RESOURCEFUL BY NATURE

BY RANDOLPH R. CROXTON, FAIA

Founded in 1970 by a group of law students and attorneys, the Natural Resources Defense Council (NRDC) helped write some of America's bedrock environment laws. Today's NRDC has a staff of more than 300 lawyers, scientists and policy experts, supported by 1.3 million members and online activists. They collectively work to curb global warming in six national and international offices. NRDC's mission is to create a clean energy future, revive the world's oceans, prevent pollution, defend endangered wildlife and foster sustainable communities.

In 1988, NRDC began renovating a former light industrial loft space in New York's Flatiron district to house its main office. The goal was to put its environmental principles into practice by designing an office that dramatically cuts energy use and demonstrates to architects, builders and businesses that "green building" concepts can create more humanistic and productive workspaces. To ensure that the office would be a model for others, NRDC insisted on using only commercially available materials and technologies.

In an age of deskbound computers, no Internet and primarily face-to-face interaction, the NRDC Headquarters office that opened in 1989 at 40 West 20th Street was a healthier and higher productivity model (soon to be called "green" design) that still cut conventional energy consumption in half. Twenty-four years later, NRDC turned to the same architecture firm to create an enterprise-wide reinvention of its work environment in the context of the Internet, iPad, smart phones and GoToMeeting.

The scope of the project anticipated the expansion and renovation of NRDC's six offices. Performance challenges included additional levels of resourcefulness in energy and water consumption, building materials, space per unit of productivity, and a new resourceful life-of-project operational strategy that can accommodate expansion and reconfiguration with minimum staff downtime and minimum disruption/contamination of building systems.

The highest return on the construction dollar, human productivity in the designed space, was advanced through 100% daylight and views, three tiers of visual connectivity (balancing privacy and collaboration), advanced indoor air quality and multiple work modes.

This case study profiles the test bed for the project rollout: the eighth floor prototype of the NRDC's New York offices, which is the physical concept of the Strategic Plan to be incorporated throughout the remaining floors of the organization's 60,000 ft^2 headquarters and the offices from Chicago to Beijing. The project achieved the highest LEED Platinum rating for a Commercial Interior under LEED-CI v2.0 by scoring well in eight key metrics.

Opposite **A signature element in the original 1988 design reinterpreted here is the sunlit open interconnecting staircase with generous landings at the top and bottom for socialization and spontaneous creative interchange.**

Below **The fully demountable wall on the left is subdivided in the three bands of visual connectivity: solid at base, translucent to seated eye level and fully clear to the ceiling—a universal order throughout for open office and team rooms.**

BUILDING AT A GLANCE

Name NRDC Headquarters Strategic Plan & Prototype

Location 40 W 20th Street, New York, NY

Owner
Natural Resources Defense Council

Principal Use Commercial Interior

Employees/Occupants 44 (167 in whole office)

Gross Square Footage 10,500

Distinctions/Awards
LEED-CI v2.0 Platinum (highest rated project for CI v2.0)

LEED-CI v2.0 Platinum (highest rated LEED-CI project in the world, including all iterations of LEED-CI, and highest rated LEED project of any kind in New York City and New York state)

When Built 1920 (estimate)
Major Renovation January 2010
Renovation Scope Eighth Floor

Total Renovation Cost $1,728,000
Cost Per Square Foot $164.57

ENERGY AT A GLANCE

Annual Energy Use Intensity (Site)
52.9 kBtu/ft^2
Electricity 17.6 kBtu/ft^2
Fuel Oil 33.3 kBtu/ft^2
Renewable Energy 2.0 kBtu/ft^2

Annual Source Energy 99.1 kBtu/ft^2

Annual Energy Cost Index (ECI) $1.54/ft^2

Annual Net Energy Use Intensity
51 kBtu/ft^2

Savings vs. Standard 90.1-2004 Design Building 39%

Heating Degree Days 4,777/yr
(Normal–NYC(LGA)); Source: NYSERDA

Cooling Degree Days 1,141/yr
(Normal–NYC(LGA)); Source: NYSERDA

WATER AT A GLANCE

Annual Water Use
43,234 gallons/year – Design Case
80,052 gallons/year – Base Case
46% reduction

Key metrics include:

1 100% of seats, workstations and offices with views

2 76.3% of regularly occupied spaces daylit

3 HVAC Energy: 40.3% better than ASHRAE/IESNA Standard 90.1-2004

4 Lighting Power Density: 40.7% better than Standard 90.1-2004

5 Water Efficiency: 46% better than EPAct (36,800 gallons/year saved)

6 Construction Waste Management: 96% diversion from landfill

7 Indoor Air Quality (expressed as percentage below LEED thresholds):
- Formaldehyde 3.2 ppb = 94% below LEED;
- Particulates (PM10) 0.7-7.1 µg/m^3 = 99.86% below LEED;
- Total VOC 256 µg/m^3 = 49% below LEED;
- Carbon monoxide not detected = 100% below LEED.

