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6G | REGISTRARS AND SUSTAINABILITY

An Introduction to the Issues and a Call for Action

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At first people refuse to believe that a strange new thing can be done. Then they begin to hope it can be done. Then they see it can be done. Then it is done and all the world wonders why it was not done centuries ago.
—Frances Hodgson Burnett

INTRODUCTION

Registrars are uniquely positioned to take a leadership role in fostering sustainable behavior both within their institutions and in the profession at large. First, registrars are trained to analyze and address actions that may affect the preservation of collections. Their awareness of the connections between behavior and its intentional and unintentional consequences is a vital resource for understanding and implementing sustainable practices. Secondly, the purview of a registrar's job is vast. Duties span many departments, requiring efficient communication and collaboration. A registrar's relationships with colleagues allow him or her to approach an interdepartmental project with a broad point of view, an attribute complementary to the sustainability paradigm. As detail oriented, collaborative decision-makers, registrars have the potential to increase the sustainability of their institutions.

In order to engage in a dialogue regarding sustainability, the terms *green* and *sustainable* must be defined. In reference to the environment, the notions of *green* and *sustainable* share a similar objective: to protect and conserve natural resources. *Green* generally refers to an end result, such as, does this product or action have a benign or positive effect on the environment? *Sustainability* instead reviews an entire system and the relationship between systems—a more holistic approach. One concise definition of *sustainable* is meeting the needs of the present without compromising the ability of future generations to meet their needs.[1] An action is rated by whether or not it maintains an amicable balance among its economic, social, and environmental components—a triple-weighted scale. Therefore, a product may be *green*, but ultimately not *sustainable*. Biodegradable plastic, for instance, can be considered green because it degrades under certain conditions relatively safely, but it is not sustainable because more fossil fuels are consumed to manufacture biodegradable plastic than traditional polymers. *Green* products or actions are a step in the right direction, but *sustainability* is the ultimate goal.

Sustainability has become relevant within the framework of climate change. Climate change is the result of humanity's perspective that nature is a force to be dominated or controlled. The Industrial Revolution, for instance, was based upon a perceived endless supply of "natural capital" and "neither the health of natural systems, nor an awareness of their delicacy, complexity, and interconnectedness, [were] part of the industrial design agenda."[2] Humanity has spanned the globe, building structures and using resources at a faster rate than can be replenished. Furthermore, the loss of natural habitat coupled with species extinction continues to occur at a rapid pace. The stress humanity has placed upon our fragile ecosphere is alarming. Museums play a role in this natural resource drain; standard museum operations such as the maintenance of stable microclimates and exhibitions do impact the environment.

There is growing support, both nationally and internationally, for sustainable initiatives within the museum profession. First, a number of publications are available that discuss museums and sustainability in the areas of outreach, education, exhibit design, lighting, and food service. A recent addition to the resource list is *The Green Museum: A Primer on Environmental Practice*, by Sarah Brophy and Elizabeth Wylie. Second, it is now typical for museum

green versus sustainable

conferences to include some element of environmental responsibility both in program content as well as event administration. At the 2008 American Association of Museums meeting, 102 people signed up for the newly formed professional interest committee, PIC Green. The British Museum's Department of Conservation and Scientific Research hosted a one-day meeting in 2009 entitled "Going Green: Towards Sustainability in Conservation." Lastly, there are a number of online resources such as the Green Design Wiki, the Green Museums Wiki, and GreenExhibits.org.

LEED (Leadership in Energy and Environmental Design)

Building green museums is perhaps the most publicized initiative within the profession. Green building methods originating from the design and engineering fields are being adopted for the construction and renovation of museums and exhibits. Many museums are also seeking LEED (Leadership in Energy and Environmental Design) certification. The LEED program was developed by the United States Green Building Council to promote design and construction practices that reduce the industry's negative environmental impact and establish guidelines for those practices. One subset of the program is LEED for Existing Buildings (EB): Operations and Management (O&M). This program was designed to implement sustainable operations and maintenance practices to reduce the environmental impact of existing buildings. The program specifically addresses the following areas: sustainable purchasing, waste stream management, green cleaning, energy performance, indoor environmental quality, and site management techniques for pests, storm water, landscaping, and lighting.[3]

Green Committees

Creating a green committee that uses LEED-EB O&M guidelines is an excellent starting point to implement sustainable operations at a museum—even if certification is not an objective. However, it is important to tailor initiatives to the specific institution in question. In *Fostering Sustainable Behavior: An Introduction to Community-Based Social Marketing,* Doug McKenzie-Mohr and William Smith provide insightful strategies for instituting behavioral changes. The authors note the importance of determining the barriers and benefits of a particular sustainable behavior. Since non-communal, drastic alterations typically do not result in long-term change, establishing an open forum within a museum, in which sustainability goals are defined and potential barriers and benefits are explored, is vital to accomplish successful behavioral changes. Staff members will have varying opinions and knowledge levels about today's environmental problems and it is important to establish an atmosphere of respect and collaboration.

