Communicating Solar Energy & Energy Saving Materials in the Home: Public Relations Design and Educational Tools for Solar Decathlon China 2013

An Interactive Qualifying Project Report

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By:

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Abstract

Although innovations in sustainable energy technologies are developed every day, fossil fuels continue to be the leading sources of power worldwide, especially in the residential sector. The U.S. Department of Energy wants to break misperceptions that industry and homeowners have about solar energy—mainly that it is comparatively too expensive and impractical as an alternative to fossil fuels. The DOE therefore created the Solar Decathlon--a competition that challenges college teams to design, build and operate life-size, net-zero energy solar houses on a budget. Worcester Polytechnic Institute, in concert with Ghent University and New York University-Polytechnic, has entered Solar Decathlon China 2013 as team BEMANY. Participating as the communications consultants on the team, I and my partner researched and developed content for promotional materials used in the competition. This IQP summarizes the research deliverables and reflects on the important lessons we learned about facilitating communications in a large-scale complex project.

Acknowledgements

Several faculty members, students and community members influenced our work and helped this IQP reach its full potential. We would like to thank our project advisors Prof. El-Korchi and Prof. Higgins for their interest; their guidance kept us on track from the earliest to the final stage of the project. Their positive attitude motivated us and proved why WPI is chosen as the best college for faculty-student relations. Receiving immediate feedback and observing how dedicated they were to the project have maximized our learning experience.

Prof. Van Dessel and team BEMANY created Solatrium from scratch, which helped us immensely by taking the time to explain every single detail of the house and the project. The sponsors of our team made our house become a reality. Without them none of the experiences BEMANY students have gained could be possible.

We would also like to thank the WPI Marketing Department for welcoming us to their world and teaching us a great deal of communication strategies. Without their valuable work, our project goals could never be reached.

We would like to acknowledge every person who has assisted us with our IQP in whatever way they were able to. This project was team work, and we wholeheartedly believe that the results can be helpful for our environment.

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Introduction

Depletion of Non-Renewable Energy Resources

The fast depletion of non-renewable energy resources, namely fossil fuels, is a global concern. Fossil fuels are non-renewable resources although it is quiet certain that they will be renewed in the next millions of years, which is too far a date to shape our environmental plans for. Fossil fuels constitute 81% of the energy currently used on Earth even though it is fairly common knowledge that these energy resources are going to last for only two generations at best, as stated in the World Energy Outlook (International Energy Agency, 2012). Fossil fuels pose environmental hazards as well. They have caused a 29% increase in carbon dioxide emissions since year 2000, a study conducted by the University of East Anglia suggests (2009).

Although the methods of producing alternative energy are exponentially improving and progressing, they are still very far from closing this future gap between our resources and the predicted energy consumption needs. Therefore, publicizing and educating people on the subject are necessary to change the way people think about producing and using energy.

The Failure to Use Green Technologies: Why Do Few Homeowners Use Them?

Many environmental technologies exist today that could reduce the amount of fossil fuels used in maintaining a comfortable household. U.S. households consume nearly a third of all energy produced in the U.S. As in many other countries, government policies are aimed at encouraging the public to implement these technologies in their homes (Chiu, 2012). The sticking point often comes at implementation (Sterns, 1992).

It has been documented that people do not have a good understanding of where they are spending the most on energy. This has not been helped by the some of the environmental educational attempts that focus on superficial savings such as turning out the lights when they are not in use (*ibid*.). In Lanzhou city, China, lighting accounts for 1.42% of the total energy consumption whereas 67.14% of energy is consumed by heating and refrigeration (Niu, 2010). If heating and refrigeration are not viewed as places where energy can easily be saved, technologies to save energies within those areas will not be used. Proper environmental

education should inform homeowners of the most beneficial applications of green technologies.

Without financial incentives, the public has no reason to implement green technologies. Energy conservation is not a sufficient reason for many people (Chiu, 2012). A financial incentive can be the proper motivation to implement costly technologies (Sterns, 1992). Many financials incentives have already been put in place by politicians, but a problem can be a lack of public awareness (Chiu, 2012). The financial benefits stemming from the conservation of home energy consumption are a murky incentive. Environmental Psychologists Gardner and Sterns remind us that energy savings can vary drastically from case to case and the most specific information about energy efficient technology often comes from the manufacturer. They have found that such information lacks credibility with the general public (1996, p.91). Financial incentives don't automatically result in increases in home energy efficiency; lack of credible knowledge can prevent homeowners from implementing green technologies.

Many of the initial decisions about household energy efficiency are made by construction companies. They decide on the appliances, the furnace and the amount of insulation with which to outfit a new house. They have no reason to put energy efficiency in front of their own profits. Constructing energy efficient homes is profitable when people know the benefits. These benefits are outlined in an energy audit. These audits reassure buyers that the home is energy efficient and that they will save money on operating costs. In turn, they will be willing to pay more for the house. With this energy audit, construction companies would have a monetary incentive to build energy efficient homes (Sterns, 1992). Home audits are credible because they are specific to a house and they are independent of the construction industry (Gardner & Sterns, 1996, p.91).

Solar Decathlon: A Challenge to Educate the Community

Net-zero energy houses use various techniques to save, produce and store electrical energy to be fully self-sufficient. Solar energy is the most commonly used means of producing energy for such homes, due to its convenience and easier implementation in comparison with other types of green energy producing systems like wind power, biofuels and geothermal

energy. Aside from producing electrical energy, net-zero energy houses in general use features such as superior insulation, passive lighting and efficient HVAC technologies. If all the households in the U.S. chose to switch their insufficient energy systems to net-zero, the fossil fuel consumption would decrease by 40%, as data from the U.S. Department of Energy suggests (2006).

One way to underline the benefits of zero-energy technologies for the home is to challenge young minds to excel in that area and to showcase the feasibility of living spaces built with these technologies. With that motivation, the U.S. Department of Energy created the Solar Decathlon Competition to communicate the importance of clean energy solutions for building. This program challenges approximately 20 university teams of students to design, build, operate and showcase solar-powered, zero-energy houses. After each team builds its own house on the competition site, they give public tours and hand out brochures to promote green energy and their design for at least two weeks. The competition plays its role by educating students and the public about monetary and environmental benefits of green products. It shows that green buildings and appliances can be comfortable and affordable along with training and encouraging students to engage in green designs.

In 2012, Solar Decathlon announced an additional competition to be held in China after the U.S. and China governments signed a memorandum of understanding. According to SD website, the memorandum states that the Governments of the United States of America and the People's Republic of China have a common goal in fostering sustainable economic and social development while encouraging the use of renewable energy sources and recognize that solar energy development and use is an important part of their collaboration. Worcester Polytechnic Institute, along with Polytechnic Institute of New York University and Ghent University from Belgium applied together as Team BEMANY to take part in the competition. Their entry was accepted and they started working on the project in early 2012. Their entry will be judged not only on architectural and engineering related areas, but also on the communication aspects to promote their entry and on market appeal qualities to persuade others of the house's value.

SD Communications as an IQP

My partner, Rebecca Cooper and I participated in this project as part of our IQPs, what WPI defines on its website as "a requirement that challenges students to address a problem that lies at the intersection of science or technology with social issues and human needs" (Interactive Qualifying Project, 2010). Therefore, as a part of the WPI learning experience, we worked as a two-student group with guidance of our advisors to support team BEMANY in its ultimate pursuit of promoting solar energy globally. We divided the work and wrote separate reports to reflect our contributions and different timelines.

In this IQP, we developed communications materials for the team's entry. We created a blog to provide updates to our audience about important current progress, which will be integrated into the team's website. Our other tasks included designing Solatrium's on-site signage and the house tour plan, making a brochure for visitors, and producing the Project Summary. This IQP report supported us in designing deliverables and having a thorough understanding of the project. Doing research on blogging and brochure making enabled us to learn about and produce successful communication materials. The report also required us to obtain crucial data about the project from the student and faculty team members, which is essential in order to communicate with the audience correctly. Figure 1 presents our tasks.

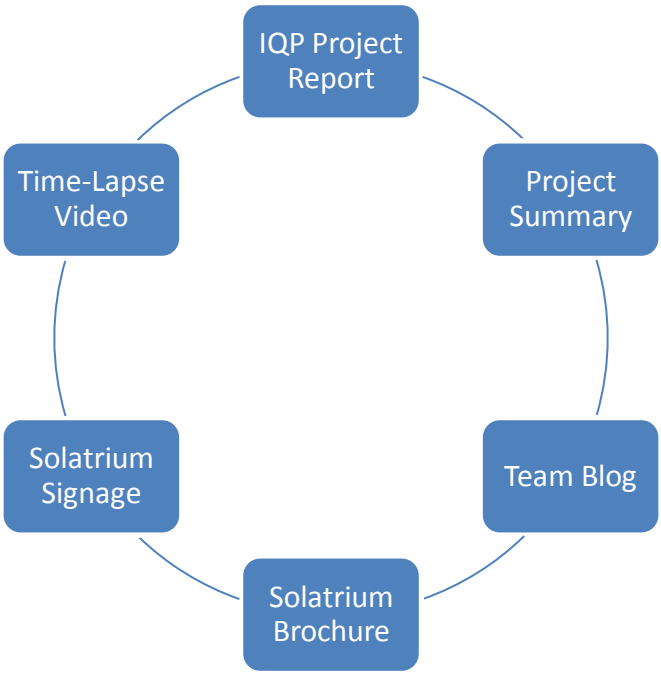

Figure 1: SD China Communications Deliverables for the IQP

These deliverables promote sustainability and our report helped us critically analyze the challenge of promoting green energy more efficiently.

Background

Solar Decathlon's History

The first U.S. Department of Energy Solar Decathlon was held in the U.S. in 2002 and now is held biennially. Solar Decathlon Europe followed in 2010, and this year, 2013, the first Solar Decathlon China is going to be held in the city of Datong. The competition is judged on ten factors, giving it the name "decathlon": architecture, market appeal, engineering, communications, affordability, comfort zone test, hot water test, appliances, home entertainment, and lastly, energy balance.

According to the official website of the competition, the project has "established a worldwide reputation as a successful educational program and workforce development opportunity for thousands of students." Having involved 112 collegiate teams, 17,000 participants and over a million solar-house visits to date, Solar Decathlon's impact is evidently enormous (About Solar Decathlon, 2013).

WPI, in concert with New York Polytechnic University and University of Gent submitted an entry to SD U.S. and SD China for the 2013 summer competitions and consequently was invited along with 21 other teams to SD China. The team's name, "BEMANY", stands for Belgium, Massachusetts and New York. Faculty and students have been working on the design and project planning for over a year. As a fruit of this hard work, the Solatrium house was designed and scheduled for building in early 2013. The name was chosen to emphasize the atrium feature of the house. Our goal is to capture the vision of energy balance embodied in the house designed by the students and faculty of WPI, NY Poly, and UGent; and to communicate this vision and promote the team's house to both the viewing public and to the Communications jury of Solar Decathlon China.

Solatrium House Features

The team designed two different net-zero energy houses for SD U.S. and SD China under Prof. Van Dessel's leadership in 2011. The 120-square-meter atrium house was chosen for BEMANY's entry into SD China 2013 in early 2012. It is a two-bedroom house with a bathroom, a small kitchen, a dining room and a living room with an atrium at the center. It is shaped like a

square, which was the inspiration for the team's logo design. The name, Solatrium, combines *the sun* and *atrium*, which stresses the passive lighting feature as well as highlighting solar power.

The following feature descriptions were based on research on the construction material and interviews with the project faculty and students.

Atrium

An Atrium is a large, open space located within a structure. It is a traditional house feature since it gives the buildings a more spacious feeling, and provides ventilation and light. It provides open space in the private environment of home, a rare occasion in highly populated areas. The human population is approximately seven billion in the world as stated by the World Bank (2011).