8 All work surfaces and demountable partitions = FSC-certified wood.

NRDC challenged the team to go beyond these traditional metrics in all design strategies that could elevate performance. The core programmatic process of the client/architect team was a collaborative series of work sessions. The sessions ranged from a self-critical analysis of NRDC's existing facilities and operational procedures, to visioning sessions that identified emerging environmental issues that would impart mission-specific relevance to NRDC's approach to facilities design.

Top 10 Design Values

The results of the work sessions were expressed in the Strategic Plan as a set of Top 10 Design Values, delivering qualitative and quantitative attributes, which had to be validated by the underlying science or peer-recognized standards of practice.

KEY SUSTAINABLE FEATURES

Water Conservation
Toilets 1.28 gallons/flush, touchless sensor operated
Urinals 0.125 gallons/flush, touchless sensor operated
Faucet 0.5 gallons/minute, touchless sensor operated, solar panel to recharge sensor battery

Recycled materials
Insulated Panels 85% recycled content
Doors 70% recycled content
Cabinets/Woodwork 100% recycled content
Paneling 100% recycled content
Ceiling Tile 70% recycled content
Gypsum Board 98% recycled content
Toilet Partitions 100% recycled content
Lobby Bench, Pantry Bar Counter, Pantry Table 100% reclaimed wood

Daylighting
Glass
U-Value 0.28
SHGC 0.27
Visible Transmittance 0.64
Shading Coefficient 0.31
Window Blinds each window has two sets, top set solid slats, bottom set perforated slats to reduce glare but maintain views, blinds are white for enhanced daylighting, 56% recycled content
Lighting Controls advanced daylighting

1 Full Spectrum Light: Most cost-effective use of solar energy (offsetting electric light), and it is a most powerful contribution to human health, productivity, accuracy, wayfinding, etc. Major design impacts include: ceiling geometry, light reflectance colors and materials, and three-tiered partition strategy (solid, translucent, clear).

2 Circadian/Seasonal Connections (mirror of nature): Biological centering of humans via connection to daily and seasonal change. Two-part window provides (in upper portion) the constant upward reflection of the sun's dynamic (intensity, angle, duration, color) across the day and the seasons.

3 Resourceful: A broad category that includes the traditional categories of energy and water conservation as well as renewable energy. Additional strategies were a 72% reduction in total materials per permanent scientist/attorney work area and a projected 96% reduction in life-of-project construction waste stream related to renovation/reconfiguration achieved by Design for Disassembly. (Every work surface and wall except the building core, elevators, bathrooms, etc., is an assembly/disassembly item; no internal fixed drywall, spackle, paint surfaces, etc.)

4 Long Life/Loose Fit: The key to long-term flexibility, minimum disruption of ongoing operations and quick response to future opportunity. The design response is reflected in a universal standard for the open workstation's "shell" for professionals and staff, which has tel/data and power infrastructure that is unaffected by flexible upgrade/downgrade of components to achieve single, double or, in some cases, triple occupancy modes. (See *Floor Plan*.)

Below **Original decorative window railings refinished. Local "gardens" beyond are beginning to sprout.**

