

# Team West Virginia/Rome Final Report

WEST VIRGINIA UNIVERSITY AND UNIVERSITY OF ROME TOR VERGATA

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## Fundraising Efforts

Team West Virginia/Rome's fundraising efforts were a result of the dedication and commitment of the team's combined outreach efforts. While the fundraising efforts for a project of this capacity are strenuous, we were able to build on relationships built from the previous competition entry. Most of the sponsors that continued their support with us were consulting with design and construction. Using this as a standpoint, we raised the raising money needed through monetary and in-kind donations. Based on the commitment from the universities, college, and department, along with the DOE sponsorship, we had approximately \$327,000 in monetary budget. We also had a donation of \$50,000 for our project. Our in-kind donations totaled approximately \$260,000. Total cash spent equaled \$360,483.

One of the biggest advantages for the team was having two home bases, meaning fundraising locally in Rome, Italy and Morgantown, WV. While some items were easier to have donated in-kind in one university's location, the focus of the other university would be getting different materials for the house. At first, the challenge was identifying the consistency of what the benefits would be given at each level of donation. Once this was identified, we were able to communicate to companies how to proceed with donations.

Each level of donation was detailed in a donor packet that included project design, media coverage of the competition, and benefits from the university. Our strategy to use the packet to contact possible sponsors was highly effective. Another similar strategy was working directly with the university to reach potential donors through events that showed the impact of the project on the universities, students, and communities. Attending conferences such as the TransTech Energy Conference helped us acquire donations from local facilities. Future teams should consider direct involvement in conferences and workshops around the area would help fundraise more money and in-kind donations from the connections made.

Another strategy for fundraising was to focus more on consulting and in-kind donations when connecting with companies. This allowed for more recognition for the company to display their systems in the house, while promoting their products through social media, website, and t-shirts. Although this method started out strong, during construction time we were held back by sponsors that lacked the ability to follow through with their commitment. Leading to potentially harmful situations.

While the university monetary commitment was given in May of 2015, identifying the rest of the fundraising goals was still unclear. Having the overall budget did not help us understand how to allot the total amount for each section of the house, this was in part due to the design materials not being completely decided on during construction time. Consequently, we were unable to have the major items sponsors in time for construction.

Overall, our biggest disadvantage was starting to contact sponsors late in the design and construction phases. Unfortunately, most companies were unable to dedicate any in-kind or monetary donations to us at a short notice in comparison to their fiscal year. Although sympathetic to our cause, each company could not provide the help we needed.

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## Media Outreach Activities

When pairing passion with dedication and education, the result is nothing less than effective. The West Virginia/Rome Team 2015 not only had the goal of successfully constructing STILE (Sustainable Technologies Integrated in a Learning Experience), but also to engage and educate the community of which surrounded our team to improve the environment for healthier living. Therefore, outreach strategies and activities were implemented in Morgantown, West Virginia, Rome, Italy, and lastly Irvine, California.

The West Virginia/Rome outreach strategies were created to educate the public about the U.S. Department of Energy Solar Decathlon program and STILE, but more importantly overall, ways to live more sustainable and energy efficient. A variety of outreach activities were organized; these activities consisted of local school visitations, OCE's (Out of Class Experiences), organizational, web-based, and "restaurant night" fundraisers, media platform usage (Instagram, Twitter, Facebook), website implementation, WVU VIP media events, information booths, and so on. Each of these strategies were crucial in spreading awareness about sustainability and cost and energy efficiency. Through these strategies and activities, the team was able to reach individuals locally and globally in addition to entire companies such as Askeen, ZMM Architects and Engineers, and ISM through personal informational visitations and demonstrations to the companies. The West Virginia/Rome team implemented a numerous amount of media-outreach activities in hopes of reaching as many people as possible. Participants/viewers were measured in three ways.