The interdepartmental nature of the registrar's position gives him or her the opportunity to take a leadership role in forming a green committee. A green committee will be most successful with the participation and collaboration of all departments. The committee's responsibility may include rethinking current needs, systems, and methodologies, and setting future goals and pathways to achieve those goals. Potential results of a "Green Team" include: economic savings, diminished use of resources including water and electricity, the formation of mutually beneficial partnerships with service providers, a reduction in museum consumption and waste, and improved standing amongst constituents and colleagues.

Registrars will find useful information in the aforementioned resources concerning energy efficient technologies and green consumer products to help launch green committee initiatives. However, much work is still needed both to consolidate and to build upon data specifically geared for the registration department. Further research into new products and procedures, such as green archival products and alternative lighting strategies, is needed in order to develop new standards. Opportunities abound for museum studies students and established professionals alike to research and collaborate with service providers to develop, test, and apply alternative methods and materials. The following discussion, therefore, should be seen as one installment in a portfolio the authors believe will continually develop as museums

bring their behaviors more in line with environmental sustainability. The topics included range from complex undertakings such as modifying lighting and climate control systems to more mundane tasks such as purchasing office paper.

As previously noted several museums are now building green and seeking LEED certification. One key component of LEED certification is the installation of, or upgrade to, energy efficient lighting and climate control systems. The guidelines also promote the use of natural light and passive ventilation as ways to reduce energy consumption. Although these ideals do not completely conform to the standards of object preservation, there are ways to mix passive systems and energy efficient technologies to reduce a museum's energy consumption.

Lighting

Electric lighting, for example, accounts for more than a third of all electricity consumed for commercial use in the United States.[4] Encouragingly, "due to soaring electricity prices and ever-growing environmental concerns about energy consumption and waste disposal, lighting is experiencing a technology revolution."[5] Museums' challenge with lighting has always been controlling the negative effects of light upon objects, which must be exposed to light in order to be viewed, yet light damage is cumulative and cannot be reversed. Light exposure can cause fading, darkening, yellowing, embrittlement, distortion, and stiffening. The type of light and duration of exposure are important factors in light damage: illuminance plus time equals total exposure. The light spectrum is divided into three sections: ultraviolet (UV), visible, and infrared (IR). Most damage to artwork is caused by the UV and the violet/blue and green end of the visible light spectrum. Damage is also caused by IR wavelengths, which produce heat. Since sunlight is full spectrum light, it is the most damaging to light-sensitive objects.

Typically, museums use halogen or metal halide track lighting in galleries, and fluorescent lighting in collection storage areas, all of which require filtering. Many types of filtering materials are available to protect objects from light damage; however, it should be noted that the "shelf life" of filtering materials varies from manufacturer to manufacturer. This museum lighting paradigm has begun to change, however, based upon advances in lighting technology and the growing need to control the cost of lighting. The following presents four lighting alternatives: LED, fiber optics, hybrid solar, and diffused natural light.

LEDs (light emitting diodes) are the most promising new light source that may have application within the museum setting. LEDs consume one-fifth as much energy as a conventional bulb and last 100 times longer. They are illuminated by the movement of electrons in a semiconductor material, which is typically aluminum-gallium arsenide. As the electrons move, photons are released—the most basic units of light. LEDs can be used in place of incandescent lights and can be dimmed without changing the color of light emitted—unlike incandescent lights, which become yellow. Although LED lighting is currently more expensive than incandescent lighting, its low energy usage makes it a cost effective alternative in the long-term. LEDs also produce no UV light and little heat, which makes them ideal for illuminating objects.[6] LED lighting, as an alternative lighting source, is still in its infancy.[7] The main drawback to full-scale implementation is initial cost and mediocre CRI (color rendering index.)[8] While there are LED products specifically designed for museum or display use, it may take some time before fixture manufacturers begin to offer a large selection of LED products for the highly specialized needs of museums. In the meantime, rigorous LED research and development continues.[9]

Fiber optic lighting, also known as remote source lighting, uses plastic or glass fibers to distribute light. The fibers can be side emitting, which means the fiber itself is lighted, or end emitting, which means the light is conducted to an attachment at the end of the fiber. The benefit to using fiber optic lighting is that the heat source is removed from the end of the fiber. The Lighting Research Center at Rensselaer Polytechnic Institute notes that: "[p]utting the light source outside of a secured enclosure, such as a display case of costly objects, means the display area doesn't have to be opened for servicing."10 Although fiber optic lighting offers creative solutions, it has

some drawbacks. Glass fibers dissipate UV light, but plastic fibers require UV filtering. The longer the length of fiber, the more loss of light occurs at the endpoint. Furthermore, severe bending of the fibers will result in extreme light loss, a consideration in configuring fiber placement. Finally, if environmental benefits were not factored into the cost benefit analysis, overall energy cost savings may not offset the expense of implementation.[11]