Solatrium adopted this feature by having an atrium in the middle of its square shape, topped with an elevated roof that has acrylic glass encased in steel trussing along the four sides as can be seen in Figure 2. The roof windows will help providing the optimum passive heating abilities through sun rays. Since the roof is not entirely covered with windows, but rather has them on a 45-degree angle along its sides, the house will not overheat during very hot days.

Figure 2: Solatrium's Exterior Rendering

Photo-Voltaic Cells

There are 40 donated solar panels, all of them to be installed on the roof. There is also an extended portion of the roof which can be seen in Figure 3. This extension will be used as a car port and will provide more roof space that provides more room for the solar panels.

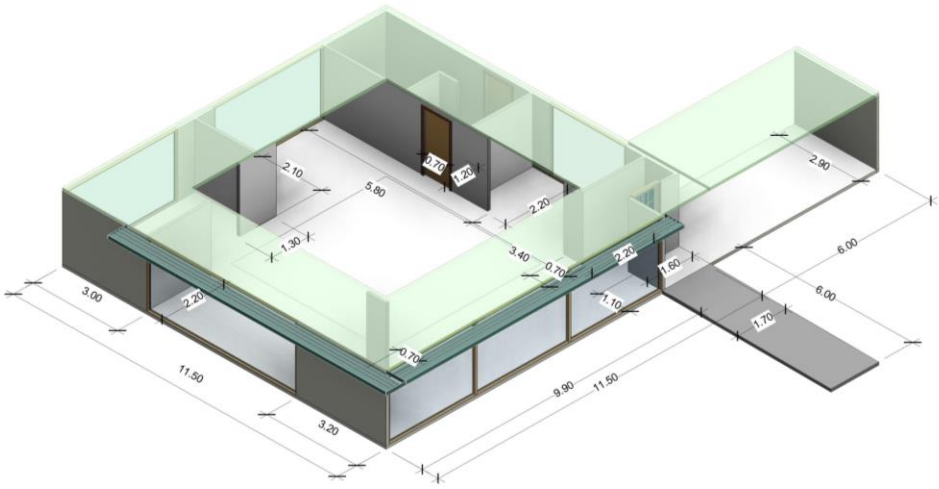

Figure 3: Solatrium 3-D Model

Panels are rated by their direct current (DC) output power; each of Solatrium's panels is 300 watts, producing a total of 12 kilo-watt energy system. This process is made possible by the wafer-based crystalline silicon solar cells that generate electrical current through the photovoltaic effect. In Solatrium, this current is fed directly into the competition grid.

Another advantage to having solar panels is the shading factor on the roof. Since very direct sunlight can be unbearable in warm climates during the summer, light-absorbing and shading panels will definitely be welcome. Each panel is expected to last approximately 20 years and they are made from inorganic materials. Although this can be seen as a disadvantage, the material can be recycled as semiconductors, which are a great necessity in making electronics.

FRP Sandwich Panels & FRP Beams

Solatrium features fiber-reinforce plastic (FRP) panels to be used as interior and exterior walls, and FRP beams to function as structural members. The lightweight panels provide a high R-value while saving from construction materials as opposed to the ways of building a traditional structure façade that would include framing, sheathing, insulation, vapor retarder and air barrier. Figure 4 shows the cross-section of the FRP panel and the more typical stick construction façades.

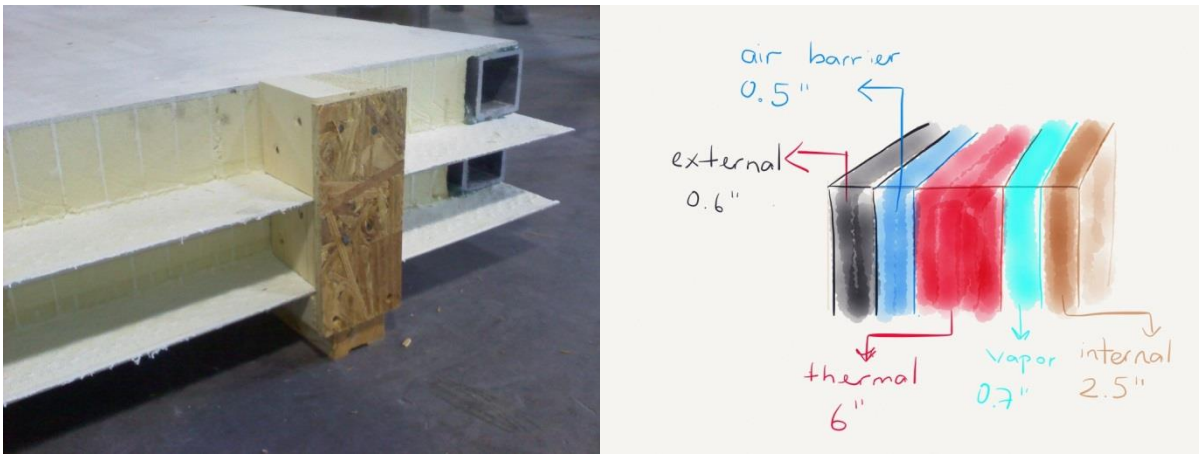

Figure 4: FRP vs. Conventional Facade Cross Sections

One challenge team BEMANY had to overcome when using the FRP materials was fire safety. The material has failed to pass the test conducted by the WPI Fire Protection Engineering Department, which can be seen in Figure 5. The problem has been solved by using intumescent coating on all surfaces for sufficient fire resistibility.

Figure 5: FRP Panels Fire Test

Phase Changing Material (PCM) Incorporated Concrete Tiles

Concrete tiles incorporating PCMs were produced by the NYU-Poly part of the team. They are a unique and very important feature of the Solatrium. The concrete absorbs and gives off heat by a simple principle. Since the melting point of the PCMs in Solatrium's tiles is 24-28 °C, when they absorb heat during the day and go above that degree interval, they will melt. They will need the heat energy to break bonds between their molecules and during this endothermic process the house will cool down. Just the opposite happens during the cooler times of the day. As the temperature drops below 24 °C, the PCMs condense and this exothermic bonding reaction gives off heat and warms up the house.

Split HVAC System

The heating-ventilation-and-air conditioning (HVAC) system in Solatrium consists of three separate heat pumps. Two of these pumps are 9,000 BTU and are located in each

bedroom area and the last member, a 1,200 BTU unit, is installed in the living room zone. The point of using more than one central heat pump system is to prevent the energy waste that occurs in longer ducts. Another advantage to using this method is its quietness.

Bamboo Walls and Ledges

Bamboo is considered a grass that has high durability and structural soundness. It grows more easily and faster than any lumber used for decorative purposes. Solatrium features two interior walls of this material, as well as bamboo ledges surrounding the double paned windows and the roof trussing. These shelf-like units provide shading, while the bamboo laminate walls add to the interior aesthetics of the house.

Dual Pane, Low-Emissivity Glass Windows

Solatrium's floor-to-ceiling windows constitute approximately 50% of the house's façade. Therefore heat insulation properties of their glass are extremely important. Having that in mind, the designers have chosen to use a double-paned glass system. This system is formed by using two glasses with vacuum as an insulator in between. Another feature of the windows is the low-emissivity material glazing, which is applied on their surface as a thin film. This glazing provides deflection of ultra-violet and infra-red radiations. In cold climates, the film is applied to the interior surface to reflect the heat back inside; in warmer climates it is applied to the exterior surface so that the heat will be deflected out of the home. A visual can be seen in Figure 7 below.

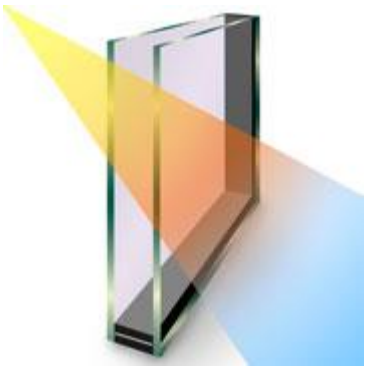

Figure 6: Dual Pane Window Illustration

The windows that are encased in the steel trussing on the atrium roof are made of plexiglass, which is a form of acrylic. These windows provide passive lighting and heating for Solatrium.

SD China Communication Deliverables

The Communication Contest comprises one tenth of the total possible score in the Solar Decathlon. It is one of five juried contests. We are working in concert with the WPI Division of Marketing and Communications (DOMAC) to deliver Communications deliverables for Solar Decathlon China 2013. Given their expertise and skill at graphics and the technical aspects of this challenge we will be guided by their knowledge and experience. There are several deliverables required under the 'Communications' section of the competition: the web site, the public exhibit materials, the public presentation, the video walkthrough, and the project summary (SDChina 2013 Rules, p.21). Of these deliverables the project summary is not a judged part of the Communications contest but it is a deliverable that was due during our IQP (SDChina 2013 Deliverables).

Much of the communications contest is focused on communicating the ideals and concepts behind the houses to the public. The requirements are that the deliverables be understandable and engage audiences with the messages and practices of SD China 2013 (SDChina 2013 Rules, p.21). Juried Solar Decathlon China 2013 contests are scored on a scale of 100 where 61-80 points indicate that the deliverable merely equals the contest criteria. A score over 90 indicates that the deliverable has eclipsed the requirements (SDChina 2013 Rules, p.33).

The Website refers to the official webpage of team BEMANY, located at http://solatriumhouse.org. It is the primary source of information regarding the BEMANY house. It was released online well before the competition and will continue to be online after SD China 2013 is over. In addition to being understandable and engaging, the SD officials indicated the website should be easy to use and aesthetically pleasing (SDChina 2013 Rules, p.21). Due to the technical and graphical nature of designing a website, this deliverable will

mainly be the domain of DOMAC, but we contributed information to them. The exception was the blog, for which Gonul provided weekly content as a part of this IQP.

There are two Communications deliverables used to communicate with the public during the exhibition of Solatrium. These are the public exhibit materials and the public exhibit presentation. The site of SD China 2013 is open for two weeks, during which each team will be expected to provide tours of their house and educate the public on the importance and benefits of sustainable technology. The presentation involves entertaining and interesting the public in Solatrium; BEMANY will be judged in the public exhibit presentation on how well we are prepared to entertain and educate the visitors. Entry into the house will be limited to the start of the guided tour; as a result lines will form outside of each solar house. The duration of the tour will depend on the number of people waiting for a tour outside the house. The Communications Jury will be given both a long and a short tour of the house to experience both possibilities (SDChina 2013 rules).

There are four required content areas within the public exhibit materials: the handout, signage, plan drawing of team site, and team uniform design (SDChina 2013 Rules, p.47). The handout is a single object (brochure) that we will be giving out to the visitors that come through Solatrium (SDChina 2013 Rules, p.15). The signage refers to signs and informational displays that will be present around the house (SDChina 2013 Rules, p.15). The signs are meant to supplement information given on the tour and in the team handout along with entertaining the visitors waiting in line (SDChina 2013 Rules, p.15). Among the signage must also be a scale drawing of the plan of the team site that includes the tour route and the location of the public exhibit materials (SDChina 2013 Rules, p.47). The team uniform must be worn by any member of the team that is the SD China Campus (SDChina 2013 rules, p.16).

The final requirement of the Communications Contest is a Video Walkthrough that will be posted to the SD China 2013 Website (SDChina 2013 Rules, p.45). The Video Walkthrough is a simple 3-3.5 minute video that shows a walkthrough of Solatrium (SDChina 2013 Rules, p.45). It will have audio narration which should not require the visuals to promote a clear understanding of Solatrium (SDChina 2013 Rules, p.45). The video be accompanied by a text

version of the audio track (SDChina 2013 Rules, p.45). The Video Walkthrough will educate the public about the solar house and provide an explanation of the design philosophy behind it (SDChina 2013 Rules, p.45). The brochure, website, signs, and other materials were translated into Mandarin by Yunqiu Sun, a WPI student majoring in Chemical Engineering and Writing.

