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The New California Academy of Sciences

30 November 2005

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Project Description

Founded in 1853, the California Academy of Sciences (CAS) is the largest cultural institution in the City of San Francisco, one of the ten largest natural history museums worldwide, and has a mission to explore and explain the natural world. CAS is under construction of a new building project that will re-conceive the tradition of natural history museums, and serve as a role model and inspiration to the world on how innovative design can achieve outcomes that are beautiful, functional and sustainable from an economic, environmental and social point of view. The project's impacts will be local, regional, national and international.

The new CAS will house 18 million natural history specimens and over 10,000 living specimens, and will include aquaria, a planetarium, rain forests, research laboratories, public exhibit space, an organic cafe, and administrative offices all under one green roof.

The new CAS will be at the forefront of green building design, showcasing world-class architecture that fully integrates green building features to reflect its mission to protect the natural world. Pritzker Prize Laureate Renzo Piano's design for the new CAS was inspired by the natural world, reflecting its beauty and interdependence, and works in harmony with the landscape surrounding the museum. The new building is designed to naturally fit into its Golden Gate Park (GGP) surroundings: the undulating living roof, covered with over two and a half acres of native plant species, will echo the contours of the landscape. Close collaboration between architects and engineers has yielded innovative strategies to help preserve the natural integrity of the park, conserve water and energy, reduce pollution, maximize natural ventilation and light, and use environmentally friendly building materials. Designed to meet the highest standards of environmental excellence, the new CAS is attempting to receive a "Platinum" rating in Leadership in Energy and Environmental Design (LEED) from the U.S. Green Building Council. Sustainability in the new CAS will also be an integral part of the exhibitions, organizational philosophy and day-to-day operations. The new building is designed to be an integral part of the community it serves and will be an educational tool. The public will be able to see and understand many of the principles of sustainable design and the building's operation, such as energy performance and production, water and indoor air quality, sustainable collections management and the green planetarium. Exhibits will explain the benefits of the living roof and other green components and systems in the building.

Opening in 2008 with an expected annual attendance of 1,600,000, the new CAS will set a standard of sustainable architectural design for civic buildings; teach the public of environmental stewardship, conservation and science; create programs to support a wide range of community members about ecology, healthy foods and biodiversity as well as the role the built environment plays in our world, and promote the need to protect the Earth's fragile environments. The new CAS is a City of San Francisco Department of the Environment green building pilot project and will be an architectural landmark in San Francisco

Project Data

Project Title: The New California Academy of Sciences
City: San Francisco
Country: United States
Type: Architecture (education)
Status of planning: Final design stage/construction started
Status of formal: permission approved
Start of construction: September 2005

Client: John Patrick Kociolek
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Target Issues and Criteria for Sustainable Construction

QUANTUM CHANGE AND TRANSFERABILITY

A major impediment to the development of sustainable strategies in the design and construction of buildings is the fear of high risk and cost. Our project has used a number of strategies to assess risk and reduce the potential negative impacts of utilizing green design approaches. These strategies include prototyping and pilot studies, as well as the use of 4-D modeling software to forecast the constructability of the myriad of building systems (structural, electrical, plumbing, etc).

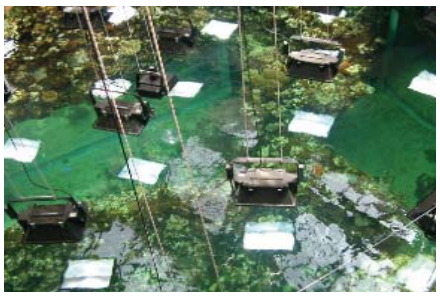
The new roof of the California Academy of Sciences will be comprised of over 2 and 1/2 acres of California native plants. Due to the undulating nature of the roof, the plant community will occupy a diversity of exposures, slopes and biological interactions as well as have a need for stable substrates able to support the plants with the nutrients and water regime they require. To assess which plant species could thrive in the climate regime of northern California, including a variety of exposures, slopes and nutrient/water combinations, the roof of the former building on the site of the new Academy was used to assess the viability of three dozen different plant species and several systems for soil mixtures and stabilization and drainage. During this process, the systems and species were not only situated on the roof, but in the courtyard of the old Academy buildings. In the case of the latter approach, the prototype was used as an exhibition to engage and inform the public of our approach and the "experiment" we were conducting.

A full-scale mock-up of a section of the roof was constructed to prototype and demonstrate not only the techniques required to bend the steel to achieve the significant degree of slope necessary for the roof's form, but then to plant the section to study plant species growth and associated mycorrhizal fungi below ground, and the native insect and bird species attracted to the species above ground. This second prototype allowed significant data to be collected on growth rates, root establishment and species viability, as well as soil retention and drainage and types of organic and sustainable components that could be used to help introduce and establish the plants. One example of this is that Rana Creek Nursery, who is helping to develop the living roof for the Academy, is developing a coconut fiber Bio-Tray for the plants. Features of this tray that will be used to establish the 1.8 million individual plants on the roof include: Providing immediate cover & root protection, developing alternatives to more typical sedum carpets & plastic trays, using a biodegradable product composed of waste material and constructed of materials that can be harvested in a sustainable way from Brazilian Amazon Rainforests. The Bio-Tray also supports indigenous cooperative enterprises in Brazil and has been prototyped through this project. It will be available to install the Academy's roof and for future projects as well.