Hybrid Solar Lighting (HSL) is one of the newest technologies in the lighting field. HSL uses solar power and fiber optics to channel sunlight into an enclosed space while simultaneously directing IR light to a concentrating thermo-photovoltaic cell that converts it into electricity. Sunlight is tracked throughout the day using a parabolic dish. Sensors are used to maintain a constant level of illumination by supplementing sunlight with traditional electric light in special hybrid lighting fixtures.[12] Since hybrid solar lighting pipes sunlight directly to the light fixture, this newly discovered process is far more efficient than photovoltaic cells, which convert 15 percent of sunlight into electricity and then change the electricity back into light, resulting in the use of only 2 percent of the original sunlight. As with all fiber optic cables, the longer the cables are the more light they lose.[13] Since the incoming natural light is full spectrum sunlight, light fixtures specifically designed for exhibiting objects and filters may make this technology applicable for museums in the near future.

Lastly, museums have experimented with natural light use in galleries. By diffusing direct sunlight and creating complex systems that track and control sunlight, museums can take advantage of natural light while simultaneously avoiding the harmful effects of ultraviolet rays. A report by David Behar Perahia on the use of daylight in museums cites several institutions in Europe and the United States that have successfully integrated architectural designs that use natural daylighting. The Menil Collection in Houston, Texas, uses a system of ceiling louvers, skylights, and large windows that allow for diffused full spectrum natural lighting in the galleries. The Beyeler Foundation in Basel, Switzerland, has a glazed ceiling that also employs the use of louvers and brise-soleil.[14] Brise-soleil, an ancient architectural shading technique, appears to be experiencing a revival and is used in the new wing of the Milwaukee Museum of Art and will be incorporated into the proposed Louvre Abu Dhabi in the United Arab Emirates.

Ultimately, advances in lighting technology may produce a suitable compromise between the needs of objects and museum visitors. A report produced by The Getty Museum Lighting Research Project noted that "[w]hen applying light damage mitigation techniques simultaneously to maximize conservation, compromises are necessary—display times are limited, and light levels may be so low that they challenge perception through skewed color rendering and reduced detail."[15] David Behar Perahia attributes this challenged perception caused by inadequate lighting to museum fatigue, a well-known phenomenon identified by Benjamin Coleman in 1916.[16] Author David Clinard states that "traditionally, color quality has been and still is one of the most critical concerns for displaying art objects."[17]

Creative lighting strategies throughout a museum building benefit an institution's budget, staff, visitors, and collections. The use of motion sensor lighting and dimmers reduce both object exposure time (thus slowing deterioration) and energy use (thus lowering electricity bills). Other forms of non-traditional lighting such as the Solatube, a lighting strategy that redirects sunlight down a reflective tube and diffuses light within an interior space, can incorporate natural light into non-art spaces such as offices, cafés, museum stores, or meeting rooms, creating a more appealing atmosphere for staff and visitors. LEDs, fiber optic lighting, hybrid solar lighting, and natural light have the potential to benefit museum objects as well as the earth's natural environment.

HVAC (Heating, Ventilation, and Air Conditioning)

Energy consumption can also be reduced by addressing museums' climate control systems. Museums use twice as much energy as typical office buildings because while office buildings typically cool, heat, and illuminate from 9 a.m.–5 p.m., Monday through Friday, museums often have extended hours and maintain constant climate control for collections.[18]

Museum HVAC systems are complex, require constant monitoring, and are one cause of museums' excessive energy use.

A typical HVAC system adjusts air temperature and humidity. In a museum air is first heated or cooled (the cooling removes humidity from the incoming air if needed), then humidified by water heaters or boilers before entering the galleries or art storage areas. Within this system the air passes through three filters: the first filter removes large particulates, the second filter removes fine particulates, and the carbon filter removes vapors. All of these processes are controlled by a central computer system. Clearly, HVAC systems use a great deal of resources and electricity.[19, 20]

Yet, even within an HVAC system, opportunities to reduce waste and decrease costs exist. The Nevada Museum of Art, for example, is currently considering alternative methods of performing air handler carbon filter change-outs. Presently, carbon filters are changed every 12 to 18 months. The old filter, made up of plastic, metal, cardboard, and carbon, is disposed of in its entirety. Alternatively, the carbon could be exchanged for fresh carbon and the used carbon could be sent to a reclaiming company for reactivation (discharging of the contaminants) so that it could be reused.[21] In addition to saving money and keeping filters out of landfills, this method would establish a waste-free recycling system for carbon.[22] This is one example of how creative thinking can reduce the overall cost of operating HVAC systems.