The Project Summary is not a Communications Contest criteria but it is a Communications Deliverable. It is a maximum of five pages and includes a narrative, a team photograph and a team logo. The narrative requires a hundred-word description of the house as well as the unique features and technological innovations. The narrative should include information on team BEMANY, a description of the Team BEMANY 'personality' and design philosophy. We were required write about the team organization and the future plans for the house that we have entered in SD China 2013. The team photograph is meant to convey the team's personality through an original photograph that includes as many team members as possible. As part of the initial website, a logo for Team BEMANY had already been produced by DOMAC (SDChina 2013 Rules, p.46), based on several students' design ideas.

The Blog

One of our IQP deliverables, the blog of the Solatrium project, is a very important part of the plan since it is a great way of giving the audience extensive updates on the project on an online, global platform. A blog is defined by the leading blogging website WordPress as a "website that maintains an ongoing chronicle of information" (Introduction to Blogging, n.d.). We planned to use this tool to attract people to the idea of living in smart houses, regularly updating the site with content relating to our project, our team, benefits of using solar energy and other creative content. We planned to update the blog at least once a week with the content gathered continuously from the team. Our advisors planned to support us by reviewing and confirming each post to prevent possible mistakes that could have negative consequences.

Rebecca Blood (2000), a famous web blogger, defines *blog* as a portmanteau of the term weblog, "an informational site published on World Wide Web and consisting of various entries in reverse chronological order." A blog can basically be about any topic or different topics together, provided that it is regularly updated. Blood explains that the blog as we know it

appeared in early 90's and gained acceleration in its growth ever since. Its foundations were built with web site features such as "What's New" sections and virtual "corkboards" used for running conversations on the web (Blood, 2000).

As Mallory Jensen, the author of "A Brief History of Weblogs", mentions in her article, blogs used to be located in separate websites. As blogging became popular, different websites such as Tumblr, WordPress and Blogspot gathered most of the bloggers on their platform and created pools of blogs in their structure. This made blogging reachable by everyone who was familiar with the computer basics and no more coding was required to maintain a simple blog. (Jensen, 2008)

Among different types of blogs are personal blogs, micro blogs, organizational blogs, and reverse blogs. Personal blogs are the closest to the "blog's roots since they are designed to be an ongoing diary being edited by an individual." Microblogging is another version of personal blog keeping, such as via Facebook, Tumblr and Twitter. Our blog fits neither the organizational blog nor the personal blog description exactly. It lies somewhere in between since its content includes mostly the personal and team experiences inside a competition group.

Our blog has two main goals: promoting/showcasing the Solatrium and educating people on using sustainable energy. The topics in our blog would be chosen accordingly. The introduction would introduce the house and our team and make our way to the future contents of the blog to define our purpose.

According to Heather Wright-Porto (2011), a computer information systems specialist, in order to maintain an out-of-the-box and appealing blog, the following key points must be followed:

- Using a conversational tone: Successful blogs are often informal and relaxed.
- Staying focused: Keeping each post concentrated on one specific topic, date or event prevents the writing from being disorganized and keeps the reading time to a minimum.
- Using keywords: Including keywords in the post content increases the chances of an internet surfer who is potentially interested in the area to find the relevant information.

For our purposes, keywords such as “green technology, net-zero energy, home and solar energy” will be often used.

- Checking grammar: Posts with grammar mistakes can often be interpreted as if the author put in less work than he should have. Therefore it is important to check the possible glitches with computer software that has a built in grammar-checking function such as Microsoft Word.
- Visual richness: Quality footage such as photographs and videos are a great way to engage the audience.
- Being on time: Updating the blog at the promised time periods is considered key to maintain the already acquired audience.
- Finding your own voice: Using one’s own style is deemed to be critical; therefore keeping an inconsistent blog may result in a decreased number of readers.
- Being empathetic: Putting yourself in the shoes of the site visitors helps the writing to be more affective.
- Proofreading: Although the posts can be edited after they have been published, clearing all the mistakes before making it go live proves to be a better process.

  (Wright-Porto, 2011)

“Blogging Heroes,” by a New York Times bestselling author Michael Banks, is a book which consists of interviews with 30 of the best bloggers –according to their popularity in the related areas. The common verdict they give is that to lead a popular blog requires a platform where the author is genuinely interested in the subject. We aim to follow this rule on the WordPress platform, which has the largest blogging community to date with approximately 65 million sites as the live activity tracker suggests (WordPress Sites in the World, 2013).

The Brochure & Signs

This section was completed by Rebecca Cooper in her IQP, 2013, and will be accessible at the end of E term.

Methods

In our IQP, we used a plethora of ways to acquire knowledge on every subject about the project. These paths included internet research, attending meetings with team members, professionals from the WPI Marketing Department and other project supporters; working in the warehouse where Solatrium was being built and deconstructed; conducting library research on blog posting and brochure making; doing on-site research such as attending exhibitions to gather information on the brochure and signage techniques; recording photographic and videographic footage to use on the blog; and last but not least, conducting interviews.

We investigated the relevant academic literature on a variety of topics. Much of our research was performed through the Summon search engine of WPI's Gordon Library. Gordon Library Research assistants helped analyze topic to select appropriate search terms. After using relevant keywords to find applicable articles and books we would trace the sources cited in the Bibliographies to expand our literature base. When those sources were not available on Summon, Google Scholar was used as a supplemental engine.

The literature review provided sufficient academic knowledge, but for practical material on Solatrium and team BEMANY we found it necessary to interview team members who possessed relevant information. We conducted both formal and informal interviews with various team experts to compile a clear picture. During the more formal interviews we would record or transcribe the exact information given to us. In less formal interviews we would seek more general ideas about Solatrium or team BEMANY for a broad understanding of the topic. Table 1 in the following provides detailed information.

Person Interviewed	Topics	Interviewer
Prof. Van Dessel	Technical and competition details	All
Prof. El Korchi	Technical details	All
Greg Freeman	Structural details and his involvement in the project. His perspective of working on his MQP with partners across the sea.	Rebecca
Christian Lecorps	Initial electrical details of	Rebecca

	Solatrium.	
Thomas Tassignon	Structural details and his involvement in the project. Video also available.	Gonul
Tim Van Parys	Structural details and his involvement in the project. Video also available.	Gonul
Charlot Tanghe	Structural details and her involvement in the project. Video also available.	Gonul
Tina Lanssens	Structural details and her involvement in the project. Video also available.	Gonul
Melody Wang	Student perspective of the project.	All
Prof. Rosenstock	Consultation for time-lapse process and camera.	Gonul
ATC Department Specialist David Botelho	Consultation for time-lapse process and camera.	Gonul

Table 1: Interview Details

Both IQP partners visited the warehouse frequently, using their spring breaks to finish up the necessary work. During these visits, we had a chance to ask casual questions about all the technical details we wanted to learn more about. Rebecca cut materials with a chainsaw, and we both helped install the bolts and connections. We also did a lot of cleaning. These visits were also a good opportunity to observe the team dynamics. Rebecca measured the discussed signage sizes in the warehouse.

On Wednesday, April 3rd Rebecca visited the Ecotarium to observe their use of signs. The Ecotarium is a science and nature museum, with much of its material aimed at children and families. The Ecotarium uses a large variety of different sign types to present its informational material. Many of the signs are interactive and can engage whole families in learning. She explored the museum and photographed the exhibits. Rebecca observed both her own interest and reactions to exhibits and the reactions of other visitors.

Rebecca traveled to Northern Show's Central Mass Home & Garden Show at the Central Mass Expo Center in Fitchburg, Massachusetts on April 7th, 2013 to experience an exhibition

and take inspiration from the previous work in the field. It is a relatively small show with around 60 booths. She selected a variety of brochures from companies that sold products or services related to Solatrium. Short to mid-length handouts and brochures were selected because they were more analogous to the intended purpose of the SD China Handout. She analyzed the brochures that she collected and paid special attention to the clarity of their message. More detailed conclusions on this subject will be available in Rebecca's report.

Table 2 below shows our planned approach toward our deliverables.

	Approach/Source	Due Dates	Person Responsible
Project Summary	• Interviews with faculty and students • Meetings with IQP advisors, team members, and the Marketing Department • Research on SD China rules • Warehouse visits	3/22 SD China due date: 3/29	Gonul & Rebecca
Brochure	• Library and web research • SD China rules research • Interviews with faculty and students • Meetings with IQP advisors, team members, and the Marketing Department • Warehouse visits • Home and Garden Show • Project Summary	Research due date: 2/20 SD China dues date: 5/07	Gonul & Rebecca
Signs	• Library and web research • SD China rules research • Interviews with faculty and students • Meetings with IQP advisors, team members, and the Marketing Department • Warehouse visits • Ecotarium visit • Project Summary	Research due date: 4/12 SD China dues date: 5/07	Gonul & Rebecca
5 Main Blog Posts	• Library research on successful blogs • Web research on blogging's	Due every week	Gonul

	history and descriptions • Interviews with faculty, students and Mr. Picardi • Meetings with IQP advisors, team members, and the Marketing Department • Time-Lapse Video • Project Summary		
IQP Report	• Research details can be found in the Table of Authorship. • Rules • Interviews • Meetings • Warehouse visits • Project Summary • Handout • Signs • Blogs	First draft due: 4/25 Final draft due: 4/30	Gonul & Rebecca

Table 2: Deliverable Due Dates and Methods

Results

Blog Posts

As one of the communications deliverables for SD China, the team website is intended to be used as a crucial interaction tool to enable the community to get to know our team and the Solatrium. Initially, designing and coding the website was going to be the main topic for this IQP since Kevin Hufnagle, a WPI Computer Science major who planned the site and drafted some initial content, had to resign from the project due to health reasons. However towards the end of December 2012, it was decided that the website designing professionals from the WPI Marketing Department should take over his work. Meetings were conducted with the department to determine the structure of the website content, using Kevin's initial ideas. I attended all these meetings and provided creative website examples of top designers. In February 2013, the team website was published under the domain "solatriumhouse.org". The Marketing Department also built the foundation for a blog platform on this website, released in late March 2013. As soon as this feature became accessible and I familiarized myself with using WordPress, I started creating and editing content for the blog posts. Each of the posts that have been published to date is explained in detail in the following sections:

Solatrium Comes to Life

The first blog post set a tone for the future posts. We aimed to introduce Team BEMANY and the Solatrium, as well as explain how the blog would operate from then on. The previous research on keeping a successful blog suggested concision, informality and genuineness. The post titled "Solatrium Comes to Life" was created and sent to our advisors for a critique. Following the approval of the final draft of the post, the appropriate photographs were inserted. This blog post (see Appendix A) received a positive comment a week after it was published.

Team BEMANY Presents the Time-Lapse Video

During 2012 B term, the IQP meetings with the advisors consisted mostly of brainstorming creative ideas that could be added to the website, the brochure, and other platforms to promote Solatrium. One of those ideas was to shoot a documentary video that

would show the entire building process of the house. This required a special video shooting technique called "time-lapse." Not being familiar with this practice, I met with several technological departments of WPI that could support the shoot and several professors from the arts department who were helpful in introducing the process. As a conclusion of all the discussions, we decided to place a Brino TLC200 camera that takes a picture every 5 minutes in the warehouse where it would record the building process from an elevated angle. This procedure began as soon as the materials came in and continued until the FRP sandwich panels blocked the rest of the view. Footage from the two and a half months, when there was no activity in the warehouse, was edited out. After the Marketing Department provided the edited version, a text was written to introduce the video. I and my partner contributed ideas for content. A screenshot of the video is available in the Appendix for further inspection. From the eyes of the blog audience, this video post would be enlightening since it clearly shows that a net-zero energy house can really be built in a limited amount of time as four months.