Thus, this San Francisco-based project has international impact for developing sustainable businesses and product development and uses.

This prototyping component of the living roof also allowed us to gather real data on dry and wet weights of soil, and develop better knowledge of seismic performance of the building given these weights. We are now engaging in the development of prototype education programs that will make use of the building to explain scientific concepts that relate to people in the San Francisco Bay Area. For example, San Francisco has a considerable problem with storm water runoff and water quality. According to the State Water Resources Control Board, "... urban storm water runoff is the leading cause of water pollution in California." And in a single month in 2004 at just one of these beaches, water quality did not meet State of California standards 12 times. According to Heal the Bay , San Francisco beaches were closed over 40 times in 2004. The Academy's new roof is designed so that soils retain 1 gallon of water per cu/ft. of soil. The Academy's roof will retain 3.5 million gallons, or 98% of all storm water, annually. Runoff from the Academy's roof will equal 87,305 gallons, and all of that runoff will be detained and percolated into the ground plane. Thus, this is an excellent opportunity for groups to learn more about these issues, the benefits of a living roof, and see the purifying effects of the living roof versus traditional roofs. In addition, education programs will assess changes in biodiversity on the roof over time, and the timing, influence and long-term effects of invasive species.

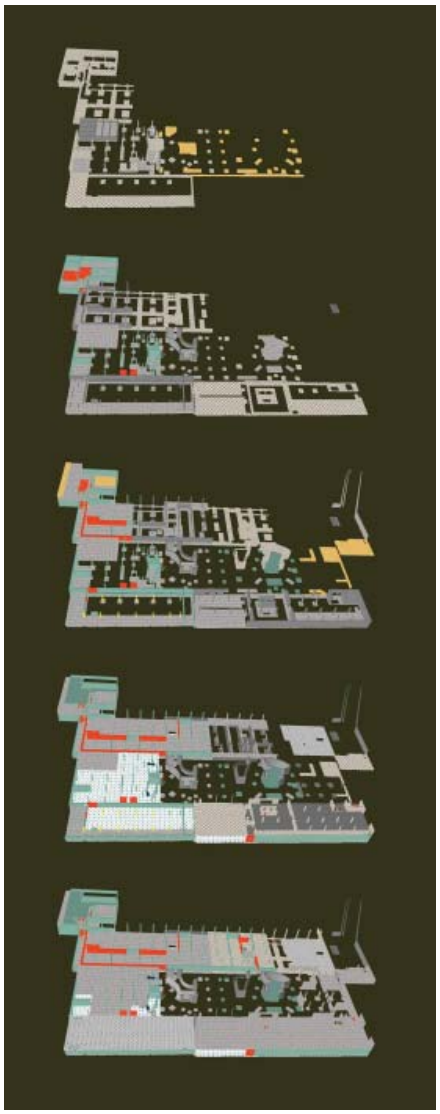
In addition to prototyping a variety of aspects of the living roof, a second area of prototyping has related to light levels, natural and artificial, to support two iconic exhibitions focused on the major biodiversity types in terrestrial ("Rainforests of the World") and aquatic (living coral reef exhibition) ecosystems, as well as heat gain in the building. Both exhibitions require high levels of natural light (for plant growth in the rainforest, and for coral growth in the coral reef exhibition). Lighting studies have determined the amount of light that the building can provide (through sky lights, the Piazza, and the placement of the exhibitions relative to sunlight). Extensive modeling has been done to establish the amount of sunlight that will enter the building and fall on the exhibitions. A wide array of actual testing of types of light sources has been done to understand the quantity and quality of light provided from artificial sources, and the ability of these sources to penetrate water (in the coral reef) and dense, living plant communities (in the rainforest), and for all of that to be done so that the building can still be naturally ventilated. A 20,000 gallon prototype coral reef tank has been built and is currently on display to the public in the Academy's transition facility, an aquarium and natural history museum open in the South of Market district of San Francisco. This tank allows us to assess light quality and quantity needs for several dozen coral species. Their light requirements, as well as nutrient, temperature and biological community responses will allow us to place these coral species, (raised in captivity—not requiring the collection of wild species) in the new, 250,000 gallon tank so that they are able to maintain populations over time.



The transition space has also allowed us to develop strategies so that aquarium tanks and systems from the original 1923 Steinhart Aquarium can be reused, and flexible systems (for an aquarium!) are being developed so that exhibitions can be changed out,and the methods for doing that will be modest, and the materials can be reused. Fronts of the tanks are interchangeable, and due to the system we have developed, tanks can easily be swapped. Systems have components that snap together, instead of plumbing requiring glue to hold piping together. The system at the new Steinhart will offer more flexibility than the current design.