The first way participants/viewers were measured was by the total number of viewers recorded by the websites and posts much like that of Facebook. In addition, because of the six hour time difference between Rome and Morgantown and additional three hours from California, our team had to determine the peak time to disseminate information via the internet. As a result of analyzing the numbers of viewers from all three areas of posts that were posted at various times during the day throughout the week, the results concluded that the most people visited our platforms between the hours of 9:00 A.M. and 2:00 P.M. EST (USA). Second, participation was measured by the number of "likes", shares, and usage of at least one of the team's three hashtags by viewers. Third, pertaining to the activities such as media events, information booths, and assemblies, participation was measured by number of attendees and strongly influenced by the number of questions asked by those intrigued and interested in our topics. In conclusion, as a result of the West Virginia/Rome Solar Decathlon 2015 Team's efforts, many articles were written in local newspapers, interviews held, and featured on others' blogs and social media platforms, reaching even more people than anticipated; this is reflected in the number of online Department of Energy fan favorite votes STILE received during the competition. With passion, dedication, and extensive research, we were able to effectively educate others, bringing us the greater lesson that hard work can literally change the world. We were happy to see our efforts acknowledged and taken in by our communities, sparking a greater interest in those around us to live "green" and help aid in saving our world.

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## Results of On-site Exhibition Activities

Our on-site exhibit activities revolved around our tours to the public. For the team, we set it up as tour shifts, meaning every student had a half day. While in the competition in 2013, we learned that full day tours did not work because of exhaustion. Earlier in the summer, we developed a plan for what and how to communicate during tours. Our communications team created a workshop that allowed us to understand what to expect during tours. Thus, we planned accordingly. Packets were made that detailed the talking points for each station. Also, since this was our second competition entry, we had the advantage of knowing the frequently asked questions. As a team we prepared the answers to each of those questions and were able to stay consistent throughout the tour days.

Two types of tours were developed to accommodate for busy and slow days. Our long tours were guided and allowed us to show the impact of the project since each student showed their knowledge of all the concepts and technical aspects of the house. For our short tours, students were stationed at each turning point in the tour. The disadvantages of this was that the tours lacked direction sometimes, especially when there were more visitors. Some tended to not wait for the group ahead of them to finish, or if the tour guide was busy answering questions they would walk away. The advantage of our short tours was that visitors could hear from different voices on the team. Especially since our team was diverse with WVU, UTV, engineering, architecture, and communications students all in the same tour.

For our sponsor visits, we had the ability to walk them through a full tour and showcase their in-kind donations. Our decking area had the space available to allow for pictures. A big feature for us was giving interviews on our deck which showed the house design and project environment. Tours for our university officials were similar. Throughout the public exhibit weeks we estimated about 1000 visitors on each Thursday and Friday, and 1500 visitors on each Saturday and Sunday. Altogether we showcased the house to approximately 10,000 visitors of all ages.

Parts of the tour included our signage which allowed the visitors to read in-depth descriptions of the house concepts. The signage was also taken highly by the Tellus team, who will display our house at their museum in Georgia digitally. Similarly, the signage allowed for visitors to walk through the house without a guided tour and still understand all the concepts behind the house design, both during slow and busy times. Having one ramp was not helpful in the overall tour day, at first it created confusion for the visitors but after realizing the issue we solved it by addressing the issue in the beginning of the tour. The greeter would let the visitors know this is where they could start the tour and exit when they are done.

Although the jury did not think the handout communicated the home's message, we chose the handout for our target audience visiting the Solar Decathlon. Not only did the handout portray the fundamental message of the project by providing the homeowner ways to save energy while promoting sustainability because it would be planted for the environment, but it was enjoyable by all ages especially middle and elementary school students. This was proven by the visitors who reacted with shock and excitement when they were told the paper was seed-able and would turn into flowers. Frequently, visitors would return to our site to ask for several handouts to take home.

On site activities also included social media posts with updates, pictures, and sponsor recognition that helped us win the fan favorite vote. It was beneficial to be active on social media because it helped us represent our universities across the country and the world.

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## Evaluation of Team Website

The WVU Solar Decathlon 2015 website was well-designed, but had a few flaws. In some places, the white text did not have a sharp enough contrast with the pictures in the background, making it hard to read. Throughout the rest of the site, the text was slightly too light, making it potentially difficult to read on some screens. Additionally, the website did not scale well to small screens, such as smartphones and tablets, and resulted in some text and images being cut off. Another major problem was that the website did not include a link to the website from 2013. Finally, part of the website relied on the Unity browser extension, which is not installed in web browsers by default, meaning that visitors had to download and install the plugin if they wanted to view that part of the site.

