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A VIEW INTO THE EVOLUTION OF A SOLAR TRAINING PROGRAM AND THE DEVELOPMENT OF A WORKFORCE

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ABSTRACT

There was once a time when only a handful of organizations offered solar workshops typically spanning no more than three days. These classes were often attended by self-confessed 'solar geeks' - the kind who wanted to build the system in their garage and install it themselves on their homes. However, as events early in this century unfolded, it became evident that the nation was primed for a boom in solar energy. It was also then that we started seeing a change in the landscape for training programs.

The trend in the types of people who have taken the Solar Center's courses, the number of courses we are offering, and the changes in our curriculum have been affected by world and national events, the policies of federal and state governments and public funding available for training. The objective of this paper is to present how these financial and political factors coupled with public pronouncements and funding come in to bring the changes in our courses to help us and other training programs prepare for the coming years.

1. INTRODUCTION

In 2004, the NC Solar Center at NC State University (NCSC), which up until then had offered no more than three-day workshops on solar thermal and photovoltaics, had just rolled out a continuing education program comprised of a series of weeklong hands-on workshops on renewable energy technologies.

This non-degree program called the "Renewable Energy Technologies Diploma Series" (a.k.a.RETDS, Diploma Series), provided an interdisciplinary platform for professionals to get their hands on solar thermal, photovoltaics, wind and biodiesel technologies. The idea was to give these renewable energy enthusiasts enough confidence in their knowledge of the technology, add to their understanding of how financial incentives work, and help them make that first step to contributing professionally to help build a renewable energy industry in North Carolina.

The first couple of years were attended by what is known in the Innovation Adoption Curve as "innovators". The shift in the mix and number of attendees became pronounced after the summer of 2007 when major policy change was instituted in our state, and further events and policy shifts in 2008 gave rise to renewed public interest in solar.

How these events played out in our state and the nation had profound effects on our training program, and continues to shape the direction of our training team and the Center as a whole.

2. CHANGING LANDSCAPE FOR TRAINING

2.1 State and Federal Policies

In August 2007, North Carolina became the first southeastern state to pass a Renewable Energy and Energy Efficiency Portfolio Standard (REPS). The law requires all investor-owned utilities in the state to supply 12.5% of 2020 retail electricity sales from eligible energy resources by 2021. Municipal utilities and electric cooperatives must meet a target of 10% renewables by 2018 and are subject to slightly different rules. The overall target for renewable energy includes technology-specific targets of 0.2% solar by 2018 (which includes solar electric, solar water heating, solar absorption cooling, solar dehumidification, solar thermally driven refrigeration, and solar industrial process heat).[1]

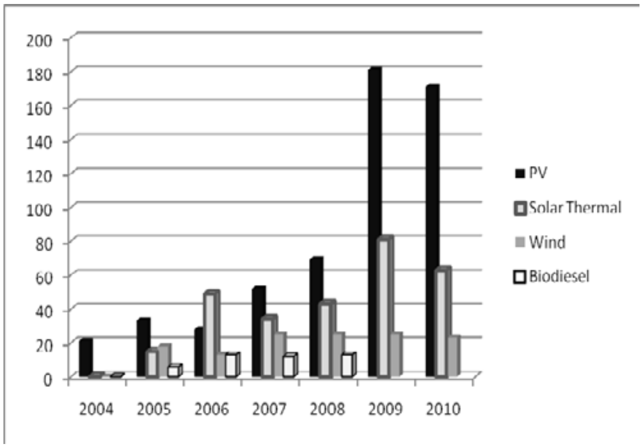

Fig. 1: Number of participants for each technology workshop per year

2008 was a most dramatic year. In February 2008, the NC Utilities Commission issued an order adopting the rules to implement the REPS. Presidential primaries and election campaigns consumed America. The Democratic Party's front-runner and eventual President had placed renewable energy high on his priority list.

A marked increase in interest in solar, specifically PV, was observed as the training team scrambled to add workshops to absorb the waitlist for PV classes. Such was the demand that the Center had quadrupled the number of solar electric workshops offered from the previous years.

Then in the fall of 2008, the financial crisis griped the nation and the world.

While the crash of 2008's financial institutions had a devastating effect on most markets in 2009 onward, the Solar Center's Training Program experienced a momentary boom. This can be arguably traced to the vocal and financial support the renewable energy industry has received from the Obama administration and the passage of the REPS in North Carolina.

The American Recovery and Reinvestment Act of 2009, signed by the President in February, provided $500 million to help workers train for "green jobs."[2] As a result, people's interest in renewable energy careers had peaked and renewable energy training programs across the country were multiplying.

Beginning in 2009, the Center's Training Program team had weaned itself off of state-appropriations and became an entirely self-sufficient entity within the Solar Center. It had generated enough revenue from registrations and customized company training to become the only one of nine programs in the Center to go without state funding. That same year, the program doubled its staff and was able to maintain its offering of eight solar electric workshops, added two solar thermal classes and another small wind workshop to its schedule. While classes did not fill up as quickly as the year before, classrooms were still filled. This boost in the demand for our solar workshops, especially for PV training, appears to trail the state and national trend in solar installations. (See Figures 2 and 3)

While the Center's solar electric workshops increased by leaps and bounds, the Training Team was forced to streamline its curriculum and concentrate on workshops that were popular, fit more in the rubric of the REPS, and had less competition from smaller organizations and community colleges. Thus, biodiesel workshops were cut in 2009.

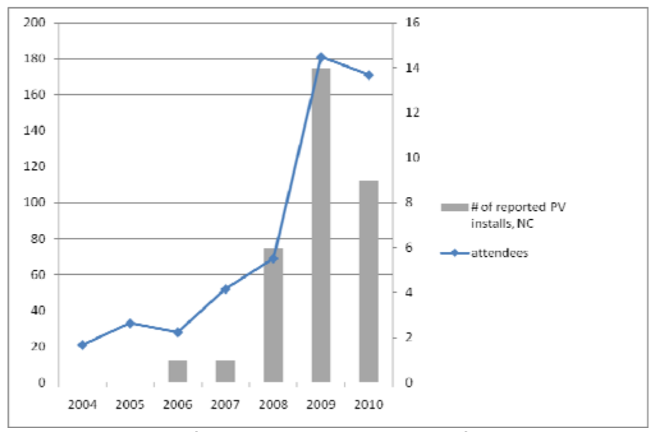

Fig. 2: Number of PV installations in NC, from NREL's Open PV Project Market Mapper compared to Solar Center's PV attendees throughout the years.

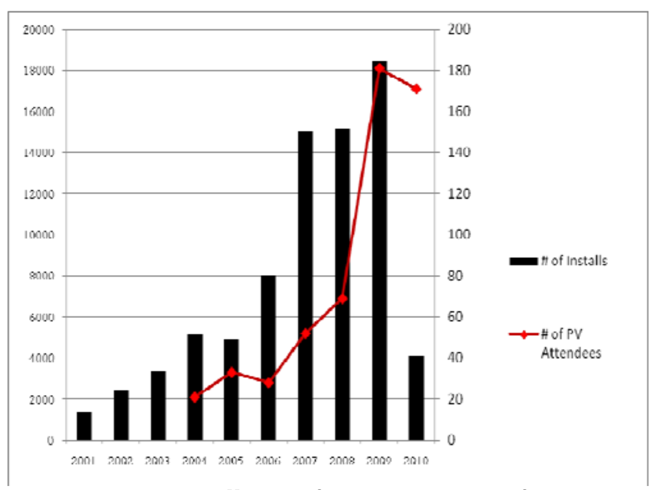

Fig. 3: U.S. PV installations from 2001 to 2010 from NREL's Open PV Project Market Mapper compared to Solar Center's PV attendees throughout the years

In 2010, we had ten scheduled classes including our first weeklong advanced photovoltaic class to answer the demand from our first generation of PV trainees.

2.2 Federal funding opportunities for training programs

In early 2010, the Solar Center was awarded by the U.S. Department of Energy (DOE) as one of nine Regional Training Providers for their Solar Instructor Training Network. The project aims to improve the quality and accessibility of solar installation training and expand the nation's trained solar workforce in community colleges and other local education institutions. DOE funded a National Administrator and nine Regional Training Providers over a period of five years to support the professional development of instructors who provide instruction on solar photovoltaic (PV) and solar heating and cooling (SHC) installations. The network will also collaborate and develop national curricula, sponsor workshops, create replicable training models for local instructors, and develop best practices.[3]

A total of 40 trainers spanning seven jurisdictions in the southern Mid-Atlantic (North Carolina, South Carolina, Maryland, Virginia and the District of Columbia) were trained in solar technologies in the summer of 2010. As of this writing, the Center is geared to continue providing solar electric and solar hot water workshops and curriculum development assistance to community college trainers so that they can develop a solar course that will build the next generation of skilled solar installers.