The Academy's project is employing building information modeling (BIM) software (Graphisoft working with Navisworks) to inform the design and construction process. The modeling programs will be used for scheduling (overall and for selected trades), anticipating and remedying construction problems before they reach the building site, estimating costs associated with construction under a variety of scenarios, and identifying materials properties and their relationships to other materials in case they are incongruent. Understanding these elements up front should reduce change orders and requests for information from builders to architects. The models can also be used to anticipate full project life cycles and future maintenance costs.

While many museums turn their backs on nature , the new sustainable California Academy of Sciences will embrace and attempt to embody nature both in form and function. With 1.6 million projected visitors, this very public of buildings is designed to use natural ventilation, and a myriad of approaches where the building itself is an exhibition-a teaching tool for the general public. It will include one of the few sustainable aquaria and the first planetarium to employ green technologies (from the materials in the facility to purchasing technology from vendors who have utilized green business practices). Technology selection factors include power, heat and materials audit, and maximizing use of recycled materials.



The Academy's broad range of educational programs will interpret the building itself, develop tours to see how the building works on the roof and behind-the-scenes. Educational materials will be available within the Academy and on the web to teach more about green construction techniques generally and how they are applicable to individual homes and businesses. Docents, student interns and staff will be trained to convey these approaches to a large, diverse audience.

ETHICAL STANDARDS AND SOCIAL EQUITY

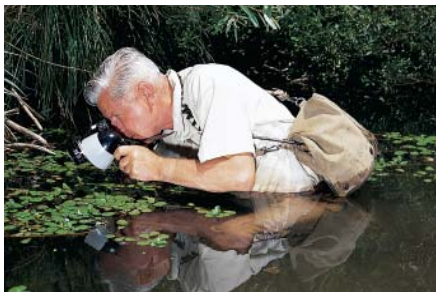
The Academy has been part of the social and cultural fabric of the Bay Area for over 152 years. It was the first home to the Sierra Club, helped establish Yosemite National Park and Big Basin California's first state park.. Our worldwide research on biodiversity, and educational programs focus on environment, ecology and sustainability. This project, then, is an expression and extension of our mission and century and a half of activities worldwide relative to our helping to protect the natural world.

Program

In terms of addressing social needs of our community, the project will serve 1.6 million visitors annually. Of those, 750,000 will be children of school-age (K-12), and over 200,000 others will be pre-school aged children. All schools in San Francisco send at least 1 class to the Academy every year (and they are admitted free of charge), and 40% of the schools from Monterey to California's northern border with Oregon send at least one class to the Academy every year. Each first Wednesday of the month the Academy is free to the public. We also offer neighborhood free days, where different communities in San Francisco are admitted free for specified weekends throughout the year.

Our building, exhibitions and research are all about conserving natural species and habitats, and having people in California understand that they live in a biological "hotspot" (Conservation International's concept of places in the world that have great and unique biological endowment that are also highly threatened). With these objectives in mind, we must remind our visitors that the built environment is also part of the solution to a viable future.

This will be done in several major areas. First the building will be an exhibition. Visitors will be able to go onto the roof of the new Academy, see the living roof and learn about how a living roof is better for the building as well as the environment. The roof will be an open air classroom for monitoring the native species there, the water quality of the rainwater runoff versus runoff from other building types. The energy produced by the PV will be highlighted and demonstrated on the publicly-accessible roof deck. In addition, tours of the building will be offered to highlight and demonstrate how the building works, the materials used and performance of conservation approaches.



Second, there will be over 100,000 square feet of exhibitions addressing biodiversity, ecology and sustainability. With the exhibitions will be educational programs, demonstrations, curricula for teachers, and tours. Related to the buildings, resources (physical and web-based) will be developed for distribution and include how-to materials for homeowners and builders, and displays and information will be developed by the Academy in collaboration with local energy providers, other nonprofits, San Francisco Department of Environment and businesses. Docents, student interns, and professional educators will help develop and deliver these materials.

Third, our cafe will offer a sustainable menu. Foods will be seasonable, obtained from local sources, grown by state of CA organic standards, and by farms that are run as sustainable enterprises (food quality, treatment of staff, etc.). Food –its variety, preparation and presentation will be "curated" in the sense that programming will be part of the cafe just as in the exhibitions area. The Academy has an endowment for the Anthropology of Food, and that will become part of the programming. Organic farmers, diversity of food and agricultural practices, and preparation techniques will all be highlighted. This approach is currently employed in our cafe in the Academy's transition site. After 18 months it has

been shown our visitors like this array of food offerings and will pay for them. In addition to the cafe, we will offer a "healthy foods" program, to schoolchildren from numerous communities, as both a healthy meal and learning opportunity about nutrition and health. The reach of the Academy will mean that children from all over northern California will have access to this program-several hundred thousand each year. Events catered at the Academy will also offer sustainable options only. All of these approaches were evaluated for operational and financial viability (on the part of the Academy and potential partners/ vendors) with the help of a grant from the Columbia Foundation.