Despite these flaws, the website was very aesthetically pleasing and informative. It included detailed descriptions of the competition and the team's house, including diagrams of the floor plan and numerous digital renderings. There was even an interactive 3d walkthrough, which allowed visitors to the site to get a real idea of the feel of the house. The site also included information about every member of the team. Perhaps most importantly, the entire website was available in both English and Italian, highlighting the multicultural nature of our team. Throughout the course of the competition, our website received several thousand visits, a large portion of which were from Italy.

In hindsight, there are a few things we would have done differently. First off, we would have designed the website from the beginning to scale well to smartphones. Next, we would have made sure that all of the text on the site had proper contrast with its background. Finally, we would have added a link to our website from the previous competition.

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## **Team Perspective on Organizer's Communication**

Throughout the two year project, the organizer's communication efforts were well appreciated. The necessary documents were given through the Yahoo group database in a timely manner. While Yahoo groups are uncommon at our universities, it's evident that this database was used for many reasons. It allowed all files to be uploaded without issues concerning storage space. During the competition period in California, it provided us with a database of contact information for all the organizers who were needed for questions and inspections.

Our competition manager provided updates, reminders, and detailed explanations through email which allowed us to effectively complete the deliverables. While he did send the emails to the yahoo group, we set up a connection between the yahoo accounts to our mailing list account. This enabled us to receive these updates directly.

Another aspect of communication with the organizers was the Design Development Workshop that was held one year into the competition. As a team we benefited not only from surveying our construction site, but also from speaking directly with the organizers about our specific projects. The commentary on our design and project was taken into consideration and improved upon. Our team's biggest gain from the workshop was experiencing the competition environment, as well as strengthened our communication and outreach efforts. Working with the organizers through our outreach expectations we gained an understanding of how to communicate our project to our community, and how to address common questions about the negative aspects of the project (i.e. cost of project).

Although we did receive feedback on some of our construction documentation and project manual, we felt underprepared when the construction phase began. Since we are a student project, a more helpful method of communicating the expectation of construction would have been a conference call with our team and the organizers. During the summer of 2015 we had a similar call with Richard King, Joe, and Sara to discuss the project as a whole. A conference call focused on construction would be beneficial in ensuring the site is in preparation, the materials have been ordered, etc.

Coming to California, we were cautious in our expectations for inspections. While we did understand what the inspectors would be looking at, we were unsure of what they were looking for. However, most of our questions were addressed during the site inspection webinar. Another confusing factor was the timeline during contest week. Specifically, the times available for each team to host open houses. The Event Schedule Summary provided to us was exactly what our management and university were looking for to plan accordingly.

Overall, the communication efforts to the public expressed the Solar Decathlon message very precisely, and helped each team showcase their advantages to the public. The re-done solar decathlon website presented new graphics and interactive data for the public to view our contests measurements. While the contests were happening, the website continually updated its features.

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## **Future Plan of House**

After Solar Decathlon 2015, STILE will travel to the Tellus Science Museum in Georgia. There, STILE will be put on exhibit to introduce museum visitors to sustainable sciences and modern movements in sustainable design. The Tellus Science Museum is a museum dedicated to educating the public about geological, mechanical, and sustainable sciences. The exhibit will showcase the innovative architecture, mechanical systems, and energy efficiency technologies found in the house.

In order to rebuild STILE in its permanent location, a few students will travel to aid in the building and consultation of the home. We believe that Tellus Science Museum is the perfect resting place for STILE For years to come. The entire purpose of the US Department of Energy Solar Decathlon is to educate the public; and what better way to educate countless people for years and years than to have the home in a museum where the goal is also to educate the public. Our hopes are that while at Tellus Science Museum, STILE will become a beacon of knowledge and inquisitive thinking for the general public, educating them about the implications of solar energy as well as inspire the youth to live more sustainable and renewable lives.

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## **Suggested Competition Improvements**

Throughout the two years, the competition contests are the focal point of the project. The newest contest was a new experience for our team. Coming from West Virginia and Italy, it is uncommon to see all electric cars in the area. Although driving the electric cars was enjoyable for the team members, an improvement for the contest would be to have a set destination, or a reason for driving the car. Since the competition focuses on sustainability, a productive use of the 25 mile drive each day would be a success.

