenience for the user.

Home Automation

With the touch of a button, our home automation system will electronically manipulate many of STILE's assets while also cutting costs on energy consumption. To accomplish this, we have created software and set several devices in place around the house. These devices include a panel, a Nest thermostat, smart sockets, smart switches, and various detectors to alert the user when something in the house has gone amiss. With these resources, we've geared our system to assist the homeowner in living a comfortable, environmentally friendly lifestyle.

One of the ways our system helps the homeowner save energy is by controlling the lights and outlets. The homeowner can set lights to turn off and on through the smartphone app. Additionally, if the owner forgets to switch the lights off when they leave home, they can remotely do so with a smartphone app.

Another energy saving feature involves using smart sockets equipped within the house. These measure energy usage of anything plugged directly into them. This will help the homeowner determine which devices are using the most electricity, to identify how to save energy.

Our HVAC system is designed from the ground up to limit energy usage. Using several temperature sensors inside and outside, our system can determine when it would be best to turn off the air conditioning and open the vents and solar chimney. We are using a Nest thermostat, which will automatically learn the homeowner's schedule and turn down the HVAC system when they aren't home.

The app also provides the homeowner with security features. We have a variety of sensors in place around the house including door and window sensors, glass break detectors, motion detectors, smoke detectors, and carbon monoxide detectors. These sensors will alert the

homeowner whenever there are irregularities around the house, such as movement when the house is supposed to be armed or smoke from a fire. All security systems can be accessed through the IQ Panel plugged into the wall and its accompanying portable IQ2 Panel, which both go through Alarm.com.

Every functionality will be able to be accessed through a custom made smartphone app. This app will be able to access Alarm.com for security. Additionally, it will be able to access the energy used by the solar panels and the car charger, and will control the HVAC system. All of these functionalities will make STILE's home automation system a useful feature for the homeowner.

Energy Analysis

We believe the projected energy behavior of a building is a fundamental parameter to measure the future impact of that building on the surrounding environment as well as its impact on the people who live inside it. This foundational concept of building design based upon the energy needs incentivized us to closely investigate the energy performance of the house, carefully choosing the materials and all technological features while paying close attention to relevant details. We want to accurately model and size our energy usage systems to ensure the most enjoyable experience for our visitors. To do so, we made an energy plan where the efficiency of the PV panels was carefully evaluated due to their role as the solitary energy provider for the household's everyday requirements.

Numerous tools and programs were employed to create simulations and run analyses on this project. Among those, our team of engineers utilized a cutting-edge energy implementation software working in direct collaboration with the building information modeling. We designed a house to perform well in multiple climate conditions, looking at Rome, Morgantown and Orange County data climates and are confident that we have been able to effectively design our system for maximum visitor comfort.

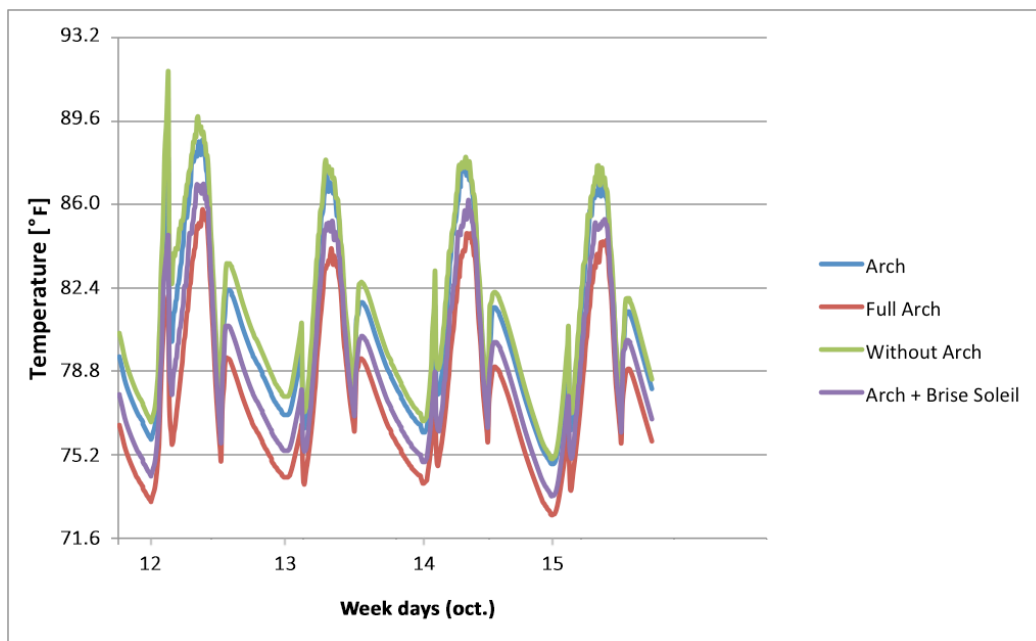
Insulation materials have been properly chosen according to the energy usage of the HVAC system to keep the indoor temperature optimal, avoiding the waste of energy not needed to heat or cool the space. The house is covered with a wall package that includes foam board insulation combined to get R-values of approximately 16 in the wall and 30 in the roof. The majority, sixty percent, of the external walls are composed of windows. While this may typically be seen as a disadvantage from an energy conservation viewpoint, our windows perform considerably more efficiently as they are designed for optimum efficiency. The structure alternates insulation layer and glass panes: from the inside we have a double glass, a low emissivity radiant barrier, a gap filled with gas and a single pane glass exterior. While the wall near the windows is able to insulate with an R-value of about 16, the windows typically represent spaces in the wall characterized by a tremendous amount of energy lost. The low emissivity radiant barrier and other insulated features in our windows are characteristics of this innovative system studied to avoid heat losses and maintain the right temperature and comfort in the house.

