The Role of Compact Storage in Green Building Design

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White Paper

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Executive Summary

"Green Storage." To some it's just another stage in the greening of America. To others, particularly those designing, constructing or operating buildings, it's a very real solution to many of today's space and sustainability challenges.

Sustainable, or "green," design[1] solutions are not new to the design industry. In addition to cutting costs and benefiting the environment, it just makes good economic sense whenever you can save green space and reduce costs over the long run.

An example would be energy reduction. Buildings represent a third of U.S. primary energy use and two-thirds of U.S. electricity consumption. According to U.S. Environmental Protection Agency (EPA) research, tenants can save about 50 cents per square foot each year through strategies that cut energy use by 30 percent. This can represent a savings of $50,000 or more in a five-year lease on 20,000 square feet[2].

The EPA, in its own case study on "EPA's Research Triangle Park Laboratory Facility," cites minimizing the total volume of the building as one way to reduce the load placed on the heating and air conditioning system, thereby saving energy and reducing heating and cooling costs.

Compact storage (also know as high-density mobile storage), reduces space needs, which in turn can minimize a building's total volume and reduce construction costs, as well as saving energy and reducing operating costs over the life of the building. It has also helped reduce site disturbance in new construction and has aided in the adaptive reuse of existing buildings. In one project alone, it saved over 30,000 square feet and $6 million in construction costs. In others, it's helped prevent the need for costly additions. Compact storage is a viable alternative to traditional, fixed storage products, and green in terms of Life Cycle Assessment (LCA)[3].

Storage equipment has even helped buildings earn points towards LEED® Certification, the consensus-based national standard developed by the U.S. Green Building Council to support and validate green building, design, construction and operations.

The focus of this white paper is the role of compact storage in green building design, and how compact storage can help contribute to green building goals and possible points towards LEED Certification.

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[1] "Design and construction practices that significantly reduce or eliminate the negative impact of buildings on the environment and occupants." U.S. Green Building Council, *An Introduction to the U.S. Green Building Council and the LEED Green Building Rating System®*, December 2004

[2] U.S. Green Building Council Fact Sheet, April 2005; Sources: 2003 U.S. DOE Buildings Energy Databook and EPA

[3] "LCA is a tool to measure, assess and manage the environmental performance of a product from raw materials through production, use, and end-of-life phases." Five Winds International, Building Product Life Cycle Assessment Webcast, BDCmag.com, April 2005

Compact Storage and its Economic Benefits

Compact or high-density mobile storage is "green" by its very nature. By eliminating the space required for multiple aisles, such systems efficiently condense storage into a smaller footprint, while increasing capacity over stationary systems - or freeing up space for other activities.

Mobile systems are available in three types - manual, mechanical and powered. All have carriages that move along a rail or track. Each type offers varying degrees of feature sophistication and overall storage density, with powered systems providing the highest levels of each.

Powered systems are electronically operated and easily programmed to automatically open and close, adjust aisle widths and protect the users with several safety features. Powered mobile systems move at the push of a button, providing flexibility, productivity and the highest level of safety and item security, while allowing companies to meet Americans with Disabilities Act (ADA) requirements.

Powered systems offer a range of features, including an energy-saving aisle-lighting option that illuminates only the occupied aisle and turns lights off automatically after a set period of inactivity; an Internet interface that assures optimal efficiency; passive, automatically activated safety sensors; and code-access keypad control for enhanced security. They can even be tied to a building's fire alarm and security system.

STORAGE EFFICIENCY COMPARISON

	STORAGE IN. / SQ. FT.
High-Density Mobile Storage	**54.8**
Sliding Shelf Units	35.9
Pullout Storage Units	32.6
Open Stationary Shelving	29.3
Rotary Storage	24.0
4-Drawer Vertical File	14.5
Mechanized Vertical Storage	13.8
5-Drawer Lateral File	13.2

STORAGE EQUIPMENT COST COMPARISON

	COST/ STORAGE IN.
Open Stationary Shelving	$ 1.13
High-Density Mobile Storage	**$ 2.30**
Sliding Shelf Units	$ 2.93
4-Drawer Vertical File	$ 4.52
Pullout Storage Units	$ 5.61
Rotary Storage	$ 6.19
5-Drawer Lateral File	$ 6.44
Mechanized Vertical Storage	$12.20

With over 28 percent of all office furnishings expenditures typically spent on storage equipment[4], and space at a premium in most industries, high-density mobile storage is a "smart" solution. It is the most space-efficient of all storage equipment in terms of optimizing space utilization, yet initial costs, per storage inch, for high-density mobile equipment are less than for most other storage products (see bar charts). ▶

Case Study

Compact shelving helps Emory University avoid costly addition

High-density mobile storage recently helped Emory University in Atlanta avoid encroaching on adjacent green space, while enabling its Robert W. Woodruff Library to continue to house its active collection in the on-campus main library building.

The alternative to compact shelving would have been to consider a substantial addition to the building or off-site storage options, both of which would have cost considerably more and neither of which would have provided the necessary storage within the same timeframe.