Bottom **Reclaimed New York wood reworked for table at the pantry.**

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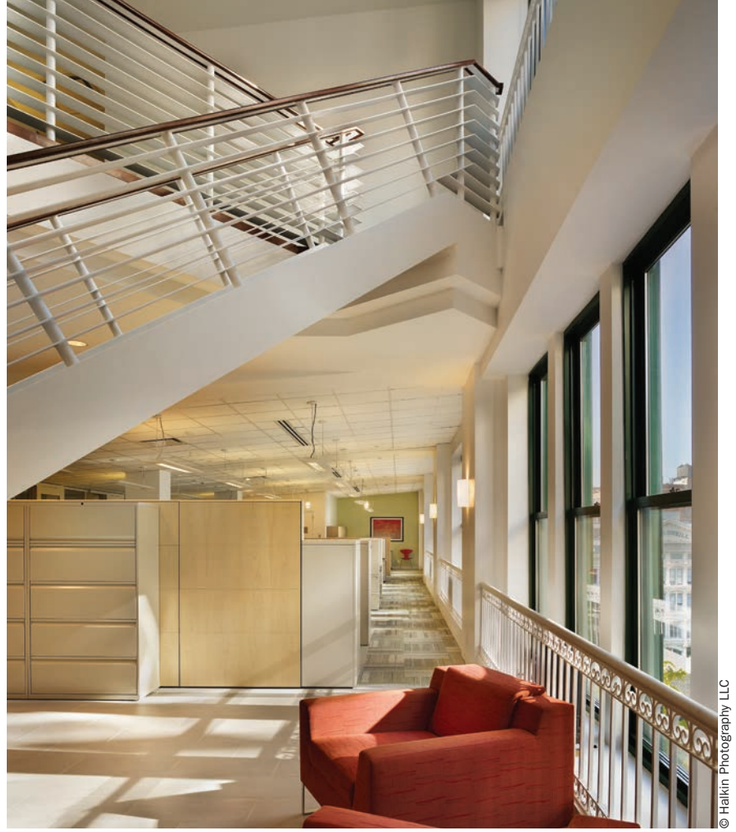
5 Teaming Culture: Key to creative and innovative NRDC culture. Design response includes unassigned multi-functional Team Rooms, informal "Living Room" sitting/gathering space, as well as a 100% perimeter "commons" access to light and air—a social corridor. All-in-all, the space facilitates spontaneous and cross-disciplinary interaction. A core feature is seated eye-level privacy with standing full view of the north or south half of floor plate.

6 Mixed Mode Functionality: Unassigned acoustically private spaces that have four key functional modes (see *Adaptable Design*). The Team Rooms facilitated the consensus to break away from enclosed offices for professionals, as long as they were supplemented with remote functioning (virtual workplace) when away from the office. This feature was also key to providing a population density "flux" capability to accommodate summer interns, fellows and future growth.

7 Indoor Air Quality: Moving beyond the VOC criteria of LEED-CI v2.0, a screening protocol addresses a broader spectrum of building materials injurious to human health. Some examples are below.

Example Building Materials Hazardous to Human Health

Substance	Hazard	Material
Ethylene dichloride	Carcinogenic (IARC), Neurotoxicant	Plastic Welding Adhesive
1, 2 Dichlorobenzene	Endocrine Toxicant, Neurotoxicant	Plastic Foam Insulation
Crystalline Silica	Lung Disease, Silicosis (OSHA)	Joint Compound
Chromated Copper Arsenate (CCA)	Carcinogen, Neurotoxicant	Pressure-treated wood



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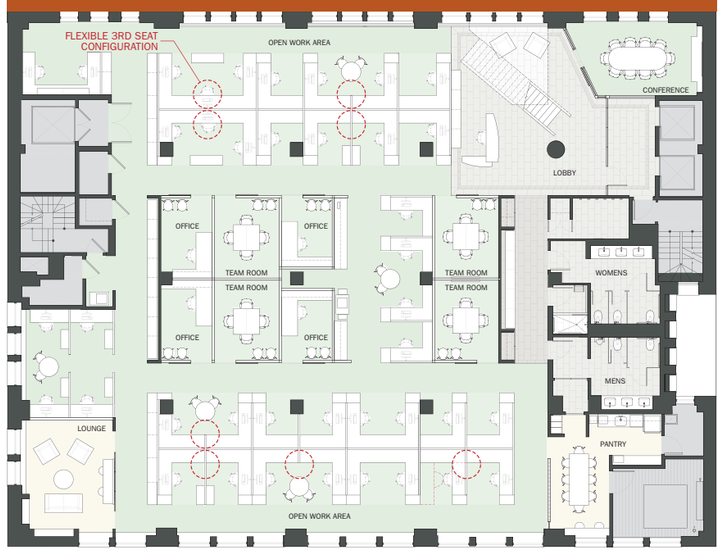
Social Corridor along north elevation provides unbroken walkway around the entire floor and also passes tangent to the south façade. Note the reflection of sunlight from the building to the north, a common attribute of urban settings.

FLOOR PLAN



In the upper right corner (NE) and the lower left corner (SW) of the floor are the informal and formal shared conference rooms on the "Social Corridor" loop, while the four shared team rooms with acoustical privacy are centered in the plan.

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The elevator banks and formal conference/video room are vertically stacked in alignment with the three (in the future) open inter-connecting stairs, which will achieve the maximum sharing/utilization ratios of these facilities.