Spotlight: Guess Who?

After introducing Solatrium in the blog, to start presenting the BEMANY members was a necessity. However, according to the previous research on blogging, introducing the entire team in only one post was not ideal since it would be too lengthy. Therefore Gonul divided the members into already formed groups (such as the structural engineers, architectural/design engineers, the communications members and etc.). All these groups would be presented one by one gradually. For the first post the structural team was chosen since the individual photos were available from the photo shoot conducted in B term. A survey was designed and sent out to all students to get a glimpse of their entire experience and their thoughts on the project so far, which can be found in Figure 12: "BEMANY Student Survey Screenshot" under the Appendix. The responses have been used to introduce the structural team and are stored to be used for future blog posts.

"Spotlight: Guess Who?" starts with a riddle related to the subject. The entire point of doing so was to make it interesting for the audience and more creative for the SD China Jury's approval. After familiarizing the audience with what structural engineering is, the post mentions each student's journey and plans. In the end of the text, the FRP sandwich panels are

introduced more in depth combining it as the favorite house feature of the team. The entire post and a screenshot can be found in the Appendix A.

Solatrium Visits Open House, 2013

WPI open house day under the Closer Look program was a great opportunity for team BEMANY to present the Solatrium to public for the first time. The visitors engaged in our presentation gave positive feedback and assured us that WPI was standing out from most of the civil and architectural college programs thanks to its involvement in the Solar Decathlon. The highlight of the day was a cake shaped like a 3-dimensional model of Solatrium. Such a unique promotion feature would have to be included in a blog post. A more important reason for preparing a post on this event was to show our blog audience that we have started educating the public on solar energy issues already before China. The post is available in Appendix A.

What Can You Do to Save the Earth?

Since we decided to launch a blog and were looking for the most relevant and interesting topics to include, the idea of carrying out an interview with homeowners who were using solar panels remained one of the most crucial. Such an interview could in fact help people understand how feasible it was to go green and even save money by doing so. With the support of Prof. Higgins, I was able to interview Mr. Jim Picardi, who is a Massachusetts homeowner gone green. The questions were mostly concentrated on the installing process and the financial realities. An important conclusion from the interview was that monetary incentive is definitely required for enough homeowners to install sustainable energy technologies. That is the reason this blog post, which can be found in Appendix A, features the financial facts very openly and aims to break the misperceptions of PV panel installation that present it as too costly.

Guest Blog Post Editing

The blog belongs to all the team members, therefore the more people contributing is the better for the audience's perspective. Taoning Wang, a junior WPI student majoring in Architectural Engineering, has written an article to reflect on his experience in the project as the student

project manager. I edited the writing for grammar issues and sent a copy to Prof. Higgins. The post can be found in Appendix A.

Providing Press Coverage Links

After the website went live and the promotions started, Solatrium received much attention from especially WPI and Worcester public. *Telegram & Gazette*, Worcester's most reputable newspaper, came to the warehouse to interview the crew. Rebecca also provided them information and *T & G* issued an article on Solatrium and team BEMANY. Another public coverage was from *Worcester Magazine*, who visited the house during the sponsors' event on April 22nd. Also, WPI's online information resource, The *Daily Herd*, posted an article mentioning the artist Eduardo Navarro, who graduated from WPI in 1981. As Prof. El-Korchi's friend, Mr. Navarro wanted to make a glass horse sculpture for Solatrium. Unfortunately, he shared the same adversary as Kevin and had a health issue during the process. Therefore he had to retire from the task.

Since our project had coverage in press, we dedicated a blog post (see Appendix A) to these articles. That way any visitor who is curious about the Solatrium and clicks on our blog can find this information in one place.

Project Summary

As a separate deliverable required, but not judged by the Solar Decathlon Communications Jury, the Project Summary is intended to be used as a guide to Solatrium's features. The summary will be used during the competition for the organizers to promote our house and provide feedback about accordance with the codes. Therefore it is supposed to provide the maximum amount of relevant information about Solatrium and the team in a limited amount of words. The specific information we needed to provide include a 100-word description of Solatrium to be used for promotions, design philosophy, design features, technological innovations, market appeal, team philosophy, and team structure. Each of the topics required extensive research, which was achieved mostly interviews with team members.

Sending many questions by email to the members associated with the specific topics, and most of the times not being able to get an answer, changed our initial way of researching;

we therefore tried to ask our questions as soon as we could contact the person face to face. That also helped us to receive immediate answers on the follow-up questions we had. I drafted the text for design features, technological innovations, team structure and a 100-word description of the Solatrium, while Rebecca drafted the future plans as well as team and design philosophy. After putting each piece together, we sent the paper to our advisors for review. After obtaining feedback from the Marketing Department and a final, edited version from IQP advisors, the file was submitted through the FTP drive for SD China Jury's inspection. Three weeks after the submission, the judges got back to us by stating that our paper was in accordance with the rules. The Project Summary can be found in Appendix B.

Brochure

As a deliverable requirement of the SD China Communications Jury, the team brochure is intended to be used as the main educational instrument along with signage during the house tours of the competition. As a visual communication feature, the brochure needed to convey appealing aesthetics, a thorough yet concise introduction text to Solatrium and team BEMANY; and other factors to convince the tourists to keep the brochure after their visit. This particular deliverable necessitated regular consultation with the Marketing Department to ensure that the design and the texts would be in accordance with each other. Another point that needed attention was to think of the brochure and the signage as elements that would complete each other, which would help in tightening the text for the brochure to make it visually more appealing. Yunqiu Sun, a Chemistry Engineering & Writing double major from WPI, translated the text into Mandarin, Chinese for her MQP. She won the Professional Writing MQP Award 2013 with this project.

The Project Summary was used as a guide for the brochure text. Therefore the information on technological and design features was written mostly by me, while the content about the team and the future plans for Solatrium were provided by Rebecca. After correcting some of the house features that changed and after multiple edits, the brochure text in Appendix C was submitted to the Marketing Department design professionals to meet the May due date.

Signage

Another deliverable by the SD China competition, the outdoor signage, is planned to engage the on-site crowd in the house touring queue; the indoor signage is required for directing people in Solatrium for a self-guided tour. After discussions about how many signs to include on which topic and how to place them, five large outdoor signs and seven smaller indoor signs were decided on for production.

Outdoor Signs

Aiming to appeal the waiting crowd in the carport of the house, the outdoor signs have to visually attract while informing the visitors about Solatrium. Therefore, the most innovative design and technological feature were agreed on: the FRP panels, PCM concrete tiles, double-paned and glazed windows, PV panels, an informative solar energy quiz, and general Solatrium design features. All of the signs except the quiz required an illustration of the innovative materials. Therefore the Marketing Department had us contact a freelance artist to convey our ideas and cross-sections of the said materials. After asking questions and doing web research on these sign topics, Rebecca and I sketched visuals for the four signs so that the Marketing would be able to communicate with the artist better. Relevant text was generated to support the visuals, which is accessible in Appendix D. The solar power quiz sign was intended to be an interactive display for the crowd. Four questions with surprising answers were created by me for this sign, a draft of which can be found in Appendix D.

Indoor Signs

These signs will act to direct and inform visitors touring the inside of the house. The following are the topics for the sign installations: moveable screens, energy efficient General Electric appliances, bamboo walls & ledges, atrium, windows, split HVAC system and PCM concrete floor tiles. Short texts explaining each feature were produced for the signs, which can be found in Appendix D. These signs were also mostly based on the Project Summary. Therefore, our initial work supported the signs; however there were many changes to most of them, which required us to contact the team on an at least daily basis. Prof. Higgins edited the final text to be translated by Yunqiu and proofread by Xin Xin.

Conclusion

Being included in such a large-scale project with a very diverse team, as well as focusing on this competition as my IQP, has taught me countless valuable lessons. This journey posed such different scenarios then the initial pictures in my head.

For instance, before I was involved, I would never assume that installing PV panels would be so feasible, not to mention the fact that they could provide income. It amazes me to see that even though I have done my high school project thesis on solar energy (which won two global awards) I was still blind to these facts. Therefore, working towards the U.S. Energy Department's initial goal of educating the community on sustainable energy usage by supporting team BEMANY's communications in Solar Decathlon has been the perfect way to try solving a problem that lies at the intersection of social needs and technology. As I educated others, I was educated as well!

One of the most important lessons was that things cannot always go as planned and adjustments are often made in real life problems. I learned this during the very start of my involvement when my IQP topic has changed day by day, starting in B term. First I tried to teach myself coding for the website. When I learned that my design would not be used (Marketing requires a specific design template), I felt as if I learned everything for nothing. But now when I reflect on that stage of the project, I see that it just made me gain another asset and taught me how to deal with dramatic U-turns. The key is to stay calm and positive when there is not much you can do about that change.

Another important experience was to learn how crucial the everyday interactions between the team members are. While writing the project summary, we would often receive several different responses to questions that had only one right answer. It showed that proper communications between those people was amiss and we had to contact them face to face to push our questions and finally get the true story. When a feature of the house changed or no longer existed, most team members would not know it a month after. Thus, we learned to raise the same questions regularly to prevent the competition deliverables from being outdated. As

the student PR lead responsible of communicating our project to the public, I also ended up being a liaison between our own team members.

The blog posts have been another outlet to communicate our overall goal. Receiving positive comments has shown that this was not a one-sided project, but an interaction with all the people we wanted to tell our story to. Being on time was crucial; even when we had competition deliverables due immediately, we still had to keep working on our blog posts to maintain the key principle of consistency from our blogging research. Being on time is important. We learned this when we had the opportunity to feature on our blog a WPI alumni who was eager to create an art piece for the Solatrium. But the opportunity was lost when we were not quick enough in communicating. I now know that whenever there is a chance to obtain something needed, it is vital to be fast about it.

Working with WPI Marketing provided me with a different perspective of how the inter-department relations work when every person already has so much on his plate. With Solar Decathlon, almost everyone's work was somehow related to others'. Therefore it taught me that pushing people is often needed to get the best results you can have for a project; and that sometimes it is not possible to obtain what is desired, as was the case when we had copyright issues for a song we wanted to play in our time-lapse video. Having four types of weekly meetings, namely with my IQP advisors, my project partner, the entire team BEMANY, and finally with the Marketing Department, educated me about where and how to speak up in what way. If I could be in those meetings again this day, I would do a few things differently. Firstly, I am a rather shy person; therefore, interrupting someone when necessary is extremely hard for me. But those meetings were not the time to hold back what I had to say, and I regret doing that. Another factor was the fact that I could hurt someone's feelings if I spoke my mind, as in the case with the t-shirt design decisions. They were not appealing for my taste, but since the designer was in the room, I could not say anything. These were wonderful experiences for me, because I know that in my career after graduation, I will be lacking in these areas more than anything else, but because of the meetings, I am learning to start challenging myself to communicate better.

Also during the meetings, taking notes and fulfilling the responsibilities as soon as possible was essential. That required answering and sending up to 35 emails per day, as well as trying to figure out countless meeting schedules. This ongoing work taught me that the best way was to "just do it" and never procrastinate. However when there was too much on my plate, I needed to prioritize and figure out which task needed to be completed as soon as possible, and which could wait until the evening. This also took away most of the stress related to the project since I learned how trying to juggle everything at the same time reduces the quality of the work and is a bad idea.

