Climate Change
A Local and Global View

Celebrations
2014 Colby Honors and Hall of Human Life

On Mentoring
From “Letters to a Young Scientist” by Two-time Pulitzer-Prize-Winner Edward O. Wilson

Of Note
Engineering is Elementary® in Uganda

This magazine was printed with post-consumer recycled paper, saving:

18 trees
52 lbs of waterborne waste
852 lbs of solid waste
1,676 lbs net greenhouse gases
12,829,900 BTUs energy
Giant Steps

In my time at the Museum of Science, I have witnessed three giant steps that have moved the institution forward. The first was our entry into the arena of formal education with our K-12 engineering curricula. The second was assuming leadership of the $41 million National Science Foundation-funded nanotechnology education initiative, which has had a profound impact on how museums and science centers around the country network with their peer institutions. And the third occurred on November 14 with the grand opening of the Hall of Human Life.

The Hall of Human Life is the largest and most complex exhibit that we have ever produced. It is the culmination of everything we have learned about making exhibits, and it has inspired us to innovative new approaches to exhibit design. Moreover, it signals the beginning of a new era at the Museum of Science, as we transform our Halls to tell the story of the natural and engineered worlds.

In the Community

Access has been a priority for many years at the Museum of Science. We want everyone in our community to experience our exhibits, programs, and presentations. Thanks to supporters like the Lowell Institute, Bloomberg Philanthropies, Hermann Foundation, and the Highland Street Foundation, we offer a variety of free and reduced admissions options for our visitors. Our Community Access Program provides free or reduced group admission rates to more than 20,000 visitors each year. Beginning in August, Massachusetts EBT or WIC card holders can now receive free Exhibit Hall admission for up to four. This new initiative expands our outreach efforts to erase admission barriers for low- and mid-income families.

In This Issue

Our cover stories offer a local and global view on climate change via two temporary exhibits, *Seasons of Change* and *Climate Change in Our World*. Both exhibits vividly document how climate change impacts our lives and our planet.

With 2014 marking the 50th anniversary of the Bradford Washburn Award, we are proud to present an excerpt from 1996 Washburn Award winner Edward O. Wilson’s new book, *Letters to a Young Scientist*. In it, he recounts his earliest field research as a teenager in the swamps and forests of Alabama and offers to budding scientists practical advice gleaned from his 50 years of teaching.

Anthony Metrano, the Yale chemistry PhD candidate and NFS Graduate Research Fellow featured in our Museum Factor story this issue, tells how he developed a passion for science and research through frequent visits to the Museum of Science using passes that his family got at his town library.

In July, Museum educators Erin Fitzgerald and Kate Sokol brought Engineering is Elementary® to the Gulu Primary School in Uganda, where they helped students learn how to design bridges and introduced teachers to a new way of teaching.

On October 24, the Museum presented trustees Malcolm Sherman and Ira Stepanian with our highest philanthropic honor, the Col. Francis T. Colby Award. Mal and Ira, both past chairmen of our board of trustees, were recognized for their leadership and support of the Museum. *In Gratitude* features trustee emerita Brit d’Arbeloff, a 2010 Colby honoree who has made a second gift to the Campaign for the Museum of Science. Brit’s new gift supports the upcoming transformation of our lobby.

The Museum of Science is an institution sustained by strong leaders—like Brit, Mal, and Ira—whose decades-long service provides continuity to our governance. It is a privilege for me to welcome a distinguished incoming class of newly elected trustees and overseers. They join a cadre of leaders who provide ideas, counsel, encouragement, and financial support to this institution.

Philanthropy has the power to change the lives of both the benefactor and the beneficiary. Those listed in our Honor Roll of Donors (pages 28-41) help this institution take those giant steps. Thanks to their support, we are poised to make our next giant steps.

Ioannis N. Miaoulis, PhD
President and Director

Museum of Science
Transforming the Nation’s Relationship
with Science and Technology
2 Seasons of Change: Global Warming in Your Backyard

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Climate Change in Our World
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Celebrating the Hall of Human Life

OF NOTE
Engineering is Elementary® in Uganda 2013 Invented Here!

Honor Roll of Donors

New Trustees and Overseers

Museum of Science
Transforming the Nation's Relationship with Science and Technology
Seasons of Change
Global Warming in Your Backyard
New England’s character and economy have been shaped over centuries by its four distinct seasons—snowy winters, lush springs, sultry summers, and blazing autumns. But today, from the mountains and forests of northern Maine to the southern shores of Rhode Island, patterns of change can been seen and measured—patterns tied to global warming.

Over the past 100 years, our planet has been heating up. If nothing changes, the average global temperature could be much warmer in 2100 than it was in 1900. This might cause New England summers to feel more like those in North Carolina today.

*Seasons of Change*, an interactive traveling exhibition at the Museum through January 5, illustrates how climate change is impacting the landscape of New England and how it affects the people who live here. The exhibition features an interactive global climate change table where visitors can simulate the effects that slight changes in water temperature have on our land, water, people, and animals.