WHAT NOT TO DO

A survey of green/sustainable projects and workplace environments clarified a range of preferred workplace attributes as well as qualities to be avoided:

Sea of Cubicles: A remaining, but declining, efficiency-driven (i.e., no full-height walls at all), egalitarian distribution of larger individual work stations with higher partitions and larger footprints. Better acoustic/visual isolation of workstations, but a "rat maze" of circulation.
Negatives: Isolating; no variation in experience, limited connection to the exterior; too high of a price for limited privacy gains; no real retreat space = Lowest Performance in Relation to Strategic Plan Values.

Furniture-on-Wheels: An early response to the desire for flexibility that was undertaken by a number of advertising and creative workplace organizations in the '90s.
Negatives: Visual chaos, lack of any boundaries, no sense of domain or personal space, no acoustical privacies, no retreat space = Low Performance.

Glass-to-Floor and "Fishbowls": A contemporary design approach to create the sense of maximum daylight and transparency within the work environment while having a degree of acoustical and personal privacy.
Negatives: Visually distracting, reduced sense of domain or ability to focus on task at hand; acoustic reverberation and loud space; no ability to have functions built in to exterior wall or expand workspace to perimeter wall; physical retreat, but no visual retreat. Performance = Net Improvement Over Sea of Cubicles and Furniture on Wheels.

8 Thermal Comfort: First requirements were to meet LEED framework. Going beyond those metrics, the social circulation spaces (i.e., perimeter wall and interconnectivity stair) will have the most thermal variability and natural light, which works well in a social space where you want sunlight while also achieving a thermal/glare "buffer."

9 Renovation "Detox": The elimination of destructive demolition and reconstruction and spackle/painting/sanding (crystalline silica in pre-existing core walls, respirable particles, etc.) improves the environmental quality of this floor. In addition, the entire building population benefits because air pressure differentials (elevator stack effect, etc.) distribute particulates and vapors throughout the building. The change agent is the screwdriver, not the sledgehammer!

10 Breaking the Shell: For NRDC, moving away from private offices as a default for professionals was informed by more than just the requirements for design for disassembly. Rather than small, enclosed air pockets of rooms (which are more vulnerable to a spill or error in paint selection over a weekend), there is a massive and diffusing "commons" of light and air that provides an inherently safer work environment. Importantly, the quantified reduction in "materiality" (the sum total of visible and invisible materials and systems necessary to achieve functionality per person) was dramatic. (See *Suburban Model vs. Nature's Model*.)

The Metrics Challenge

One area needing improvement was that of measuring sustainability. For instance, by finding ways to increase the net density of NRDC's population, the per capita consumption of energy, materials and capital was reduced and yet is not fully reflected in the Btus per square foot metric. The reason is that more people are accommodated per floor.

Another challenge is a higher utilization factor (early morning, late evening) at NRDC than is typical in this building type, which also is not accommodated in the traditional building type with kBtus per square foot model.

This gets back to one of Buckminster Fuller's favorite questions: "How much does your building weigh?" In other words, what is the measurable net efficiency in relation to outcome?

In this context, energy consumption needs to have a leveling factor that recognizes variations in utilization levels as well as climate. To accomplish this, the energy consumption per square foot can be expressed as per average operational hour, and a climate factor could be applied to level a Monterey, Calif., building to a building in Gainesville, Fla.

In the case of NRDC, the supporting physical infrastructure and energy required per occupant in a given climate is the leveling metric being developed for each location. Therefore:

(average energy/person/hour)
× (climate factor) = comparable metric

The long-term sustainability benefits of design for disassembly also will vary depending on "churn rate," or frequency of change within an organization. Therefore, if no history exists (as in the case of NRDC), it requires detailed and extended post-occupancy reporting to establish the equivalent of an energy payback and life-cycle cost analysis.

A NATURAL SETTING

Full spectrum light as applied to the design of NRDC refers to the maximum use of and access to natural daylight throughout the interior. Artificial light cannot reproduce the full electromagnetic spectrum of sunlight that our eyes have evolved to capture. And, most importantly, it does not impart the biological orientation to time of day and season that is inherent in the sun's daily traverse (circadian rhythm) and seasonal variation in length of day.

Our responses to the dynamic characteristics of natural light (direction of the source, vertical height, color, duration) and the interaction with passing clouds, weather change, surrounding buildings and the sun's dramatic rising and setting are all conscious and subconscious connections to not just physical orientation (where we are) but also to temporal orientation (when we are).

The greatest misconception in the integration of daylight is the glass-to-the-floor concept of more is better. The provision of controlled light and views at seated eye level, and the reduction of glare and contrast at the exterior wall by redirecting natural light to the upper ceilings (inward sloping preferred), recreate the lighted canopy overhead that we intuitively recognize as natural.