One of the most important contests is Energy Balance. The two goals of this contest are to produce more power than consumed, and also to consume less than 300kW. Our team did not succeed in consuming less than 300 kW due to an accident during public exhibit when the HVAC was turned on during a non-competition time. A concept to consider would be to limit the power consumed based on a ratio of the size of the house. This would allow all teams to adapt their house to the actual usage of power a homeowner would use.

For the contests that are not measured, they are juried by a selected committee. This committee is given the construction drawings, project manual, audiovisual presentation, and 20 minutes on site with the team. The extent of the project extends beyond a 20 minute walkthrough that teams could benefit to present to the jury firsthand. Having a longer period of time with the jury will allow for more design concepts to be exhibited thoroughly.

In terms of communication efforts, there are clear rules defining the handout and the visibility of sponsors around the house during public exhibit. While this is an understandable assessment of visibility for the Solar Decathlon sponsors, we believe having a space available for our team's sponsors would help bond ties with them for future competitions. In 2013 the innovation tent allowed us to have a space to showcase our sponsor brochures, and the innovation tent would be an extreme benefit for the 2017 competition.

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## Information for Future Teams

### Successes and Failures in Design Phase

The aesthetic design of STILE is unique and beautiful. The roman inspired arch sets the house apart from all others. The curvilinear element adds a gentle form to the rigid monolithic structure of the house beneath. It also creates shade for half of the house and deck. The floor plan was laid out well to emphasize mixed-use living spaces. The core isolates the private rooms of the house and creates a distinct separation between the public and private areas of the house. Since the deck is twice the size of the interior area, it creates large areas for entertainment and emphasizes outside living. The green wall was located right beside the kitchen to allow for fresh produce and spices to be used during cooking; this is another way the house emphasized healthy living. All these elements work together to make a unique and simple house.

The engineering that is in this house is functional and well put together. The main emphasis of this house is the structural engineering that went into the arch. A large steel sub frame had to be designed to hold the weight of the arch. Computer engineering is another main form of engineering in the house. There is a comprehensive home automation installed in STILE to remotely control the lights and monitor energy consumption from all outlets; there also can be schedules set for lights to come on and go off. All this can be displayed on a smartphone or on the main hub in the house. Electrical engineering plays a large role in the house. The use of optimizers instead of micro inverters helps the house create the excess energy during the daytime. These optimizers recognize when a panel is not operating at full capacity so it makes other panels operate more to make up for the panel that is not working. The optimizers allow for one current to be used throughout the array. The house has one inverter to convert the current instead of many small inverters. This increases electrical efficiency by negating the loss involved during conversion. The house's HVAC system is an advanced system that allows for 3 distinct climate zones that can be changed by thermostat. All the appliances are Energy Star compliant to increase energy savings.

STILE is supposed to appeal to a two-person family that is looking to downsize after their children move out, hence the one bedroom. However, very few amenities and design choices were focused on that market. The kitchen was too small to cook anything substantial without having to use the dining room table as counter space. The bedroom did not contain much space for movement and was not private due to the large window. The hallway was very narrow and did not create a comforting flow in the house. The ceilings were very low which made the house feel much smaller than it actually was. The amount of usable wall space that had to be sacrificed for the windows was not justifiable for how little the windows offered to the functionality. Sustainability in building materials was not considered; the siding of the house was fiber reinforced plastic which is not good for the environment after its useful life. During the design of the house, there were some systems that were overlooked. A few examples include the steel structure in the house interfered with the HVAC system and the electrical system interfered with fire suppression. These conflicts were not resolved and had to be worked around when the time came to install the systems.

The team learned a lot about how a house should be designed to incorporate all systems into a harmonic form instead of everything being designed separately and pieced together. This project taught us the importance of truly designing and collaborating with everyone involved in the process during the planning phases. Having a task force that works as a team is necessary to this project especially when students are doing all the designing. The need for the engineering team and architecture team to work

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very closely was not emphasized in the design process of STILE; and the lack of a cohesive design proves this. Maximizing square footage was another lesson learned in this project. STILE did not make use of every available space. It was meant to be a scaled down villa. In this process of scaling down elements like storage space and clever tricks to make rooms feel more open did not get implemented despite the glass walls attempt. These issues can be easily rectified and improved for future designs in future projects and each individual's career.