Case Study

Green storage saves 30,000 square feet and $6 million in construction costs

When Central Michigan University's Charles V. Park Library in Mount Pleasant, Mich., recently underwent a four-floor renovation and expansion, architects specified high-density, powered mobile shelving to house the library's collection. The 1.1-million-volume collection, which was consolidated from several campus locations, would have required 75,000 square feet had stationary shelving been used. Architects reduced the overall building footprint to 45,000 square feet simply by utilizing mobile shelving.

The stacks were designed into the new addition, where the 30,000 square feet saved contributed to $6 million in construction cost savings, allowing the resulting structure to include a multi-floor atrium with an abundance of natural light.

When LCA is used to evaluate energy-saving strategies, high-density mobile storage also gets high marks. The concept fosters the use of smaller buildings, reducing the amount of building materials consumed and saving energy by having to heat and cool less square footage over the life of the building. It also fosters the use of on-site storage, which requires less energy to retrieve than items stored in an off-site location. As a facility's needs change, high-density mobile storage equipment may be relocated and reused - and at the end of its useful life, because it is manufactured primarily of steel or aluminum, it can be recycled again.

Space conservation is the most obvious environmental benefit of compact storage. Economic benefits include savings in construction materials, energy consumption, and personnel costs associated with maintaining and staffing a new facility or addition.

Switching to high-density mobile storage can immediately increase storage capacity in an existing facility by 50 to 100 percent, often helping an organization avoid the expense and hassle of a move or new construction.

Today's space planners and facility managers must evaluate not only current and anticipated space requirements, but also Life Cycle Costing (LCC)[5], including the costs associated with operating in that u space. Consider the following factors that make up the annual cost per square foot of leased space:

- Rental Cost
- Utilities
- Maintenance

By allowing facilities to reduce existing space or minimize the total volume of a new building, high-density mobile storage can yield (or "contribute to") savings in all these areas.

Another way to look at it is to multiply the annual energy cost per square foot by the square footage saved through the use of high-density mobile storage. With annual energy (electricity and gas) costs in the U.S. averaging $1.52 per square foot in office buildings and $2.15 in hospitals[6], an office building or hospital saving 10,000 square feet, could save $15,200 or $21,500 annually in utility costs alone. If you add the rental and maintenance costs per square foot, the actual savings from the use of compact storage increase dramatically.

Note ongoing costs per square foot for rent, utilities and maintenance of downtown office buildings in six major cities[7].

When the issue is expansion or new construction, space and cost savings can often be realized by planning for high-density mobile storage in advance - during the initial planning stages. This allows you to consider the structural system necessary to support high-density mobile storage, while reducing the overall footprint of the addition or building. With cost estimates for new construction running as high as $168, $180 and $315 per square foot for office buildings, libraries and hospitals, respectively, the savings can be enormous. High-density mobile systems recently helped Central Michigan University save $6 million in construction costs (see case study).

Note construction costs for six major cities[8], on next page.

Most compact mobile storage installations can also be cost-justified by the increased productivity and efficiency from storing more materials closer to point of use. Optional features that can boost efficiency even more include aisle-end shelving for quick access to "active" files and materials, plus barcode and RFID ▶

[4] BIFMA International, Rpt #9a, *2003 shipments of Office Furniture by U.S. Manufacturers*

[5] "LCC … the focus is on the economic impacts, not on the environmental and health impacts." James A. Fava, PhD, Managing Director, Five Winds International, Building Product Life Cycle Assessment Webcast, BDCmag.com, April 2005

[6] Platts, a Division of The McGraw-Hill Companies, Inc., http://www.nstaronline.com/your_business/energy_advisor/CEA_home.html

[7] Institute of Real Estate Management, *2004 Income/Expense Analysis®: Office Buildings*

[8] RS Means, http://www.rsmeans.com/calculator/

technology for enhanced tracking and retrieval of documents or inventory. A well-organized system improves workflow, decreases filing errors and inventory problems and gives employees better access to frequently needed materials.

Floor space remains a high, fixed-cost element in today's interior environment, whether the situation is new construction or an existing building. A smaller building footprint resulting from use of compact storage reduces energy consumption over time.

CONSTRUCTION COSTS PER SQUARE FOOT OF FLOOR SPACE

	Hospital - 100,000*		Library - 30,000*		Office, Mid Rise - 50,000*	
	Preliminary Cost Est. Per Sq. Ft.		Preliminary Cost Est. Per Sq. Ft.		Preliminary Cost Est. Per Sq. Ft.	
	Low	High	Low	High	Low	High
Atlanta	$129	$230	$79	$132	$75	$124
Boston	$166	$297	$102	$170	$95	$158
Chicago	$161	$287	$99	$164	$92	$153
Dallas	$121	$215	$74	$123	$70	$116
San Francisco	$177	$315	$109	$180	$101	$168
Seattle	$149	$266	$91	$152	$86	$143

*Gross Sq. Ft.