Fourth, major stakeholders in the building project are the Academy staff members. The building itself, and the systems that the building will employ have benefited from intensive and extensive staff input. Some of this expertise dealt with work flow issues, the practical and most efficient ways to store, conserve, access and use the 18 million scientific collections housed by the Academy. Work environment, quantity and quality of space, adjacencies, and operational issues all have been directed by Academy needs. A detailed program was developed by the Academy, and we have tried to be proactive clients. This has all benefited from the expertise of nearly 400 staff members and over 1,200 volunteers.

Thus, no matter if you come to visit the museum exhibitions, explore the workings of the building, have a meal at our cafe, or work at the institution, there will be a seamless, consistent message about sustainability.

Stakeholder Involvement, transparency and political involvement
San Francisco is a very participatory place in terms of public (and private) institutions, places and programs. Although the Academy is a private organization, it is viewed as a public organization, and its setting in Golden Gate Park provides a higher level of scrutiny and involvement by the public.

While we are changing the physical nature of the Academy, we have also been changing the nature of natural history museums, aquaria and planetariums. To support this change, we held over 150 focus groups, including not only the Academy's staff and Board of Trustees, but also members of the Academy, bay area residents, school children, scientists from around the world and other museum professionals. We interviewed thousands of people about their aspirations for and concerns about the Academy's project. This involved many public meetings, meetings with politicians and local groups (Chamber of Commerce, school districts, and Park neighbors). Because the project is being funded in part with City general obligation bonds, (the result of 2 political campaigns--the Academy is the only cultural institution to pass two bonds, each requiring 2/3 of the vote to pass in support of a capital project), the project was discussed with a large number of people. This included elected officials, community leaders, a large number of City commission hearings, civic and community centers and open meetings at the Academy. In addition, approval for the project required EIR, Entitlement process and permits to begin work.

Several San Francisco commissions (Recreation and Park, Planning, Board of Supervisors.) also have held public hearings on the project. All approvals were given with unanimous support. No law suits have been lodged against the project.

Strict San Francisco and state of California provisions govern the working conditions of those involved in the project. All firms providing construction services (general and subcontractors) are required to prohibit discrimination in employee benefits based on marital and domestic partner status. These benefits are to be equal to the spouses of their employees. Every subcontractor underwent a formal prequalification process. Only those subcontractors that were pledged to incorporate labor and materials provided by Disadvantaged Business Enterprises (DBE) were allowed to bid.

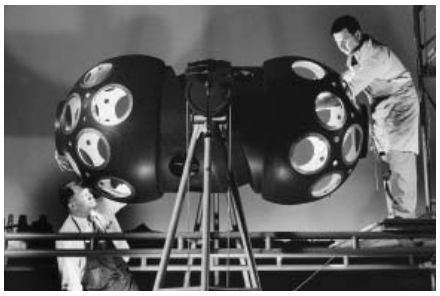
In an effort to increase the field of pre-qualified bidders and to encourage participation of a large population of Disadvantaged Business Enterprises, the general contractor (Webcor Builders) sent out letters to every registered DBE firm in San Francisco inviting them to participate in the bid process. Working with the City of San Francisco's Human Rights Commission, DBE contracting goals were established for all publicly bid subcontracted trades. In addition, DBE participation was also encouraged for privately funded subcontracts. As a result, an overall project goal of 8% DBE participation has been reached – a significant accomplishment for a project of this scale.

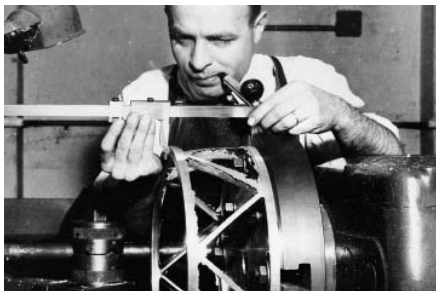
All successful pre-qualified bidders had to comply with the following:
A "First Source Hiring Program" which fosters construction and permanent employment opportunities to economically disadvantaged individuals. As part of this program, each subcontractor forecasts how many entry level or apprentice positions will be needed in each of their trades. Some of these individuals are sourced through the City of San Francisco's "Workforce Development System" which matches qualified disadvantaged individuals with subcontracting firms.

Each subcontractor is required to pay no less than the highest prevailing wage rate for work in their field. If a subcontractor is not a signatory to recognized apprenticeship or training program, they are required to pay into an apprenticeship fund set up for the purpose of increasing entry level and disadvantaged employment opportunities.

ECOLOGICAL QUALITY AND ENERGY SAVING

The California Academy of Sciences has resided in Golden Gate Park for nearly a century, relocating there after its downtown building was destroyed by the 1906 earthquake and fire. Twelve disparate buildings comprised the original Academy in the Park. The new Academy will be just one building with a footprint that is one acre smaller; in other words this project will create an acre of new Park space.