In addition to the already existing training programs at DOE, the Department of Labor has come out with the Green Jobs Innovation Fund competition that will support opportunities for workers to receive job training in green industry sectors and occupations. This approximately $40 million program will enable existing training providers to develop programs that incorporate green career pathways and ensure middle to low-income workers are able to obtain the skills needed to enter or move along a green career pathway and ultimately earn family sustaining wages.[4]

Funding like the aforementioned that specifies the type of training, technology, geographic location and target trainees further shape the curriculum and training program offered at the Solar Center. It is not a stretch to argue that funding sources have a profound effect on all types of learning institutions that receive public funding for their programs.

As a direct effect of DOE funding for example, the Center has acquired assets that can help institutions with limited facilities hold solar training. The Center is also able to develop online teaching and learning tools that are useful for renewable energy classes outside the Solar Instructor Training Network program.

2.3 Everybody Loves Renewables (especially PV)

Today, anecdotal evidence from sold-out career advice workshops held by the Solar Center suggests that many people in transition are thinking of renewable energy jobs as a viable career option. Those who have been unfortunate victims of the economic times have found ways to fund their training through federal and local funding primarily spawned from the Workforce Investment Act. Others who are unable to take advantage of government programs are paying their own way in hopes that the returns will be professionally (and personally) gratifying.

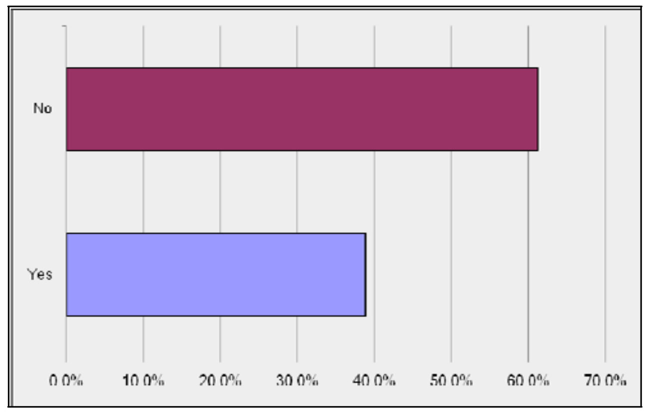

Fig. 4: Responses of past Diploma Series participants to the question *"Were you working in the renewable energy/green building industry when you took the class?"*

Peter Kliehans had 15 years of experience in sales, marketing and finance when his company laid off their employees, Klienhans among them. He felt that it was the time to go in the direction he has wanted to take all his life. "I came across [this energy efficiency and solar energy company] a little over three years ago. I was researching companies in the area that are doing what I want to be doing."

In the spring of 2010, Mr. Kliehans took his first solar class and in July 2010, he completed his Renewable Energy Technology Diploma at NC State University as part of his goal to land his green dream job.

"Working for that company would be more than a job - it would be a career that would fill a deep need within myself as well," said Peter. "It's a wonderful way to help people and the environment and broaden my horizons as far as sustainability. It's all about putting my efforts into a worthwhile endeavor and getting paid to do the right thing."

One of the more memorable students is Mr. Robert Allen of Michigan. He took the class in the spring of 2010 with his wife. As co-owner of the roofing company Allen Brothers, Inc. with his brother Gary, Mr. Allen came to North

Carolina to learn about installing photovoltaic technology from the Solar Center. The economic slump forced his company to re-think their business and re-tool. Later that year, the brothers spun off a new solar roof product. Their story was captured during the President's 2011 State of the Union Address where Mr. Obama singled out Robert and his company for "re-inventing" themselves and letting us see the "promise of renewable energy".

3. <u>WHAT'S NEXT FOR TRAINING CENTERS</u>

Training programs across the country vary in scope, target audience, and length. There are different courses on solar geared for students and professionals. In states with a robust solar industry, training programs have been developed to target a specific audience. In North Carolina, where the solar industry is still squarely in the early adopters phase, training programs have not become as segmented as California's. Technical solar workshops, whether offered by community colleges or universities, are still being offered as a non-credit continuing education courses typically attended by professionals. Efforts are underway, however, to change that.

3.1 <u>Cost of renewable energy training</u>

As more and more local instructors get trained in solar, either through the DOE-program or more locally funded efforts to gain solar instruction, there is no doubt that community colleges are joining the fray and adding to the multitude of training organizations that have cropped up in the recent past.

In North Carolina, sustainable technology courses are part of the Common Course Library, which allows for solar courses to be taken for credit by a community college student. Previously, alternative energy technology workshops were only offered as non-degree continuing-education classes.

Movement seems to be afoot to incorporate in-depth courses in solar and other renewable energy technologies in existing fields such as engineering, environmental studies, building sciences, and other technical two-year and four-year degrees so that one does not 'earn' a renewable energy degree, but may concentrate their studies on it. The model is taken from Hudson Valley Community College, where a student studying to become an electrician can take courses on wind and photovoltaics,. This allows the student to have more options outside the renewable energy industry should policies and markets become unfavorable.

With the influx of new training centers, the availability of online workshops, and the future of incorporating solar into credit programs, one can only predict that the overall cost to register for a course in basic solar installation will decrease.

3.2.<u>Who will absorb the trained workforce?</u>

The often unmentioned elephant in the discussion of developing the workforce is "Who will hire these trained solar installers?" In developing the RETDS, the model was to train the installer who would also be the entrepreneur. However, while the Center had been able to churn out entrepreneurs and "pollinators" (those who are able create productive partnerships) through the years, it does not necessarily create the large number of solar positions needed to employ the thousands of people who have lost their jobs.

So aside from creating a fertile renewable energy policy regime that will help drive down the cost of installation and increase the efficiency of the technology, there must also be a push to educate executive and management types who will invest in these technologies and be the ones creating the jobs.

Many potential investors in this industry who might be on the fence about renewables but just need a class to make them feel comfortable with the basics of how renewable technologies work and the creative ways to use existing incentives to make a project profitable. Current and future managers who might not have a mind for turning wrenches might be better in a class that has a business bent.

3.3 <u>What becomes of the (NCSC's) Training Programs?</u>

This question has been brought up during several meetings of the train-the-trainer team. Since the Center is essentially training future 'competitors,' how will the Center's programs fare in the future when the market gets saturated with installer training?

A brief survey of past workshop participants and a study of market trends point to several options: a) continue being a train-the-trainer center to provide continuing education opportunities to instructors; b) offer advanced courses; c) offer technical workshops on technologies that are emerging; d) offer courses specific to managers and top-executives; e) distinguish courses by offering more options for certifications and getting third-party accreditation.

Train-the-trainer center. DOE is in its second year of the Solar Instructor Training Network program. It is expected to end program funding after year five. Following the end of DOE funding for this project, the Solar Center will be poised to continue providing training services to community college, and even university instructors, especially those who seek to advance their knowledge of renewable energy topics and want to continue their professional development in this growing industry.

Offer advanced courses. The Center already offers an advanced photovoltaic class that meets the continuing education requirements for NABCEP-Certified PV Installers. As more people get trained in the basics of renewable technologies, we are positioned to offer advanced courses to further their technical expertise and/or meet continuing-education requirements.

Offer emerging technologies workshops. Going back to our pioneering roots in teaching 'emerging' technologies, the Center can continue to nurture its relationship with the 'innovators' who took the first diploma series workshops by offering technical workshops on technologies that are ready for market adoption.

A survey to all 883 past participants was conducted in early March to decide on next steps for the NCSC training programs with 94 responding to the three questions asked. In figure 5, results showed that technologies like geothermal, mico-hydro, tidal and wave energy could be the next technology workshops offered.

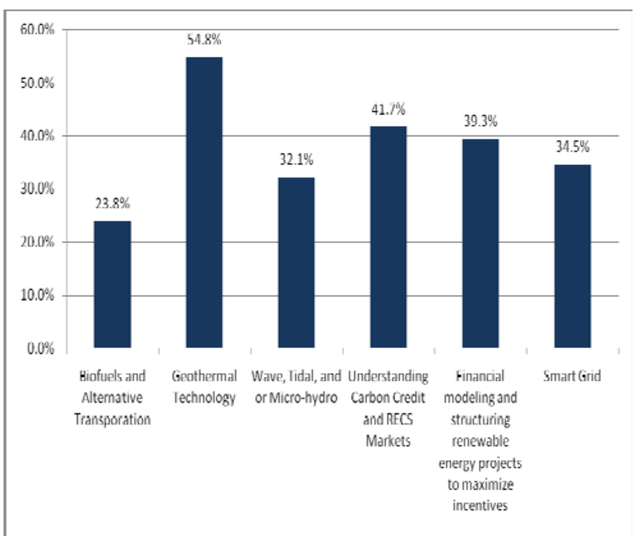

Fig. 5: Answers to question "Which topic/s for workshops would make you come back for another certificate? (You may choose up to 3)"

Offer courses for managers and executives. This type of certificate should be launched before the end of the year to ensure that the Center capitalizes on the immediate need for this kind of certificate course in the market. The program, "Certificate for Renewable Energy Managers" will be offered as a continuing education course, but has future plans to be integrated in NC State University's MBA program as a credit class, and perhaps a concentration.