**The forests are already changing**

New England forests are currently comprised of about 25% maple trees, but by 2100 oak will begin to dominate. Areas populated with maples, beech, and birch will give way to oak, pine, and hickory. Without red maple and sugar maple leaves, the most colorful fall foliage will disappear. This could have a significant financial impact upon those picturesque towns in New Hampshire, Vermont, and Western Massachusetts that depend upon income from fall foliage tourists.

Our birds, too, will change. Purple finches, blackpoll warblers, and pine siskins might disappear in New England. Songbirds will lose their habitat as higher temperatures in the region change the composition of their habitat.

Maple sugaring is a traditional New England farming activity, but scientists predict that weather conditions will not support commercial operations in most of the region by the end of the century. Sugaring relies on freezing nights followed by warm days in late winter to create the right conditions for maple sap to flow. If average nighttime temperatures become only two degrees warmer, there will be far fewer days in which the sap will flow in most of New England.

Every year since he started tapping trees on his Langdon, New Hampshire farm, Alvin Clark has kept track of the beginning and end dates of the maple sugaring season. What his records show is a gradual but steady shift: the season starts more than three weeks earlier and ends almost two weeks sooner than it did 50 years ago.

Using more high-tech equipment and large-scale production, maple producers have been able to compensate for less favorable weather conditions over the past few decades, but that will come to an end when the winters are too warm and the snow too infrequent. According to his records, Clark’s farm started using tubes rather than buckets in 1958 and then added a vacuum system in 1978, innovations that have helped him produce more syrup.
But that might not be enough. “Once the weather gets warmer, the sugaring will come to an end,” Clark says. “Years ago, we used to get heavy ground freezing. In 2009, around here the ground never froze. I just hope that we can continue on as we have in future generations.”

Consider the lobster

At every stage of their life, lobsters are threatened by New England’s changing climate. Timing is everything. If eggs develop too fast because temperatures are too warm, lobsters may move north to colder waters and delay the production or larvae. If lobster eggs do not develop properly, larval and juvenile lobsters will be out of sync with the food supply they depend on.

By the end of this century, scientists expect North Atlantic average water temperatures near the sea floor to be above the thresholds tolerated by lobster and fish species such as cod. Average surface temperatures in the Gulf of Maine are projected to rise by five to eight degrees by 2100.

Low temperatures are important when these animals spawn. Animals will be forced further north, perhaps out of New England altogether. Warming waters will also allow new invasive species to establish themselves in New England.

Elliott Thomas, a lobsterman from Yarmouth, Maine, has witnessed warming trends firsthand. “Water temperature has been warming, I can document, since 2001. We have temperature probes that we leave on the bottom for the whole summer. Over that period of time, temperatures have gone up on the bottom maybe three to four degrees Fahrenheit. That doesn’t bode well for the future, if the water keeps warming up. Lobsters have a temperature range that they can live in, and you always fear that the water will get too warm.”

Scientists agree that our climate is changing and that human activity is a significant driver of that change. Over time, human population growth, energy use, agricultural methods, and land development have all had a measurable effect on our climate. Our activities have raised the amount of carbon dioxide in the atmosphere to its highest level in millions of years. The average temperature is climbing out of the range in which living species evolved and is now affecting sea level, ocean acidity, and water availability. Melting ice caps and glaciers, as well as weather extremes, have also resulted from this phenomenon.
Scientists agree that our climate is changing and that human activity is a significant driver of that change.
Environmental photojournalist and writer Gary Braasch was the first photojournalist to travel to remote areas of the Arctic, China, the Pacific islands, Australia, and Antarctica exclusively to document climate science.

Climate Change in Our World

Photographs by Gary Braasch

His project and website *World View of Global Warming* was the first dedicated photo documentation of the effects of rapid climate change. His images have been published by *Time, Newsweek, Life, Scientific American, Discover,* and *Smithsonian.* *How We Know What We Know About Our Changing Climate: Scientists and Kids Explore Global Warming,* a children's book co-authored with Lynne Cherry, has won a number of children's literature and science writing awards.
Ice cave in Marr Glacier, Anvers Island, Antarctica, disappeared as the front of this glacier has receded.
The Athabasca Glacier in Jasper National Park, Alberta, Canada, has retreated about 4,000 feet since the early 20th century. Shown in 1917 and 2005. (1917 photo by A.O. Wheeler. Copyright Canadian National Archives.)

Villagers of Bhola Island, Bangladesh, are among the more than 16 million people living only a few feet above high tide in the huge delta of the Ganges and Brahmaputra Rivers. Bangladesh is made up of 90 percent floodplain and faces rising sea level.

Cooling towers of the 2,900 megawatt Amos coal-fired power plant near Charleston, West Virginia.