This IQP also taught me how to write effectively, as a perk of having a writing professor as one of our advisors. I had to send every single piece of writing to Prof. Higgins for her edits before using the content. At the earlier stages of the project, when I received the edits, there would be countless edits, which did stress me out. But then, as a non-native English speaker born and raised in Turkey, I started seeing it as a chance to improve my writing abilities. This positive attitude helped me overcome my anxiety when sending various texts to our advisors for their review. Another thing I learned about writing on technological topics was that it isn't as easy as I thought. Every single detail needed to be conveyed perfectly in as few words as possible; the goal was to make a 6-year-old understand what we were talking about. I witnessed that the writers have to learn the subject thoroughly to be able to explain it. Now that the IQP part of the project is ending, I do believe I made the right decision to see it as an opportunity. The comment boxes on my writings get fewer and fewer every day, and that is all the proof needed to show how informative this project was.

Helping in the warehouse was yet another lesson that I will most probably use every day in the future as a civil engineer. It also proved to be an extremely important step to stay updated about every detail related with the project. Going to the warehouse whenever possible and getting a chance to work with a multi-cultural team was a wonderful experience. Overall, Belgian students seemed to be very disciplined when it came to working in the warehouse. Thomas, Tim and I were the only people who went to work during the snow storm. In a world that is getting smaller every single day, chances are that a lot of our team members will end up

in a similar work or research environment in their future. Therefore it was most valuable to be able to obtain such hands-on experience before many of my peers.

Overall, being in a school that lives and breathes projects, I believe that my IQP on Solar Decathlon China communications was the most valuable of all. It made me realize that even college students can create an impact in the world when supported and when working in unison.

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Appendix

A: Blog Posts

Solatrium Comes to Life

Text:

Welcome to Team BEMANY's blog. We are one of 22 groups competing in Solar Decathlon China, hosted in Datong in July, 2013. Three institutions with a mutual ambition to help promote sustainable energy united in 2012 to create BEMANY: Students and faculty from Ghent University, Belgium; Worcester Polytechnic Institute, Massachusetts; and Polytechnic Institute of New York. We are joining the competition with our collaboratively designed, net-zero energy house we've dubbed Solatrium, a home that draws its energy from the sun and has a light-filled atrium at its core.

Things actually started heating up this December when the construction process got a start in a Worcester warehouse in one of the five snowiest winters in city's history. Members of our construction team from around the globe have been working together, and many, many mugs of coffee have helped us overcome jetlag and long hours in the cold warehouse, but we haven't dropped our drills yet. Seeing our blueprints slowly come alive has been the most exciting part of this project to date. Ours is one of the largest houses (120 sq. meter or roughly 1500 sq. ft.) ever built in Solar Decathlon's history. Check out a few of the photos below and see for yourself how Solatrium is becoming a reality.

Some of Solatrium's coolest features include

- An airy, sun-filled atrium to provide passive lighting and ventilation
- Lightweight, composite wall panels with an insulation core, providing both structural integrity and a thermal barrier
- Concrete tiles incorporating phase-changing materials that absorb and release heat as needed, helping maintain comfort levels and enhancing the efficiency of the home's three heat pumps
- Glass windows with a special glazing to moderate light and radiation levels.

Stay tuned for further construction updates on Solatrium. We'll introduce you to the members of our multi-continental team, preview some of the home's more artistic elements, and share the latest on green energy solutions for the home. China, here we come!

Screenshot:

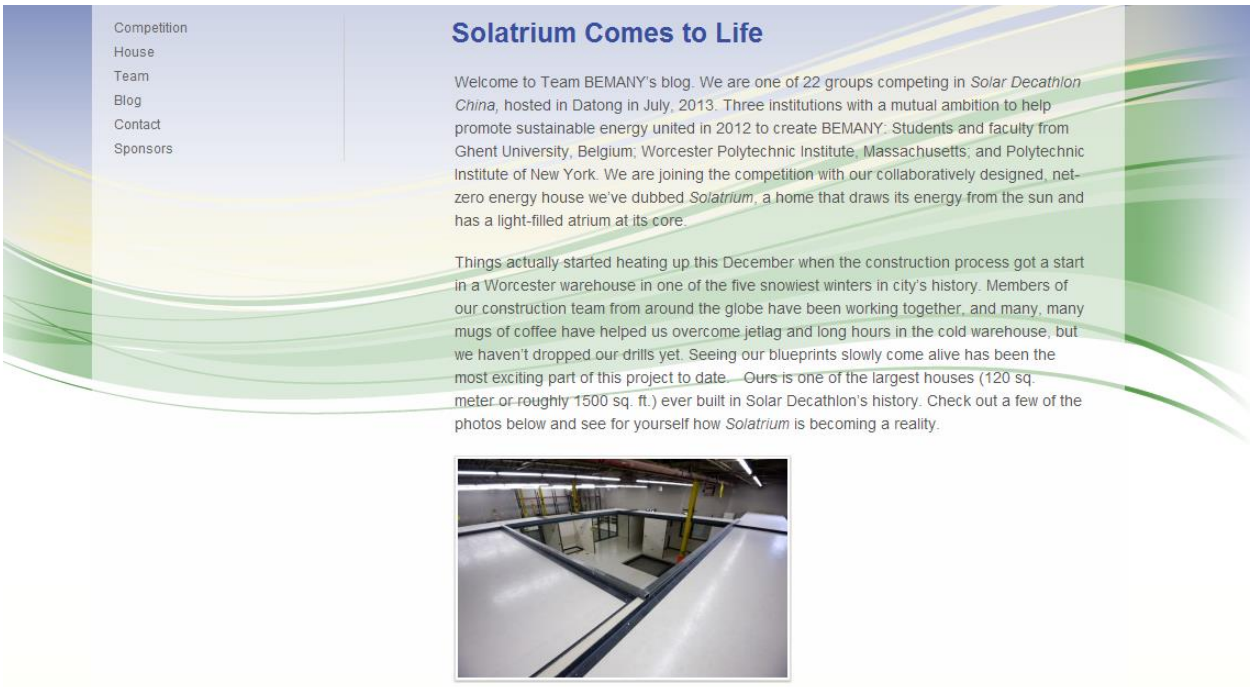

Figure 7: Solatrium Comes to Life Screenshot

Team BEMANY Presents

Text:

Drumroll, please…

Solatrium is almost up, everyone! Check out our time-lapse video to see how Solatrium has emerged over the last few months from a mere pile of construction materials on the warehouse floor.

Screenshot:

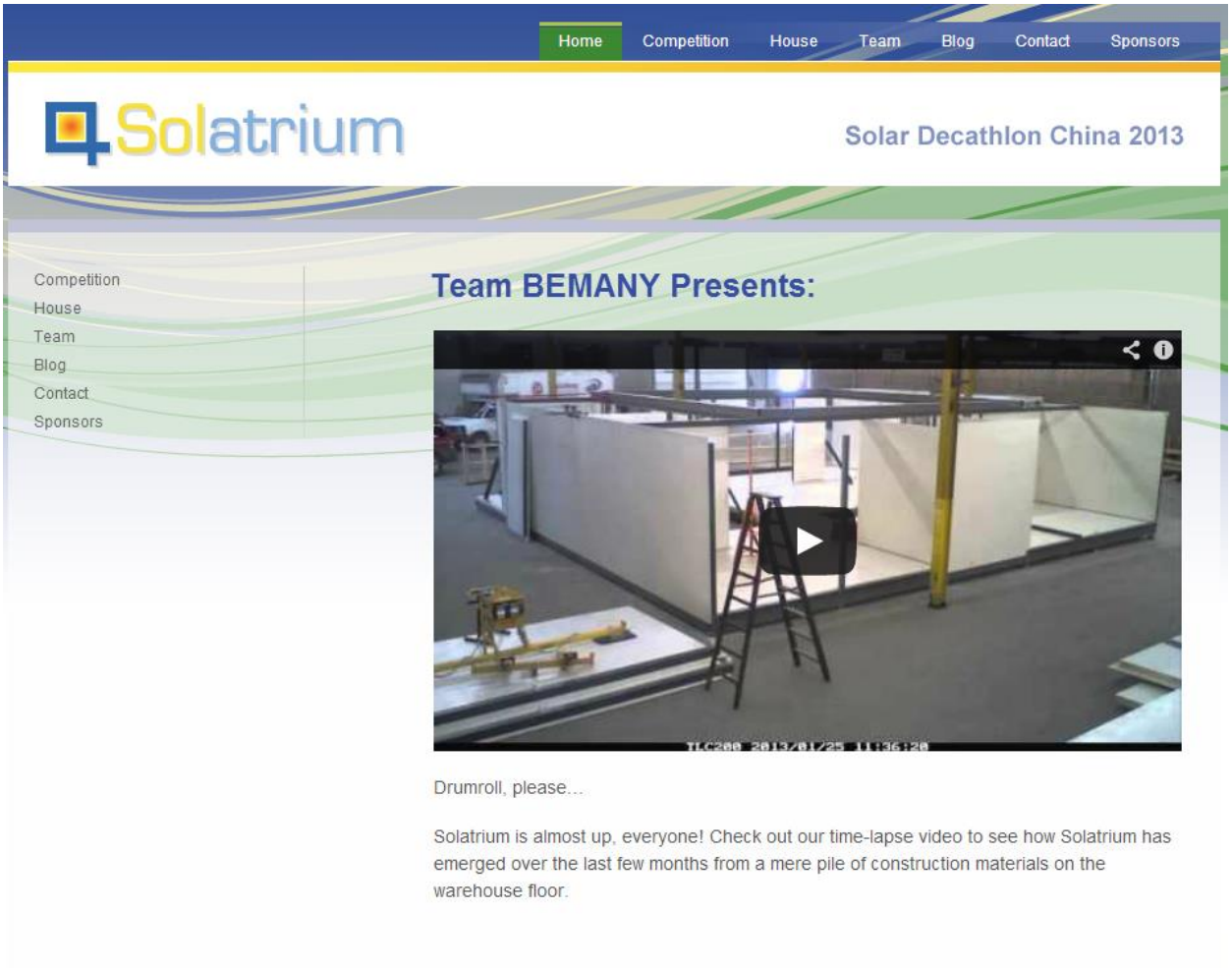

Figure 8: Team BEMANY Presents Screenshot

Spotlight: Guess Who?

Text:

Let us start with a riddle:

They study so that you can be safe

Their books are heavier than the beams they design

If their calculations go wrong, the walls will never align. . .

Who are these folks?

You guessed it– they are structural engineers! Structural engineers are civil engineers who design and analyze structures that support or resist loads, often the buildings we live and work in.

Solatrium's structural group makes sure that our house will be safe and sound. The group includes Charlot Tanghe, Tine Lanssens, Tim Van Parys , and Thomas Tassignon–graduate students studying Civil Engineering at Ghent University, and Greg Freeman, a senior Civil Engineering major at WPI. The Ghent students are basing their master's thesis on the Solatrium project, while Greg is doing his Major Qualifying Project (senior capstone design project) on the house.

They subject Solatrium's construction materials to rigorous tests in the lab, applying loads, compressing the materials, and observing how well they stand up under various forces. They use these tests, computer simulations and software programs, and hand-calculations, moving back and forth between the lab, their desks, and the warehouse where Solatrium is being built. This group is an integral part of the building process since they know the ins and outs of the house from its foundation footings to its roof girders. After all, they helped design the structural members and joints that hold it together.

Greg from WPI and the Ghent students in Belgium communicated across the Pond (the Atlantic) for most of the past 18 months, analyzing, designing and reviewing each other's work mostly through the Internet. They are all thankful for the magic of Skype. Can you imagine the phone bills without it? And this winter, the Ghent group made the trip to Worcester, where they collaborated in person with the entire team and were actively involved in the materials testing and construction. Thomas and Tim came to WPI early March and stayed until the end of the month; Charlot and Tine came two weeks later and they are still here.