2011 ELECTRICITY USE

	kWh
December 2010	2,927
January 2011	11,860
February 2011	7,808
March 2011	8,520
April 2011	4,356
May 2011	5,944
June 2011	6,588
July 2011	6,372
August 2011	9,412
September 2011	6,228
October 2011	5,832
November 2011	10,012
December 2011	6,345
Total	**92,204**

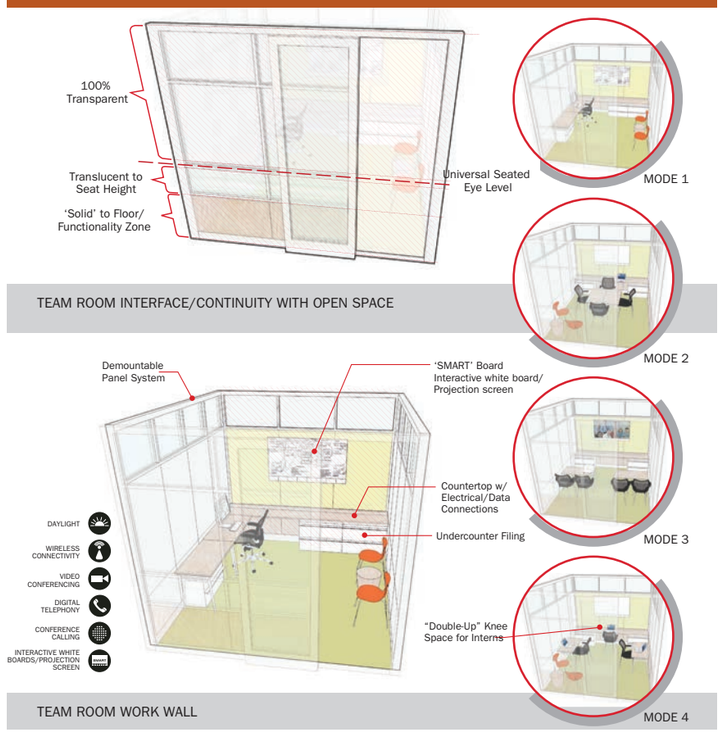
Note: Dec. 2010 invoice includes Jan. 2011 data; usage pro-rated for 2011. Dec. 2011 invoice includes Jan. 2012 data; usage pro-rated for 2011.

2011 FUEL OIL PURCHASES, USE

Inventory	Quantity (gallons)
1/1/11	1,800
12/31/11	44
Purchases	
1/21/11	2,200
2/4/11	2,200
3/18/11	1,500
10/28/11	1,500
12/3/11	1,700
Total	**9,100**
Total Fuel Use	**10,856**
NRDC total portion	5,428
NRDC Eighth Floor	1,086

Note: Heating for NRDC eighth floor steam heat from one-pipe boiler system; single boiler in basement serves whole building; fuel oil pro-rated by floor area.

ADAPTABLE DESIGN



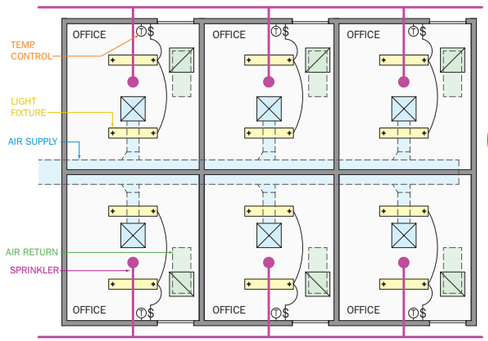
Innovative Design

The chronic underuse of enclosed or private office space is the norm in the United States (60% vacant) and, if anything, was even higher in the case of NRDC given its requirements for work in the field and the increasing ability to work remotely. The necessity for a private office for writing and analytical tasks has always been a given (don't go there) in office planning for NRDC. However, Ashok

SUBURBAN MODEL VS. NATURE'S MODEL

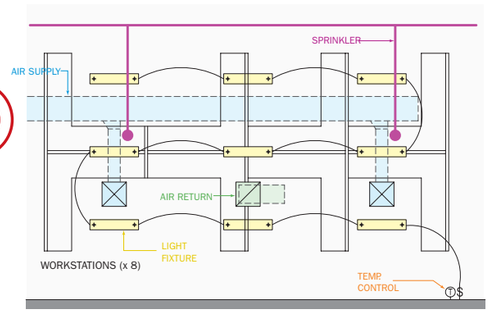
(Note: Massive materials, controls and systems consumption with high-risk IAQ geometry)	=	MAXIMUM Global Warming Climate Change IMPACT	(Note: Resourceful utilization of materials, controls and systems with low-risk IAQ geometry)	=	MINIMUM Global Warming Climate Change IMPACT