The Irene Vorrink wind project stretches along the shoreline of the IJsselmeer, a large, artificial lake in the central Netherlands.
In spite of my young age and lack of experience, he expected me to behave as a professional entomologist. He insisted that I just get out there and get the job done.
A Mentor and the Start of a Career

As a callow, severely undereducated eighteen-year-old student at the University of Alabama, I began a correspondence with a Ph.D. student at Harvard University named William L. Brown. Although only seven years my senior, Bill was already a leading world authority on ants. At that time there were only about a dozen experts on ants worldwide and he was one of them, not counting those who specialized on the control of pest species.

The most inspiring thing about Bill Brown was his devotion bordering on fanaticism—to science, to entomology, to jazz, to good writing, and to ants, in that rising order. He was, as I wrote of him in a 1997 memorial tribute, a working-class guy with a first-rate mind. He visited bars, enjoyed beer, dressed poorly by the stiff standards of the Harvard of his day, and mocked pretense whenever he encountered it in the faculty. But he was a godsend to the boy he befriended.

“Wilson,” he wrote his teenage follower, “you’ve made a good start with your project of identifying all the species of ants found in Alabama. But it’s time to get serious about a more basic subject, where you can do original work in biology. If you’re going to study ants, get serious.”

Bill, when I first came to know him, was at that time absorbed in classifying a group of species called the dacetine ants, limited mostly to the tropics and parts of the warm temperate zone. These insects are easily distinguished by their bizarre anatomy. Their jaws are long and hooked at the end and lined with needlelike teeth. Their bodies are clothed in various combinations of curly or paddle-shaped hairs; and, in many of the species, a spongy mass of tissue encircles the waist.

“Wilson,” Bill went on, “there are a lot of species of dacetines in Alabama. I want you to collect as many colonies for our studies as you can, and while you’re at it, find out something about their behavior. Almost nothing has been done on that subject. We don’t even know what they eat.”

I liked the way Bill Brown addressed me as a colleague, albeit one in training, like a sergeant instructing a private. If we had been in the U.S. Marines, I suppose I would have followed him to hell and back—or something like that, assuming there are ants living somewhere in hell. In spite of my young age and lack of experience, he expected me to behave as a professional entomologist. He insisted

that I just get out there and get the job done. There was no hint of "get in touch with your feelings" or "think about what you'd most like to do."

So, pumped up with his confidence in me, I got out there and got the job done. I began by molding a series of plaster-of-Paris boxes with cavities the size of those that wild colonies occupy in nature. I added a larger adjacent cavity where the ants could hunt for prey. Into many such cavities I placed live mites, springtails, insect larvae, and a wide variety of other invertebrates I found around the nests of dacetines in natural habitats. I was later to label this the "cafeteria method."

So, pumped up with his confidence in me, I got out there and got the job done.

My efforts were rewarded quickly. The little ants, I discovered, prefer soft-bodied springtails (technically, entomobryoid collembolans). As I watched them stalk and capture these prey, the odd anatomy of the dacetine ants made perfect sense. Springtails are abundant around the world in soil and leaf litter, and in some localities they are among the dominant insects. But ordinary predators such as ants, spiders, and ground beetles find them very difficult to catch. Beneath the body of each is a long lever that can be sprung violently but most of the time is locked in place—in other words, constructed like a mousetrap. When the springtail is disturbed even slightly, it pulls an anatomical trigger and the lever is released. Slamming against the ground, the lever catapults the insect high into the air. The equivalent acrobatic feat in a human being would be a leap of twenty yards up and a football-field distance forward.

The high jump works well against most predators, but the dacetine ant is built to defeat it. Upon sensing a springtail close by with the sensory receptors in her antennae—she is mostly blind—the huntress throws her long mandibles open, in some species 180 degrees or more, and locks them in place with a pair of movable catches on the front of the head. The huntress then slowly stalks the prey, literally step by cautious step. In the presence of a springtail, she is one of the slowest ants in the world. Her antennae wave side to side, also slowly, fixed on the location of the prey, turning to the right when the odor grows faint on the left, and to the left when the odor grows faint on the right, keeping the ant on track. Two long sensitive hairs project from the stalkers' upper lip. When their tips touch the springtail, the catch is pulled down, releasing the powerful muscles that strain at the base. The mandibles slam shut, driving the needle-sharp teeth into the soft body of the springtail. Often the prey is able instantaneously to release its abdominal lever, throwing it and the ant spinning into the air. I've often thought that if dacetine ants and springtails were the size of lions and antelopes, they would be the joy of wildlife photographers.

From my and Bill Brown's early studies, various of which we published singly or together, a first picture of dacetine biology emerged. First, physiologists came to realize that the closing of the mandibles is one of the fastest movements that exist in the animal kingdom. Also the spongelike collar around the dacetine's waist was discovered by later researchers to be the source of a chemical that attracts springtails, drawing them closer to the mandibular snare.

In time we and other entomologists came to recognize the dacetines as among the most abundant and widely distributed of all ant groups. Although their tiny size makes them inconspicuous in the soil and litter, they are an important link in the food chains of the world's habitats. And, incidentally, colonies of many species live in rotting stumps like the one I described earlier.