The Academy's original building was taken down, except for outer walls of the African Hall. 100% of the materials in the original building have been recycled-stone, wood, glass, etc. The stone was crushed and included in a number of public building and construction projects around the Bay Area. Over 9,000 tons of concrete went to the Richmond Roadway project site, over 1200 tons of metal were recycled at Schnitzer Steel, and 120 tons of greenwaste were recycled for landscaping on-site.

The sighting of the new Academy's building was done not only to align with the formal concourse and our neighbor (the de Young art museum) across the concourse, but also to be able to take advantage of prevailing breezes and course of the sun for daylight for the staff and public spaces.

A major design element of the building that is also instrumental to the sustainability strategy is the roof. The undulating roof, organic in form and unifying the entire Academy complex, mimics the hills of San Francisco. Functionally, the roof helps to serve as chimneys so that when hot air in the museum rises, the public spaces will be naturally ventilated. The 2 and 1/2 acres of living roof, comprised only of native California plants, will serve to save energy with the roof having a R value of R23, (keeping the interior temperature 10 degrees cooler), conserving water through the use of reclaimed water in a micro irrigation system and having native plants that are adapted to the water regime of the region, attenuating sound via reduction of low frequency noise by 40 decibels and deflecting higher frequency sound, decreasing the Urban Heat Island Effect with the roof temperature staying 10 degrees cooler, using an integrated pest management system, planting a diversity of plant species and addressing storm water management issues by having a 36,000 gallon capacity for a one-hour storm; over the course of a year 3.5 million gallons of rainwater won't flow into the storm drains of San Francisco (which still has a combined storm water and sewage system), but be captured on the Academy's roof.

The perimeter of the roof is bordered by nearly 18,000 square feet of high efficiency photovoltaics. This system will not only provide cover and modulate light for visitors, but provide over 220KW of energy annually. That is the equivalent of preventing 400,000 pounds of greenhouse gases emissions, and would be the equivalent of planting 340 trees. Photovoltaic cells will generate 5 % of the building's energy. Multicrystalline technologies are being evaluated for efficiency and light transmittance. The design is not only green in philosophy, it is green in color.

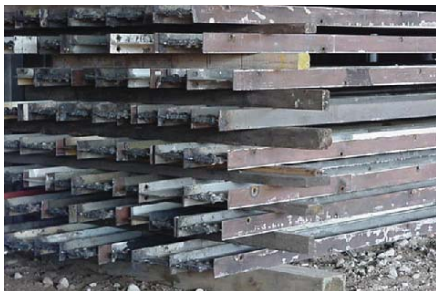
Operable windows, daylight and views in 75% of all regularly occupied research and office spaces will ensure thermal comfort, health and productivity of staff and volunteers. The public spaces have 90% with daylight and views.

By employing natural daylighting and ventilation, high-efficiency electric lighting, and commissioning, the building will use 30% less energy than federal and state

requirements. The glazed transparent facades and roof sections of the building will allow daylight to be filtered into the office, research and exhibition spaces, helping to reduce energy use and heat gain from electric lighting. Lighting controls include dimming, linked to the external light level, to ensure that a minimum of electric light is used at all times.

As part of the low energy design strategy, the Academy plans to minimize the use of mechanical systems for ventilating and cooling internal spaces. The exhibit area will be naturally ventilated. The roof shape in the form of bubbles provides the height differences required for stack driven (warm air rises) ventilation on calm days. On days with some wind, the roof bubbles generate a negative pressure at the top, to provide driving pressure for airflow. The open offices will be naturally ventilated. The building shape and materials are designed to be a climatic filter, limiting the solar gain and cooling/heating requirements. Easy to open windows will be used so that occupants still have control over their local environment. Natural daylight will be accomplished with the glazed facades, the roof design, and lighting controls.

Of the materials to be used in the project, 10% overall will be recycled. 100% of the concrete with have 30% fly ash incorporated. 20% of all materials will be obtained locally, reducing impacts of transportation of resources. 50% of the wood will be from certified renewable sources. Paints, adhesives, sealants, and carpets will be low-emitting, non-toxic, environmentally-friendly materials.



Use of reclaimed water & low-flow fixtures will use 20% less water than required by code, and reduce reliance on municipal potable water for wastewater conveyance by 85 %. Low flow fixtures are planned for the sinks in the bathrooms that regulate water use. They contain a mini-turbine, and power themselves. The building is plumbed for use of recycled water, which will be provided by the City of San Francisco. The supply is expected to be available by 2006. Recycled water will be used in the bathrooms and in the Life Support Systems to backwash the aquarium filters.

We have also developed water systems for the aquarium so that energy and potable water use are minimized. A number of strategies have been employed for the “greening” of the life support system of the aquarium. They include: emulating natural systems with removal of waste, adjusting water clarity to approximate nature (versus having “gin clear” water), minimizing energy use through mechanical design (with big pipes, small pumps, equipment locations following pipe layouts, use of variable speed pumps, foam fractionators that reduce ~50% filtration, cooling tower water chills warmer exhibits), minimizing use of potable water (by using reclaimed (gray) water to backwash recovery filters) and minimizing water discharge to sewers (with backwash recovery systems and closed versus flow-through systems). This entire industry that will benefit from the technologies we are employing.