'SUBURBAN' MODEL



VS

'NATURE'S' MODEL



COMPONENT		AREA/QTY	EMBODIED ENERGY (BTU's)
Walls			
Metal Studs	=	1,237 SF	19,921,938
Gypsum Wall Board	=	2,843 SF	21,641,304
Paint	=	2,843 SF	2,873,638
HVAC			
Ductwork	=	275 SF	1,284,876
Diffusers and Return	=	24	1,505,731
Temperature Controls	=	6	–
Sprinklers	=	95 LF	509,355
Light Fixtures	=	12	292,781
TOTAL	=		48,029,623

COMPONENT		AREA/QTY	EMBODIED ENERGY (BTU's)
Walls			
Metal Studs	=	0	0
Gypsum Wall Board	=	0	0
Paint	=	0	0
HVAC			
Ductwork	=	285 sf	1,331,599
Diffusers and Return	=	3	188,216
Temperature Controls	=	1	–
Sprinklers	=	54 lf	287,383
Light Fixtures	=	9	219,586
TOTAL	=		2,026,784

95.7% reduction in embodied energy

Gupta, NRDC's Director of Energy Policy, stepped forward in the work sessions to say that he and his group would be the first "colonists" of the eighth floor prototype.

The design process was a "clean sheet of paper" exercise in how to move much further, much faster by leveraging technological advantages (iPad, smart phones, GoToMeeting, etc.). Looking at a typical time and use profile, it became clear that the combination of a much smaller and open work space (60 ft^2 vs. 120 ft^2) combined with enhanced connectivity to work remotely and, when needed, the ability to take any office calls or redirect office calls to any work point on the floor plate could create a more resourceful and flexible physical infrastructure for NRDC. However, the greatest benefit is proving to be the enhanced collaborative and team-centered work modes.

This quantitative enhancement would not result in long-term productivity and teaming culture advantage unless the qualitative attributes identified in the "Top 10 Design Values" work sessions could be included. The most common frustration expressed with all forms of open plan is balancing the sense of visual privacy and sense of "my domain" with connectivity to colleagues, open space and community when desired.

Workstations

The three-tiered layering of solid, translucent and transparent form throughout the work spaces offers seated visual privacy with a right-angle corner to turn into for fully blocked peripheral vision. Translucent panels allow light to reach all desktops.

BUILDING TEAM

Building Owner/Representative
Natural Resources Defense Council

Architect
Croxton Collaborative Architects, PC

General Contractor ICS Builders

Mechanical, Electrical Engineer
WSP Flack + Kurtz

Structural Engineer ETNA Consulting

All solid bases (desktop to floor) are modular for functional refitting as required. Upper zone transparency allows direct views to the upper zone "commons" portion of the windows by all professionals and staff in Team Rooms or workstations.

Mechanical Systems

Circulation, horizontal and vertical, is organized to pass by the exterior wall with comfortable variability in temperature and naturally changing sunlight quality. This is the essence of a social and dynamic space. It allows for a lower ambient temperature setting for heating and cooling than at the more variable perimeter edge, which is a source of complaints that drive greater energy consumption than necessary.

The mechanical system, a high-efficiency direct expansion (DX) unit and fully integrated BMS with water-side economizer cycle, couples with nature to capture free cooling throughout the winter and shoulder seasons. A 5.55 kW rooftop photovoltaic array was constrained in NRDC's urban location by surrounding structures shading the roof. However, the remainder of the roof is being developed as a green roof, urban agricultural garden and apiary (see *Roof Plan*).

A continuing built-in frustration is that the base building's central boiler uses fuel oil and is a number

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Informal conference room (yet to receive artwork, side tables and lamps) is linked to the Social Corridor and converts the traditionally private "Corner Office" with three large windows into a common space.