Temperature and humidity guidelines currently utilized by museums also offer energy and cost reduction possibilities. The mechanisms of decay for objects can be attributed to three situations in humidity and temperature control: too low, too high, and too much fluctuation. The resulting damage can be chemical, mechano-physical, or biological.[23] Most museums follow the guidelines for humidity and temperature control as presented by Garry Thomson in The Museum Environment, published in 1978. Thompson recommends a narrow humidity range of ± 4 percent or 5 percent humidity. However, Thompson states that "[t]he tolerance usually quoted of ±4 or 5 percent RH is based more on what can be expected of an air-conditioning plant than on what exhibits can actually stand without deterioration, which is not known in any detail."[24] Despite his forthright admission of how he obtained his guidelines and their potential lack of accuracy, museums have adhered to his ranges, sometimes even implementing stricter guidelines of ±2 percent.

Research published in 1994 on the specific properties of materials by Marion F. Mecklenburg, Charles S. Tumosa, David Erhardt, and Mark McCormick-Goodhart of Conservation Analytical Researchers (CAL) widened the range of humidity control to 50 ±15 percent.[25] Although the results were considered highly controversial at the time, gradual acceptance has yielded the current Smithsonian-recommended ranges of 45 percent ± 8 percent RH and 70° ± 4°F. Applying these guidelines nationally could result in significant energy savings. Mecklenburg, Tumosa, Erhardt, and McCormick-Goodhart note that "[o]ngoing implementation of the new guidelines in Smithsonian museums resulted in cost savings of $2.7 million in just the second half of 2006 (out of $32 million total energy costs for all of 2006), and $1.5 million in the first quarter of 2007."[26] Additionally, allowing for seasonal drift to occur (a slow adjustment in the humidity and temperature set points to allow for seasonal change) could result in monetary savings by maintaining an environment that correlates more closely to outside temperature and humidity. The building envelope (the separation between the interior and exterior environments of a building) must also be considered, especially in older buildings, because introducing high humidity into the air can cause condensation to develop within the building envelope, which can then freeze and cause accelerated deterioration of the façade—thereby promoting mold growth. If acceptance of the Smithsonian-recommended temperature and humidity ranges, including seasonal drift, were to replace current rigid humidity and temperature control limits, museums could incur substantial savings from diminished energy usage while still maintaining safe environmental controls for the objects within their care.

Materials and Products

Alongside lighting and HVAC systems there are other operations under a registrar's purview that could become more environmentally friendly. One way to review daily tasks is to apply the familiar "Reduce, Reuse, Recycle" mantra, maximized by a fourth "R"—rethink. Ask questions related to the three R's when deciding how best to accomplish a project: What is the minimal amount of material needed to properly store, display, or ship an item? Will waste be generated from the action and are there systems in place to store, recycle, or dispose of that waste properly? Is this product needed for long or short-term use? Answers to these incremental questions will often reveal sustainable alternatives, and such analysis is far more manageable than detangling the web of issues posed by the question, "What are the economic, social, and environmental costs to executing this task?" The following will discuss potential products and practices registrars should explore to align their departments with the goals of sustainability.

As indicated previously, there are differences between purchasing green versus sustainable products. Locating a collection care product that balances the triple weighted scale of sustainability—economy, society, and environment—is difficult in today's global economy. Comparisons between raw materials, such as tree versus plant based papers, are dependent upon specifying the geographic location and manner in which the resource is grown, followed by how it is processed, where and by whom. For example, one group of people state that the agricultural plants hemp and kenaf, both rapidly renewable resources, have high yield rates, require minimal amounts of fertilizer, and have lower lignin contents than trees—thus requiring fewer chemicals in the pulping process. A different group of people state that tree plantations certified by the Forest Stewardship Council (FSC) prevent soil erosion, provide habitat for more species, and typically apply fertilizer once every crop rotation (7 years) compared to once a year with annual agricultural crops.[27] Common among all groups is an argument against over-consumption and monocultures, and agreement that even the greenest pulp mill generates some form of pollution. Ultimately, product choice is an act of compromise. However, if consumption is warranted—having first taken "Reduce, Reuse, Recycle, and Rethink" into account—it is important to support companies that have made the effort to incorporate some form of sustainability rather than none at all. The following will place the tasks of purchasing archival products, and packaging and shipping loans under the lens of sustainability.

Plant and tree fibers are key ingredients in many archival materials. Sustainable alternatives to conventional paper products and textiles are available to other markets, but further effort is needed to bring appropriate products to the museum profession. It is possible to produce organic, non-bleached cotton cloth and to produce ANSI certified archival paper from 100 percent post-consumer content without the use of chlorine.[28] Why, then, are these products not available in standard archival catalogues? Understandably, there are concerns within the profession that deviations from approved standards may ultimately harm collections. However, if museums recognize their responsibility to educate and promote sustainability in the public sphere, it is irresponsible to ignore the world's environmental problems behind the scenes. Alternative products should be tested and everyday practices should be reviewed to determine their environmental impact.