Operations

A variety of strategies have been developed and employed by the Academy today, and several are in development for the new building to support operating the institution in a sustainable fashion. The Academy currently employs a green, integrated pest management strategy to ensure no chemicals are used to monitor and rid the building of dermestid beetles (an organism that could literally eat its way through our natural history collections), but the same philosophy applies to the staff occupied spaces, the public spaces and the aquarium. Green materials are used to clean the building. The Academy has a long history of encouraging both public and staff to take public transportation to its facility. Members of the general public receive a discount on entry if they show their fare receipt from either MUNI (San Francisco) or BART (Bay Area) public transportation systems. Staff receive $20/month paid by the Academy to take public transportation—that is have nearly 1/2 of their monthly fares on MUNI. The institution pays nearly $40,000 annually to support these efforts. More than half of the staff participate in this program. The Academy provides receptacles and other resources to encourage recycling, composting and other sustainable practices. The Academy's "Green Team" continues to bring innovation to the institution's operations.

It is important to note that this building went through the extensive EIR and entitlement process in San Francisco in just one year. We attribute this fast approval process in part to the sustainable building we are building. In contrast, a museum building to be built in the same general area in Golden Gate Park that is 1/2 the size of the Academy's building (in terms of square feet), took nearly four years to be entitled (and was the object of lawsuits). The savings realized with the help of this sustainable approach, in escalation alone, must be valued at tens of millions of dollars.

ECONOMIC PERFORMANCE AND COMPATIBILITY

Funding for this project, the largest cultural project in the history of a city that celebrates culture, is a public-private partnership. Such a funding mosaic is helpful to better ensure successful financing and completion of the project. The project costs $400 million, and to date over $300 million has been raised by public and private sources. In addition, the Academy has sold bonds to ensure financial resources are in place to complete the project.

In terms of public support, the Academy has garnered over $150 million, from local, state and federal sources. The Academy has put before the voters in the City and County of San Francisco two bond measures—both have passed. These general obligation bonds, meaning that they do not have to be repaid by the Academy, are financed through property tax increases in the City and County of San Francisco. These measures required a 2/3 plurality of voters, and speaks to the popular support the Academy has in the City. The Academy is the only cultural organization to have passed two bonds measures. This support totals $120 million.

In addition to the City and County of San Francisco, support has also come from the State of California. To date, over $20 million is coming from the State of California.

Federal government support currently includes a grant from National Science Foundation ($3M) and recent budget support from the National Aeronautics and Space Administration for the Planetarium and the National Oceanic and Atmospheric Administration. Federal support totals over $10 million.

In terms of private support, the Academy is still in the quiet phase of a capital campaign. Board (past and present) has given nearly $90M, including a $25M lead gift thought to be the largest gift given to a cultural institution in SF. Over $150 million of contributions have come from private donations. We expect that over 10,000 individual contributors will have given to the Academy's fundraising campaign by the building's opening in 2008.

For the long term, the Academy has an endowment for the long-term operation of the Academy. Endowment to annual operating budget is more than 7:1, that is very strong relative to natural history museums, aquariums and planetariums. Endowment value in September 2005 was $138M. The funding strategy we are employing is also providing for augmentation of the endowment, through the capital campaign and other funding outcomes of financing approach. Current and future endowment additions will ensure the long-term financial health and viability of the Academy.

The Academy has sold $180 million in bonds to ensure we have the cash to complete the project. These bonds were sold with a single covenant, and only dramatic changes in endowment value, operating shortfalls and construction costs together (with no response by the Academy) are required for the covenant to be broken. The Academy's long (152 year) history and documented performance/track record were essential to obtain this financing.

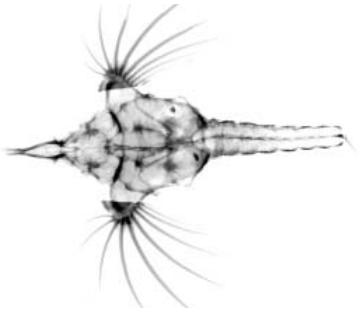
Innovative and proactive aspects of project management have been employed to reduce risk through a very difficult construction period in the U.S. and internationally. Prices on other Bay Area projects have more than doubled in about the same time period of the Academy's project. For example:

* Several contracts were awarded to European firms during the course of the project's buy-out phase. To protect against currency fluctuations in the exchange rate between the US dollar and Euro, approximately $10M worth of Euros were pre-purchased to be used to pay for goods and services when they would be needed approximately a year later. This strategy protected the Acdemy from large run-ups in the price of Euros thus helping to protect the project's overall budget.