During the next decade, Bill Brown and I took the next logical step into evolutionary biology. Armed with growing information, we reconstructed the changes in dacetines across millions of years, as they spread around the world and their species multiplied. In what manner and under what conditions, we asked, have the different species grown or shrunk in anatomical size? How and why did some of them evolve to build their nests in the soil and others in fallen twigs on the ground, or in rotting logs and stumps? A few, we learned, are even specialized to live in the root masses of orchids and other epiphytes of the rain forest canopy.

The history of the dacetine ants came into focus as we continued our studies. It turned out to be an evolutionary epic comparable to that of all the kinds of antelopes, for example, or all of the rodents, or all of the birds of prey.
You may think that ants like these, being so small, must also be unimportant and deserving of less attention. Quite the contrary. Their vast numbers and combined weight more than make up for their puny individual size. In the Amazon rain forest, one of the world’s strongholds of biological diversity and massed living tissue, ants alone weigh more than four times that of all the land-dwelling vertebrates—mammals, birds, reptiles, and amphibians—combined. In the Central and South American forests and grasslands alone, one taxonomic group of ants, the leafcutters, collect fragments of leaves and flowers on which they rear fungi for food, making them the leading consumers of vegetation. In the savannas and grasslands of Africa, mound-building termites also rear fungi and are the primary animal builders of the soil. Although insects, spiders, mites, centipedes, millipedes, scorpions, proturans, pillbugs, nematodes, annelid worms, and other such lilliputians are ordinarily overlooked, even by scientists, they are, nonetheless the “little things that run the world.” If we were to disappear, the rest of life would flourish as a result. If on the other hand the little invertebrates on the land were to disappear, almost everything else would die, including most of humanity.

Because as a boy I dreamed of exploring jungles in order to net butterflies and turn over stones to look for different kinds of ants, I followed by happenstance the advice I gave you earlier: go where the least action is occurring. Just by any small twist of fate, I might easily have joined the large population of young biologists working on mice, birds, and other large animals. Like most of them, I would have enjoyed a productive and happy career in research and teaching. Nothing wrong with that at all, but by following the less conventional path, and by having an inspiring mentor like Bill Brown, I had a far easier time of it. I discovered early the special opportunity to conduct scientific research in rotting stumps and other microcosms that make up the foundation of the living world, but which then and to this day remain so easily passed by. ●

1996 winner of the Bradford Washburn Award, Edward Osborne Wilson is recognized as one of the leading biologists in the world. He is acknowledged as the creator of two scientific disciplines (island biogeography and sociobiology), three unifying concepts for science and the humanities jointly (biophilia, biodiversity studies, and consilience), and one major technological advance in the study of global biodiversity (the Encyclopedia of Life). Among more than 100 awards he has received worldwide are the U.S. National Medal of Science, the Crafoord Prize (equivalent of the Nobel, for ecology) of the Royal Swedish Academy of Sciences, the International Prize of Biology of Japan, and, in letters, two Pulitzer Prizes in nonfiction, the Nonino and Serono Prizes of Italy, and the International Cosmos Prize of Japan. He is currently Honorary Curator in Entomology and University Research Professor Emeritus, Harvard University.
Now a National Science Foundation Graduate Research Fellow at Yale, Anthony Metrano discovered his passion for organic chemistry at the Museum of Science.

Museum as Catalyst

Anthony Metrano’s parents always made education a priority for him and his younger brother, Joe. “They knew that learning wasn’t just for the classroom,” he says. “Our family vacations to places like Colonial Williamsburg, Gettysburg, and even Hollywood always had an educational element. But the place we visited most and the place that had the greatest impact on where I am today—working on a PhD in organic chemistry at Yale—was the Museum of Science.”

His family got Museum passes from Richards Memorial Library, right down the street from his father’s barbershop in North Attleborough, MA. He bought his first Periodic Table poster at the Museum of Science gift store, and it hung on his bedroom wall all through high school only to be taken down and put up on the wall of his college dormitory.

He recalls being intrigued by an exhibit that showed the molecular difference between table sugar (sucrose) and Splenda (sucralose). “When just three of the eleven oxygen atoms in sucrose are exchanged for chlorine atoms, it becomes sucralse. Because of that seemingly tiny change in molecular structure, the body won’t metabolize sucralse. I was able to see for the first time,” he says, “how making such a minor change in the structure of a molecule could have a profound effect. I was fascinated and this helped spark my interest in organic chemistry.”
Guided Inquiry

After high school, Anthony headed to the College of the Holy Cross, which is one of the country’s top producers of chemistry graduates certified by the American Chemical Society. As an undergraduate at Holy Cross, double majoring in biology and chemistry, Anthony was introduced to the guided inquiry approach to coursework. Developed mainly in the Holy Cross Department of Chemistry, guided inquiry introduces fundamental concepts in the laboratory, then follows up with discussion and further elaboration on the concept in classroom lectures.

