

BIM and Sustainable Design: Understanding your Design Decisions



Renderings by Pecahra Studio

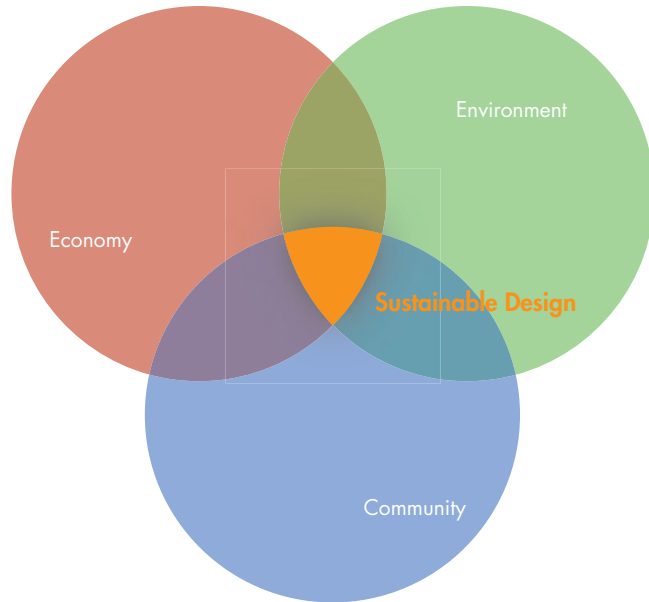
A Case Study of American Canyon High School

by Aaron Jobson, AIA, LEED AP



QUATTROCCHI KWOK ARCHITECTS

Sustainable Design has become another buzz word in the construction industry. With so many ideas and descriptions circulating, it's important to define what sustainable design is and how this process and Building Information Modeling (BIM) work together. Before Quattrocchi Kwok Architects makes a design decision, we consider the triple bottom line: the environmental, economic and community impacts. Our definition of sustainable design is achieved when we can positively affect all three areas. Building Information Modeling (BIM) tools provide thorough information to guide and improve design solutions. In the design of American Canyon High School, BIM facilitated our design decisions and helped achieve our sustainable goals.



American Canyon High School (ACHS) is a new 2,200 student high school campus located in American Canyon; a city in southern Napa Valley. The client, Napa Valley Unified School District, stipulated in the Programming phase of the project that the design incorporate sustainable strategies, where economically feasible.



Throughout the design process QKA sought to exceed these goals and design one of the most sustainable public schools in California. Currently under construction, the new high school will be the first school approved under the Collaborative for High Performance Schools (CHPS) Verified program.

Throughout the design process we used the CHPS rating system to organize and track our progress in a variety of sustainable design strategies, from site design to materials selection. American Canyon High School incorporates daylighting, natural ventilation, materials with high recycled content, materials low in volatile organic compounds (VOC) which contribute to poor indoor air quality, water conservation, a ground loop heat pump mechanical system, and a 500kw photovoltaic system which provides more that 25% of the school's energy. As a result the school will earn up to \$1 million in additional funding from the State of California.

When it came to site design, BIM was instrumental. The site for ACHS sits at the eastern edge of the growing suburban city of American Canyon. The site provides southeastern views of the adjacent hills and long views southwest across San Pablo Bay to Mt. Tamalpais, a regional landmark. We wanted the buildings and site features to frame these views and connect the campus to not only the local community but the greater Bay Area as well. As we modeled the buildings in ArchiCAD™, our BIM program, we were able to export the 3D model of the campus to Google Earth™. Through Google Earth, the design is displayed in a dynamic 3D environment which shows topography and aerial photos of the surrounding area. This definitively showed how our site design properly frames the views.