Obtain distinction from third-party accreditation agencies. Established centers with a long history of providing renewable energy training may be at an advantage due to name recall and relationships built with instructors, suppliers and other stakeholders in the renewable energy industry. It also helps to have third-party accreditation and accredited and certified instructors to help market the course.

4. HELP US HELP YOU: THE SYSTEM OF CERTIFICATIONS AND ACCREDITATIONS

Quality has a way of deteriorating when there is more of it. Fortunately, consumers can easily find quality installers and training programs. North American Board of Certified Energy Practitioners (NACBEP) Certified Installers have passed a rigorous exam and shown proof of experience and/or education in installing renewable energy systems. The Institute of Sustainable Power Quality (ISPQ) meanwhile accredits instructors, training programs and continuing education providers based on a set of standards set forth by the Institute of Sustainable Power, a non-profit organization incorporated in 1996, to coordinate, develop, and maintain international standards for the education and qualification of renewable energy, energy efficiency, and distributed generation providers.

These certifications and accreditations are important in ensuring the integrity of the renewable energy industry. It is also helpful for marketing purposes as it distinguishes an accredited instructor or program from the pack, and an installer who knows what he is doing from one who does not. However, if ordinary individuals do not know what an "ISPQ-Accredited" seal means, or what value a NABCEP-Certified Installer has, the value of obtaining that third-party seal of approval is diminished.

Case in point: in North Carolina, it is not required to be NABCEP-Certified to install PV on someone else's home, rather you must have an electrical contractor's license.[5] Thus, an electrical contractor who is unfamiliar with the nuances of inverters and photovoltaic modules can install a PV system but a NABCEP-Certified PV Installer who does not hold an electrical contractor's license cannot sell or install a PV system in this state.

Furthermore, ISPQ-Accreditations have not yet reached the level of popularity that the US Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) system does. Despite the rather complicated process and levels of LEED Certification and LEED Accreditation, the LEED program is still a widely successful program. Its success is not only measured by how federal, state and local government agencies have mandates to build to LEED standards, it has permeated into markets outside of the U.S.

Fig. 5: A LEED registered building in Manila, Philippines.

Despite the 'depression' in the real estate and building industry in the U.S., USGBC has been able to promote and quantify the value of a LEED-Certified structure outside the States that newly certified international LEED floor area doubled the total certified to date.[6]

Figure 5 is a picture of a LEED-registered building in the business district of Manila, Philippines. It is not a LEED-Certified building yet, but it shows that this builder has chosen to go with a US-based standard and is using this as a marketing tool to distinguish it from others.

What does certification and accreditation have to do with our training programs?

In our quest to provide the quality students and a quality training course, we follow the country's premier accrediting and certifying bodies. We follow the NABCEP Task Analysis to guide us in developing curricula, offer NABCEP-Entry Level Exam, and we are in the midst of an intense application to receive ISPQ-Accreditation as a Training Program.

When NABCEP comes out with a new class of certification, we think of how we should adjust an existing curricula or what class to create to suite the given task analysis. When we realized that being an ISPQ-Accredited Training Program was 'higher' than a Continuing-Education Provider, we quickly recalled our Continuing-Education Provider application in favor of the more intensive, more expensive level of ISPQ accreditation.

There is definitely innate value in constantly evaluating programs and having a third-party look over one's work. But at the end of the day, all of these efforts would feel insignificant if the target audience for our training products do not recognize the value we provide by having these accreditations.

It is my hope that the renewable energy industry as a whole come out with its full support of these seals, and be as successful in marketing them it to the general public and policy-makers as USGBC has with its LEED certification.

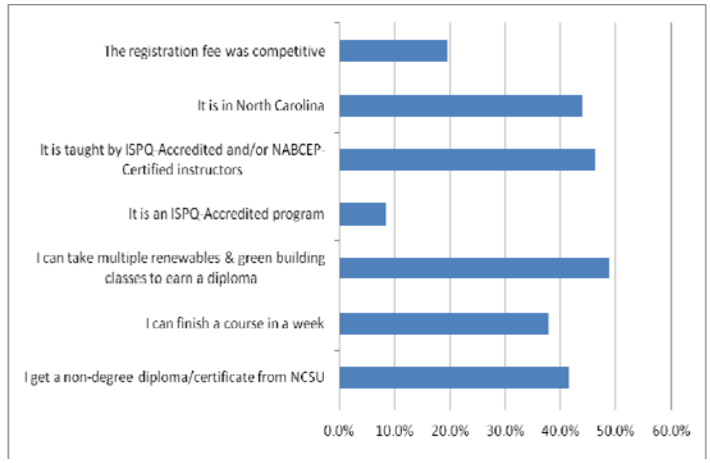

Fig. 6: Answers to question: What made you decide to take a workshop at the NC Solar Center at NC State University? (You can choose up to 3 answers)

5. CONCLUSION

With more community colleges and other local educational institutions adding capacity to train technicians in solar technology, it can be predicted that the role of established solar training centers in the nation will evolve to meet a demand for specialized solar training such as solar sales, business management, advanced PV and solar thermal, and customized training. More importantly, these solar centers will continue to be a venue for current and future solar entrepreneurs, managers and policy makers to network.

Those who have balked at the current cost of solar instruction might be comforted to know that this projected increase in solar education will eventually bring down the cost of workshop registrations. The development of a national curricula and making training models available to teachers mean that schools can spend more resources in procuring equipment than deciding the nuances of how solar is taught. The entry of community colleges in offering credit and non-credit courses on solar and other renewable energy technologies is already providing some respite to some who are cash-flow challenged.

In my humble opinion, this is the direction we should go. Our goal as training program providers is to not only bring out the entrepreneurs in solar innovators, but also to help the renewable energy industry find a skilled workforce that still brims with the enthusiasm of those early adopters. We want more renewable energy businesses. We want more trained people working in the industry. And, if the law of supply and demand holds true, more trained workforce and more businesses competing can mean lower cost of solar installation. And that, overall, is a good thing.

6. ACKNOWLEDGEMENTS

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SOLAR ENERGY WORKFORCE DEVELOPMENT:
CROSSING THE 'T'S AND DOTTING THE 'I'S

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ABSTRACT

Despite its nickname, "The Sunshine State," Florida has lost its position as a leader in the deployment of distributed solar energy in the marketplace.[1] Hoping to reverse that trend, in 2006 state government announced several ambitious initiatives that would help Florida recapture at least some of the stature it enjoyed in the 1970s and 80s. At the same time, anticipating a demand for skilled and trained workers by the solar energy industry, the state's workforce agency designated a center dedicated to meeting that need–the Employ Florida Banner Center for Clean Energy (BCCE). Through the BCCE and its partnering efforts, more than 400 workers have been trained in the installation of solar thermal and electric systems. However, to create an environment for stable employment in the renewable energy sector, these training and educational efforts need to be accompanied by commensurate long-term policy initiatives that will sustain the market.

1. BACKGROUND

In February 2011, nationwide unemployment rates dropped to 8.9 percent, nearly a two-year low. Florida, however, still ranks 49th of the 50 states and the District of Columbia[2], and posts employment numbers about 30 percent higher than the national average. Only California and Nevada report greater unemployment. Though currently slightly below the state unemployment average, Brevard County (where the Banner Center for Clean Energy is located) unemployment is expected to spike mid-year with the end of the Space Shuttle Program.

To counter this unemployment issue, in 2006 Florida developed the Employ Florida Banner Centers. Each Banner Center increases opportunities for cutting-edge training for Florida workers while supporting high-wage, high-growth sectors - a priority of the Roadmap, the state's economic development plan. The centers also are a top strategic priority of the entire workforce system, including Workforce Florida, the Agency for Workforce Innovation (AWI) and the state's 24 regional workforce boards and about 90 One-Stop Centers. Since their inception, more than 6,000 people have enrolled in Banner Center training, with in excess of 3,000 earning either industry or academic credentials. In 2010, Banner Center trainees' wages increased, on average, by 21 percent one year after completing training.