“This discovery method demands more engagement from participants,” says Anthony’s advisor at Holy Cross, Brian Linton, assistant professor of chemistry. “Ideally, the process draws the students in more than a lecture.”

As an undergraduate, Anthony says he was fortunate to get a broad range of research experience. “I started off as a biology major because I thought biology would be a nice application of my interest in chemistry. I was able to work on small insect metabolism, trying to determine the rate of metabolism in wolf spiders. As soon as I took Organic Chemistry, I knew I wanted to focus on chemistry.”

Anthony would put together practice problems for his fellow classmates in Organic Chemistry, and though it is not uncommon for students who have already completed the course to help guide other students through the class, Anthony was the only currently-enrolled student who played such a role. “That is a testament to Anthony’s abilities as well as his passion for helping others,” says Professor Linton.

At Holy Cross he was elected to Phi Beta Kappa, received the American Institute of Chemists Foundation Award, and the Redican Medal for excellence in the third year of study and for making unique contributions to the academic life of the College. He presented his research at two National Chemistry Society meetings. He founded and co-directed
a program called Bio Buddies to provide walk-in tutoring and mentoring for biology students. “I recently visited Holy Cross and saw flyers for Bio Buddies,” he says, proudly noting that the program is still going strong.

Anthony was a member of Linton’s research group for over two years, which is not uncommon for students at Holy Cross. “That prolonged involvement permits students like Anthony to build a greater sophistication for what it takes to do research, and, by extrapolation, what it takes to become an expert in a topic.”

Asked if he thinks the Museum’s impact on Anthony is a factor in his commitment to science, Professor Linton says, “Students benefit from every experience, but the difficult part is getting them to appreciate that life-long learning is a fun activity. Activities like those at the Museum of Science get students revved-up about how cool science can be.”

What It Takes

Upon graduating from Holy Cross, Anthony had acceptances at the California Institute of Technology and Yale University among others, and he had a choice to make. “It was a multi-factor decision,” he says. “When you’re choosing a graduate school you have to choose your school wisely based on your level of interest in the research being conducted there and the environment that the faculty provide for your growth as a scientist. It has to be research that you would be intrinsically motivated to carry through to completion under the supervision of a professor who inspires you and works well with you. For me, all signs pointed to Yale.”

His advisor at Yale, Scott Miller, the Irénée du Pont Professor and Chair of Chemistry, says, “Anthony has an off-scale level of curiosity and innate interest in science. His passion naturally translates into his high level of dedication. He just loves chemistry.” That passion and dedication led to a three-year graduate research fellowship from the National Science Foundation. “Anthony’s fellowship is wonderful recognition of his promise as a young scientist,” says Professor Miller. “Students who receive these fellowships often have a high level of independence as they join research groups, allowing projects to take some unanticipated directions.”

Anthony is excited and challenged by his research. “We are designing small peptides as catalysts for organic reactions. They’re intended to mimic enzymes, which are nature’s catalysts. All the reactions carried out in nature are catalyzed by enzymes, which are long strands of thousands upon thousands of amino acids. But within the larger structure of the enzyme, there is typically only one small portion consisting of a few important amino acids that actually carries out the chemistry. This is called the active site. In our lab, we design small peptides that mimic the active sites of enzymes to carry out specific chemical reactions.”

Professor Miller also recognizes the value of Anthony’s visits to the Museum. “Many students have their first formal introduction to science through organizations like the Museum of Science. Often, young people have actually never met a scientist. Thus, venues like the Museum of Science introduce young people to areas of inquiry where people make a living asking: Why? How? What if? It’s very powerful.”

What’s Next?

Professor Linton pictures a bright future in science for Anthony. “With his diverse interests it is difficult to say exactly what discipline. I imagine there will be a component of community-service, either as an extension of his science or just personal involvement.”

Anthony wants a balance of research and classroom teaching, at the undergraduate and graduate level. And maybe high school as well. He recently participated in the American Chemical Society Science Coaches program, visiting his old high school eight times over the school year to present chemistry demonstrations. “A major goal of my future career will be to help younger students embrace chemistry, especially organic chemistry, as important to their everyday lives. I want them to see chemistry as the central science. Its principles and laws provide a practical application of physics and define the foundations of biology and the medical sciences. There are countless connections between the microscopic world of chemistry and the material world around us.”

Professor Miller says he sees “a limitless future for Anthony, sharing the fascinations of science with others.”
On October 24, members of the Museum’s Colby Society gathered to recognize trustees Malcolm L. Sherman and Ira Stepanian with the Museum’s highest philanthropic honor, the Colonel Francis T. Colby Award.

Colby Honors

Presented annually to members of the Museum’s community who have made extraordinary contributions of time, treasure, and talent to the institution, the Colby Award recognizes the deep financial commitment and generous volunteer efforts of people who are so important to the Museum achieving its mission.