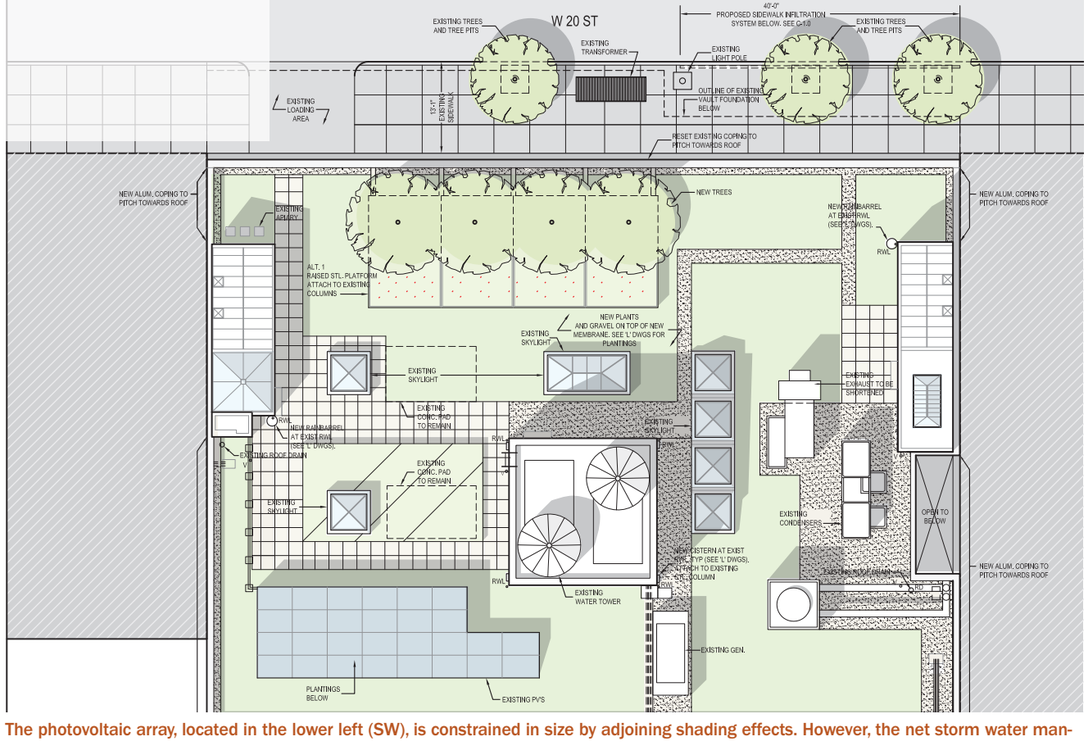
BUILDING ENVELOPE

Walls
Type Existing masonry (thermal upgrade)
Overall R-value R-12.6 (added insulation R-7.4 – 2 in. cellulose)

Windows (upgrade)
U-value 0.27
Solar Heat Gain Coefficient (SHGC) 0.27
Visual Transmittance 0.63 (63%)