Each of Florida's Banner Centers aims to:

- Become the statewide nexus for industry knowledge related to workforce needs of a targeted industry.
- Support the pipeline development needs of key Florida industries from entry-level to advanced workers.
- Deliver workforce development products, services, training and access to certifications valued by industry.
- Promote and support economic development in a targeted industry throughout the state

2. EMPLOY FLORIDA BANNER CENTER FOR CLEAN ENERGY

The Banner Center for Clean Energy (BCCE), hosted by the Florida Solar Energy Center, is one of 13 current and planned Banner Centers located throughout Florida. Using a "train the trainer" model, the BCCE has trained 66 instructional professionals (43 individuals) from 28 educational institutions throughout the state in solar water heating, photovoltaics, or both disciplines. They in turn have trained more than 400 students and incumbent workers

[1] Florida is among the top ten states for utility scale solar deployment.
[2] US Bureau of Labor Statistics, Local Area Unemployment Statistics Information and Analysis, PSB Suite 4675, 2 Massachusetts Avenue, NE Washington, DC 20212-0001, 2011.

for jobs in the solar energy industry. These partners now offer in excess of 40 courses on solar water heating, solar pool heating and solar electricity. Course offerings range from college credit courses to certification classes to non-credit technical and professional training in support of local industry skilled workforce needs. BCCE also has partnered with Florida business and trade associations to develop customized training curricula.

3. FLORIDA WORKFORCE CHALLENGES

Florida is home to more than 200 solar energy businesses that install, manufacture or distribute solar energy products. A series of solar industry focus groups conducted in 2010, representing about 15percent of the industry, found that company employment over the proceeding four years had both increased and decreased due to the beginning of a state solar rebate program and the demise of that program. Though the political environment has shifted some since these focus groups were conducted, at the time participants were split in their assessment of the industry's future growth, citing Iraq and Afghanistan Wars, the Gulf oil spill, legislative passage of the Property Assessed Clean Energy financing initiative, the state of Florida rebate program and a Florida Public Service Commission mandate for solar investor-owned utility programs as potentially increasing industry attention and effecting positive growth. On the downside, the end of the state of Florida rebate program, tightening of financial markets and lack of state solar policy initiatives (Renewable Portfolio Standard, Public Benefit Fund) were expected to negatively impact industry growth.

According to labor market statistics, more than 70 percent of Florida's current labor force will still be participating in the state's workforce 12 years from now. Entry level and skills upgrade training opportunities will be critical to businesses and also critical to Florida's future. But unemployment will only decline as jobs are available for these trained workers. The challenge that now presents itself is: will those students find jobs in their chosen field, or join the ranks of over-qualified, under- or un-employed workers in Florida? Policy initiatives that create a sustainable renewable energy economy are a vital component of any workforce development program.

4. POLICY INITIATIVES

In order to assure that the solar market is sustainable and supports job growth, it is necessary that sound policies be instituted towards this end. The solar energy industry in Florida has spent some time and effort exploring the best menu of policies that would result in steady market growth that would assure the employability of those workers being trained by the BCCE and its training partners.

4.1 Dedicated Funding Source for Financial Incentives

Florida's short-term rebate program both stimulated and depressed the state's solar market. The program was funded at marginal levels and funds were exhausted before the end of each fiscal year, leaving eligible applicants waiting for extended periods to receive their rebate, or worse yet, stalling the purchase of solar energy systems until new funds became available. Long-term, a system similar to a Public Benefits Fund would provide a stable fund to buy-down the cost of solar installations. This type of funding measure is most commonly supported through a surcharge to all customers based on electricity consumption, e.g., 0.2 cents/kWh. Examples of how the funds are used include: rebates or performance based incentives for customer sited and owned renewable energy systems; funding for renewable energy R&D; and development of renewable energy education programs. Eighteen states and the District of Columbia have a Public Benefits Fund.

4.2 Renewable Portfolio Standard

A statewide Renewable Portfolio Standard (RPS) can provide a clear public pathway that shifts the state's energy usage from conventional sources to a diverse portfolio which includes renewable sources. A RPS goal applied statewide and apportioned year-by-year based on the actual electricity sold by investor owned electric utilities, municipal utilities, and rural electric cooperatives could provide, over the long term, reliable and environmentally benign energy generation for the state. Currently, 36 states and the District of Columbia and Puerto Rice provide either a renewable portfolio standard or goal for their electric utilities to achieve with regard to renewable generation.

4.3 Property Tax Exemption

Investment in solar energy by property owners is often an economic decision. If property taxes increase as a result of installing a solar energy system, that increase offsets the value of the solar energy generated. Currently, 34 states and Puerto Rico offer a property tax based exemption of some kind.

4.4 Codes and Standards

Local code jurisdictions vary in their prerequisites for solar installations, ranging from wind load, to structural, to licensing requirements and permit fees. This often causes needless delays and increases system costs caused by efforts to comply with diverse, and often undefined, parameters. Solar system certification can provide local code jurisdictions with evidence of compliance with minimum codes and standards without incurring undue time, effort, and potential liability by establishing their own process for code compliance. A statewide uniform system that prescribes the standards, licensing, permits and inspection required for installing solar thermal and electric systems would assure a fair and balanced process that protects the consumer while supporting the industry.

4.4.1 Standards

Solar energy systems are subject to a broad range of electrical, roofing, plumbing and structural codes and standards. Lacking in this process is a “system” certification that provides evidence of compliance with relevant codes and standards that would allow the local building department to sign off on the “accepted” protocol for solar system installation. Florida, in 1978, established a solar system certification process that adapted to the ever changing solar energy market. Currently, FSEC certification is available for solar thermal (hot water and pool heating) and solar electric (residential and commercial scale photovoltaic) systems. Replication of this system certification and approval process (via SRCC or another recognized certification agency) would provide a tool for building departments to establish minimum standards for solar system installations.

4.4.2 Licensing and Certification

The Florida Legislature and the Construction Industry Licensing Board established the scope of work for solar contractors. Certified Solar Contractors are authorized to install residential and commercial solar thermal and electric systems and are exempt from subcontracting certain tasks involved in residential installations. In addition, electrical contractors are authorized to install PV systems and plumbing contractors are authorized to install solar water heaters and pool heaters. A method of regulating those that are responsible for solar system installation is critical to effective control over the entire regulatory process, including permitting, inspection and system certification. For those jurisdictions that do not have contractor licensing schemes, NABCEP certification should be required. In those jurisdictions where contractor licensing does address solar installations, NABCEP certification should be viewed as a value added credential, and considered as a requirement for participation in incentive programs where a third party (utility, state government, etc.) is making an investment in the equipment. In no case should NABCEP certification supplant contractor licensing systems.

4.4.3 Permitting

The permit process for solar energy system installation can be exhausting. Since the installation of a solar energy system crosses several trades, the permit requirements may include roofing, plumbing, structural, and electrical components. Since the permit system for the most part pre-dated solar technology, unless the agency having jurisdiction (AHJ) over the permitting system has adapted their process, multiple permits will be the norm.

It is entirely feasible to create a single permit system for solar energy installations, both for solar thermal and PV. Several states have adopted a single permit scheme and there are models for legislation to create a single permit system.

4.4.4 Inspection

The inspection of a solar energy system will not occur unless the AHJ requires that a permit be applied for as a prerequisite. This process also presumes that designated trades are eligible to install these systems and that specified codes and standards must be complied with. In order for the building inspector to sign off on the installation of a solar energy system, he/she must have been trained in the technology and know what constitutes acceptable workmanship. Training of building officials is paramount to this process.

5. CONCLUSION

Solar energy workforce development initiatives must be comprehensive in scope to be effective. Instituting training and education programs is insufficient unless policies that insure jobs will be available to trainees are simultaneously adopted. The infrastructure that assures quality control of systems installed must be a parallel effort.

THE RESEARCH STUDIO, A COLLABORATIVE MODEL FOR INTEGRATING SUSTAINABILITY ISSUES INTO ARCHITECTURAL STUDIOS

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ABSTRACT

This paper is based on the premise that integrating sustainability issues into educational curricula is best achieved through problem-based learning activities that encourage students to take an active role in addressing real life problems. Campus projects offer a unique opportunity in this respect by allowing students to have a positive impact on their immediate environment. This paper describes the process and outcomes of a collaborative studio/seminar model, in which students developed environmentally sustainable design solutions to renovate a 1970's campus building. Students were tasked with collectively developing a single renovation proposal that represented a hierarchy of three possible intervention scenarios. Each studio group worked with their seminar counterparts to simulate the environmental impacts of their proposals, through multiple iterations that allowed students to optimize their designs. While the use of simulation tools in early design stages is still not common-practice in the profession, this project illustrates the potential these tools offer especially when introduced to new generations of architectural students.

1. INTRODUCTION & PREMISE

1.1 Sustainability, Environmental Performance, and Performance Simulation

Reducing the negative environmental impacts of buildings is an objective shared by an increasing number of architects. Numerous studies have clearly indicated that the design of high-performance buildings inevitably requires integrating environmental performance considerations in the early stages of the architectural design process. Design decisions made at these stages have major impacts on the building's environmental performance, and the potential for having such large impacts diminishes in later design stages. While architects previously could only rely on generalized rules of thumb to inform their design decisions in these stages, new generations of performance simulation tools are making it possible to have a more detailed assessment of the performance implications of early design decision thus potentially resulting in more informed decision-making and more optimized designs. Additionally, integrating sustainability issues, and in particular issues of building environmental performance, in architectural design studios necessitates going beyond conventional studio formats, which only address form and image, and developing newer models that introduce students to methods and tools of designing high-performance buildings including digital modeling and performance simulation tools.