Registrars could begin taking responsibility for their departments by asking vendors if sustainable alternatives are available. The more the profession requests sustainable alternatives, the more industries will seek them out to maintain and build their customer base. As of this writing B- and E-fluted corrugated boards distributed by Gaylord Brothers are made with post-industrial waste.[29] These products meet the same archival standards as corrugated board made from single stream pulp. However, Gaylord does not advertise the products' environmentally friendly aspect due to concerns over a potential reduction in sales. This is a good example of the importance archival vendors place on consumer trust and how the industry could be encouraged to seek sustainable alternatives with collaboration and support from registrars.

The archival industry is considered a niche

market. Due to its small size and specific product requirements the industry is not able to withstand economic forces from larger competing markets. Suppliers struggle to maintain product quantity and quality as mills close down, merge, or move overseas.[30] However, the archival industry's small scale may lend itself to the support of smaller localized farms, manufacturers, and businesses. For example, Vision Paper, a company in New Mexico, has been working with local farmers since 1990 to grow the rapidly renewable plant, kenaf, for paper production at mills with strict environmental standards. Several of Vision Paper's products are archival. Over the past five years the mills that produced Vision Paper products have closed, and the specialty mills still available are priced too high and cannot meet the company's specifications. Rather than admit defeat, Vision Paper is in the process of forming its own pulp and paper mill, buying used machines at favorable prices from other mill closures.[31] The potential for creating a sustainable, archival market, integrating local suppliers such as Vision Paper, could increase with support and demand from the museum, archive, and library professions.

Switching from traditional products to green products does not necessarily solve the sustainability issue, however. Product change does not equal behavior change. For instance, using bio-composite board or FSC certified wood products for crate exteriors instead of traditional plywood does not reduce the amount of natural resources consumed and wasted. It is the system in which crates are used that is unsustainable—not the crates in and of themselves. While it is important to incorporate more sustainable and green products and methods into the profession, such alternatives lose their luster if used within an inefficient and wasteful system. As with product choice, registrars could fill an important leadership position by fostering the development of new norms through collaborative research with service providers.

Loans and Traveling Exhibitions

Loans and traveling exhibits are two systems managed by registrars. These systems have an admirable, educational mission but consume physical and financial resources in a single-use manner, producing a significant amount of museum waste. Three pitfalls of the current loan system that make it unsustainable are: a lack of support to facilitate the reuse of packaging and crating materials, the inefficient and polluting manner in which loans are transported, and the lack of environmental responsibility when creating and disposing of museum generated products.

The Guide to Organizers of Traveling Exhibitions: 2003 Edition lists 110 exhibit agencies serving museums nationwide. The amount of materials consumed and discarded each year is enormous if one considers that the 40 current SITES (Smithsonian Institution Traveling Exhibition Service) exhibitions require more than 400 crates, and ExhibitsUSA's 30 exhibitions require 240 crates.[32] Crating and packaging is expensive and a large amount of museum resources are used to fund loans. Results from a 2007 online survey show that out of 105 participating institutions, 29 reported ordering a total of 426 crates in 2006 for a cost of $412,108. Unfortunately, disposal fees are inexpensive, and once-valuable materials are routinely thrown away with no regard to the associated environmental costs.

There is a significant price difference between purchasing new crates and retrofitting used crates. Results from the aforementioned survey show that 30 participants reported retrofitting 510 previously used crates for a total of $38,563. This equates to an average of $75.62 per crate instead of an average $967.39 per newly built crate.[33] Therefore, retrofitting crates not only reduces waste but also saves a significant amount of money. The argument could be made that costs associated with storage and transporting empty crates would decrease any monetary savings. However, before adequate feasibility studies have been undertaken and a true lifecycle analysis between reusing and building new crates occurs, it is premature to assume that crate retrofitting would not yield savings.

In order to facilitate reuse, crates must be stored. The National Gallery of Art retains a large collection of crates (approximately 300) that are stored and managed by a local fine art shipper. The museum typically retains medium-sized crates for versatility of reuse and as a rule does not use a crate if it is more

than 12 inches bigger than the artwork in any one direction. Although neither the museum nor shipping company keeps track of the number of times crates are reused or which ones are used the most, the museum estimates that 95 percent of single object loans travel in retrofitted crates, at a third less than the cost of a new crate.[34] For those institutions that cannot afford storage, a cooperative warehouse system could be developed, managed, and collectively funded by local or regional museums. Crates could be leased, with resulting funds returning to the cooperative or to the proprietary museums. Alternatively, an independent third party could purchase, warehouse, and either lease or sell materials, similar to a construction salvage center. Art handling and exhibition companies could form similar partnerships and devise ways of profit sharing when resources are needed by clients outside of the contractor's immediate service area. While such systems would not satisfy every situation, they would reduce the production rate of new materials and provide a means for organizations to retain valuable resources. This model could also be followed for commonly used and discarded exhibition support materials beyond crates.