The members are especially big fans of the lightweight but structurally supportive sandwich panels used in Solatrium. These FRP composite panels create the walls, floors, and

roof in the interior and the exterior of our house. The team loves them because they simplify the work: they are so much lighter to move around, and they require much less material than used in traditional stick construction, which would require structural members, insulators, vapor retarders, air barriers, sheathing—many more layers of material than in our all-in-one, four-inch sandwich panel. Check out our video animation of a load test above if you'd like to know more.

Screenshot:

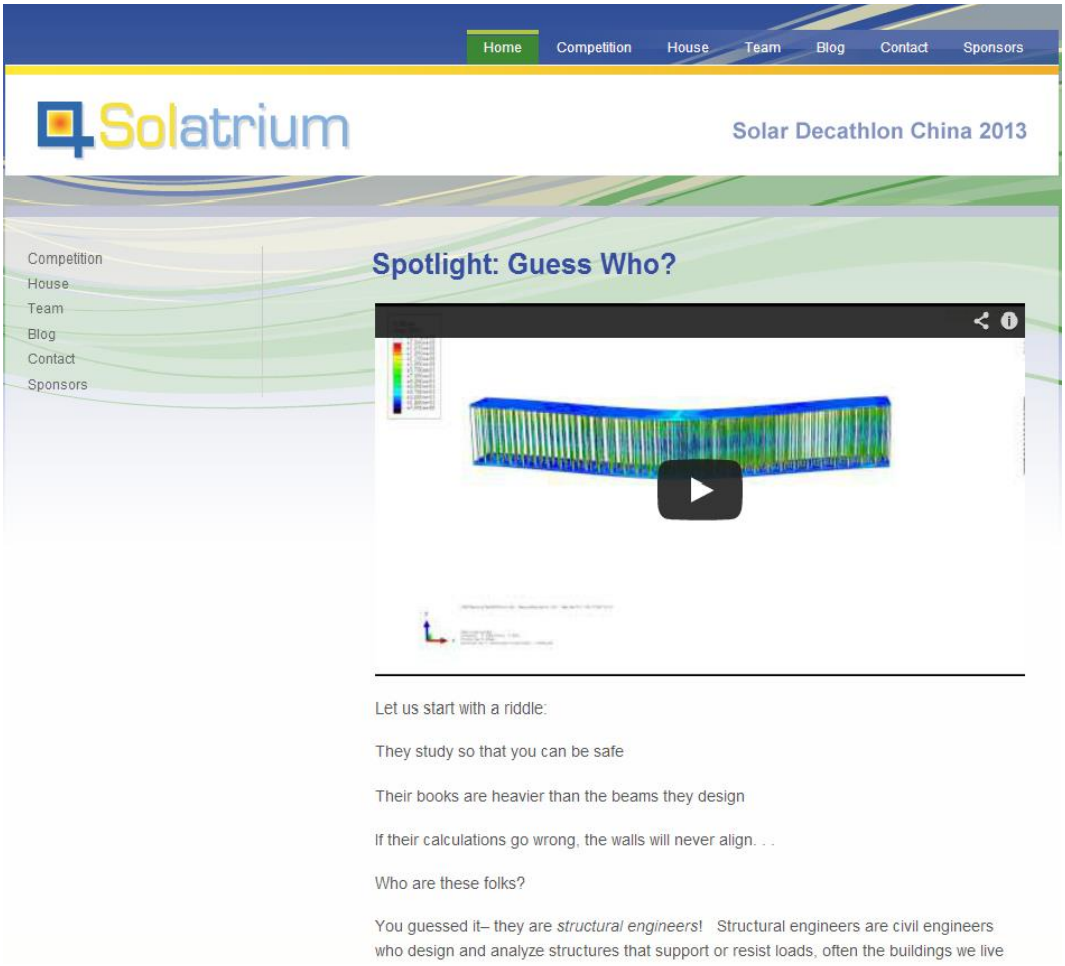

Figure 9: Spotlight-Guess Who? Screenshot

Figure 10: Structural Team Photo

Solatrium Visits Open House 2013

Text:

Do you remember the excitement you experienced when you attended your college's first open house? At WPI, we definitely do, thanks to the Closer Look Open House program offered to admitted students each April. Team BEMANY attended this year's event and met prospective first year students and their parents . All were eager to hear about our project . (What better chance to educate an interested audience about solar energy, right?)

INSERT PRESENTATION PHOTO

This was the first time we had an opportunity to talk about Solatrium with such a diverse group (everyone from little brother to Grandma), and they gave us valuable feedback. During the presentation, we had a chance to describe our house using a 3D model. But surprise—the model was constructed out of mouth-watering cake in the shape of the house, a very tasty treat!

INSERT CAKE PHOTO

After the presentations, we cut our cake just to practice the disassembly process that Solatrium will undergo before being shipped in pieces to China. The cake was a big hit with everyone who stopped by for a piece in the Campus Center.

INSERT CC PHOTOS

Check out how BetXi Bear (mascot of one of the Greek clubs in WPI) tasted our Solatrium cupcakes:

INSERT TEDDY BEAR PHOTO

What Can You Do to Save the Earth?

What is Solar Decathlon's mission? Why did the governments of the U.S. and People's Republic of China invest millions of dollars and yuans to this project? Well, we think they believed that the way to secure a bright future for the environment was to educate as many people as possible on the topic. That's why the public tours are a crucial part of the competition. But what is the next step? Okay, we convinced the public and now they want to go green. Yay! The way to actually do that can be as simple as planting a few trees in your backyard; but let's say you really, really want to contribute. Then the answer is using sustainable energy to power your house. In most cases, the easiest way to do that is installing solar panels that are enough for your needs- and maybe more so that you can feed into the grid and actually earn income with that excess.

Having that in mind, we wanted to interview someone from the public who uses solar panels so that you'll know it is a very beneficial option. Both for your wallet and the environment… Jim Picardi, a University of Massachusetts Amherst graduate self-employed cabinetmaker who resides in Shelburne Massachusetts, has kindly accepted to tell us his story of going solar.

"As a college student, I studied environmental economics and traveled the country while learning about building houses that run with solar energy. 22 years ago, I have built my own house mostly by myself and planned it to have perfect southern exposure and insulation. It is designed to be a solar house and is very traditional looking." Even if he had it in mind to install solar panels for his home as soon as possible, it was not very easy to fund this brilliant idea. As more innovations occurred in the solar panel industry and it became clear to government that fossil fuels really are running out, federal and state incentives have been developed to make going solar more economical. Mr. Picardi was finally able to carry out his project 2 years ago. He mentions that he's been "doing his homework" for a long time and has researched many options from different companies that install solar panels. He considered both leasing the panels which had no initial cost, and owning them. His final choice was to own them by the support of federal and state loans, which cut the costs in half. "There are 27 panels which create a 6.4 kilo-Watt system. They make up for 125% of the energy the house is using. The extra goes back into the grid and helps to pay off the initial fee." He says it is almost as if he isn't paying anything extra, since the amount given monthly for the debt is about the same as the would-be electricity bills.

When we ask if there is a way to check these numbers, he mentions the software the company provided. So it is basically possible to check every single watt if you want to see it for yourself, how great is that? When he graduated in 1979, Mr. Picardi expected there to be more innovations in 30 years in the area and more people who care about it. “It has been going slower than I thought, but now you can see there is a momentum towards green energy and things actually move along. If it’s a good investment as well as the right thing to do, why wouldn’t you do it?”

Well, if installing solar panels really is that easy, then why aren’t more people doing it? The answer lies with the knowledge in this area. There are many solar installation companies that are on your site to support you, but finding the most fitting solution needs some effort. When we question how we could make this process smoother between these companies and the public to build more trust, Mr. Picardi says that “there are dozens of resources on the internet, but you have to research on trustworthy sources. The rest is fairly simple; it is an investment that just keeps rolling value.”

Other than living in a solar-powered house, he also contributes by using environmentally friendly building materials for his cabinets. The wood he uses is sustainably produced and the finishes are low or no VOC.

We appreciate Mr. Picardi's time and valued counsel as a home-owner experienced in this subject. The bottom line is: you do have the power to do something that will affect all our futures.

Guest Blog Post: Taoning Wang

Throughout my three years of college, I developed a passion for architectural engineering. Among all the activities that I have been involved in, Solar Decathlon has been one of the most crucial. We are building a beautiful net-zero energy house which produces all its energy from solar photovoltaic panels. This project gives me all kinds of opportunities to learn. First of all, I learned the challenges of team work. The team consists of people living in different time zones and different cultures. Communication is essential and yet hindered by time and space We had to sacrifice our expendable time and make way for late night meetings. It was critical to respect different work ethics since we have different cultural backgrounds. The team structure reflects that of the real world. Today, more projects are carried out globally and draw on resources from different parts of the world.

Self-learning is another asset I acquired. In order to build the house, I needed to acquire a huge amount of knowledge and the ability to use modern tools. I was a sophomore when we

started, and did not take enough classes yet to overcome all the difficulties. Self-learning became a critical skill. During the summer, I had to teach myself AutoCAD, and, more importantly, use it for designing the building connection details. I also learned the building system and became familiar with modern building components. By the time I had a grasp of the big picture of this house, I was able to practice holistic thinking on such a large scale..

Designing and building a house like this requires careful work from mechanical, electrical, and structural engineers. When designing electrical components, you have to think about their placement, capacity and integration with other components. A building is an immense network. Whenever making a decision on one component, I have to examine its effects on others and the network as a whole. It is critical to have a clear image of how the house will come together physically and aesthetically. I often omit the latter part, which concerns the artistic and social value of the house. I found this to be the reason, most of the time, why architects and engineers argue. I cherish the opportunity to work with an architectural professor from Belgium. A precious moment emerged when I observed the conversations between my engineering and architecture professors. An open mind is required for such occasions. Seeing two types of thinkers clash has taught me many lessons, and I obtained a clear idea of what I want to change in the world.

We are building an ideal house in a real world. In order to make the house stand, I have to understand how things work in the real world. I realize that building a house requires more than sitting in front of the computer. By going on business trips with professors, I understand that we need to visit the manufacturers and present ideas to raise funds.

As my college journey proceeds, I realize how humanities, arts, and engineering are closely tied up. If I step too far away from humanities, my engineering work will be blunt and lifeless. I joined Engineers without Borders to understand the basic objectivse of engineering, but I learned more. I realized how an uncomplicated gutter that collects rain water might potentially change the life of a family. In Guatemala, every day, the people of Guachthu'uq spend more than four hours collecting water for the family. This arduous and time-consuming activity prevents children from going to school and other family members from working and

earning more. As young engineers at WPI, we decided to change the situation, surveying the area, calculating the water flow, estimating the cost to raise funds, and seeing the fruits of our plan. It was a treasured experience.

Art raises questions about this society, and engineering provides possibilities. If science enables us to see more into the universe, art enables us to see it from different angles. I often think that the completion of a building requires architects and engineers to argue until they reach a compromise. Now, I want to be the architectural engineer who truly appreciates the architects' vision. I am planning to focus my future research on building energy modeling and building physics. Currently, in the U.S., buildings consume about 48% of our total energy. Thus, the need to reduce energy consumption in buildings becomes urgent. My journey will continue, and I want to pursue a Ph.D. degree in building technology.