1.2 Sustainability Education & Problem-Based Learning

While interest in sustainability education in architectural programs in the US is clearly increasing, a study by the Association for the Advancement of Sustainability in Higher Education (AASHE, 2010) indicates that, currently, there is only a relatively small number of sustainability-related degree programs and certificates in schools of architecture (16 degree programs and 27 minors, certificates, and concentrations). This indicates a clear need to further integrate sustainability into architectural educational curricula. A recent report by the American College and University Presidents Climate Commitment (2009) further argues that the educational experience of graduates should reflect an intimate connection among (1) curriculum; (2) research; (3) understanding and reducing any negative ecological and social footprint of the institution; and (4) working to improve communities so that they are healthier, more socially vibrant and stable, economically secure and environmentally sustainable. This same report urges colleges and universities to complement their formal curricula with "active, experiential, inquiry-based learning and real-world problem solving".

Problem-based learning is an instructional approach commonly used in several disciplines such as architecture, engineering, medicine, education, and the sciences (Hung, Jonassen, & Liu, 2007; Kang, Jordan, & Porath, 2009; Lehmann, et. Al., 2008, Walker & Leary, 2009). Focusing on case studies of the campus built environment as the basis for students to learn sustainability concepts and skills offers clear potential for effective and impactful problem-based learning. Collaborative learning in interdisciplinary also teams fosters interdependence among all group members working towards a shared goal while also valuing the individuality of each contribution (Van der Linden, et al., 2000). Smith and McGregor (1992) further contend that collaborative learning lends itself well to problem-based learning.

1.3 Service Learning & Student Activism

Another educational model offering strong potential in the area of sustainability education is service learning. Service learning typically includes a structured learning experience that responds to community-identified concerns and combines community service with preparation and reflection (e.g. Prentice and Robinson, 2010; Robinson, 2010; Seifer and Connors, 2007, Young et al., 2007). Service learning activities increase students' reasoning, logic, leadership, confidence, civic involvement, and passion; and result in more appreciation and retention of the academic content. Engaging student in service learning activities, which aim to improve the environmental performance of campus buildings offer a unique opportunity in this respect by allowing students to have a positive impact on their immediate environment.

1.4 The Research Studio as a Model

The previous sections illustrate a clear potential for integrating environmental performance considerations into architectural curricula through design studios that focus on improving the environmental performance of campus buildings. Based on this, this paper describes the process and outcomes of a collaborative studio/seminar model, in which students developed environmentally sustainable design solutions to renovate a 1970's campus building in the University of Texas at San Antonio.

Such projects, however, can be relatively complex and require students to already have a working knowledge of a wide range of topics such as building environmental systems, building detailing, and sustainable technologies (to name a few). This becomes even more important when more technically advanced topics, such as environmental performance simulation, are also addressed. To respond to this, this project was implemented within a "research studio" format. The research studio is the final, senior level, studio within UTSA'a undergraduate architectural curriculum and is designed to allow instructors to pursue more advanced topics and to explore alternative formats for studio teaching, thus making it ideal for the purpose of this project. The objectives of the project included: 1) engaging students in learning about environmental sustainability and building performance, 2) organizing and supporting a problem-based learning opportunity with a strong service-learning component, 3) fostering collaborative and team-work skills, and 4) introducing students to concepts of interdisciplinary practice by creating an interdisciplinary environment in which some students adopt the role of environmental performance consultants.

2. PROJECT FORMAT

2.1 Building on Previous Collaborations

The experiment described in this paper builds on previous collaborative efforts for the authors, which explored different models for integrating sustainability and environmental performance criteria in architectural education in general and architectural design studios in particular (for a review of possible integration approaches see Brown, 1980; and Wright, 2003) . These experiments included two semesters in which the authors implemented the studio/seminar model used in this project (see Rashed-Ali, 2009), as well as one semester in which they collaborated with two other instructors from UTSA's Interior Design Program in another similar project (see Rashed-Ali et al, 2010). All of these projects were implemented in collaboration with, and with the full support of, the UTSA Office of Facilities Management and aimed to provide this office with information to assist them in identifying possible performance improvements to UTSA campus buildings.

2.2 The Studio/Seminar Model

The studio/seminar model described in this paper (see figure 1) built on previous collaboration and combined a senior-level research studio, with 14 students, with a performance simulation seminar with 10 students. The intent of the studio was to propose modifications and additions to one of the original buildings of the UTSA main campus. These modifications aimed to improve the building's environmental performance, while in the same time being mindful of its architectural significance and addressing other

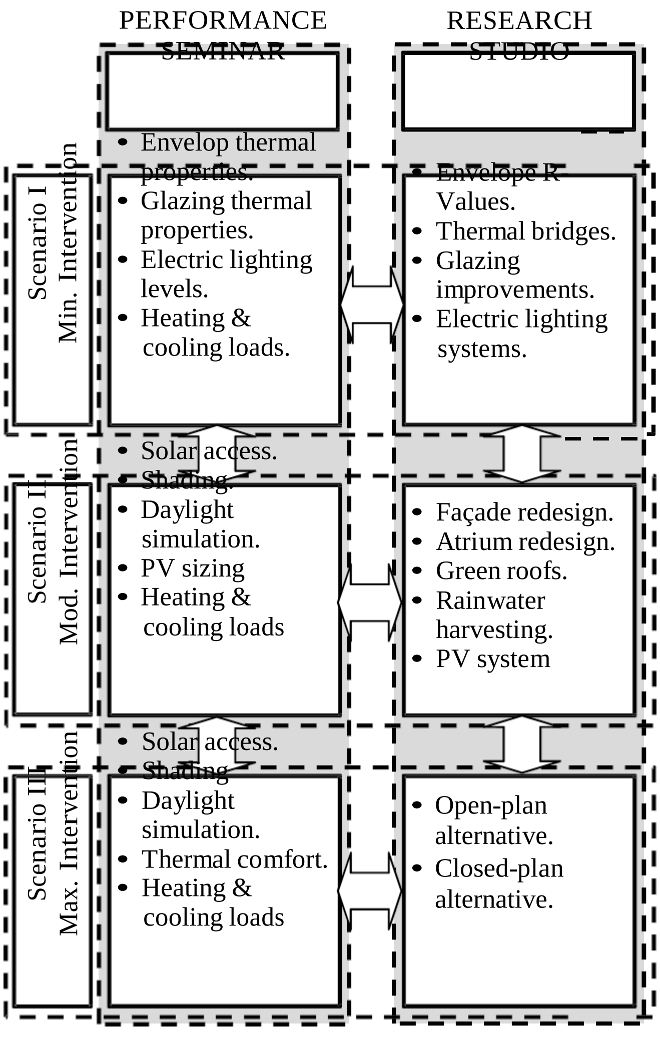

Fig. 1: The studio/seminar model structure

important aesthetic and functional consideration. The seminar, on the other hand, introduced students to several performance-related topics and digital performance simulation and decision-support tools used to assess building environmental performance metrics, and inform the design process. Topics covered in the seminar included:

(1) Climate analysis.
(2) Analysis of site natural resources.
(3) Solar control and shading.
(4) Daylight analysis and simulation.
(5) Simulation of heating and cooling loads.
(6) Whole building energy use simulation.
(7) Sizing of photovoltaic and rainwater harvesting systems.

Most of the performance simulation and analysis tasks conducted within the seminar/studio utilized the simulation tool Autodesk ECOTECT Analysis (Autodesk, 2009). . ECOTECT is a building design and environmental analysis tool that includes a range of simulation and analysis functions, and which is designed specifically for an architectural audience. ECOTECT aims to allow designers to work easily in 3D and apply all the tools necessary for the needed performance analysis. Other simulation tools used within the seminar included Climate Consultant 4 (Milne, 2008); Radiance and DAYSIM (NRC, 2004), used to simulate daylighting performance, and eQUEST (Hirsch, 2003), used to perform building energy use simulations.

Unlike traditional studio structures, participating students were tasked with collectively developing a single renovation proposal for the building that represented a hierarchy of three intervention scenarios: minimal, moderate, and intensive. The scope of each scenario and the issues to be addressed within it were determined by the instructors and will be described in more detail below. This approach aimed to offer the UTSA Office of Facilities Management a range of options for building upgrades and improvements, as well as to provide to the students with a unique team-working experience. Students in both the studio and the seminar were divided into three groups, and each was tasked with developing one of the three renovation scenarios. Each of the three scenario groups was further required to coordinate with the other groups so that each scenario builds on, and becomes a continuation of, the previous scenarios.