It is important to note that the European museum community has successfully instituted a crate leasing program. Several European crate companies have designed reusable crates, especially for two-dimensional works.[35] In general fine art crating companies in the U.S. do not believe a leasing system would be efficient due to the country's larger size and museum density differences in comparison to Europe. However, a modified system that approaches leasing from a regional perspective and promotes cooperation among independent crating companies should be explored in America if museums wish to carry out loans in a more sustainable manner.

Transport is the second aspect of loans that makes them unsustainable. Traveling exhibitions equal greenhouse gas emissions. Just one SITES exhibit, "The Burgess Shale: Evolution's Big Bang," traveled 20,044 miles, producing 38 tons of carbon dioxide. This is equivalent to 80 barrels of oil, and 6.3 passenger vehicles traveling 12,000 miles per year.[36] If traveling exhibitions are to continue, the field must develop alternative methods to rotate and transport them. Currently, where and when an exhibit travels is the outcome of variables presented by both the exhibit and the borrower. The content, cost, and size of an exhibit generally determine the borrower and hence the location, while the borrower's internal exhibit schedule—which may or may not be planned in advance—typically determines the dates. These variables often cause exhibits to travel great distances back and forth across the country. A new system in which lenders direct how exhibitions circulate based on geography, not time, could be developed. Exhibit companies often advertise works-in-progress to judge interest levels. This business strategy could be a means to establish schedules based on the location of interested borrowers. Exhibit brochures could indicate when a particular exhibition would be available in a certain region. Such a system would continue to allow advanced planning for both lender and borrower but would reduce the frequency of long-distance round trips.

In conjunction with improved scheduling methods, exhibits could be transported using more energy efficient technologies. For example, low to moderate security exhibits, especially those that do not contain collection items, could travel by train. Comparisons between highway and rail transport have shown it is more economical to use trains for distances beyond 500 miles.[37] On average, railroads are three times more fuel efficient than trucks; railroads move a ton of freight an average of 404 miles on a single gallon of fuel. The U.S. Environmental Protection Agency (EPA) estimates that for every ton-mile, a typical truck emits roughly three times more nitrogen oxides and particulates than a locomotive.[38] Museums and art handling companies should consult with the railroad industry to explore current options and encourage the development of equipment and services that would facilitate a variety of museum shipments. Fine art transport companies could therefore expand their services to include intermodal transport. When highway transport is necessary, support should be given to companies that use energy efficient technologies such as vehicle idling reduction initiatives and auxiliary power units that reduce greenhouse gas emissions.[39] The EPA's website lists transport companies (rail, truck, and intermodal) that are a part of their

Smartway Transport Partnership Program.

Finally, museum loans and exhibitions produce vast amounts of waste. Again, reuse is rare due to a lack of storage space, and the true cost of land-filling our waste is masked by inexpensive disposal fees. Recycling packaging components, which for the purposes of this essay means implementing a secondary use for a material, is rarely practiced. There are bins for soda bottles and office paper; why not foam and metal? There are regionally based online recycling communities such as Freecycle, why not "Museum-cycle"? Ely Inc., an exhibit and museum service company based in Maryland, is recognizing the need for reuse and recycling in the museum profession. On the company's website there is an "Ely Recycle" web page where museums can post exhibit frames, crates, and other items for sale, trade, or donation.

There are options to reduce the amount of waste generated from loans. Scott Carlee of the Alaska State Museum stated the following about resource-saving practices in his museum:

> We probably do more than most museums just because it is so expensive to get materials shipped up here. Therefore material is more precious to us than to most museums. We will take apart a crate and reuse the wood for some other task or we will take apart exhibit walls and make crates out of them. For our traveling exhibits we have reusable crates that were custom-built for the shows that travel. We reuse whatever we can and when something just can't possibly be used one more time it is disposed of in a landfill. All burnable wood is usually given to someone to burn in their wood burning stove for heat. The biggest drawback is space to store the material before we can reuse it.[40]

Museums in the lower 48 states should perhaps adopt an Alaskan state of mind when it comes to the life cycle of museum-generated products. Redesigning crating and packaging systems to increase recycling is a necessity. For instance, gluing crate joints in addition to using typical metal fasteners impedes the break-down of crates. Wood from crates has been used by art organizations and businesses for sculptures and cabinetry or as fuel in ceramic kilns or furnaces. The use of cardboard instead of Coroplast™ or Gatorfoam would increase the percentage of packaging material that can enter the conventional recycling stream. Before purchasing a product, a registrar should determine whether or not the manufacturer has a recycling program. Sealed Air Corporation, the manufacturer of both ETHAFOAM and Bubble Wrap®, for instance, has a mail back recycling program. Materials sent back to one of their seven receiving facilities is reprocessed within the company or by an outside company. DuPont has a similar mail-back recycling program for Tyvek®. Additionally, pack-and-ship centers frequently welcome packing supplies to support their operations, and the cleanliness and integrity are often not an issue.

