Autodesk Building Performance Analysis Certificate

Demonstrating Thought Leadership in Education

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ABSTRACT: The Autodesk Building Performance Analysis Certificate is an educational program for architecture and engineering students who want to prove and improve their fluency in the strategies and tools of sustainable building design. The program is an online learning path with associated online tests and software exercises that is rigorous enough to have real merit, is synergistic with coursework, and can be done on a student's own time. Supported through the Autodesk Sustainability Workshop website, it is an online, open book series of questions and exercises that are design and workflow-oriented across multiple software platforms. This paper outlines the research and development of the program thus far in preparation for the global launch in August 2013. It also describes outcomes and future work gathered from test pilots conducted in the Summer and Fall of 2012.

Keywords: education, fundamentals, software, analysis, workflows

1. INTRODUCTION

In the building science community, it is a well-known fact that buildings account for over 40% of energy consumption in the US. This attention grabbing fact often acts as a call to action for the building industry to reduce the energy consumption of buildings and contributions to global emissions and other environmental issues. Coupled with this plea are initiatives, legislation, and regulations like Architecture 2030, California Energy Commission's Title 24, and the US Green Building Council's LEED building rating system. The reduction of building energy consumption is quickly maturing from a want to a need. The problem is that many designers and engineers do not have the skills and experience to fill that need.

A recent survey of 448 American Institute of Architects (AIA) members found that 56 percent of the firms surveyed "reported difficulty finding employees with adequate green skills." For small firms, that number is even higher at 72 percent (Hanley, 2012). This skills gap must be filled in order for the building industry to be able to reduce its energy consumption and environmental impact, and it starts by filling a gap in building science education.

2. EDUCATION NEEDS

Current students have desires and intentions to make a positive impact and make the world a better place. For students interested in building design and construction, this desire aligns with sustainability and lessening the environmental impact of buildings (EDUCATE Project Partners, 2012).

Unfortunately, sustainable building design practices are usually not yet part of the mandatory curriculum for architecture and engineering students. The topic is still slowly being introduced into academia, if at all. Academia is falling behind industry practice and industry demand (Mazria, 2012). Sustainability should be a key component in the education of architects and engineers to meet industry demands (EDUCATE Project Partners, 2012).

Thus, students are often left to their own devices to teach themselves sustainable design tools and practices. Given that there are numerous resources, concepts, and analysis tools that need to be understood, this self-teaching process can be confusing, cumbersome, and discouraging. Educators often want to incorporate building performance and energy analysis into their courses, however they too frequently run short of

accessible and reliable resources, or become overwhelmed at the amount of material.

An additional roadblock to understanding sustainable building design is current educational models, where theoretical knowledge is taught separately from practical application. This leads to a good base foundation of fundamental knowledge, but no clear path on how to utilize the information to impact design decisions (EDUCATE Project Partners, 2012).

2.1 Fundamental Knowledge

A basic understanding of how buildings are designed and constructed is the first requirement for learning about sustainable building practices. This need is met by the universities educating the students, or through professional experience gathered by students.

However, building upon this basic understanding with sustainable building design concepts is where academia often falls short (Rügemer, 2009). For example, students need to understand dependencies like: utilizing natural daylight for interior spaces can decrease the demand for electric lighting, but can also increase the heat gain inside a space and require more mechanical cooling efforts.

These fundamental concepts can be enough to encourage students to effectively improve their design, but it is also important to give students the case studies and references to go further. Information such as material properties, metrics, and practical applications can provide a deeper understanding of sustainable building practices (Rügemer, 2009).

2.2 Software Fluency

Computer modeling, and more specifically Building Information Modeling (BIM), is becoming standard in architecture and engineering courses. Quite often students know how to do basic simulations and analyses in these software programs, but do not always have the full knowledge to do them correctly (including understanding common errors and pitfalls).

A study conducted by Diego Ibarra and Christoph Reinhart compared daylight factor measurements of undergraduate architecture student models to best practice models. Conclusions from the study included “dramatic errors” when instructors provided no simulation guidelines; as a remedy, they suggested an “emphasis on the importance of high quality teaching material to complement simulation workflows” (Ibarra and Reinhart, 2009).

Perhaps more importantly, if students do not understand the concepts behind the simulations and analyses they are conducting, the results can become meaningless. An accurately simulated daylight factor serves no use if the student does not understand what it is indicating, and how it should influence their design.

