
SUSTAINABILITY BASE
NASA's First Space Station on Earth
NASA Ames Research Center
Moffett Field, California
William McDonough + Partners

A few years ago, I had the privilege of meeting with NASA leaders in Washington, Houston, and then at Ames Research Center in Mountain View, California. We talked about design, and space stations, and we got to talking about the next space station. I suggested that we think about the next space station as not one just for the red planet, but what about our blue planet first? We all got excited about the concept… and things, well, took off.

NASA, it turns out, is a client and owner extraordinarily well positioned to embrace and support the idea I have been exploring for years—that design is the signal for human intention. Working with the amazing team at NASA, we have created a concept, now realized as a building, that is NASA's first space station on Earth.

I feel a coming together. I have been talking about "a building like a tree" for decades now, and this project represents a unique merger of that concept with technological advances and anticipatory design. It's a special happening, something a poet might call "a beautiful, fierce commotion."

We have had the honor to work with NASA and a number of firms to make this a reality. We are humbled by the opportunity, and inspired by the possibility. This building could be the first to truly demonstrate what "continuous improvement" means in the built environment, and this is due in large part to NASA's commitment to making it a true testbed for technologies and strategies over time. We honor the humility inherent in this work of progress, which is also a continual work *in* progress.

William McDonough, FAIA, Int. FRIBA

BUILDING FORM & CONCEPT

The form of Sustainability Base seeks to evoke the wonder and vision of space travel as evidenced on Earth. Inspired by the wind tunnels of the NASA Ames Campus and images of NASA satellites, the exoskeleton approach provides real performance benefits. It gives the building increased structural performance during seismic events, provides an armature for daylighting and shading strategies, and creates a column-free interior that facilitates workplace flexibility.

ECO-EFFECTIVE DESIGN FRAMEWORK

At the project outset NASA established four principles that Sustainability Base should embody. Goals were derived based on these principles, strategies were outlined to achieve these goals, and metrics were established to benchmark performance.

Principle 1: Create a Compelling Business Case.

Goal: Optimize Workplace Effectiveness
Goal: Reduce Operational Costs

Principle 2: Create a Model High Performance Building.

Energy Goals:
Optimize building energy demand
Meet remaining energy needs from renewable sources
Water Goals:
Reduce potable water demand and sewer/storm discharge volumes
Materials Goals:
Maximize material value
Eliminate materials going to landfill

Principle 3: Showcase NASA Technologies and Approaches.

Goal: Partner with NASA in the design of the building
Goal: Evidence NASA technologies
Goal: Develop industry partnerships

Principle 4: Keep the Project within Budget and On Schedule.

Goal: Adhere to project timeline
Goal: Design for the construction budget

AN OPTIMIZED WORKPLACE

Sustainability Base is a flexible and collaborative work environment that actively supports the health and well-being of all occupants, and creates a positive workplace for NASA employees. Strategies include:

Dynamic Natural Light

- Tall floor to floor heights, large windows, skylights on the second floor, and narrow building floor plates provide natural lighting deep into the interior of the building. Modeling suggests that electrical lighting will only be needed 42 days out of the year.
- Exterior aluminum shades reduce heat gain and mitigate glare.

Excellent Thermal Comfort

- Super insulated exterior metal panel system with high performance glazing provides a tight, warm envelope for cool Bay Area mornings.
- Operable windows controlled by users and building management systems create gentle cross-ventilation.
- Localized heating or cooling is provided by radiant panels, allowing for longer periods of natural ventilation.

Indoor Air Quality is supported by utilizing raised access floors throughout open areas, allowing for user and system flexibility, and connected to a dedicated outdoor air system which provides fresh air distribution when building's windows are closed.

Creation of Community by dividing the open office floor plan into neighborhoods of 25 to 30 people, linked by common services and aligned along an interior street to provide team-building and collaboration.

BENEFICIAL MATERIALS

A rigorous materials selection protocol for Sustainability Base was implemented through two approaches. First, Cradle to Cradle Certified^{CM} products were used when available, cost effective, and achievable through a competitive tender process. When certified products could not be implemented, other products were evaluated with McDonough Braungart Design Chemistry (MBDC) for their Cradle to Cradle® potential. Products in a similar material class were compared on a relative scale of human and ecological performance. Strategies included:

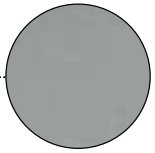
Material use considerations included utilizing an external braced frame to reduce the amount of steel (by weight) in the building. The lightweight insulated metal panel cladding also reduced the amount of material required for construction.

Material health concerns resulted in a specification process that favored materials that were beneficial to human health, ecological health, and were designed for technical and/or biological cycles. When these materials were not available due to performance requirements, remaining materials were evaluated for obvious risks to the biosphere.

Material content considerations included recyclable/recycled materials, salvaged materials, locally available and/or rapidly renewable materials and certified wood. The main components of the design (concrete, steel, glass, aluminum) have high recycled content and are regionally available. The lobby areas reuse oak flooring from a transonic wind tunnel on the NASA Ames Campus.