For the first time, this year’s Colby Awards went to two past board chairs:

During his tenure as chairman of the board of trustees at the Museum of Science from 1996 – 2000, Ira Stepanian oversaw the successful merger with the Computer Museum. Along with David Ellis, director emeritus, Mr. Stepanian understood that the Museum needed to do more in the area of technology, in exhibits and programs, and on the board of trustees.

Since serving as chairman of the board of trustees at the Museum of Science from 1992 – 1996, Mal Sherman has played a central role in developing the Museum’s board through his leadership of the nomination committee. Recently, he was among those who led efforts to bring the Dead Sea Scrolls exhibit to the Museum.

Board chair Howard Messing praised both Colby awardees for their dedication to the Museum. “Mal, along with his great friend Ira Stepanian, worked to shore up the fiscal standing of this institution as successive board chairmen during the 90s. And I think it can be said that their efforts helped to position the Museum for the success we are witnessing now during the Campaign years.”

The Colby Society, named in memory of the Museum’s first million-dollar benefactor, is comprised of donors whose cumulative giving to the Museum of Science totals $100,000 or more. Current Colby membership numbers 299 donors, including 14 new in fiscal year 2013. Collective giving of this esteemed group exceeds $320 million. Videos honoring Mal, Ira and all of the Museum’s past Colby awardees can be viewed at mos.org/colby-society.
“The major change in mapping in the past decade, as opposed to the previous 6,000 to 10,000 years, is that mapping has become personal. …a map has gone from a static, stylized portrait of the earth to a dynamic, interactive conversation about your use of the earth.”
— Michael T. Jones, 2013 Walker Prize Winner

2013 Walker Prize
As Google’s chief technology advocate, Michael T. Jones is charged with advancing technology to organize the world’s information and make it universally accessible and useful. Michael travels the globe to meet and speak with governments, businesses, partners, and customers in order to advance Google’s mission and technology. He previously was chief technologist of Google Maps, Earth, and Local Search—the teams responsible for providing location intelligence and information in a global context to users worldwide. Before its acquisition by Google, Jones was CTO of Keyhole Corporation, the company that developed the technology used today in Google Earth. He was also CEO of Intrinsic Graphics, and earlier was director of advanced graphics at Silicon Graphics.

A prolific inventor and computer programmer since the fourth grade, Jones has developed scientific and interactive computer graphics software, held engineering and business executive roles, and is an avid reader, traveler, and amateur photographer using a home-built 4 gigapixel camera made with parts from a U2/SR71 aircraft.

The Walker Prize, awarded annually by the Museum of Science to recognize outstanding published scientific investigation and discovery, is funded by the Museum’s oldest endowment, established in 1864 by William Walker, MD.
Trustee emerita Brit d’Arbeloff’s second leadership gift to the Campaign for the Museum of Science will help to underwrite the renewal of the Museum’s entrance, lobby, and exterior, transforming the visitors’ experience from the moment they arrive.

**A Grand Entrance**

In characteristic fashion, Brit d’Arbeloff bluntly crystalizes the mission-based need for the Museum’s major renovations of its lobby entrance. “We don’t want the lobby to be a ‘pass-through’ space,” she says. “It’s a lot of space that we just aren’t utilizing fully. We need to use the lobby to get visitors excited about doing the activities inside the Museum.”

She connects all of her support—more than three decades—to the Museum’s mission to transform the nation’s relationship with science and technology. “It’s a very important mission, to get people interested in science. In the lobby, we really need to focus on what Ioannis (Miaoulis, president and director) calls ‘the wow factor.’ We need eye appeal to draw in visitors and keep them coming back.”

The lobby will retain the grandeur of one of the most iconic public spaces in Boston or Cambridge and it will remain a space to welcome arriving school groups and families. The bold makeover will deliver introductory content on the natural and engineered worlds as visitors segue into The Yawkey Gallery on the Charles River.

**Addition, Subtraction, Transformation**

The first comprehensive makeover for the lobby since its construction will revive the look, feel, and function of the space. Featuring the Charles River as backdrop, visitors will see bold graphics and an eye-catching dynamic video display on the bridge that spans the Blue and Green Wings.

New three-story windows will be installed on the river side of the lobby, from the ground floor to the ceiling. This new glass will be electro-chromatically tinted and connected to solar sensors, so the amount of direct sunlight into the lobby can be controlled. This will greatly reduce late-afternoon solar glare in the lobby and also help the Museum conserve energy.
A sense of the Museum’s long-standing presence in the community will be highlighted in the lobby by new full-wall plaques that record the Museum’s leaders and greatest benefactors. Visitors will immediately recognize that the Museum of Science is about both the natural and engineered worlds through the use of new visually-appealing graphics and video.

The Information Booth will be relocated from the center of the lobby to the corner entrance of the Red Wing, making it visible to visitors approaching from both the concourse and front doors. In addition to providing improved way-finding for first-time visitors, the open lobby floor will allow for a new, virtually uninterrupted view of the Charles River. The large screen monitor beside the second floor lobby will be removed.