ONGOING COSTS PER SQUARE FOOT OF FLOOR SPACE FOR OFFICE BUILDINGS, DOWNTOWN

	Rent*		Utilities*		Janitorial, Maintenance and Repair*	
	Low	High	Low	High	Low	High
Atlanta	$19.04	$22.76	$1.35	$1.50	$1.85	$2.33
Boston	$24.23	$35.00	$1.34	$2.85	$2.14	$2.88
Chicago	$13.85	$19.23	$1.20	$1.70	$3.11	$3.76
Dallas	$13.28	$19.42	$1.63	$2.33	$1.77	$2.55
San Francisco	$24.78	$38.15	$2.09	$3.06	$3.31	$4.13
Seattle	$21.28	$25.92	$1.21	$1.78	$1.94	$2.91

*Per Sq. Ft. ($ Per Net Rentable Office Area)

A Commitment to Green

When selecting storage equipment, it's important to look at the manufacturing company for a proven commitment to environmental sustainability. The manufacturer should have well-established "green" manufacturing processes in place to minimize the impact on the environment.

Key Components of Green Manufacturing:

- **Lean manufacturing principles:** Products are manufactured using a minimal number of parts, making them interchangeable, easier to assemble and environmentally sound. The company continually looks for ways to remove waste of motion, time, energy and resources from every step in the manufacturing process and regularly updates production practices, keeping up with advances in technology, as well as in health and environmental standards.
- **Recycled content:** Steel or aluminum with a high percentage of recycled content is used whenever possible.
- **Recycling:** The company uses recycled water to thoroughly clean its products before painting. This solvent-free process, called aqueous degreasing, along with strict product selection and quality control, prevents greenhouse gas emissions and eliminates heavy metals from wastewater, a process so effective that products need only be painted once. In addition to recycling water whenever possible, the company should also be recycling materials, such as steel and aluminum, from their ▶

Case Study

High-density mobile storage recently helped the highly acclaimed Seattle Public Library building earn a Silver LEED® certification from the U.S. Green Building Council (USGBC) for incorporating design elements that demonstrate environmental stewardship.

Other LEED® certified buildings that have conserved significant space through the use of high-density mobile storage include the William J. Clinton Presidential Library in Little Rock, Ark., and the Mark Twain House & Museum in Hartford, Conn.

fabrication process, as well as implementing programs to reduce the amount of corrugated cardboard used for packing and shipping.

- **Low-emitting materials:** Powder-coat painting is a highly efficient and solvent-free process, especially when a manufacturer confines and reclaims the powdered paint to minimize waste and avoid air pollution. At least ninety-seven percent of the paint should end up on the product. Powder-coat paint, which requires no primer, also smoothes metallic "burrs," eliminating the need for grinding or filing.
- **Flexible, reusable products:** The company's finished products themselves should be easy to reconfigure, reuse and recycle to prevent them from ending up in the nation's landfills.

LEED® Rating System

The LEED rating system was developed by the USGBC to assist owners, architects, contractors and vendors in designing, constructing and fabricating products that are environmentally friendly when compared to standard building practices.

Compact mobile storage systems may assist projects in obtaining a LEED rating in five of six categories:

Category 1 - Sustainable Sites

By allowing a dramatic increase - as much as 50 to 100 percent - in on-site storage over conventional, stationary methods, compact storage may help reduce building size, thus minimizing site disturbance and preserving open space. By greatly expanding on-site storage capacity, an existing facility could be renovated, rather than constructing a new building.

Category 3 - Energy & Atmosphere

By compacting storage to reduce building size, high-density mobile systems may help reduce energy consumption over the building's life, since smaller buildings typically take less energy to heat and cool. Choice of aisle-lighting options may further contribute to energy savings.

Category 4 - Materials & Resources

Recycled content in high-density shelving could also contribute toward a project earning LEED points. Recycled steel content varies and often a manufacturer's recycled steel content may be as high as 80 or 90 percent. Retaining the building's shell also could assist a project in achieving points in the building reuse category.

Category 5 - Indoor Environmental Quality

High-density mobile products finished with a powder-coat paint that emits no volatile organic compounds may contribute toward credits for low-emitting materials. Space planning, densification of storage areas (especially to the interior of a project) and/or limiting of storage system height may also contribute toward credits for occupant access to daylight and outside views.

Category 6 - Innovation & Design Process

If a project's environmental goals cited in any of the above categories are significantly exceeded, additional points may be earned for innovation in design.

Conclusion

Since the USGBC evaluates each project individually, the role high-density mobile storage systems plays will be different for every project. It is the design professional's responsibility to ascertain a project's eligibility for any of the credits proposed and prepare the necessary documentation for submission to the USGBC. The final determination, however, will always be in the hands of the LEED Steering Committee.

About the Authors

Alfred J. Herzog, PE, LEED AP, is employed at Emory University in Atlanta, Ga. His career spans 28 years in facility-related activities, design, construction, operations and maintenance. He has been a member of Emory's Facilities Management Division since 1987 and served in the United States Air Force as a commissioned officer for 10 years.

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Click here *to see The Construction Specifier article based on this white paper.*

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