Soatrium's Coverage in Press

Solatrium in Press:

Check out these articles about the Solatrium and the folks who help it become a reality below:

http://www.worcestermag.com/city-desk/top-news/WPI-builds-house-with-everything-under-the-sun-204650111.html

http://www.telegram.com/article/20130315/NEWS/103159704/1101

http://wp.wpi.edu/dailyherd/2013/04/18/horse-sense/

Thank you for supporting team BEMANY, Worcester! We feel the love ☺

B: Project Summary

House Description

Solatrium is designed with a sun-filled atrium at its core and floor-to-ceiling windows that invite the outside in. Two bedrooms, one bathroom, utility room, kitchen, and common areas encircle the atrium in our 120 m2 , one-story house. Moveable panels enable residents to customize the central living space. Behind the simplicity of Solatrium's open floor plan, its construction materials from floor to rooftop work intelligently to maximize comfort and

efficiency. Phase-changing tiles absorb and release heat, composite wall panels do double duty, providing structural integrity and insulation, and 40 solar panels draw energy in.

Unique House Features

Our unique design is built around the central atrium. Historically, the atrium has been used in homes all over the world, from China to Morocco. An atrium brings some of the outdoors in and creates a spacious, central gathering place, extending the livability of a smaller home and reducing the need for excess building materials. Our open plan limits the number of walls between the atrium, dining area, and hallways. Instead, moveable bamboo panels allow customization of the space for parties or other family functions. Our atrium has an elevated roof supported by steel trusses inlaid with acrylic windows, providing air circulation and passive daylight. A decorative bamboo window ledge at the base of the roof windows will obscure small fans and lights, and another bamboo ledge above the floor-to-ceiling windows along the home's outer walls will provide additional shading.

Technological Innovations

Solatrium's intelligent construction materials demonstrate the possibilities of combining green technologies in new ways. Concrete floor tiles incorporating phase-changing materials (PCMs) provide passive temperature control and take the strain off the HVAC system. Phase Changing Materials (PCMs) melt and solidify at fixed temperatures, storing and releasing energy during exothermic/endothermic reactions. Our team created a concrete mix using PCMs and formed 62 x 62 cm flooring tiles that release heat when temperatures fall below 23 °C and absorb it when they rise above that mark. We included a split HVAC system as opposed to a single system, reducing ductwork and thereby minimizing air loss. Our three heat pumps are located one in each bedroom and one in the living room.

Our composite, fiber-reinforced polymer (FRP) panels make up sub-floors, walls, and the roof. The strength of these 4-inch panels provides structural integrity; the insulated core material has a high R-value, providing insulation and an effective thermal barrier. These all-in-one panels eliminate the need for additional layers of construction materials, and their light weight simplifies installation. The large floor-to ceiling windows along the exterior walls of the

house incorporate an energy-efficient window glazing that moderates the influx of light and radiation into the home, reducing glare and moderating temperatures. Together with Solatrium's 40 PV panels, these materials maximize the use of solar energy in the home.

Market Appeal

Solatrium is an attractive option for the energy-conscious couple with an active lifestyle and the desire for a flexible, low-maintenance home they can modify according to their needs. Solatrium would be the perfect starter home, falling on the upper end of the price spectrum for the average home in Massachusetts; green technologies employed in the home would minimize utility bills and offset original investment costs. The 40 rooftop solar panels provide enough energy for a three-person family.

Solatrium's sleek, intelligent design provides great flexibility for inhabitants of all ages, allowing homeowners to adjust the central living space as needed for family and social events. The second bedroom provides for an office or child's bedroom as the family grows, and sliding bedroom doors allow for additional control of privacy and light levels in the home. Saving energy is almost effortless in that the home's smart materials work together to harness natural sunlight, provide air circulation, and moderate temperatures.

Solarium would also appeal to homeowners seeking to downsize in their retirement years and to transition to convenient one-floor living on a budget. The open plan and adjustability of space in the home makes it all the more livable for those with mobility issues.

Design Philosophy

Solatrium's design is intended to draw the outside in—to blur the barriers between the house and its natural surroundings and to provide a sense of freedom and openness to its inhabitants. Our vision for the house was achieved through the inclusion of a spacious atrium. Although a closed structure, its elevated roof and windows are expansive, providing a view of the sky and allowing light, air, and landscape to enter from above as well as through the many floor-to-ceiling windows lining the exterior walls of house. Light flows uninterrupted through the open floor plan of the home. Even the more private bedrooms have sliding doors so that the space might be enlarged and one's vision might extend from one side of the house all the

way through to the other side and beyond—into the surrounding landscape. The central, common areas of the home coupled with moveable, bamboo panels offer options that will accommodate versatile lifestyles. Homeowners may divide or open the space as necessary.

Solatrium's combination of green technologies provides another kind of freedom: they work together to make the homeowner energy independent, and they make it easy to maintain comfort levels in the home. Enough energy for a family of three is drawn directly from the sun through the 40 rooftop solar panels. Intelligent construction materials ensure that comfortable temperatures and adequate lighting will automatically be maintained at all times—worry free.

All of these elements, from floor to rooftop, were designed to provide a sense of openness, freedom, simplicity, and flexibility in the home—an aesthetic that will appeal to future homeowners. Our goal is to show that this aesthetic and responsible use of the earth's resources can be achieved through green technologies and intelligent design.

Team Philosophy

Team BEMANY is an international team working together to build a functional, inviting, single-family home with innovative technologies for energy efficiency. Our team values a sustainable-energy future, and we want to be working towards fresh, green technology. Our team members are from three separate universities and we have been working both separately and in concert from different campuses. To build the Solatrium for Solar Decathlon China, we need to be able to integrate the individual contributions of the team members into a cohesive presentation for the judges and public.

Team BEMANY has a surprisingly relaxed personality given the comprehensive and intense nature of the competition. Our team meetings have their share of jokes and team members lightheartedly catching up on the progress of Solatrium. We are rather informal; during a meeting we encourage participation, anyone can be expected to volunteer for an unassigned task. Our team is also ambitious; we strive for perfection and are aiming to do well in each of the competition contests. Solatrium is going to be one of the biggest houses completed for a Solar Decathlon. To do so much the members of BEMANY have given up

weekends and vacations to complete key features of Solatrium. Everyone in our team values the hands-on experience they gain through their participation.

Team Organization

Team BEMANY is comprised of 25 actively-participating graduate and undergraduate students from a variety of disciplines at three universities; 11 faculty advisors (nine from engineering and two from Humanities); eight student helpers from Worcester Technical High School, and a number of part-time student and staff volunteers. To date, 41 sponsors--alumni and leaders in manufacturing and construction--have donated funds or materials to make Solatrium possible.

Students are organized in four core groups: the structural team, the architectural/design team, the communications team and the PCM design team. Four students and two advisors on the architectural team designed Solatrium. They oversee plumbing and interior design. The structural team of five students and four advisors ensure the house is structurally stable and conforms to building codes. PCM designers are NYU-Poly students who have researched and integrated PCMs into a suitable concrete mix for the floor tiles. The communications team, comprised of three students and two advisors, is responsible for PR and content for the website, brochure, blog, and other promotional materials. This team has been supported by volunteers from Marketing.

All team members help with Solatrium's construction and share responsibility for deliverables. Our team members are always willing to pitch in, and each of us is stays abreast of what others are up to. The teams and the larger group meet regularly and share information through a group Dropbox, the blog, and various email lists, but talking together informally over pizza or coffee (in a cold warehouse!) is often where we share unexpected details about the project and each other's lives. Our schools are not only located on different continents, but our teammates come from around the globe. Part of this project's excitement comes from joking with each other and learning about our different cultures.

Future Plans

After the competition, Solatrium will return to Worcester in Central Massachusetts where it will be reassembled in Institute Park next to the WPI Campus. The park is frequently used for summer concerts and other civic gatherings, and there Solatrium will be unveiled publicly for the first time in the US. The team is currently deciding between several future uses. One proposal is to convert it to campus office space with a full kitchen and bathroom. A second is to turn it in into a permanent exhibition/museum open to the public, furthering its educational reach. WPI has many sustainability initiatives that would be well framed by display in Solatrium. The space could also showcase the digital and modern art of WPI students. Finally, some have proposed using it as a laboratory where architecture and engineering students can study the house's materials and construction or test out new materials in the future.

C: Brochure Text

Introducing Solatrium

Solatrium is an attractive option for today's energy-conscious family seeking a versatile, low-maintenance home. This one-story, 120 m2 dwelling is completely powered by the sun. Solatrium draws energy in through its 40 photovoltaic (PV) panels, which produce 300 watts of power each. The construction incorporates green materials from floor to rooftop and uses energy-smart appliances and mechanical systems to maximize comfort and efficiency. The home's centerpiece is a spacious, indoor atrium that feels like an extension of the home's outside environment. The sleek, open floor plan features two bedrooms, one bathroom, dining and living room areas, a utility room, and a kitchen.

<Use for panel 2>

Design Philosophy: Flexible Living, in Harmony with Nature

Solatrium is designed to draw the outdoors in—to blur the boundaries between the house and its natural surroundings and to provide a sense of ease and openness to its residents. The home is organized around a spacious central atrium. The elevated roof and windows are expansive,

providing a view of the sky and allowing light and air to enter from above as well as through the many floor-to-ceiling windows lining the exterior walls. The open floor plan provides easy access to all areas of the home. Line of sight may extend from one part of the house to another and beyond—into the surrounding landscape. Central common areas with movable panels offer options that will accommodate diverse lifestyles or allow for additional control of space and light. Sustainable bamboo comprises the two interior walls, providing additional privacy for the bedrooms, and bamboo window ledges provide shading.

Solatrium's combination of green technologies offers homeowners almost effortless energy independence by maximizing energy efficiency. The home's smart materials work together to harness natural sunlight, provide air circulation, and moderate temperatures automatically.

<panel 3>

Innovations in Green Technology

- Solatrium's 62 x 62 cm floor tiles were created from an advanced concrete mix incorporating phase-changing materials (PCMs) that release heat as indoor temperatures fall below 24°C and that store heat as temperatures rise above 27°C, providing passive heating and cooling, and reducing strain on the home's smart HVAC system.

- Solatrium uses a split HVAC system as opposed to a single system, reducing ductwork and thereby minimizing energy loss. The split systems feed into two 9000-BTU heat pumps that are located just outside each bedroom and a third 12,000-BTU unit located just outside the living room.

- Composite, fiber-reinforced polymer (FRP) panels are used form Solatrium's sub-floors, floors, walls, ceiling, and roof. FRP beams and columns criss-cross the entire substructure to provide needed support against Worcester snow loads, Datong earthquake loads, and everything in between. The Transonite™ system is a 90 mm thick panel with an 81 mm thick polyurethane foam core. The core material has an R-value of about 20, providing insulation and an effective thermal barrier. It is sandwiched between two, 4.5 mm thick FRP skins connected by 3mm glass fiber rods stitched across the insulation. The composite material is 60% glass fiber

by weight. These sturdy panels provide structural integrity and eliminate the need for additional layers of construction materials, and their lighter weight simplifies transport and installation.

- Twenty double-paned windows incorporate an energy-efficient window glazing that controls the influx of light and radiation into the house, reducing glare and moderating temperatures. Some windows in the bedrooms and central living space serve as doors for easy access to the outside from anywhere in the house.

- Solatrium's 40Forty PV panels generate 12kW of power under desirable conditions. Two 6kW inverters will convert DC to AC power at 50Hz and 208 volts (3-phase; 4-wire).

- A fire retardant, intumescent paint coating on the wall paneling creates a protective barrier that chokes fire.

- Solatrium usesSolatrium uses energy-efficient appliances and an energ**y-smart hot water heater.**

<panel 4 (if both sections can fit there) OR panel 4 AND 5>

Knowledge Iis Power: Some Facts about Solar Energy

- Every second, our sun produces enough energy to sustain the Earth's needs for 500,000 years.

- Ninety-five percent of people who are asked overestimate the cost of "going solar."