The Museum’s commitment to environmental sustainability will be signaled outside, with a living green wall on the five-story parking garage and a cistern positioned to collect rainwater from the garage roof. New concourse restrooms will use this recycled graywater in the toilets. As they reach the box office, visitors will read the names and stories of Museum supporters, illustrating the strong connections between the Museum’s mission and the inspiring work of its donors. The remodeled box office will incorporate all ticketing, including self-serve kiosks.

A True Trailblazer
Brit was the first woman to earn a mechanical engineering degree from Stanford University, where she graduated first in her class. She was the only woman graduate engineering student in her class at MIT. She worked in the aerospace industry early in her career and then in manufacturing software. Throughout her professional life, she deftly balanced career, family, and volunteering.

In 1988, trustee Richard DiPerna recruited her to become an overseer at the Museum of Science. She then served as a trustee from 1992 to 2004, and has held emerita status since that time. Over the years, she has served on innumerable committees and working groups at the Museum, including the Master Plan Committee, Program Advisory Committee, and the Educators Resource Group.

She helped to form and still serves on the Museum’s influential Women in Science committee. “Women in Science showcases the amazing work that women are doing in science, which has been underreported in the press. Women in Science was kind of an oxymoron in the eighties because nobody paid any attention.” She’s proud of the impressive roster of speakers who have participated in the Women in Science lecture series over the past fifteen years. “Recent speakers like Barbara Hughey and Cynthia Breazeal went on to join our board as overseers. And last year’s Walker Prize went to Angela Belcher. Of course, they’re all from MIT.”

She goes on to say that the Museum of Science “ties in perfectly with my volunteer work at MIT” where she is a life member emerita of the MIT Corporation and serves on the board of the Whitehead Foundation and the Council for the Arts. At MIT, she and her late husband Alex established the d’Arbeloff Lab in the mechanical engineering department and the d’Arbeloff Fund for Excellence in Education, which supports innovative ideas about teaching.

She says, “Science education itself is important, but there is more to it. People should learn about the fun and the excitement of science. The Museum can play a huge role in doing that. But the Museum of Science cannot become a museum of old science that we no longer use. It has to be a living, vibrant, and continually changing place.”
Nearly a decade in the making, the Hall of Human Life signals the beginning of a new era at the Museum of Science, as the exhibit halls are transformed to tell the story of the natural and engineered worlds.

Celebrating the Hall of Human Life

The Museum community gathered in force to celebrate the grand opening of the Hall of Human Life (HHL) on November 14.

The largest and most complex exhibit ever produced by the Museum, HHL is a highly interactive and highly enlightening new exhibition on health and human biology. The exhibition addresses the need for greater health literacy among the general public, exploring the factors involved in individual and societal health care issues.

In his remarks to the 500 guests attending the grand opening, president and director Ioannis Miaoulis thanked the lead donors whose support sustained the development of HHL. He offered a special thanks to the Massachusetts Life Sciences Center and Governor Deval Patrick for its $5 million matching grant, and he credited trustee Henri Termeer with inspiring the Museum to think big and bold in developing the Hall of Human Life.

The exhibition incorporates the most current research and perspectives from a network of over 130 content advisors—leaders in public health and policy, the biotech industry, the medical research community, and university labs from around the country—many of whom were in attendance for the grand opening.

HHL is designed for all of the Museum’s visitors—schoolchildren, teens, adults, and seniors.
The Hall of Human Life’s exhibition space is 10,000-square-feet, but in the process of building The Hall the Museum renovated the entire second floor of the Green Wing—some 16,000 square feet. The exhibition includes over 50 computers, compared to 300 in use in exhibits throughout the entire Museum.

The walls were stripped to metal studs and the floors were taken down to bare concrete. The contractors uncovered remnants from past exhibits and the floor to the old Friendly’s restaurant that some visitors might recall.

New systems have been installed for all mechanical, electrical, plumbing, fire protection, and air handling systems. The Museum also added new restrooms in the Green Wing, part of the Campaign goal to improve visitor amenities.

In addition, the public balcony above the lobby has been re-opened, along with a new entrance to Nichols Gallery.
ENGINEERING IS ELEMENTARY: BUILDING BRIDGES IN UGANDA

Visiting schools across the country is routine for Erin Fitzgerald. As a professional development associate with the Museum’s Engineering is Elementary® (EiE®) project, she leads teacher workshops about this state-of-the-art curriculum, which integrates engineering with science lessons for elementary students. This past summer, though, Fitzgerald went even farther afield. With EiE colleague Kate Sokol, she brought bags bulging with classroom materials to a small primary school in rural Uganda.