STILE house is made by a modular prebuilt section with open spaces and south facing glass walls. The south wall is fixed, while the west and the east walls are equipped with sliding doors. Finally, to shade all these glass walls we conceived and designed an arch which, in addition to supporting the solar panels, spans the extent of the house to block direct radiation of heat from the sun.

One of the first simulations computed was used to compare the results between a house with and without an arch. We needed to verify that it made a significant difference on the indoor temperature during a sunny day and as it is shown by the following graph, temperature in the living room is strongly influenced by blocking direct sunlight thanks to the arch above.

The green line represents the temperature variance of a normal rectangular house without the arch. It is clearly visible that it performs at a higher range of temperature compared to the other three cases. The blue one represents the case in which the arch is made of beams as support for just solar panels. The temperature range is still high because there is a lot of space between the panels and the shading is limited. Just to evaluate the difference, an extreme case is shown in red: the full arch. It means that now the arch is simulated as a solid surface and not just as beams like it is.

The living room is completely shaded, and as a result has the lowest temperature variance. At this point it is important to think about a compromise between the arch and solar panels. The two elements trap heat and create a high temperature in the house, which is not positive for the house. The solar chimney, when well heated, can work efficiently (as we will see later); with the full arch the house is totally shaded, which would not be beneficial for the solar chimney. The best compromise is shown by the violet curve, which remains in an acceptable temperature range for both our necessities, shading the house and heating the chimney. The configuration chosen is made of four arch beams as frame for the solar panels and brise-soleil, which are used as simple shading elements. An opening is then left at the top of the chimney in order to not shade it. A simulation was evaluated in a time step of 4 days, from October 12 to 15, during the competition week. These multiple benefits helped to justify our architectural and economical choice of utilizing an arch. The data collected showed that our predictions about utilizing an arch and solar chimney were correct.



Particular attention was paid to the cooling and heating system since the HVAC represents the biggest portion of the house's energy consumption. The house is comprised of two ventilation systems, one mechanical and one natural. The moisture protection and minimum air exchanges in thermal insulated buildings can be fulfilled only by controlled, mechanical ventilation. From an energy point of view, opening the windows would negate the desired heating cost. The portion of ventilation heating losses through opened windows increases to over 50 % of the total heating loss of an energy efficient building. Research proves that people living or working in inadequately ventilated buildings suffer from many ailments such as headache and allergies. Humans spend about 90 % of their life in closed buildings.

STILE house is built for people of all ages but it is particularly accessible to elders. By providing a system that guarantees healthier indoor air, free from odors and low humidity, it will ensure a higher quality of life for its inhabitants. To ensure healthy air flow throughout the house, humid stale air toxins and smells are extracted from the open space via specially designed valves that lead to the heat exchanger in the ventilation unit. The outside air takes the heat energy from the extracted air, with a tested efficiency of up to 90%. The two fluxes are hermetically separated and are cleaned through filters. Following this process the extract air is expelled as exhaust and the intake air is heated, cleaned, and led into the house as supply air.