Conclusion

Many museums and service providers are adopting green and sustainable practices. For example, Atthowe Fine Art Services uses solar panels on the company's roof, biodiesel in its fleet of vehicles, and recycles cardboard, wood, foam, and bubble wrap. In September 2008, the California Academy of Sciences opened the doors of its new museum, which is on track to achieve LEED Platinum certification. The building includes a 2.5-acre living roof, 60,000 photo voltaic cells, denim insulation, and natural lighting from skylights and exterior walls of glass. The academy has an official statement on sustainability approved by its board of directors as well as a green team. Initiatives developed by the academy's green team have altered many routine operations and include the elimination of plastic bottles at all staff meetings; the reuse and recycling of packing supplies; bulk ordering; and the elimination of anti-bacterial soap, which is harmful to marine life. In the past year, the academy recycled nearly 80 percent of its garbage.[41] These institutions and individuals have taken a leadership role in the sustainable movement and their efforts will help facilitate sustainable practices across the profession.

As stewards of the past, present, and future, registrars must continually assess how products created for and by museums affect the world. They can update accepted standards of collection care and management to reflect environmental stewardship and take a leadership position in forming and managing a green

committee within their institutions. Registrars can be active participants in the pursuit of a sustainable future by being open to new technologies, working with service providers to bring new products to the market, and collaborating with colleagues throughout the museum world. •

NOTES

1. World Commission on Environment and Development. (1987). *Our Common Future.* New York: Oxford University Press.

2. McDonough, William and Michael Braungart. *Cradle to Cradle: Remaking the Way We Make Things.* North Point Press, New York, 2002, p. 26.

3. United States Green Building Council. *LEED® for Existing Buildings: Operations & Management.* p. 4, accessed at https://www.usgbc.org/ShowFile.aspx?DocumentID=3617, October 11, 2008.

4. U.S. Department of Energy, *Solar Lighting Basics.* accessed at http://www1.eere.energy.gov/solar/sl_basics.html, October 18, 2008.

5. McKenzie, James and Majd Zoorob, "Design Considerations for Intelligent Color-changeable LED Luminaires." LEDs Magazine, Oct 2008, p. 33. accessed at http://www.ledsmagazine.com/magazine/pdf/0810, October 11, 2008.

6. Lighting Design Lab, *Advantages of LED Lighting.* accessed at http://www.lightingdesignlab.com/articles/LED_fund/led_advant.htm, September 19, 2008.

7. Krieger, Sari, "Bright Future: Thanks to Improved Technology, LED's May be Ready to Take Off." *The Wall Street Journal,* September 15, 2008. accessed at http://online.wsj.com/article/SB122123942429828649.html?mod=ITPWSJ_20 , September 17, 2008.

8. McKenzie, James and Majd Zoorob, "Design Considerations for Intelligent Color-changeable LED Luminaires" LEDs Magazine, Oct 2008, p. 33. accessed at http://www.ledsmagazine.com/magazine/pdf/0810, October 11, 2008.

9. Lighting Design Lab, *Disadvantages of LED Lighting.* accessed at http://www.lightingdesignlab.com/articles/LED_fund/led_disadv.htm, September 19, 2008.

10. Lighting Research Center, "Lighting from Afar." *Renssalaer Polytechnic Institute,* no. 3 (1998). accessed at http://www.lrc.rpi.edu/programs/Futures/LF-RemoteSource/index.asp, September 21, 2008.

11. Lighting Design Lab, *Introduction to Fiber Optic Lighting* accessed at http://www.lightingdesignlab.com/articles/fiberoptic/intro_fiber.htm, September 21, 2008.

12. U.S. Department of Energy, Solar Energy Technology Program, *Solar Lighting Research and Development.* accessed at http://www1.eere.energy.gov/solar/sl_research_development.html, October 18, 2008.

13. U.S. Department of Energy, Solar Energy Technology Program, *Solar Lighting.* accessed at http://www1.eere.energy.gov/solar/solar_lighting.html, September 19, 2008.

14. Behar, David, Dr. Capeluto Guedi, and Professor Levin Michael. *Light in the Art Exhibition Space.* Faculty of Architecture and Town Planning, Technion Israel Institute of Technology, Haifa Israel. May 2007.

15. The Getty, *Museum Lighting Research.* accessed at http://www.getty.edu/conservation/science/lighting/index.html, September 15, 2008.

16. Perahia, David Behar, Ph.D. Technion Israel Institute of Technology (Haifa, Israel). Telephone interview by author, April 15, 2007.