The need for simulation guidelines, best practice tips, workflows, and software transparency is reiterated not only through Ibarra and Reinhart’s study, but also through student and educator interviews. The starting place for this information should come from the software company. It is their responsibility to provide accurate documentation and explanation of how their tools work.

2.3 Synthesis

To fill the current void in education, students need to be supported in learning building science fundamentals, and how to put these fundamentals into practice through software simulation. Educating students about fundamental design concepts and software practices together, instead of treating them as separate entities, will increase the student’s understanding and make them more fluent in putting these ideas into practice. The union of fundamental knowledge and practical application is essential for pushing the building industry forward.

3. A COHESIVE EDUCATIONAL PROGRAM

The Autodesk Building Performance Analysis Certificate (BPAC) is designed to meet the current education needs in sustainable building design. In the bigger picture, the program tries to provide students with the skills and knowledge required to drive an industry-wide transition to performance-based sustainable design.

The program ties building science fundamentals to Autodesk building performance analysis tools through an online course. It has been designed for architecture and engineering university

students seeking to improve their ability to design and optimize high-performance buildings.

Learning is supported by text articles, videos, case studies, software workflow tutorials, and links to external content for more detailed information. This online learning content is freely available on the Autodesk Sustainability Workshop website.

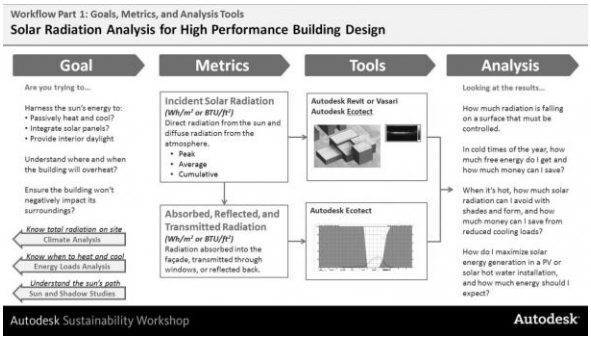

Fig. 1: Software workflows provide students with an actionable path, with ties to fundamental design concepts.

Software exercises give students practice using the concepts and software in realistic workflows, and then online quizzes assess the students' understanding and ability to synthesize these concepts.

While the program is self-paced and allows students to complete it on their own, the BPAC program has also been designed to be synergistic and supplemental to coursework such as studio projects or design competitions like the Solar Decathlon.

The topics currently covered are:

1. Climate & Weather Analysis
2. Sun & Shadow Studies
3. Conceptual Energy Analysis
4. Energy Loads
5. Wind & Airflow Analysis
6. Solar Loads Analysis
7. Daylighting Analysis.

For each topic, there are two quizzes: a fundamentals quiz and a software exercise quiz.

The fundamentals quiz is meant to test students on the basic concepts of the topics such as terminology, common practices, and case study interpretations. Questions are designed to require the students to synthesize and interpret the concepts, not just locate and regurgitate information.

The software exercises feature two to three evaluations of the student's proficiency in Autodesk software, and their ability to apply the fundamental concepts to design optimization. With datasets provided and instructions given as to what specific analyses to perform in the software, the questions ask students to interpret the results and make conclusions about design decisions. All the software exercises were designed to be "machine gradable."

4. DEVELOPMENT METHODOLOGY

To test the design and robustness of the BPAC program before a planned global launch in August 2013, three controlled pilot programs were planned. Two pilots have already been conducted in the Summer and Fall of 2012, and as of this writing, the third and final pilot is occurring in Spring 2013.

The Summer pilot included 31 participants who were already members of the Autodesk Student Expert Program. The students were asked to complete the program in an aggressive timeline of one topic each week, for seven weeks (both the concept-based multiple choice quiz and software exercises). After completing each topic, students completed a feedback survey with detailed questions pertaining to their learning experience, previous knowledge, question usefulness, and effectiveness of the supporting content. Additionally, a conference call was conducted with these students in which they voiced questions, concerns, and suggestions for program improvement.

The Fall pilot ran in alignment with the traditional college semester and lasted 12 weeks. Two groups of students participated in the pilot: 1) Independent students signed up to complete the certificate on their own, and 2) Instructor-led students were participating as part of an academic course. The pilot included 6 educators, who offered the certificate in their course as either a requirement or as extra credit.