Within each scenario group, the seminar students were responsible for conducting the performance analysis tasks needed and providing feedback to the studio students to inform their design decisions. Two students were enrolled in both studio and seminar and were responsible for exchanging information and maintaining coordination between the two. This format provided the students with a unique, and multi-layered, group work experience in which they needed to collaborate with colleagues within their immediate group, while at the same time maintaining a high-level of coordination with the other groups.

2.3 The Arts Building

Similar to previous collaborative efforts, the authors based their selection of a target building for this project on the premise the building(s) in which educational programs are located play an important role in influencing students' learning (Orr, 2002). The authors further believed that integrating sustainability issues into educational curricula is best achieved through projects that encourage students to take an active role in addressing real life problems, and in projects that focus on improving the environmental performance of campus buildings because of the unique opportunities these projects offer by allowing students to have a positive impact on their immediate environment.

Based on this, the authors selected to implement the project on the UTSA Arts Building at the university's main campus (see figure 2), The Arts building is one of the university's original structures, designed by Ford, Powell and Carson,

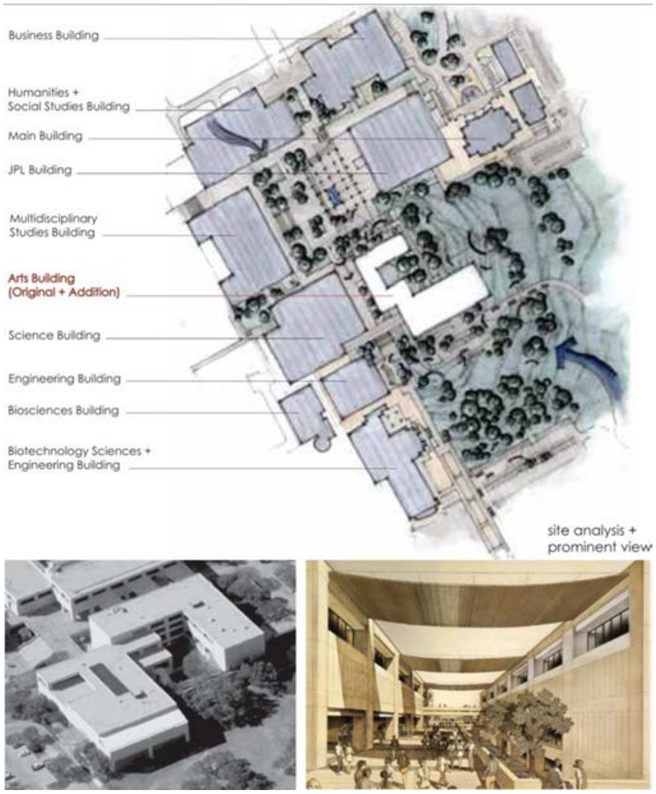

Fig. 2: The UTSA Arts Building, designed by O'Neal Ford.

and constructed in 1973, with an addition designed by Bartlett Cocke and Associates in 1980. As such, this precast concrete building possessed a level of architectural significance both within the campus and in San Antonio. In addition to offering students the potential to make their campus environment more sustainable, focusing on the Arts building also provided students with the opportunity address the unique set of challenges typically encountered in existing buildings' renovation projects.

3. <u>THE THREE INTERVENTION SCENARIOS</u>

As stated previously, students in both studio and seminar were divided into three groups, and were tasked with developing renovation proposals for the building that represented three possible and increasing levels of intervention. Proposals developed by each scenario group were considered as the starting point for the proposals of the more invasive scenarios. As expected, the existing status of the building's envelope and systems reflected the standards prevailing at the time, but were far from what would be required under contemporary codes. Students were tasked with developing realistic proposals for addressing these issues at the increasing levels of intervention mentioned above. The following describes the scope and limitations of each scenario:

3.1 <u>Scenario I: Minimal Intervention</u>

The first scenario group was allowed to propose 'behind the scenes' upgrades that would not affect the appearance of the building. The scenario focused on upgrades to three specific building systems:

(1) The opaque envelop elements, which have minimal thermal insulation (R-2 for original building, and R-4 for addition). The structural elements of the precast concrete system also provided very large thermal bridge areas.
(2) The glazing system, consisting of single-pane glass with metal frames, and the similarly-constructed atrium.
(3) The electric lighting system, which was clearly over-designed and, in most cases, consisted of old and very inefficient lighting fixtures.

Students in this scenario were tasked with auditing existing conditions in the building, researching alternatives of the each of the three systems above, and using performance simulation and decision-support tools to compare these alternatives and identify optimum ones. This included calculations of overall R-values of façade elements as well as simulations of cooling / heating loads using ECOTECT. The final proposals of this scenario became the starting point of the other two scenarios. While HVAC systems in both buildings were clearly outdated and in need of renovation, this was considered beyond the scope of the studio and possible HVAC renovations were not addressed.

3.2 <u>Scenario II: Moderate Intervention</u>

The second scenario group was asked to develop additive elements to the building's envelope without impacting its internal space arrangements and uses. This included a complete redesign of the building's facades to improve its environmental performance while being responsive to its original architectural language and the status of the building within the campus. Façade redesign proposals developed by the group (see figure 3) included: 1) shading systems for both existing glazing and outside corridors, courtyard, and terraces; 2) green screens to protect the building's south and west facades; and 3) LED screens to display student work. Other renovation proposals included green roofs; a rainwater harvesting system; and a PV system. These proposals were supported by simulations of solar access and shading for different façade elements and orientations using ECOTECT, as well as sizing calculations for PV and rainwater harvesting systems.

3.3 <u>Scenario III: Intensive Intervention</u>

The third scenario group was given license to strip the building down to its concrete structure and envision new arrangements of interior spaces as well as reevaluating its fenestration, cladding and insulation. Proposals for re-arranging internal spaces were informed by interviews with

Fig. 3: Proposed façade modifications

Fig. 4: Scenario III alternatives: open vs. closed-plan.

representatives of different user groups in the building including students, faculty, staff, and facility personnel.

Students in the group opted to pursue two alternative proposals (figure 4). The main difference between the two proposals concerned the status of the circulation system in the building. In the first alternative, public and circulations spaces were enclosed and air-conditioned; while in the second alternative, these spaces were assumed to be open and passively cooled/heated. Other proposed modifications were generally similar between the two alternatives.

4. STUDIO ACTIVITIES & OBSERVATIONS

4.1 Improvements from Previous Model Implementations

In developing this project, the authors aimed to build on the strengths and avoid the limitations identified in previous implementations. This resulted in several modifications from previous offerings that can be summarized as follows:

(1) While previous implementations of this model involved a junior level studio, this iteration involved a senior level research studio. This was meant to attract students with a higher level of knowledge and skills.

(2) Unlike previous offerings, the first author co-taught the studio in addition to teaching the performance seminar. This allowed both authors to be more actively involved in the activities of the studio.

(3) The pairing of one studio student with one seminar student, used in previous offerings, which occasionally resulted in ineffective collaborations, was replaced with the group structure described above.

(4) The simulation tasks performed by the seminar students were tailored to meet the needs of each scenario.

(5) The scheduling of the seminar and studio activities was modified to allow for a higher number of iterations in the performance analysis/design sequence, which was previously seen to produce higher quality results.

4.2. Use of Performance Simulation

Within this project, Autodesk ECOTECT Analysis was used to analyze the natural resources of the projects' sites, by conducting solar access and shadow range studies; to design shading devices; and to perform daylight analysis (see figure 5). ECOTECT's Weather Tool was used to perform climate analysis. Energy use simulations were also performed using eQUEST. In general, the effectiveness of the simulation tasks in informing design decisions within this project was found to be higher than previous implementations of the model. This was due to several reasons including: 1) the involvement of both authors in the studio thus allowing for better utilization of simulation results; 2) the restructuring of the simulation tasks to better fit the needs of each scenario; and 3) the reliance on two students with concurrent enrollment in both studio and seminar to coordinate the exchange of information.

4.3 Participation of Local Professionals

During the project, students benefited greatly from the experiences of several prominent local architects, from some of the leading design firms in San Antonio, who participated in a number of interim reviews for the project. Most notable of those was Mr. Boone Powell, of Ford, Powell, and Carson (figure 6), who is one of the designers of the original building, and who provided students with valuable insight regarding the rationale behind different design decisions. These reviews proved to be extremely

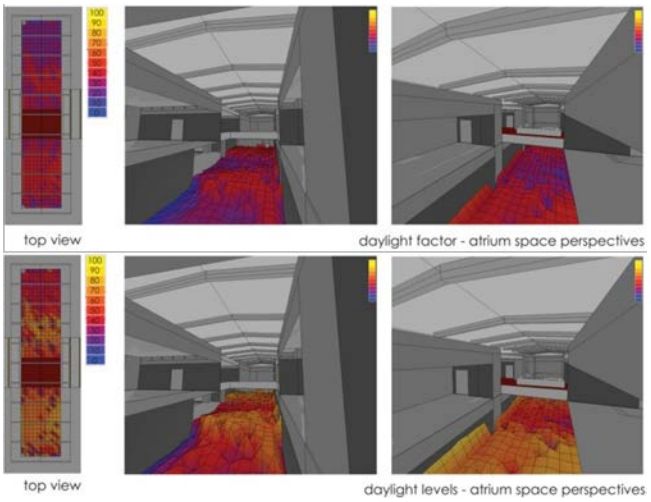

Fig. 5: Daylight simulation: above) original condition, below) proposed modifications.