- Massachusetts homeowners report that they can pay off the cost of buying and installing solar panels in 8-10 years, simply by using the money they save in monthly electric bills.

- China and the United States are two of the top ten countries using solar power.

- Enough energy for all of China can be supplied by 260 km2 of solar panels.

- Your neighbor is more likely to installtion solar panels if you do.

- Switching from coal to solar energy can reduce energy costs by 80%.
- Of all home appliances, electric ovens consume the most energy, followed by microwaves.

Solatrium by the Numbers

- Solatrium weighs 15,000 kg.
- The sSteel trussing insupporting the atrium roof weighs 1280 kg.
- Solatrium has a footprint of ~135m2 and a volume of 325m3.
- It's structure is supported by 32 FRP beams and 41 columns.
- It can withstand a snow load of 1.92 KN/m2, winds of 40 km/hr, and an earthquake shear force of 37 KN.
- Solatrium uses 335 m2 of FRP panels, saving 2.35 m3 of wood framing and 81 m2 of other wood products that would be used for a house of comparable size.
- Solatrium's solar panels produce 12 kW of clean energy, enough to supportfor a

family of three.

- Its PV panels produce the same amount of energy as ~1000 kg of coal, saving keeping ~1500 kg of CO2 from being released into the atmosphere.
- The panels save ~4500 liters of water that would be needed for to cooling turbines that generate electricity.
- Solatrium's 350 phase-changing material concrete floor tiles mixed with phase-changing materials will reduce electrical demand on the house's HVAC system by up to 20%.
- It takes 45 days to ship Solatrium's construction materials to China from the United States.

<panel 5 or 6 NOTE: please include the schools' logos somewhere>

Team BEMANY

Team BEMANY comprises 25 students and 10 faculty members from three universities: Ghent University, in Belgium (BE-);, Worcester Polytechnic Institute in Massachusetts (MA-),; and the Polytechnic Institute of New York University (NY). BEMANY's goal is to design an attractive, net-zero energy home to inspire and educate the public. Our message is that comfort, affordability and responsible use of the Earth's resources can be achieved by combining green technologies and intelligent design.

Our team members study engineering, architecture, and writing and are organized into four groups.

The structural group ensures that Solatrium is structurally stable and conforms to code.

The architectural/design group oversees interior design and utilities integration.

The PCM design group is responsible for the concrete mix that integrates PCMs into Solatrium's flooring.

BEMANY's communications group develops content for the website, brochure, blog, and other promotional materials. This group is assisted by WPI's Department of Marketing and Communications.

Student volunteers from Worcester Technical High School and their teacher welded the atrium truss and created joint fixtures. All team members have contributed to Solatrium's construction.

<panel 6 or 7>

WHAT'S NEXT?

After the competition in Datong, Solatrium will return to Worcester in Central Massachusetts, where it will be reassembled and used as an interactive exhibit space.

Solatrium will continue to educate students and the general public about green construction techniques, new energy systems, and strategies for sustainable living. Now that you've seen Solatrium, what will you do to promote a more energy-efficient future?

D: Signage Text

Outdoors Signs

Sign 1

Structural Support and Insulation

Composite, fiber-reinforced polymer (FRP) panels, beams, and columns

FRP panels with a polyurethane core are 90 mm thick, with an insulating R-value of 20. These lightweight panels form the sub-floor, walls, and roof—and simplify transport and installation. Intumescent paint on the paneling's surface provides fire-retardant benefits.

Prismatic FRP columns and beams crisscross the entire substructure.

Strong and durable, FRP materials provide structural integrity, so Solatrium can support its own weight and withstand external loads from environmental stresses like wind and earthquakes.

These "lean" materials eliminate the need for additional construction products.

Sign 2

Energy-Smart Flooring

Concrete with phase-changing materials (PCM)

Solatrium's flooring consists of 62 x 62 cm tiles made with an advanced concrete mix.

Its PCMs melt and solidify at fixed temperatures, allowing them to absorb and release heat in the house when temperatures fall below or rise above a comfort zone of 24-27°C.

The tiles provide passive heating and cooling, reducing electrical demand on the house's HVAC system.

Sign 3

Beckoning the Outdoors In

Windows made for comfort and a view

Floor-to-ceiling windows cover roughly 50% of Solatrium's outer walls, offering an expansive view and a feeling of openness.

Additional acrylic windows are framed by the trussing that supports the atrium roof, showing a glimpse of the sky.

Windows provide passive heating, cooling, and lighting, as well as air circulation.

The vacuum between the larger windows' double-paned glass provides insulation. E-glazing incorporated into glass windows allows sunlight in and blocks out harmful UV rays, helping moderate indoor temperatures.

Sign 4

Powered by the Sun

How photovoltaic (PV) panels work

Solatrium's 40 rooftop PV panels generate enough electricity for the average three-person family. Under favorable conditions, each panel produces 300 watts, a total of 12kW.

In sunlight, the panels' solar cells absorb photons and release electrons. Semiconductors capture the free electrons and create direct current (DC).

An inverter transforms DC to alternating current (AC): 220V at 50Hz (Chinese standard), which feeds into the competition's grid. Solatrium then draws on that power, converting it to 120V at 60Hz (US standard) to run utilities and appliances. SD China monitors each house's power use.

In communities, power generated by solar homes is fed into a larger grid that stores power and carries it to the entire community. Meters track how much each creates and uses. Solar homes

can use as much power as they generate at no cost, lowering their electric bills. Homes that generate more than they use may be credited for the extra energy they produce for the grid.

Sign 5

What Do You Know?

- *What percent of people overestimate the cost of installing solar panels?*

9

59

95

95% of people who are asked overestimate the cost of "going solar."

- *China produced …. % of the PV technology sold in 2010.*

1

21

51

China was the leader, with 51 percent, followed by Germany.

- *PV solar panels are the only means of generating electricity without requiring any:*

Water

Moving Parts

Wiring

PV panels need no moving parts. They require very little water (just enough to keep surfaces clean).

- *A rooftop PV system needs which of the following to produce usable electricity for the home?*

A battery

A connection to the electric grid

An inverter

An inverter is needed to convert the direct current (DC) produced by the solar panels to the alternating current (AC) required by most household appliances.

Indoor Signs

Welcome to Solatrium

Totally powered by the sun, our 120 m^2 home is designed to draw the outdoors in—to blur the boundaries between the interior of the home and its natural surroundings, providing a sense of ease and openness to those who live here.

Solatrium's sleek, open-floor plan features two bedrooms, one bathroom, versatile dining and living room areas, a utility room, and a kitchen, all of which border its crowning centerpiece—a spacious, indoor atrium.

Solatrium's green technologies offer the homeowner energy independence. Built with PV panels, energy-efficient windows, composite structural materials, and innovative flooring, Solatrium harnesses sunlight and moderates the indoor climate almost effortlessly.

Welcome in, and see how comfort, affordability and responsible use of the Earth's resources *can* be achieved by combining green technologies and intelligent design.

Moveable Privacy

Moveable panels of sustainable bamboo balance the composite structure's strength with the beauty of a natural product—and allow homeowners to customize the interior living space.

Energy-efficient appliances

Solatrium's appliances are Energy Star compliant. Our hybrid electric water heater uses up to 62% less energy than a standard 50-gallon (190-liter) electric water heater.

Atrium

The atrium has an elevated roof with adjustable windows, providing passive heating, ambient daylight, and air circulation.

Sustainable Bamboo

Bamboo is a fast-growing, durable construction material now used in many

homes. The bamboo trim above the windows with southern exposure and along the perimeter of the roof truss provide shade from intense sun. Outside the home, it offers some protection from the elements. Two fixed walls of laminated bamboo soften the ambience and provide privacy for the bedrooms.

Windows

These double-paned windows are well-insulated and made with *e-glazing* that lets in warmth and light while blocking harmful UV rays.

PCM-Concrete Floor Tiles

These floor tiles of *phase-changing materials or PCMs*, absorb and release heat as needed when indoor temperatures fall outside a comfort zone of 24°C-27°C.

Split HVAC system

The split heating, ventilation, and cooling system uses two 9000-BTU heat pumps, one in each bedroom, and a 12,000-BTU unit in the living room. Using several pumps reduces ductwork, minimizing air loss and maximizing energy efficiency.

E: Team BEMANY Survey

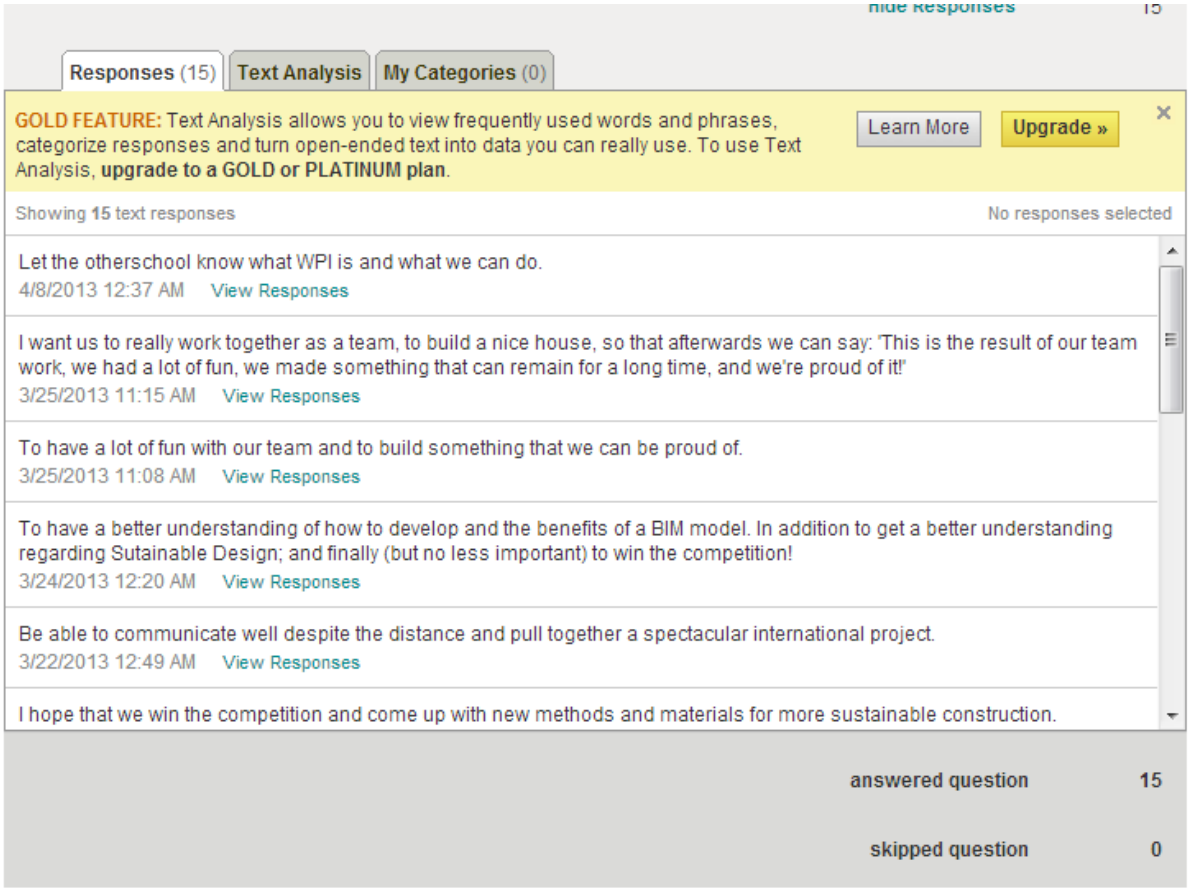

Figure 11: BEMANY Student Survey Screenshot