Design for disassembly was facilitated by choosing a steel structure (rather than concrete) that can be easily dismantled as well as repaired after a seismic event. Exterior cladding was provided in pre-fabricated unitized components.

CRADLE TO CRADLE CERTIFIED^{CM} PRODUCTS



Centria Dimension Series® panels (certified silver)

Alcoa, Inc. Kawneer 1600 SunShade® louvers (certified silver)

PPG Industries Solarban 70XL™ architectural glass (certified silver)

Alcoa, Inc. Kawneer 1600 Wall System® (certified silver)

Alcoa, Inc. Kawneer InLighten® Light Shelf (certified silver)

Mechosystems, Inc. Mecho®/5 with EcoVeil (certified silver)

Icestone® Durable Surface (certified gold)

Herman Miller Mirra® chair (certified silver)

A MODEL HIGH PERFORMANCE BUILDING

ENERGY

The building site is designed to be net energy positive through two main strategies: optimizing energy demand and providing needed supply from renewable sources. The overall energy goal is to create a system that will rely only on renewable forms of energy as they become cost effective. Although natural daylighting and ventilation are used extensively, the building still has active heating and cooling systems to maintain the rigid comfort ranges throughout the year.

Ground Source Heat Pump

- 106 well bores, 58º F ground temperature year round
- 4 heat pumps

Radiant Heating/Cooling

- Radiant cooling ceiling panels, 40% less energy use than typical variable air volume (VAV) systems
- Hot water radiant wall heating panels
- Natural ventilation with automated windows to allow flushing during evening hours

Intelligent, High-Performance Lighting Systems

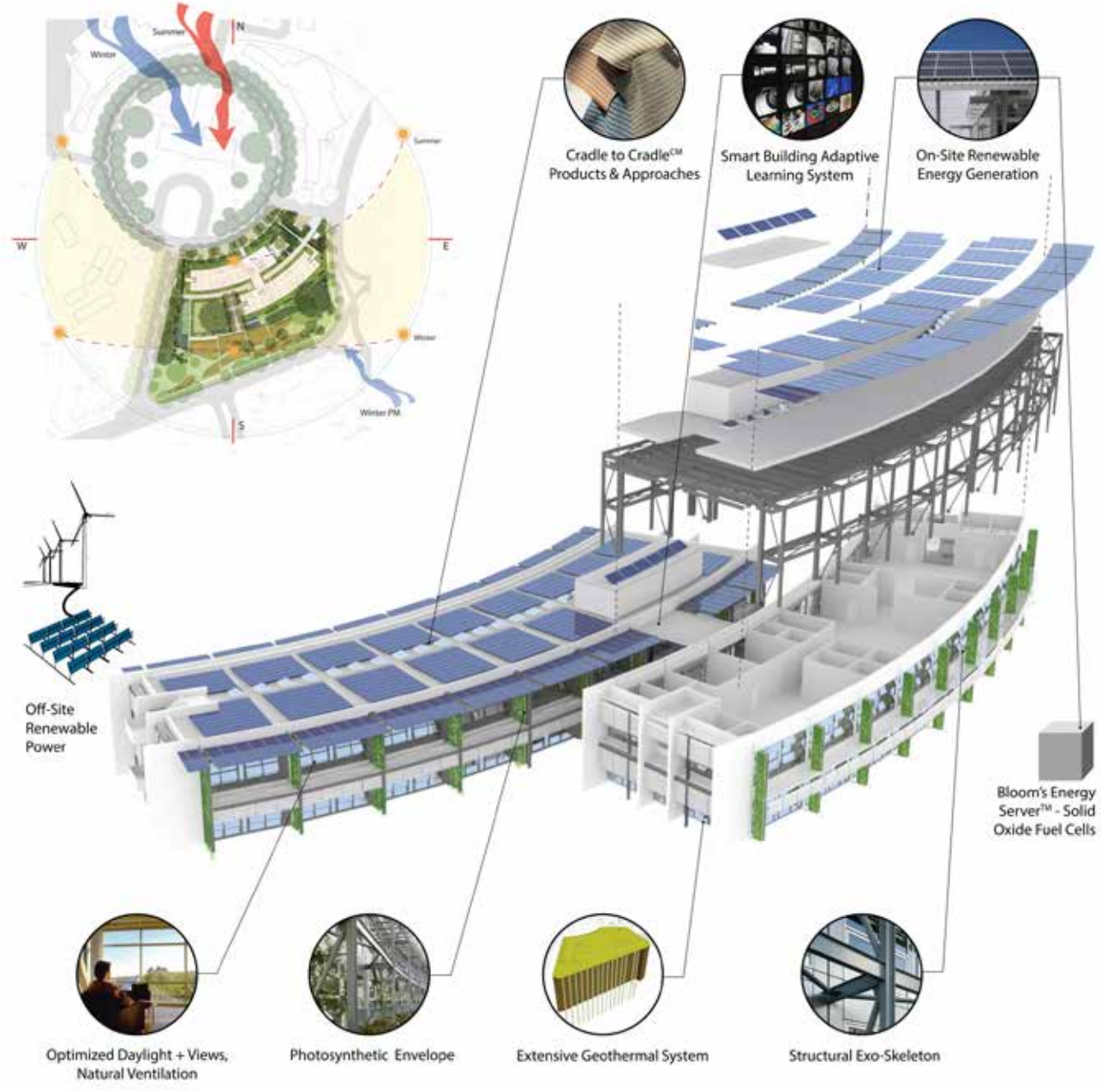
- LED fixtures
- Sophisticated lighting control system automatically dims lights to adjust for ambient conditions and time of day