* Materials options were purchased through subcontractors for aluminum, steel, concrete forming materials, cement, etc. to hedge against commodity pricing escalation experienced over the course of this project's long development time line.
* Some critical path trades (e.g. aquarium acrylic) were bid early to reserve production schedules due to extreme high demand for product and to insure timely fabrication and delivery thus avoiding cost and schedule risk to the entire project.
* Technical trades (mechanical, electrical, plumbing, structural, fire life safety) were bid before design drawings were fully complete to allow subcontractors to participate in the completion of the design by working side-by-side with the engineers (referred to as "Design / Assist"). This allowed for evaluation of best-practices, constructability review and value engineering to be incorporated into the final design limiting field changes and increased cost.
* For the first time in San Francisco's history, a bid process was implemented that allowed bidders to make cost saving suggestions at bid time and to have these suggestions reviewed and incorporated into their final price. This allowed the Academy to realize cost saving opportunities beyond those incorporated in the design for the building and its systems.
* All pre-qualifications and final bids were reviewed by the entire project team (contractor, architect, and owner) to insure completeness in each subcontractor's understanding of the project scope and the rationale behind their pricing.

We have received Guaranteed Maximum Price bids for the building, and carry a contingency of 8% (relatively high at this stage of the project) as conservative approaches to the project.

We have run a wide array of financial models to estimate and assess costs for running the new facility. The new living roof will require less maintenance than our previous one, and the energy and water requirements (and payments) will also be less. The original Academy complex, consisting of 11 joined but separate buildings, had 19 possible points of entry—the new building will have two. Hence securing the building will also be significantly less expensive to secure than the original complex. Once the building is completed, financial models suggest that the Academy will not only use a prudent level of endowment to help fund programs, but be able to set aside financial resources to maintain the building and develop a robust level or programmatic change-necessary to achieve attendance levels after the initial excitement of a new building have faded.



Impact of the Project to the local economy has been projected to be between $180,000,000 to nearly $190,000,000 annually. The calculation to arrive at this financial impact is shown in the following table.

TABLE: Estimating The Impact Of The New Academy Of Sciences

1. Value visitors bring to the City of San Francisco

Out of town visitors to Academy/year 500,000 (Academy estimate): $22,500,000 to $30,000,000

Out of town visitor spending/day: $180 (SF Convention & Visitor Bureau)

Time spent at the Academy in days: 0.25 to 0.33 (visitor survey)

2. Educational/entertainment value

a. Organized programs for visitors

Value of docent time: $324,000 (Academy estimate)

Organized (adult) educational program: $324,000

b. Overall entertainment/educational value

Annual number of visitors: 1,600,000 (Academy estimate)

"Do it yourself" entertainment/educational: $12,800,000

Average entrance fee (adult & children): $8.00 (Academy estimate) value for all visitors

c. Educational value of 3rd - 5th grade program

Number of schools covered by Wild City: 30 (Education dept.)

Value of 3rd - 5th grade program/year: $179,000

Number of students reached by Wild City: 700

Number of docent and self-guided tours: 1245

Number of students served by docent and self guided tours: 39,000

Value of Wild City and Tours: $179,000

d. Value of courses and lectures offered (Education dept.)

Value of lectures and youth & adult courses: $210,000 $210,000

e. Value of local economic impact

Number of FTE jobs supported*: 2,735 (Arts USA estimate)

Dollars spent by CAS and its audiences**: $83,864,000 (Arts USA estimate)

*Value of household income***: $58,450,000 (Arts USA estimate)*

*Value of local gov't revenue****: $3,510,000 (Arts USA estimate)*

TOTAL ANNUAL VALUE OF THE ACADEMY: $181,837,000 to $189,837,000

* Total number of jobs in the community supported by the expenditures made by the Academy and/or its audiences.

** Total dollars spent by the Academy and/or its audiences, including event-related spending by its audiences

*** Total dollars paid to community residents as a result of the expenditures made by the Academy and or its audiences.

CONTEXTUAL RESPONSE AND AESTHETIC IMPACT

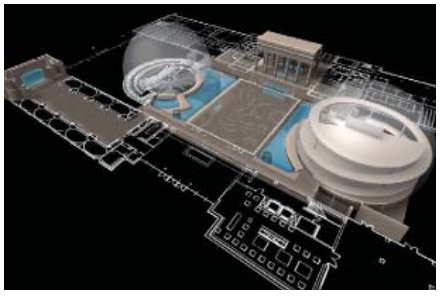
The new Academy facility will retain its general location and orientation, and like the original academy, all functions will be organized around central Piazza, or courtyard.

Three historic elements of the previous Academy will be maintained in some fashion, as a memory and a link to the past: African Hall, North American (California) Hall and the entrance to the Steinhart Aquarium.

A roof, floating at the same height as the original Academy Halls, will formally unify the mueum. This roof will be landscaped with native plant species and undulate to accommodate the Academy's major programmatic components beneath: the new Planetarium, the Rainforest Exhibit and the Steinhart Aquarium entrance. In the center of this Living Roof a glazed skylight covers the Piazza and other smaller skylights allow natural light into the exhibit space and can be opened for the natural ventilation of the space below. The roof will extend beyond the perimeter walls into a glass canopy to provide shade, protection from the rain and generate energy through more than 55,000 photo voltaic cells in the glass.