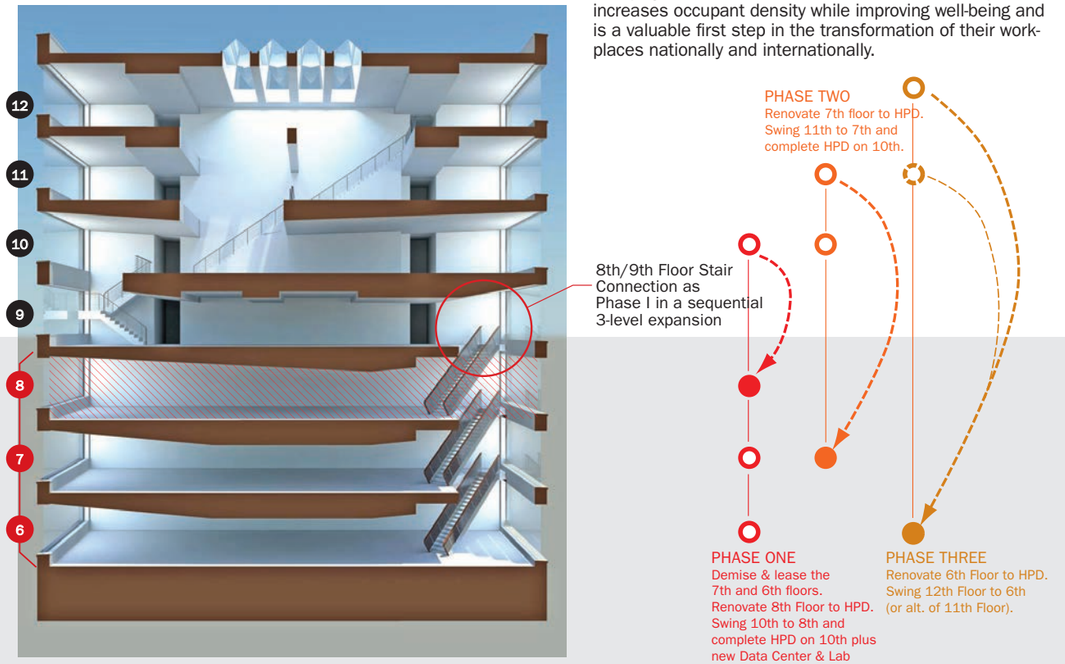
Location
Latitude 40.740503°

ROOF PLAN



The photovoltaic array, located in the lower left (SW), is constrained in size by adjoining shading effects. However, the net storm water management capacity of the landscape design can handle the full storm loading of a typical meteorological year. An apiary (bees), urban agriculture, and large scale trees are in planning/design stages now.

STRATEGIC PLAN



This project creates a more sustainable, universal plan that increases occupant density while improving well-being and is a valuable first step in the transformation of their workplaces nationally and internationally.

8th/9th Floor Stair Connection as Phase I in a sequential 3-level expansion

PHASE TWO
Renovate 7th floor to HPD. Swing 11th to 7th and complete HPD on 10th.

PHASE ONE
Demise & lease the 7th and 6th floors. Renovate 8th Floor to HPD. Swing 10th to 8th and complete HPD on 10th plus new Data Center & Lab

PHASE THREE
Renovate 6th Floor to HPD. Swing 12th Floor to 6th (or alt. of 11th Floor).

of years away from a changeover, and the basement is too space-constrained for ice storage technology at this point. Both issues are on the long-term agenda for sustainable technology upgrades.

LESSONS LEARNED

Waterless urinals, used in multiple previous renovations over the years, have been monitored for operational function/maintenance and were ruled out by NRDC in favor of one-eighth gallon/flush versions, which are environmentally superior.

Four months into post-occupancy, responding to some calls for greater privacy, the Air and Energy Group had 12-in. extender translucent panels from the open office system installed. By consensus, they were removed three months later and the original design is intact and validated.

Storm Water

A separate design opportunity is under way for the introduction of a storm water infiltration vault beneath the sidewalk on 20th Street. This is intended to become a New York City prototypical storm water feature in all existing structures undergoing major renovation in the future. (New York City already requires that all such sidewalks be structurally upgraded to carry the load of fire emergency vehicles when a major renovation is undertaken, presenting this opportunity.)

The volumes of storm water carried by sidewalks in NYC are not just what falls on the sidewalk, but also the large amounts of rainwater that sheet down the face of the buildings, adding significantly to the storm water management potentials of this strategy.

Conclusion

The NRDC project team accomplished three transformational design tasks:

1 Set aside the private office as a default standard for the scientists and attorneys of NRDC by using Internet, telephony and personal video interconnectivity and privacy options within the "commons." This increased net density by more than 30%.

2 Provide every occupant with direct visual access to nature while preserving a sense of a personal domain.

3 Create a "social circulation" pathway at the building perimeter for interaction that is sunlit, thermally variable and interconnected to formal and informal conference rooms and adjacent floors.

Three areas of enhanced performance and quality, not currently embodied in architectural/engineering practice, were central to the NRDC effort:

1 Measures/metrics of performance in energy and materials. Moving from kBtus per square foot by building type to a more nuanced metric of climate/duration leveling may have an obvious advantage; however, having transparency about the total consumption of materials to meet mission is a new challenge. Just as some projects list cost as confidential, some projects may choose to handle the materiality of their solution in the same manner. If we are to learn how to do more with less, we need these metrics.

2 Full spectrum screening of materials used. While VOCs are considered a qualitative screening issue, an array of carcinogenic, neurotoxic, endocrine disruptive, etc., substances in building materials remain invisible. This is an enormous opportunity for qualitative enhancement.

3 Maximum daylight commons. Daylighting remains an underused and 'no cost' asset typically characterized as useful in only the outer 15 ft of the typical floor. Deep daylighting strategies extend subtle, but essential, qualities of full spectrum light into the heart of the building.

All of these areas are extensions of the foundational high performance strategies of best practice: the envelope upgrade, the HVAC equipment efficiencies, the water conserving fixtures, the daylight dimming, the free cooling, etc.

They extend the realm of consideration to include human factors and productivity, risk avoidance, long term habitation and renovation efficiencies, etc.

They are but hints of the massive challenges of continuous improvement and innovation that will be required as we strive for the ultimate high performance threshold: sustainability. ●

ABOUT THE AUTHOR

Randolph R. Croxton, FAIA, LEED AP, is president of Croxton Collaborative Architects, PC in New York.