Fig. 6: Boone Powel, designer of original building reviewing student proposals.

valuable both in improving the quality of the project as well as in increasing the enthusiasm of the students.

4.4 The Final Project

Concurrent with the design proposals, the class as a group designed the final graphic presentation of the project, culminating in approximately 25 boards that described in detail the three levels of intervention, including the graphic results from the performance simulation tasks. The project boards were exhibited in an end-of-semester event and were later exhibited in the 2010 Convention of the Texas Society of Architects (TSA) and the AIA San Antonio Newsletter.

5. PROJECT ASSESSMENT

The project described in this paper represents a continuation of a previously successful model to integrate environmental performance criteria in architectural curricula. The project aimed to build on lessons learned from previous model implementation. Based on an analysis of anonymous student evaluations, feedbacks of guest critics, including local practitioners, faculty colleagues, and other design professionals, the following could be concluded:

(1) Implementing the model in a senior-level “research” studio proved more successful than implementations in junior level studios. This was both because of the higher levels of student knowledge and skills, as well as because the research studio format was a much better fit for the experimental nature of this model.

(2) While the group-work format of this project was initially hard to adapt to for some students, who were more accustomed to doing their own design work. However, as the semester progressed, students became much more accepting of this format and appreciative of the advantages it offered. By the end of the semester, the group developed a sense of collective ownership of the project that had a very positive impact on the final product and its success.

(3) Similarly, students tasked with working in scenario I initially expressed some dismay with the tasks involved in it, which seemed to them to be of less value and not sufficiently design-oriented. This attitude also gradually changed as the work progressed and the impact that scenario I tasks had on the overall development of the project became clearer. Reviews from local practitioners, who confirmed the importance of these tasked, also played a positive role in this regard.

(4) The use of simulation tools continued to be an advantage in making students better appreciate the environmental impacts of their design decisions. Additionally, as discussed in section 4.2, performance simulation outcomes were generally better integrated into the design decision making processes in this implementation compared to previous iterations. Having an iterative process of design and simulation also continued to have a strong positive impact on the quality of the projects. (5) Similarly, the focus of the project on improving the environmental performance of a campus building continued to be a clear strength and students generally expressed their appreciation of this in their anonymous evaluations, thus supporting the premise of the project.

(6) The project was also very well received by local practitioners who expressed their support for the project premise and their appreciation of the issues and skills addressed within it.

With regard to obstacles and limitations, the following could be observed:

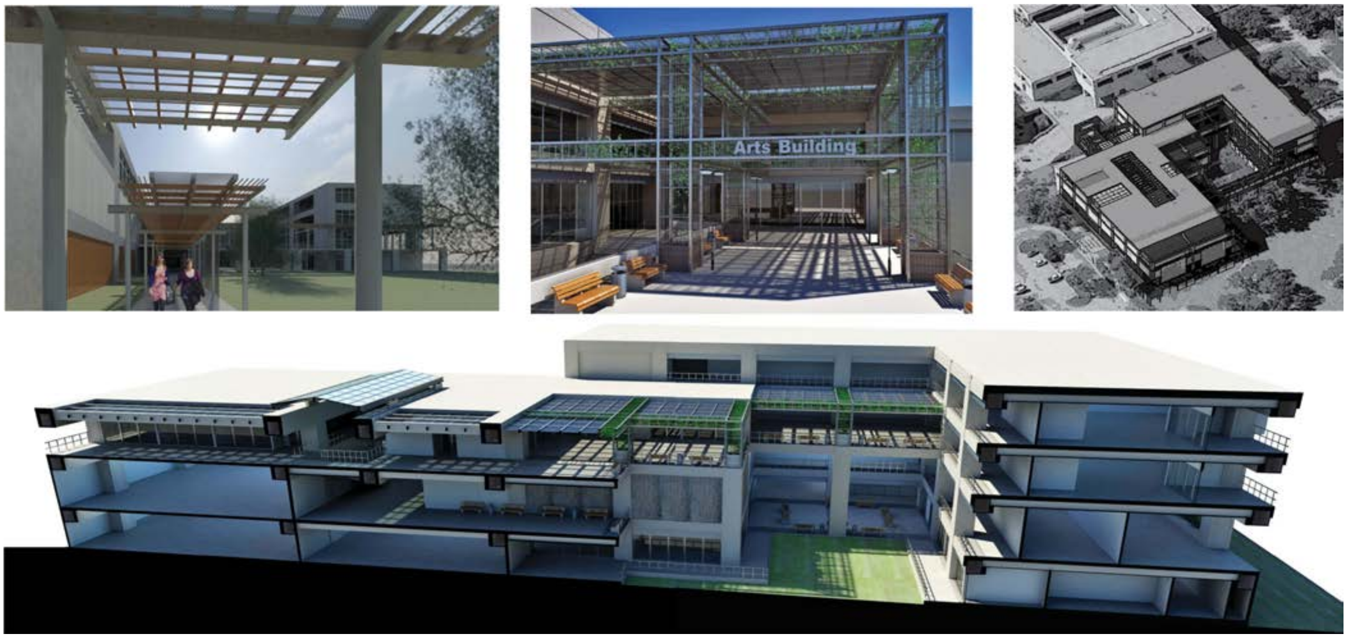

Fig. 7: Final project model.

(1) Scheduling conflicts between studio and seminar students remained a limiting factor, although having group coordinators with concurrent enrollment in both classes reduced the negative impact of this issue from previous implementations.
(2) Initial skill level of students, especially with regard to familiarity with digital modeling tools, also remained an issue of concern, and some students still required some time to adapt to the studio's high emphases on using these tools. Again, however, implementing the studio in a fourth-year studio reduced the impact of this issue from previous implementations.
(3) Seminar students, on average, did not develop the same sense of ownership and pride in the project as studio students. This may be because they had less time to interact with each other and with the project.

6. <u>CONCLUSIONS AND RECOMMENDATIONS</u>

The analysis above indicates the project was generally successful in achieving the objectives set forth for it by the authors. The continued success of this innovative and experimental model further supports its premise that projects focusing on improving the environmental performance of campus buildings offer strong potential in integrating environmental performance criteria in architectural curricula. The success of the project also further indicates the existing potential and need for breaking away from the conventional, form and image-based, studio format and adopting alternative models that allow for the consideration of environmental performance criteria as one of the factors informing the design decision making process.

The project also indicates that strong potential exits to increase the use of performance simulation tools in design studio s. This issue continues to gain importance as more design firms explore moving towards BIM technology and Integrated Project Delivery models, in which these performance simulation tools can play a very important role. While the use of simulation tools in early design stages is still not common-practice in the profession, this project illustrates the advantages these tools offer especially when introduced to new generations of architectural students.

The continued support from the College of Architecture for the implementation of this innovative model indicates their support for the integration of sustainability into the architectural curriculum. However, similar to many other schools of architecture in the country, much more needs to be done to explicitly integrate sustainable design issues, including environmental, social, and economic sustainability considerations, into all parts of the architectural curriculum. The potential indicated by the continued success of this model, however, indicates that such integration is certainly possible though likely not easy to achieve.

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A Triple Purpose Solar Demonstration Project

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ABSTRACT

Students at the Eden Valley-Watkins High School, participating in the state wide "Minnesota Schools Cutting Carbon" program, recognized solar energy would have great educational impact on our school, school community and the broader community. Although wind energy is displayed prominently in western Minnesota with commercial wind farms and farm water pumps, there are no examples of solar direct conversion in our community. Some of the students weren't even aware of the possibility of harvesting solar derived electricity. We had the challenge of introducing solar energy to our instructors, classmates and rural community. This paper reviews the components of our student project and challenges faced in design and presentation to the communities, including presentation formats and emphasizing the curriculum development undertaken by the students.

1. INTRODUCTION TO THE CARBON CUTTING PROGRAM

The Eden Valley- Watkins High School's Green Team called Carbon Cutting Eagles, is a student group lead by Stephanie Wirz, the project manager/president of the group. The group was awarded a grant of $10,000 to install a project on the campus called "A Triple Purpose Solar Demonstration System". It includes 3 components: reducing our carbon-footprint using solar energy, educating community members, and educating k-12 students in energy efficiency and renewable energy. Designing and construction of the solar equipment was a lot of work, but it paled compared to trying to develop curriculum and the students efforts to learn about energy. For the 20 plus members in Carbon Cutting, working on the school's solar project was an eye-opening experience. The whole system was installed between January and May 28th of 2010. The experience was very educational, and students were present every step of the way. Our team was put in a business situation, the grant had a deadline, and the student's availability after the end of school appeared limited. As the group's leader I definitely noticed changes in maturity of my classmates and myself, and the educational benefits of doing a small (1.3 kW) solar tracker project. We met our deadline of May 28th and worked through the summer to put the community education classes together for the fall. However the 3rd task, developing curriculum, was delayed until late August.