17. Clinard, David. "Show & Tell: Museum Lighting." *Architectural Lighting* 17 (April/May 2002): 59.

18. Brophy, Sarah, and Elizabeth Wylie. "It's Easy Being Green: Museums and the Green Movement." *Museum News,* September/October 2006, p. 39.

19. Elliot, Garth. Chief Engineer, Nevada Museum of Art. Interview by author, February 13, 2007.

20. Sugarman, Samuel C. *HVAC Fundamentals.* Lilburn, Georgia: The Fairmont Press, 2005.

21. The granular carbon reactivation process renders saturated carbon into reusable carbon through thermal reactivation. The spent activated carbon is treated in special kilns with steam that are devoid of oxygen at 850° C or more in order to release organic compounds. The volatized organics are destroyed in the furnace's afterburner. Volatile inorganics are then removed by a wet chemical scrubber. A complete description can be found at http://www.water.siemens.com/SiteCollectionDocuments/Product_Lines/Westates_Carbon/Brochures/reactivated_carbon_q_and_a.pdf.

22. Elliot, Garth. Chief Engineer, Nevada Museum of Art. Interview by author, October 6, 2008.

23. Brokerhof, Agnes W. *Applying the Outcome of Climate Research in Collection Risk Management.* accessed at http://www.padfield.org/tim/cfys/mm/brokerhof/brokerhof.pdf, November 11, 2008.

24. Erhardt, David, Charles S. Tumosa, and Marion F. Mecklenburg. *Applying Science to the Question of Museum Climate,* November 2007, p. 13. accessed at http://www.padfield.org/tim/cfys/mm/erhardt/erhardt.pdf, September 15, 2008.

25. Originally named Conservation Research Laboratory (CRL), it was renamed Conservation Analytical Laboratory (CAL) in 1963 and was renamed in 1998 as Smithsonian Center for Materials Research and Education (SCMRE). It is currently named Museum Conservation Institute (MCI).

26. Erhardt, David, Charles S. Tumosa, and Marion F. Mecklenburg. *Applying Science to the Question of Museum Climate,* November 2007, p. 15. accessed at http://www.padfield.org/tim/cfys/mm/erhardt/erhardt.pdf, September 15, 2008.

27. The Forest Stewardship Council (FSC) is an international organization that has established policies and standards to protect forest ecosystems. http://www.fsc.org/en/. "Paper Listening Study", Conservatree.org. accessed August 25, 2008

28. ANSI, American National Standards Institute oversees the creation, promulgation and use of thousands of norms and guidelines. Cascades Fine Papers Group includes Rolland Enviro100 which is made of 100% post-consumer waste that is processed chlorine free in a plant that uses biogas and is certified Permanent Paper by ANSI.

29. Post-industrial waste is leftover material created when manufacturing a product. This type of waste can be collected to be used in-house or by an outside party to make a similar or different product. In contrast post-consumer waste is material that has been used by a consumer and discarded at a recycling center such as used newspapers, plastic bottles, or aluminum cans.

30. Dolores King, Product Manager, Gaylord Brothers; interview with author (Warden) August 25, 2008

31. Vision Paper www.visonpaper.com accessed August 31, 2008

32. Of the 40 exhibits advertized in "Update: Smithsonian institution Traveling Exhibition Service Catalogue of Exhibitions 2008–2009" only 35 list crate quantities for a total of 390 crates.

33. Twenty-nine museums reported ordering a total of 426 new crates in 2006 for a cost of $412,108, which averages to $967.38.

34. Johnnie Mizell, interview with author (Warden) March 2007; Sally Freitag, Chief Registrar, National Gallery of Art, email correspondence (Warden) September 26, 2007

35. Hasenkamp, 2-D and 3-D crates www.hasenkamp.com; Turtle Box by Hizkia Van Kralingen, Netherlands, www.turtlebox.com also www.vankralingen.com; Pegasus Packaging Crate by Helicon: The Conservation Specialist, Netherlands, www.helicon-cs.com

36. The average tractor trailer, fully loaded, gets 6 miles per gallon. Carbon Dioxide data was calculated using The Greenhouse Gas Protocol Initiative's Sector Tool, CO2 Emissions from Transport or Mobile Sources, http://www.ghgprotocol.org/calculation-tools/all-tools; and the U.S. Environmental Protection Agency Greenhouse Gas Equivalencies Calculator; http://www.epa.gov/solar/energy-resources/calculator.html both accessed November 8, 2008.

37. H. Conlon, Hub Group, Inc., interview with author (Warden) April 5, 2007

38. "Overview of U.S. Freight Railroads" National Atlas of the United States, accessed at www.nationalatlas.gov, October 20, 2008.

39. Environmental Protection Agency, SmartWay Transport Partnership http://www.epa.gov/otaq/smartway/index.htm

40. email correspondence (Warden) April 19, 2007

41. The California Academy of Sciences www.calacademy.org accessed October 20, 2008