### **Successes and Failures during Construction Phase**

During the construction phases of STILE we learned a lot about what it takes to build a house from the ground up. Taking a house from paper to reality can present you with many problems, hardships and successes. These problems can be addressed and fixed in the coming competition. Also, the successes we must improve upon and strive to better.

The problems that we encountered throughout the construction consisted of too many Lowes trips, lack of multiple-similar tools, lack of people with desired expertise at certain times, too many/too few people on site at one time, lack of donated materials at essential times, and miscommunication between team departments.

To elaborate on each of these construction problems I will start with the excessive amount Lowes trips. This is due to a lack of communication and fore thought. We are human and building a house for the first time has shown us that sitting down and brainstorming all the type and quantity of materials could prove to be more useful and time efficient. Also, having a budget for every trip requires more consideration of what materials are more time essential. I would recommend a person devoted to the materials planning and purchasing before the projects construction phase has begun.

The lack of multiple similar tools is also a huge bottleneck in the construction department. For example if one person is installing walls with a drill and another person needs the drill to build roof sections. There is always someone elsewhere on the site requiring a tool that someone else is using. This then requires you to leave the area you are working to go and find the tool that you require. Also, this tool that you need might not be in use or in the box that is designated for the tool furthermore you waste more time looking for the misplaced tool. The tools need to be returned if they are not being used. One main purchase of power tools at the beginning of a project is recommended so that you do not end up making excess trips to Lowes to get more tools. In the beginning of the project a set size screw tip needs to be determined and only buy that kind. For example if you are using T25 tips you need to stay with that tip and not buy anything that is T20 this will save on costs and time switching bit tips in and out. Also, if power tools are bought at different times this gives room for someone to buy a power tool with a different type of battery like the 18V and 20V drills. This causes more chaos when trying to keep drills charged and limits the interchangeability of the batteries and devices. Finally the batteries need to be charged every night so that the morning shift does not have a lack of power tools.

Each department of student working on the project need to be aware of what each other department is doing. This awareness allows you to think ahead so that you are not faced with a bottleneck of where one team needs to put the walls up but the plumbing or electrical is not behind the wall. This needs to be set on a firm schedule that needs to be followed so that each team does not fall behind because of one underestimation of time for the set task. Also, if a task such as running electric or plumbing needs to be done a member from each corresponding teams should be present so that if any interference arises the problem can be solved on the spot without hesitation or waiting for a solution from an off site member.

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Nights and days can be long so it is important that people stick to their assigned schedules. If there is a conflict please notify the person in charge of the schedule at a minimum of 3 days before the conflict. If there are too few people on site this can lead to a bottleneck for the next shift of students. If there are too many people on site, there will always be work to do but the problem will arise with the physical tools to get the job done. A set number of people on site need to be determined so that there is no conflict with one another. After this set number of people is determined, this will then decide how many drills, saws, measuring tapes, and etc., need to be purchased.

Students need to be more on top of contacting their donors. Meaning that there needs to be a reliable way of contact such as meeting them in person, phone calls, and consistent emails. The latter two presented problems this year as phone calls were not answered nor returned and emails were not returned. If you can have face-to-face communication with a donor it is strongly recommended. This way it is more personable and the donor can relate with you and your cause. We had sponsors not get back to us and this caused us to make more trips to Lowes to buy the materials that we previously thought was donated. Also, when dealing with a donor make sure that when you submit a donation list it is complete with more than enough materials than you will require. You do not want to go back to them two-three times asking for more materials. This is unprofessional and makes you look like you do not know what you are doing.

Communications between the different teams on the solar decathlon needs to be smooth and fluid. There cannot be stubborn people that are unwilling to change their design. This is a multi department competition that requires you to work with your colleagues not argue. Sometimes there may be a simpler or easier solution that someone came up with. Don't argue just analyze the new design with an open mind and come to a reasonable conclusion. Time needs to be used efficiently for example if something is already done, it is not a priority to go back and fix it. The priority should be to continue with the construction and if there is time at the end to go back and fix it. As mentioned in a previous paragraph the communication and awareness of what each group is doing needs to be airtight. You don't have to understand all of what is going on in each group but a basic understanding is essential. To improve this I would recommend during construction a meeting between leads to elaborate on progress or lack thereof, made in the project that week.