Solar Photovoltaic/Thermal Panels

- 432 panels in 24 strings of 9 modules on each building (north and south)
- Photovoltaic panels generate up to 30% of building energy demand
- Solar thermal panels provide domestic hot water

Bloom's Energy Server™ Solid Oxide Fuel Cells

- Solid oxide fuel cell currently utilizes natural gas as fuel; future plan for methane capture
- Expected electric conversion efficiency 55% (almost twice that of conventional power generating plant and grid system efficiency)



WATER

The overall water goal is to create a system that will use water in continuous loops. Water that falls on the site will leave at the same rate, volume and cleanliness of pre-development conditions. The keys to closing water loops on-site are matching cleanliness to use, stepping water uses where possible, and integrating water cleansing into the cycle.

The design employs a number of methods to optimize water quality and use:

Water fixtures selected for optimized performance including quality and quantity of flow and automated control systems.

Groundwater reduces the demand for potable water. An existing facility to pump and cleanse contaminated MEW groundwater is located near the building site. Sustainability Base uses this cleansed water to irrigate the landscape.

Forward osmosis water recycling system developed by NASA for use on the International Space Station is available to purify water to drinking water quality. Due to regulations in California limiting use of treated wastewater, it is currently used to treat graywater from sinks and showers for reuse in toilet and urinal flushing. The technology will be monitored and tested to perfect its performance in space.

Intelligent landscape design includes native and drought-tolerant species selection, drip irrigation systems and the design of water cleansing systems. These further reduce water demand and cleanse water that runs through the site.

NASA TECHNOLOGIES & PARTNERSHIPS

To assist with the achievement of a high-performance building, Sustainability Base showcases software developed by NASA for projects such as the Mars Rovers, Opportunity and Spirit. NASA software has been adapted to monitor the building through a wireless sensor network which will provide real time data to the building controls system.

Supporting the concept of constant improvement, an **Inductive Monitoring System** will be used to record the building functions and systems to allow for continual analysis and optimization.

Prognostics are used by NASA to predict the life span of machinery and components by individual characteristics. Maintenance costs can be saved through condition-based maintenance, rather than a generic maintenance protocol.

NASA excels at **Data Mining:** the organizations take complex data sets and render them in easily understandable and highly evocative ways. These skills dovetail well with the pedagogical intent of the facility.

Computational Fluid Dynamics Analysis will be used to study air flow both outside and inside the building. This tool will allow NASA to perfect the design of the HVAC controls to maintain occupant comfort and optimize energy use.

The realization of Sustainability Base involved a number of partnerships, including: Lawrence Berkeley National Lab, Integrated Building Solutions, UC Berkeley and Carnegie Mellon University, Autodesk, Enmetric Systems and Verdigris Technologies.

TESTIMONIALS

"Working closely with Bill McDonough and his team was inspirational and extremely beneficial. The collaborative process yielded a highly sustainable and beautiful design—optimized for building performance and representative of our values. I see this as a prototype of a 21st-century building. This is the way we're going to have to think about building in the future."

Steve Zornetzer, Associate Director
NASA Ames Research Center

"This is an exciting and potentially groundbreaking building on many levels—design process, technology, systems integration, occupant-focus, and smart operations. We look forward to continuing our collaboration with NASA and William McDonough + Partners and to all this building will have to share in the years ahead."

Stephen Selkowitz, Department Head, Building Technologies Environmental Energy Technologies Division, Lawrence Berkeley National Laboratory

TEAM

William McDonough + Partners, *Design Architect*
AECOM, *Architect of Record / Landscape Architect of Record / MEP / Structural / Civil Engineering*
Loisos + Ubbelohde, *Daylighting / Lighting / Energy Consultant*
Swinerton Builders, *General Contractor*
Siteworks Studio, *Design Landscape Architect*
McDonough Braungart Design Chemistry (MBDC), *Materials Assessment*
TBD, *Cost Estimator*

AWARDS & CERTIFICATIONS

LEED® Platinum Certification
Center on Environmental Innovation & Leadership, 2011 Leadership in Innovation Award
White House GreenGov Award 2011, Lean Green and Mean
ENR California, Best Projects of 2011, Award of Merit - Green Building
Silicon Valley Business Times' Structures Awards 2010, Best Green Project
GSA Real Property 2010 Award for Green Innovation

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