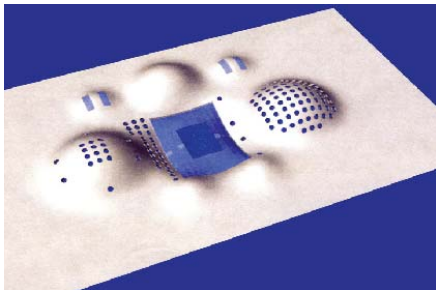
The building is designed to allow the highest degree of flexibility in terms of uses. The exhibition floor is designed in terms of floor loading and other infrastructure (availability of water, IT, power, etc.) so that exhibitions can flex and change. Unlike the old model of natural history museums, where exhibitions were designed to demonstrate some eternal truth or dogma, the new Academy's exhibitions will allow new data, hypotheses and interpretations to be incorporated into the exhibition program, thereby remaining up-to-date and allowing the museum to attract returning visitors. Also, we are breaking down the old division of aquarium and museum, since the design allows living organisms to be incorporated throughout the displays--the aquarium "spills out" into the natural history museum.

The contextual response and aesthetic impact of the new California Academy of Sciences was informed by addressing two significant questions:



1) What is an appropriate design approach to building within the context of an Urban Park setting?

The California Academy of Sciences is located in Golden Gate Park, which remains one of the most important examples in the U.S. along with New York's Central Park (1858), Philadelphia's Fairmont Park (1865) and Brooklyn's Prospect Park (1866) of large urban parks developed in the 1870s.



Designed by Fredrick Law Olmsted between 1866 through the 1870s, large urban parks were often considered social experiments. To this date Golden Gate Park and its resources, including the California Academy of Sciences, remain highly public, open, inclusive and democratic in expression of physical form, integration of park landscaping and built form as well as functional use and sustainable operations.

The site planning, program of uses and design of the Academy are respectful of that history and commitment to social responsibility. The building typology selected by Architect, Renzo Piano is that of a Pavilion- a minimalist structure that sits lightly on the land, that is porous at its edges and is egalitarian in its expression.

As a Pavilion :

the building is fully integrated with, and a part of rather than separate from, the surrounding landscape and urban park setting. Pedestrian circulation flows as easily from park to structure and back into the park; scientific experiences of the park are extended into the scientific explorations of the Academy. Pedestrians flow from open to enclosed spaces in natural transition yet spatial expressions are dynamic, of the 21st Century and form clear linkages between natural landscape and built form.

the structural expression is light in consumption of building materials; utilizing a minimum of structure is indeed ecologically significant in minimizing the use of man made building materials.

the building is organic in the way that it breaths and in its organization of utility infrastructure; a large portion of the building is naturally ventilated and flexible in use while limiting mechanically serviced areas to only those more complex functional uses.

the sides of the building are transparent glazed or operable enclosures; the exception being the south face which defines the historic edge of the Music Concourse. As with the porosity on the north, east, west sides, the roof of the central piazza is partially open and, or, glazed; thus minimizing the sense of building enclosure and encouraging a greater integration to the natural Park setting.

A significant expression of the Park structure is the fully planted roof that has been described by Piano as “cutting the ground plain of a park and lifting it 38 feet into the air.” More than imagery, the roof structure is publicly accessible, is educational in its exhibits and places the viewer at a height which is in the middle of the surrounding trees.

2) Can a complex building of the 21st Century evoke an appropriate historic and cultural competency while contributing to the long-term aesthetic impact on the physical environment?

The design of the Academy reflects an appropriate long-term aesthetic impact by its sensitive placement on the site, its scale, configuration and responsiveness to the park setting. Additionally, the simplicity of form, mass and materials are sustainable, socially responsible and represent an aesthetic that is timeless.

The massing of the Academy is respectful of the surrounding uses including the deYoung Museum, the Spreckles Band Shell and the open space of the Concourse. The solid south face of the building is used to define one of three important "edges" of the Music Concourse, which is an important open space. The total area of land occupied by the building footprint has been reduced significantly to minimize the impact of building in a park.

The latest configuration of the Academy was the result of 11 different building additions built over its 85 year life span. The original massing of three buildings forming an inverted U shape around a courtyard has again been restored as the basic spatial organization of the new Academy design.

While seemingly simple in form, the architectural aesthetic is both complex and sophisticated in detail. Little is apparently extraneous, yet significant skill and creativity is expended to reduce the architecture to its functional essence while capturing a three dimensional experience expressive of continual changes in light, wind, temperature and views that form space.

Internal spatial organization permits flexible use for major public assembly, changing exhibits and educational opportunities. More complex functions of scientific research are consolidated in areas where mechanical services are focused. Administrative areas are naturally ventilated and illuminated ; use of operable windows and automatic sun blinds create a work space which is both healthy and respectful of the work force. Added work place considerations include the ability of individuals or groups to control environmental indoor quality including ventilation and lighting.