The HVAC system we have chosen in our house is a Carrier multi-zone ductless system, made of three internal units (2 in the living room, one in the bedroom) and one external unit. In order to follow the elegant line that the whole house presents, we designed an innovative method to hide these units in the ceiling, obtaining the same comfort result through linear air diffusers installed in the ceiling of the living room and of the bedroom. A system of short pipes conducts the air to the diffusers located in the ceiling edge in the living room and close to the closet in the bedroom.

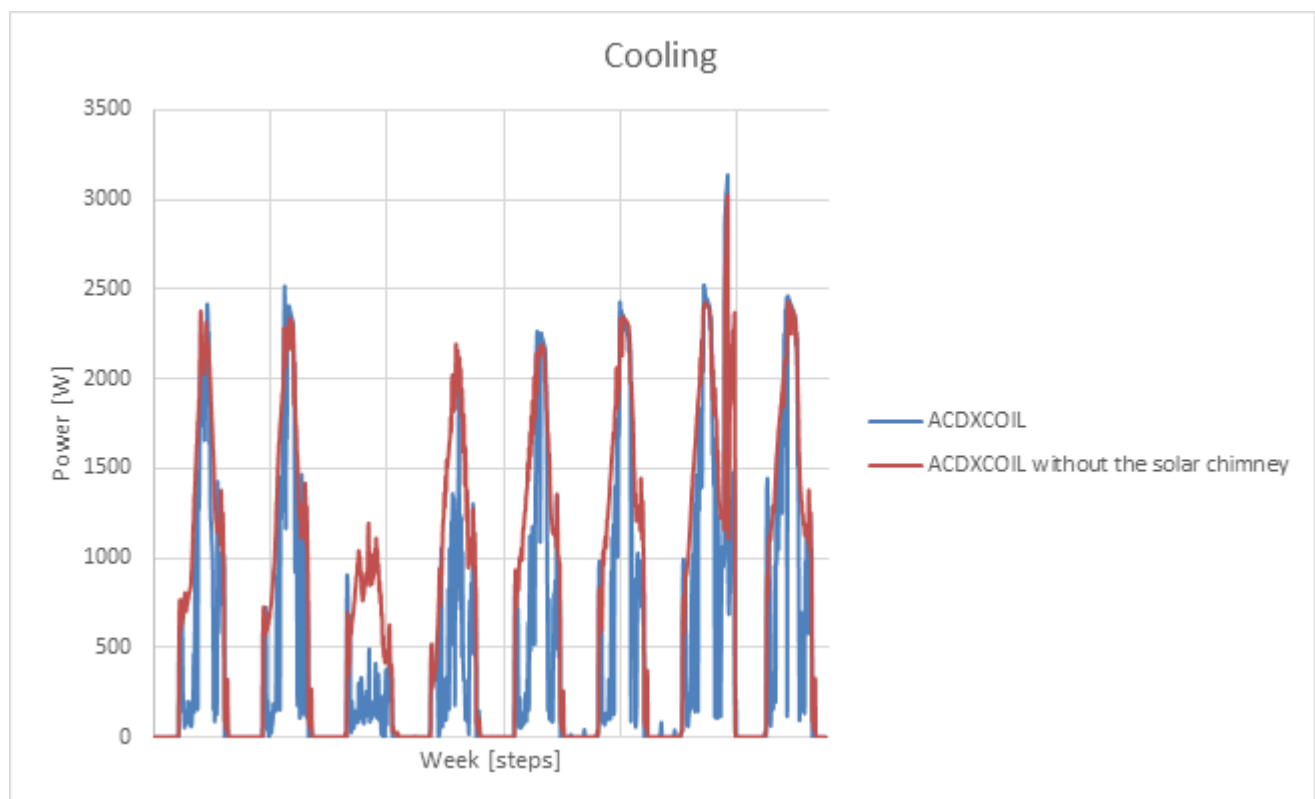
The overall result is the same in terms of HVAC efficiency and performance, but it's very efficient considering the aesthetic and architectural point of view. Every system inside the house is technologically advanced and fits perfectly with the linear and modular style of the house.