2. PROCEDURE

One of the biggest challenges we had was finding where to start with the design of the program such that it would fulfill our desires and address concerns for environment and energy. Our goal was to affect as many citizens as possible through education and demonstration. Presenting our ideas through the project hardware, community outreach and incorporating as much curriculum as we could into the already developed k - 12 curriculum. The objective is bringing adults and students to make environmentally friendly decisions when it comes to careers, home-owning, consuming, raising their families, etc.

2.1 Hardware Design

With the MNSCC program we were offered the chance to compete for a grant up to $20,000. We entered and won $10,000. In preparing the proposal students consulted magazines, catalogs, and internet sites. We were lucky that one classmate's grandfather, a former solar installer, reviewed our designs. The goal of making a visual impression was paramount and led to the selection of a pole mounted solar tracker at the southwest door of the school. Additional design features included a kiosk in the school entrance displaying the solar energy production and operation.

2.2 Community Involvement and Fund Raising

The Carbon Cutting group is split into departments, one of which is called the Marketing Department. This department was in charge of getting people to the group's events. By writing up columns for the local newspapers, making creative posters, and passing out invitations to people who were most likely to attend they got the community involved. The community was also present throughout the project another way. Most of the donations came from within the Eden Valley-Watkins area in forms such as supplies and labor. Another department that Carbon Cutting has is a Finance Department. Their job is to search out and apply for grants, manage the money flow through the account, and ask for donations from businesses and organizations. Carbon Cutting doesn't do a formal fundraiser, like cookies or pizzas, because there are too many of those in our small community.

2.3 Construction Considerations

The students participated in all phases of the construction. With the volunteer-donation aspect of the involvement of the contractors, students could choose to work with the excavation, pole and foundation, or the electricians. Electrician's said it was like having five apprentices. Others worked with reporters to get the news into the local paper and still others did record keeping and project coordination.

3. CURRICULUM DEVELOPMENT

Another challenge we had was finding what needed to be taught and how our curriculum could fit into existing programs. It came down to 2 questions: what the students need to know to fulfill our goal, and what they had already learned.

3.1 Adult Education

We answered the first question by doing a survey of the community members attending our community education classes. The community feedback was the key to determining what the "green" curriculum should include because they had already earned their degrees, bought their houses and cars, and started raising their children. It was important to hear what they wished they would've learned in school so that students aren't wishing the same things in 10-20 years. Some of the topics that the community voted on covering in the classes are:

- How to do a home energy audit/ green home improvements
- Tax credits, rebates, and incentives for being "green"
- How to analyze your energy bill
- Home energy conservation, fixing the envelope

Furthermore, our group decided to add renewable energy courses to the existing adult education offering. We formed committees to attract topic speakers and include our own solar equipment and its performance in the presentations. The developed and offered courses were successful having attendance of 20 to 40 adults, which is as successful as any offering in the adult education series. The offered courses included:

- Residential Solar Energy: costs and benefits
- Small wind installations real world results
- Ground Source Heat Pumps what is required

3.2 K-12 EERE (Energy Efficiency and Renewable Energy) Needs Assessment

Every other Friday at school, there is a 20 minute period of basically "home-room" in the high school. Groups of about 20 students go to their "advisor" room and take surveys that are usually about bullying, peer pressure, etc. This was a good time to survey the seniors! Being that they had gone through k-12 and were about to enter the world as young adults, we were interested in seeing how much they knew about the world ahead of them. The results were poor.

- 32.5% had a basic understanding of how solar energy systems worked
- 67.5% could name 4-5 energy saving tips
- 45% knew what kWh stood for (taught in 9th grade science!)
- 25% knew what a CFL was
- 17.5% knew (within 25 cents) how much one kWh costs from their power company (these are future homeowners, they should know how to analyze the bills they'll be paying!)
- 60% knew basic recycling guidelines

Results like that don't simply come from not teaching about alternative energy- which is what we were originally going to do. Our group had to stick lessons and green curriculum into multiple places.

3.3 Integration with Existing Curriculum Working with Teachers

We started by going through the state standards and looking at classroom lesson plans. We modified our ideas and are building lessons to fit into the already established curriculum. Our administration very concerned about our project and they have been willing to help integrate our proposed curriculum. Here are some of the places we found to stick "green" curriculum. We are currently working on getting all of the teachers on board. Our plans are for high school students to work with the teachers and bring these proposed lessons and demonstrations to the classroom.

3.3.1 Starting with Habit Forming

K-2nd graders presently aren't required to learn about renewable energy, the concept is believed to be too difficult. But this is when teaching about recycling, energy conservation, and introducing the idea of wind mills/solar panels etc can be made a priority. Awareness and habit forming are essential to the long-term goals of our group.

Working with young children can also help gain popularity for being environmentally friendly by clearing up misconceptions about environmentalists (typically labeled tree-huggers). We originally thought games and easy lessons would make teaching them easier. We learned that this isn't true because they don't retain information as well when they're not being tested on the curriculum. This curriculum, which should fit into the "homeroom" time or the natural science hour, needs to seem like part of the normal curriculum-not something added.

3.3.2 Giving Ownership of Ideas

3rd graders study sound waves, which is the introduction to the concept of energy itself. 4th and 5th graders learn about conduction/convection, batteries, and energy flowing through a house. At this stage, students begin to assemble projects in an individual way. We are trying to develop a series of hands-on and thought based projects the students could develop and present to their class mates. It would use a bigger emphasis on the actual home energy systems and what can be done for future homes. 6th graders study systems, engineering, and transferring energy. Here is where whole systems (like solar) would come in. We even bought 2 extra solar panels to be used in the classroom this way. While talking about transferring energy, this makes a great tool for demonstration and experimentation.

3.3.3 Diversifying and Specializing the Topics

Middle and High School is where the integration gets more difficult. The students begin taking a variety of courses and a variety of learning objectives. Integration is not only needed in science but in social studies and home economics.

7th grade: In 7th grade our school requires all students to take FACS class- Family and Consumer Sciences. It seemed like the perfect place to put information about green purchasing, but through discussions with teachers we have learned that the 7th graders wouldn't learn or take as much interest in this as we want. This is evident when looking at the number of times some of the same topics are covered in the state standards between 4-8th grade. Our team decided habit forming would be good here again. After the teacher goes over healthy eating habits, she fits in a week long unit about not wasting. Because it stems from the healthy eating unit, students learn how to make good decisions about only taking what they need, reducing, as well as reusing and recycling what they don't.

8th graders learn Earth Science and do a review of what they learned in 4th grade. We found there are about 4 days in the curriculum where fossil fuels are covered. A modified version of that lesson is one where students have to identify why fossil fuels are bad for the environment. After that, they break into 10 groups and each group does a presentation on some sort of alternative fuel.

9th grade: Physical science includes units. When going over units of energy (kW, W, megawatt) teachers should put the units into perspective. Students can see how big a yard is by holding up a yard stick, but how do you show someone how much a watt is? Explaining that by using examples like: kWh's are how your energy bill is calculated- would give a clearer idea for students. That would also be a great time to talk about the cost differences between units and across the country.

10th/11th/12th grade's classes are combined, and very few are required.

Economics: Everyone is required to have an economics credit. Here is where green purchasing could be taught. When talking about rate of return on a purchase, the economics teacher can simply hand out a situation like purchasing a large residential solar system or a wind turbine.

Drafting: The drafting class could study a unit on Passive House design- a personal favorite of mine!

Comp 2: All students in MN are also required to take Composition 2. It's basically a class that is supposed to help students figure out what they want to do with their lives. A good portion of the class is about jobs. What a great place to stick a unit on all of the different types of "green" jobs! We are still working on finding the right place to put this lesson in that class.

Independent Living: This class is for students who don't plan on going to college. A big review of the green curriculum they've learned so far, plus a unit of analyzing their bill, green tips, etc would fit perfectly in this class.

Computer Graphic Arts: This class put together the slideshow in the kiosk in the High School entry way that shows the amount of energy our system has produced, pictures, etc. It exposed the students to solar energy. We are trying to have them work on a Carbon Cutting website as well.

Another thing we've done this year and last year was a Green Fair. The fair is open to everyone in 7-12th grade and students can gain extra credit in the class their project relates to by turning their score sheet into the teacher. First through third places also get prizes and are moved on to the Earth Day festival in New London-Spicer. Last year the green fair was a huge success. We had guest speakers, displays, and even prizes for the community members who came!