In total, 222 students signed up for the Fall pilot, 88 of whom independently signed up. The feedback process was similar to that of the

Summer pilot in that students were required to fill out a feedback form after they completed each topic. A conference call with the educators was held at the end of the pilot.

During each pilot, a help-line was offered and open lines of email communications were kept with participants in the program.

In the interim periods between pilots, the feedback that was collected was evaluated and analysed to improve the program. Questions were changed, content was added, platforms were updated, and learning paths were made clearer in preparations for the global launch in August 2013. Additionally, industry professionals were also asked to review the content.

Even though it is still in its pilot phase, the BPAC program is quickly gaining popularity. The first pilot group from Summer 2012 had 8 out of 31 students earn a certificate. Round two, Fall 2012, had 91 out of 222 students earn the certificate. For the Spring 2013 pilot, over 20 educators and over 600 students participated. These numbers were achieved with no formal marketing efforts. All BPAC graduates are featured on an online roster.

5. CONCLUSIONS & DISCUSSION

Both the Summer and Fall pilot programs provided valuable insights about student learning patterns, educator needs, and software applications. These insights have been, and are currently being used to revise the content and user experience of the program.

Provide linear learning paths and consistent frameworks

At the beginning of the Summer pilot, students were only provided with one content link that served as a launching page for all the content pertaining to topic. While the link was straight forward, it was not always clear which concepts were pertinent to the topic and the site navigation made it difficult to follow the progression of the quizzes.

Towards the end of the summer pilot and throughout the fall pilot, playlists were introduced that helped make the student's learning path more scoped and linear. The playlist hosts all of the content and videos that are already on the Sustainability Workshop website, but guides students through the content in a sequence that not only builds upon concepts and software practices, but also follows the flow of the quizzes.

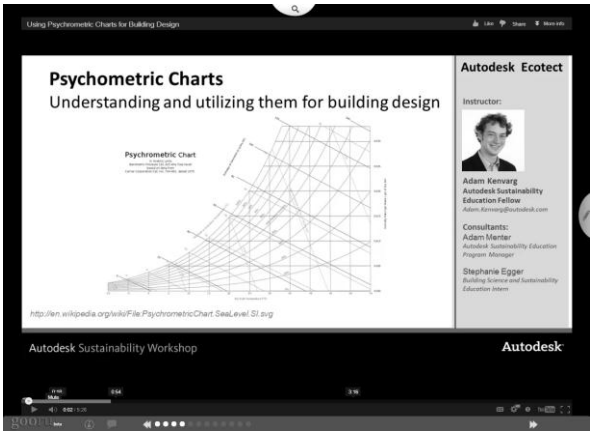

Fig. 2: Playlist viewer that presents articles and videos in a logical order.

At the same time, new website navigation was introduced with a stronger content taxonomy, so students could understand the concepts as part of a consistent framework. The new navigation allows users to parse through topics as they are related to fundamentals and software use.

Make the takeaways actionable

Another takeaway from the pilot programs was the need for more practical applications, and real project examples that put the concepts into practice. Fifty-eight percent of students from the Fall pilot responded positively that they would use the knowledge they gained from the BPAC program in future projects. However, during a final call with the educators who participated in the same pilot, their closing remarks were that they wished the program included more practical project examples, design practice, and detailed software guidance.

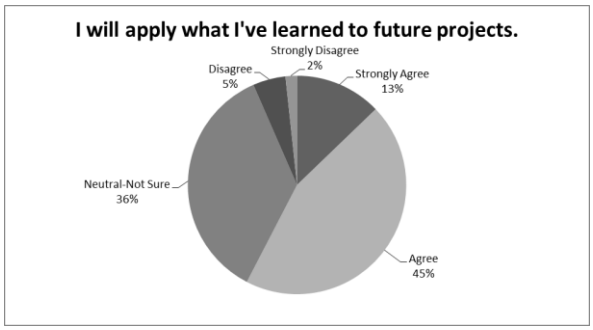

Fig. 3: Application to future projects from the Fall feedback.

Educators admitted that even after reviewing the content and passing the quizzes, their students were not always clear on how to apply their knowledge to their design projects. Additionally, they requested that the workflows be more detailed and specific.

This feedback brings up the issue of how much material the BPAC program can and should cover. For example, the program could feature a capstone style case study that requires students to perform a thorough analysis of all the topics covered, however when the program is used as supplemental material in an existing course, this may be too time consuming for the students and also raises difficulties in the ability for the quizzes and exercises to be machine graded.