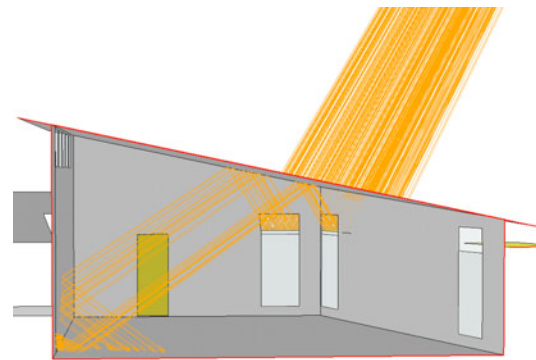
View of Mt. Tamalpais



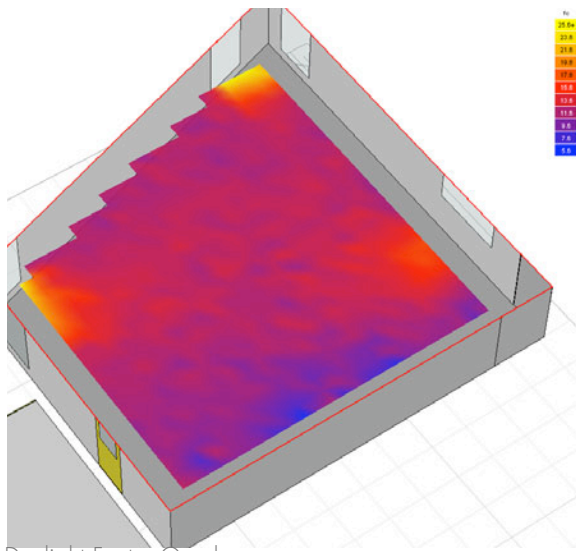
View of adjacent hills

For this project, the BIM model had the most impact on daylighting. Daylighting is an important design consideration for schools, as research has shown there is a connection between improved daylight and improved student learning. In conjunction with the design of the solar shades, we considered daylighting in all of the

classrooms. To help inform the daylighting design we imported our ArchiCAD model into Ecotect™, which analyzes a building model for a variety of issues such as air movement, acoustics, shading, thermal performance and daylighting. One aspect we analyzed was how sunlight reflects off the exterior sunshades and disperses in the room. Through a sun ray diagram the light can easily be adjusted for different times of day and days of the year.



Sun Ray Diagram



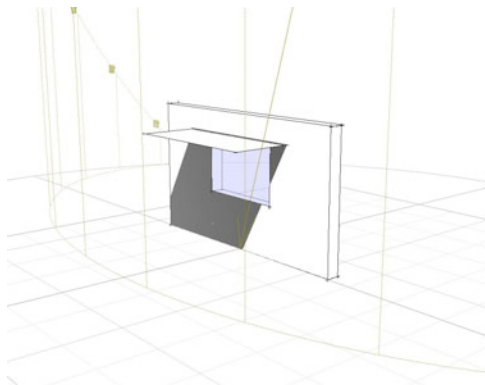
Daylight Factor Graph

Ecotect also analyzes the amount of daylight in the room and calculates an average throughout the year. The analysis grid can be configured to conform with the CHPS standards to show the light levels three feet from the walls and on a plane, thirty inches above the floor. Ecotect then creates a color coded graph showing the average light level in foot candles and the daylight factor. The analysis can be run with a number of different window and sunshade conditions to find the design that creates the best distribution of daylight.

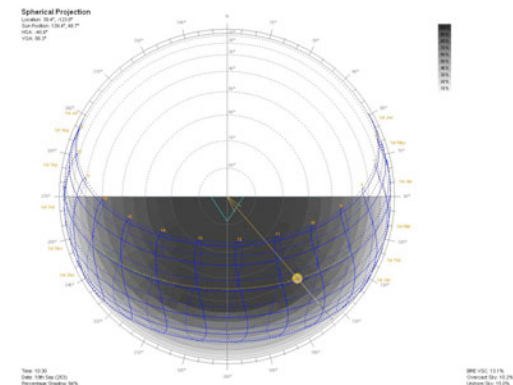
When configuring the exterior sun shades we also turned to BIM. From the early design stage, we included exterior sunshades for all the south facing windows, as well as the east and west, to reduce glare and control solar heat gain. The BIM model allowed us to accurately design the sunshades for our specific conditions. To do this we used the Ecotect Solar Tool; an independent program used to analyze a particular shading condition. A simple model is quickly created of the window in question. Then a variety of vertical and horizontal sunshade configurations can be added and manipulated.

As the sunshade configuration is manipulated, Ecotect Solar Tool generates a variety of shading diagrams in real time. The tool illustrates in one diagram, how the window is shaded at any time of day, on any day of the year. This is an easy way to evaluate a wide variety of sunshade designs and their performance. The level of

performance is then considered with other factors such as cost, maintenance, and appearance, before the final design decision is made.



Sun Shade Configuration



Shading Diagram

These are a few examples of how a BIM model provides quantitative analysis of different design scenarios to facilitate design decisions. It is important to note that in each case these applications were used as tools to guide decision making and did not replace or drive the design process. Building Information Modeling can be a powerful tool for making informed decisions to create more sustainable building designs.

Aaron Jobson is an Associate at Quattrocchi Kwok Architects, an award winning architecture firm specializing in educational facilities, located in Santa Rosa, CA. Aaron has lead QKA's transition to BIM and has been an advocate for Sustainable Design at QKA and in the community. Aaron was Project Architect for some of QKA's most successful projects, including Tamalpais High School, Live Oak Elementary School and American Canyon High School. This article is based on a presentation made at the 2008 Greentools for Health Schools Conference sponsored by the Collaborative for High Performance Schools (CHPS). For more information on QKA go to www.qka.com.