Concerning the passive cooling system, the objective in designing the living room's ventilation system was to allow the living room to have as much fresh air as possible. Our solution to allow as much fresh air as possible was to implement a solar chimney located in the ceiling of the living room as well as air vents set on the floor. Fresh air can enter the house through the air vents. Due to density differences of the fresh and warmed air, a convection is established. The hottest air goes up, drawn by the chimney that is covered with highly conductive material in order to be heated by the sun. The hotter air is sent out from the chimney and the colder air is able to remain inside the house to refresh the ambience. This is a practical method employed to cool the house during summer using the coldest air available during the night and storing it in the basement of the house. The solution we devised is more sophisticated than the traditional solar chimney, which utilizes air vents traditionally located on the bottom of the walls. We did not want to simply replicate this design, but rather created one that fits the needs of the homeowner best.

In order to catch the fresh air under the house, we decided to compose the platform of the house with beams. The beams also create channels that canalize the captured air into the vents that are located around the house. We have found pipe-less linear styled vents that are going to be installed in the living room on both the east and west side. Through these vents, air is blown

from the basement and brought inside the house. Appropriate filters are installed inside the vents and clean the air from eventual impurities. When the weather conditions allow full use of the solar chimney the vents are opened, but when the homeowner uses the HVAC, a magnetic cover is positioned on the top of each vent to close it. Closing off the vents prevents a huge loss in tempered air. In this way there is no losses through any pipes, which guarantees equal ventilation throughout the house simply using natural convection. In addition, the presence of the air under the platform creates a “pad” that enhances the global insulation of the house.

The following graph shows a simulation of the behavior of the cooling system, including the solar chimney, during the contest week. The red line, that represents the cooling without the help of natural ventilation, is higher than the blue one, this means that the use of only the air conditioning system is not energetically convenient. The blue line clearly shows the energy saving using the solar chimney, even in the hottest hours of the day.



An automation system is used to integrate both the mechanical and natural ventilation. Getting this information the system is ready to iterate possible solutions to help the homeowner decide if natural or mechanical ventilation is most effective in those specific conditions.

The main goal of the home automation system is to minimize the energy consumption in each case. For example in a particular hot summer the system never opens the vents and the chimney. In some intermediate case it could be difficult to decide which option is the most energy efficient. Indeed there are situation in which it's more comfortable and affordable to have air conditioning for a specific lapse of time than open and close continuously all the openings in

order to find the comfort, increasing the electrical consuming without reaching globally the indoor comfort desired. At the same time, if there are the right wind conditions and temperature is acceptable the system doesn't turn on the air conditioning, but instead allows the solar chimney to start working.

The home automation system integrate indoor and outdoor temperature sensors and a Nest thermostat to determine when it would be best to turn off the air conditioning , then open the vents and solar chimney using natural ventilation. The thermostat will automatically learn the homeowner's schedule and turn down the HVAC system when they are not home. In this way, our system is able to assist the homeowner in living a comfortable, environmentally friendly lifestyle.

Communications Narrative

West Virginia University (WVU) and the Università degli Studi di Roma Tor Vergata (UTV) have joined cultures, ideas, and skills to create and develop a unique architectural, cost and energy efficient home presented as STILE – sustainable technologies integrated in a learning experience. With every unique idea that has the ability to successfully change the perception and implementation of “green” technology and development, goals must be set and met. First, analyzing our audience is crucial in knowing how much they know about the project, universities, Department of Energy Solar Decathlon 2015, and energy efficient technology and living. This can be done by asking questions through media, speeches, and surveys as well as analyzing demographics of specific areas through research. Second, after collecting responses and demographic information, increasing awareness of the Department of Energy Solar Decathlon 2015 and STILE became a top priority; the reason for increasing awareness is to educate the public on ways to save resources as well as show the benefits of saving resources through the use of sustainable products in addition to catching the eye of potential sponsors. To do this, STILE’s website was created, social media platforms launched, and informational events were held. Third, is to acknowledge and address if the audience understands our message or not, and how we can make sure they understand and retain the information that they are given. This goal is met by directly asking our audience questions and seeking out conversation with the audience. Fourth, each team member is to be trained to present concepts in technical and non-technical ways; facts are to be given during each presentation, but each member is to be welcoming, approachable, and versatile as visitors tour STILE. Passion for each area of the competition, a thirst for knowledge, and love for our planet form the foundation of why we initially decided to be involved in our areas of study and the competition; each STILE team member wants that to be evident as we inform others, for that initial spark of interest is what can cause a flame of action and change in others. To successfully teach each team member how to present effectively, public speaking workshops and one-on-one lessons with professionals in the communication studies field were organized for the team. Lastly, we have a global vision. This vision includes global learning, knowledge, and cross-cultural assessment and implementation.