Currently though, a compromise has been developed, in which an effort will be made to feature more pertinent case studies in the Sustainability Workshop Project Gallery to give students a sense of how all the fundamental and software knowledge can come to play in real life applications. Additionally, partnerships with professional architecture firms have been made in order to increase accessibility to case studies and relevant examples of sustainable building design applications.

Give instructors confidence and help fill knowledge gaps

Educators proved enthusiastic about using this material to introduce concepts in a classroom setting. They acknowledge that sustainable building design is an important subject - however their knowledge of all aspects of the subject may not be at an expert level. For example, instructors teaching BIM may not know many of the design concepts and instructors teaching design may not know the software tools. Furthermore, keeping up with the latest tools and practices is difficult. It is important that educators “continually evolve their knowledge base” so that they may properly prepare their students for the needs of the industry (EDUCATE Project Partners, 2012).

From the Fall 2012 pilot survey, students admitted that they had some experience with the topics covered in the BPAC, but were not very familiar with the concepts. These topics were new to 26% of the students, and only 5% considering themselves “Very Familiar” with the topics. Additionally, forty percent of the students were learning this material through their current coursework.

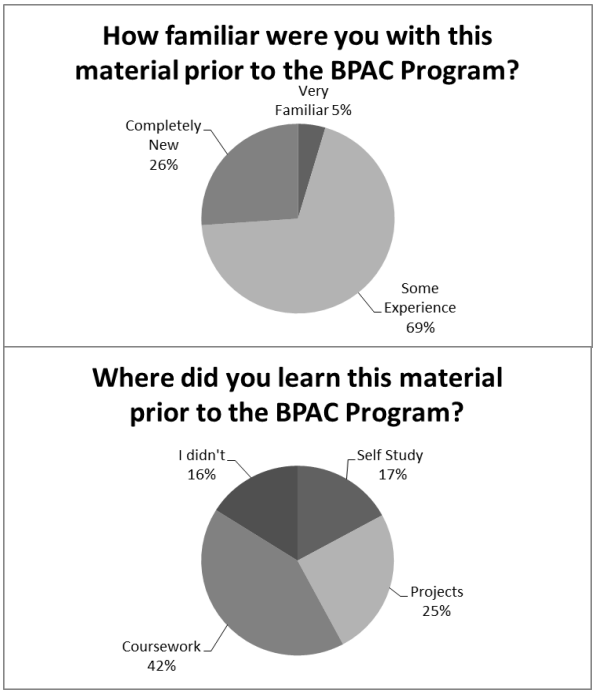

Fig. 4: Student experience with the material and where they were learning about it prior to participation with the BPAC.

These figures conclude that while the BPAC program can be completed independently without the guidance of an instructor, it is quite often the case that students are only being exposed to this material in the classroom. This course material can give instructors confidence to engage more with their students on the topic of sustainable design. A live student-teacher interaction is very effective for learning and instructor-led coaching sessions were often paired with a design studio project.

Response

All feedback received through the pilot programs has been valuable. It has helped to clarify the educational needs and methods necessary for improving the BPAC. More so, the feedback has underlined the need for the BPAC. Fig. 5 includes several quotes from students who have participated in the pilot rounds. These quotes reassure that the BPAC program is filling a hole in the current education system, and that the students see the experience as a valuable use of their time. Additionally, they acknowledge that information they learned can be applied to their future designs.

Fig. 5: Student quotes about the BPAC program.

6. FUTURE WORK

Still in the pilot phase, the Autodesk BPAC program is continuously adding new aspects in preparation for the global launch in Fall 2013. Plans include student design simulation awards, featuring more project examples, external content review, continuing work with industry thought-leaders, and packaging content as AIA and GBCI Continuing Education Units for professionals.

On a broader scale, there is an intention to create a community of practice around Autodesk's building performance analysis tools, with the BPAC program as a strong channel for gaining expertise. In an effort to bring together the building science community, students, educators, and professionals will have a space where they can interact and share thoughts, questions, and projects. This environment can provide new case studies, workflows, and practices.

The value in the Autodesk BPAC program lies in its ability to be adaptable. As best practices in the industry change and as new software is released, it is essential that the learning material that the BPAC is built from also evolves. As the global launch nears, efforts are being made by Autodesk to close knowledge gaps in their products and increase software transparency to build trust and confidence among new and current users.

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