Finally, we had many successes during the project with a few expected mistakes due to the fact that it was many students first construction experience. These consisted of bringing every component of the house together to build a fully functioning house, organization, shift schedules, deadlines met, following safety guidelines, making new friends, gaining knowledge of the construction aspect related to your major, and working with international colleagues that spoke small amounts of English.

Working with different types of departments can be frustrating but it is a real world application and skill. To gain experience with this will help us all in the future. We were able to work with all different types of engineers and architects so that we could put together all the small interworking of a house. This consists of making sure that none of the piping or ventilation interferes with the electrical or architectural aspects of the house. As a team we did this well and worked together to make sure that all the components came together under pressure and finish the project.

We made containers and organized all the material very well. We also documented all materials purchased and donated. This was very helpful when trying to figure out if the material was already purchased or donated. Then the material was placed into the storage-shipping container in areas but sometimes material would spill into another section. I would recommend sectioning out and labeling with

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duct tape different areas for each type of material. This will help to eliminate wasting time looking for different components. Constructing boxes and tables was a great idea and is a necessity for the start of every project. One size bit tip and screws needs to be a priority. Also excess tips need to be bought as they are easily misplaced and lost.

The shift schedules were well planned out and most of the time people showed up for their shifts. People did work overtime so that we could meet deadlines. This should be avoided because then it causes grogginess and a diminished work speed for the next day. This was not a problem during construction but future decathletes need to be aware that this may happen. You just need to tough it out because you will be able to sleep when it's done!

Overall, we all made new friends with colleagues from other departments and this is a great way to make future contacts with not only companies but with your peers. Everyone in the solar decathlon was very nice and accepting. You all have a common goal and this brings you together no matter what the diversity. It also gave the decathletes experience collaborating with international students. This is a very useful skill to get exposed to another culture and how they work. It also allows you to find ways to work through a language barrier better your communication skills.

Most importantly during the construction of the house we all were exposed to the fieldwork of our respective major. We will most likely be in an office for our careers but this fieldwork may come in handy when we apply to jobs in which there is hands on work to be done. The senior engineers will most likely not want to go out into the field and test something when they have a fresh new college graduate employee that can go and relay the information that they need for the calculations. Also, this helped with the design phase due to the fact that now we know how it looks on paper and then take it to the application.

Looking back on the project after its completion I am glad that I've had an experience such as this. It has taught me more than I have ever learned in a classroom. Things that I learned on the Solar Decathlon will follow me for the rest of my life and has shaped me to be an ever harder worker than when I started.

### **Successes and Failures in Management**

Team WV/Rome was a unique competitor in the 2015 competition because of the union between West Virginia University and University of Rome Tor Vergata. WVU brought mostly engineering students as well as representatives from communications, landscape architecture, interior design and business throughout the project. All of WVU's students were unexperienced, undergraduate students searching for real-world experience that could help them find a future career as well as make new friends and discover their passion along the way. The students from UTV were graduate architecture students as well as a few engineering students, some of which had some experience. They were looking to experience a cross-cultural international competition. Because of the diversity within the team as well as the efficiency and organization of a large group of changing people, a management hierarchy was developed in the beginning of the competition. This hierarchy had many positives and negatives to the team, the house, and the overall competition.

One of the best things about the management structure was the ability to divide tasks. Each task throughout the duration of the project was divided among the team so that internal teams were able to focus on specific parts of the competition. It also allowed tasks to be completed efficiently and create experts on certain aspects of the house. As the competition became closer, it was very beneficial to have

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experts because the project lead and project manager always knew who would have an answer to a question whether it was regarding the design, build or sponsorship of a system in the house.

This same division also caused issues within the team. Many members of the team became very specialized and no longer knew the overall design of the house. Each of the internal teams had a lead that became the point-of-contact for the project lead however, even these internal teams' leads did not know the overall house design as well as they could have given that "lead meetings" were held periodically to ensure that everybody was kept up-to-date on changes.

The hierarchy developed created a strong management group set to have a strong ability to communicate to every member of the team. The people in management roles knew exactly what each team member's specialty was and how to utilize each member's strengths to help improve the design of the house. Each strength helped the team to work together to help each team member develop skills and experience. As the students gained a deeper passion for innovative technology and solar energy, it was evident that they became more interested and devoted towards making STILE the best it could be.