STILE has a large target audience that we plan to fully engage and immerse into “green” information, practices, and techniques. STILE’s target audience consists of all visitors of STILE from its building site in Morgantown, West Virginia to the competition site in Irvine, California; these visitors are the part of the audience that we hope to see become more actively involved. In addition to visitors, STILE plans to specifically grab the attention of those in West Virginia that heavily rely on coal and other non-renewable sources for energy; this is just one way we hope to change the face and practices of West Virginia and other states like it on a larger scale.

STILE’s key message is to prove to not only the rest of the country, but also to Italy, that even students from West Virginia, a state that has consistently ranked poorly on financial, educational, economic, and health levels, and other poorly ranking areas, can overcome those odds, and in collaboration with Italian students go above and beyond to create a house that surpasses all expectations. The WVU-UTV team can be seen as the pilot for a greater collaboration between the United States, specifically in West Virginia and Italy. Housing such as STILE could be the new face of West Virginia as it would increase jobs, revenue for businesses, and open up doors for international collaboration in the areas of design, business, and development. The Italians have consistently produced some of the best architecture in the world

with a variety of numerous achievements that have influenced architecture through the implementation of domes, arches, and more. Through the WVU-UTV team and solar decathlon, multiple nations are going to see a glimpse of what this collaboration could do on a bigger scale. The STILE team is competing with the aim of a much bigger goal, and we will succeed.

Reaching other professionals and companies through networking is crucial in the search and confirmation of sponsors that support the development of STILE. Networking is interacting with other professionals in order to form professional contacts that may be used throughout one's career or for the duration of a project. To be successful at networking, one must present themselves in a professional manner; this includes wearing professional or appropriate attire, having an attention-grabbing tone, being confident and genuinely engaged in each conversation. Having a welcoming attitude, upbeat personality, appropriate attire, tonal variability when delivering messages, confidence, and engaging in conversation shows others what it means to be a valuable resource with great potential. These assets are what set teams apart from ordinary teams, and the WVU-UTV team plans to show all teams, jurors, and visitors at the Department of Energy Solar Decathlon 2015 exactly what an extraordinary team is.

Through our social media platforms on Facebook, Twitter, and Instagram, we are able to engage public and sponsor involvement. Social media platforms are vital in constructing a social environment in which followers find STILE to be constantly progressing and evolving above its competitors. Through these outlets, we are able to ask and answer questions, receive input, and spread information concerning the team and house. Messages are sent across all platforms of ways that sustainability is easily integrated into everyday life, solar energy can benefit every homeowner, and students are able to be involved to prepare them for the future. Student recruitment booths are aimed to replenish innovation and excitement in STEM, design, and communication fields within the educational system as well as rebuild the team for the next competition season. Additionally, STILE team members decided to choose and design a handout that would not only be environmentally friendly, but also leave those with a lasting impression of what it means to have STILE. For this reason, seed paper was chosen as the material for the visitor handout. Spreading awareness is one of the primary goals of our project. Therefore, STILE team members have made it a point to visit local high schools in West Virginia that do not teach on energy efficiency, reusable or sustainable products, to discuss the importance and benefits of solar energy, energy efficiency, sustainable products, and the cost efficiency of it all. We believe that all ages should be involved in the exhilarating movement of "going green" to live a healthier, more energy-efficient, and cost affordable lifestyle; everyone should be able to enjoy, not use, the world and all it has to offer because it is truly a beautiful place to be. As communication efforts increase, more responses result, and the success of communicating our key message is enhanced. Communication efforts must be measured for the team to know if they are successful or not. The STILE team measures effective communication in six ways. Media relations and communication through media platforms and news outlets are measured by the usage of specific hashtags developed for STILE and overall coverage by photographers, videographers, and journalists. Events such as information booths, visitation days, and speeches are all measured by the number of attendees, usage of hashtags and coverage, but more importantly, by whether or not the target audience understands the key message, shows interest in the project, supports the project and key message, and acts upon what they have learned. We aim to see our target audience take action, and we will equip them to do so effectively.