Since many of the WVU students were engineering students and the UTV students were architecture students, the internal teams with their leads created an unnecessary divide between the two schools' students. The hierarchy allowed a group of architecture students from Italy to work side-by-side with a group of engineering students from the United States rather than blend the groups together. This division exposed a deep cultural divide and created unnecessary arguments that were difficult to compromise.

Despite all the benefits, the hierarchy was very structured and limited team members' ability to learn the most about the project. The vertical hierarchy segregated the internal teams and somewhat limited the collaboration between students of different universities, different cultures, different majors, and even different skill levels. The vertical hierarchy assumed that people would constantly be speaking to the people both below and above them passing knowledge along. In an ideal situation, this strategy would work but, since the team members were all students, their ability to meet regularly was limited due to other commitments. A more horizontal structure allowing students to collaborate with everybody regardless of specialty, major, language, or culture would have benefited the entire team.

Overall, Team WV/Rome had a great hierarchy that allowed the team to remain organized and complete the tasks efficiently. However, one of most affected aspect of the team was the communication and collaboration internally. The team could have improved this by designing the internal teams differently. Because of the divide created by separating people by their skills, people could have been separated by specific contests such as market appeal. Creating a group specifically for market appeal would incorporate people from many different backgrounds to accomplish a common goal. They would still communicate with people within their major but would maintain communication with people within their team as well. This would likely have worked better with a team so unique to improve the collaboration between everybody.

## Advice for Future Teams

There are many areas of the Solar Decathlon where future teams could use some advice. The first topic would be choosing the right leaders for each team and the project. When choosing a leader think about their availability and devotion to the project. Choose someone that will work to help the project and turn deliverables in on time. When choosing a project manager, think about who is organized and trustworthy. Another thing that might be hard is choosing a leader that will be participating throughout

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the whole project and not leaving midway through. Trying to catch a leader up on the project can be a waste of time and a lot of backtracking through the project. A new leader leads to different ideas and changes to the design and project. Changes to the design can be detrimental to the project and cause extra work. Keep the changes to a minimum especially towards the end of the design process.

Another key to the success of this project is communication between the different teams and leads. Our team this year worked with another school in a different country, so communication was a big part of our project. Without communication in our project, deliverables wouldn't be turned in on time and design problems wouldn't be solved. One thing that helped with communication was meetings at least once a week. The lack of communication can also lead to mistakes in the project. Make sure communications is one of your top priorities. Communication between each team and the leads is especially needed. In our project we ran into a lot of things being changed and only a few people knew. When changes are made, everyone on the teams should be notified. A decision made by one team can greatly changes the plans of another team. This is another reason why changes should be kept to a minimum.

Scheduling is another huge topic that future teams need to know about. Scheduling is required for deliverable and construction time. As for the deliverables, make sure everyone on the team knows the due date. Also it is up the project manager to let each team and members know the when there part of the deliverable is due to get ready to turn in. Once every team turns their part of the deliverables in, the parts need to be combined to send in. Make sure you give everyone enough time to complete their parts and send reminders out. This seemed to work for our team really well for all of our deliverables were turned in on time. When it comes time to construction, scheduling is very important to get things done. Our team lacked this when it came time to build.

During construction, divide the work up into two shifts and let those people know. Also on site post up a work schedule of all the different jobs that need to be accomplished that day and week. The jobs should be divided amongst the students and emailed to each student on the team. This will eliminate standing around and wasting time on the construction site. Also elect a safety person for each shift to observe as everyone is working and fix safety violations. Our team was caught violating our safety plans a lot during construction. Scheduling is also important when it comes to competition time. Each student need to be notified well in advanced to when they work during competitions.

The final topic is expectations and assumptions throughout the project. When designing your house don't expect everything to go exactly as you planned it. Things will change and it's up to you as a team member to work with your team and solve the problem. Also never assume a company is just taking a long time to accomplish your task, follow up on them, people forget. This can lead to faster responses you need to move on in the project. When it comes time to construct, don't think everything will go smooth with no problem. As you move along in construction process things will change, what looks good on paper, doesn't always work when building. Though things don't go as expected, try not to cause any conflicts because of it. Conflicts can slow your progress in the project down and waste time. Remember this is a learning experience, learn from your mistakes, and don't take it out on everyone else. This is a great opportunity, just have fun and enjoy working with your teammates.

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