Over the course of a ten-day visit, the two educators worked with 60 children in two classrooms at the Gulu Primary School, teaching the hands-on EiE lessons. And under the tamarind tree that shades the school’s meeting place, they met with teachers to share instructional strategies. “The Gulu teachers already use the approach we call hands-on learning in their science classes,” Erin notes. “But in Uganda the emphasis is on direct instruction, where teachers deliver information in a lecture, and memorization. EiE emphasizes project-based learning, where students learn actively. So we had to blend these teaching styles.”

There are 20 different EiE units, and Erin and Kate chose two for their Gulu students: “A Sticky Situation: Designing Walls” and “To Get to the Other Side: Designing Bridges.” They made the selection in part because they thought the activities would be inspiring for kids. “Uganda needs civil engineers to support growth, public infrastructure, and economic stability,” Erin notes. But the Gulu school also has a number of students who are blind, so the educators chose units with a strong tactile component that makes them particularly accessible for blind students. “Every EiE curriculum unit was designed to support learning for all students,” Erin says. “But the work in Gulu was an exciting opportunity to see if there are ways we can make units like ‘Designing Walls’ even more accessible.”

Bringing EiE to Gulu was the idea of Texas educator and philanthropist Sandra Washburn, a distant cousin of Museum founder Brad Washburn. She herself is the founder and director of Oysters and Pearls, a program that brings educational tools to the blind students who attend the Gulu Primary and Secondary Schools. Where does an engineering curriculum fit with that mission? “It’s a bit of a long explanation,” Sandra says.

Over the past four years, Oysters and Pearls has worked to equip students with canes, Braille typewriters, and computers. “On my last visit I noticed we were having a big impact,” Sandra says. “In fact the blind students were more proficient with computers than the sighted students! So I thought we needed computer lessons for the sighted students, too—but not just teaching them word processing. That led me to the idea of teaching robotics. And that led me to the idea of teaching STEM in general!” (STEM refers to instruction in science, technology, engineering, and math.)

Soon after, back in the States, Sandra and a visiting Ugandan school director happened to tour the Hockaday School for Girls in Dallas. “The very first teacher we met told us about EiE, showed us the kit of classroom materials, and explained about the hands-on engineering activities and how they help children learn,” Sandra says. “And I thought, ‘Wow, this is amazing! It makes science and technology fun and hands-on. Could it work in Uganda?’”
Erin and Kate say that it did. Although English was a second language for many of the children, they were able to understand the lessons—and find creative engineering solutions for the unit activities. Meanwhile the EiE educators say they learned as much as they taught at Gulu Primary School. For example, how to “think locally” about the classroom materials you need to teach a lesson. “We designed the EiE lessons so they use materials we think of as inexpensive and easy for teachers to get,” says Erin. “For example the EiE unit on the design of walls calls for clay as a building material, and in America you can buy modeling clay at any craft store.” But when Erin and Kate prepped for the lesson in Gulu, they learned the town has no craft stores. “The nearest clay source, says Kate, “was a riverbank.”

So they planned an expedition to the riverbank to dig for clay—and that was another lesson for the EiE educators, about how Ugandan culture stresses the importance of community. “The riverbank was a twenty-minute walk from the school, so we thought just a few children would go with us,” Kate explains. “But the Gulu teachers insisted all the children should go.” What’s more, every single child carried a bucket to fill with clay. “We knew we wouldn’t need that much clay for the lessons,” Kate says. “But the teachers explained it was important for every child to contribute.”

After the class arrived at the riverbank, some students left the group to look at a nearby bridge. “I thought that they were just playing,” Erin says, “and I walked over to ask them to rejoin the class.” As she got closer, though, she could hear the students were actually discussing how to improve the bridge—using ideas they’d absorbed from the EiE unit, ’Designing Bridges,’ which they had used in class the previous week. “We had emphasized to the students that civil engineers use their knowledge of math, science and engineering to keep people in their community safe,” Erin says. “These kids were already thinking like civil engineers.”
AN EVENING OF BIG IDEAS

On September 19 the Museum of Science spotlighted New England’s newest and most innovative technologies with the third annual Invented Here!

Through Invented Here! the Museum hopes to encourage future generations of inventors and entrepreneurs by sharing ground-breaking technologies that shape the way people interact with each other and with the world around them, fulfill important individual and social needs in novel ways, or ensure a more sustainable future for humanity and the environment.

Emcee Robin Young, host of WBUR’s news magazine Here and Now, this year’s edition of Invented Here! was once again presented in collaboration with the Boston Patent Law Association. Honorees were selected from nominations submitted by corporations, law firms, research labs, and colleges and universities throughout New England.

All nominations were vetted by the Boston Patent Law Association for their eligibility.

A Selection Committee (see right) comprised of leaders in business, law, academia, and technology reviewed the nominations and ranked finalists based on each invention’s potential impact, novelty, and commercial viability. The 2013 Invented Here! featured honorees were:

Aaron Ganick and Daniel Ryan of ByteLight, Inc.
LIGHT POSITIONING SYSTEM USING DIGITAL PULSE RECOGNITION
ByteLight is revolutionizing indoor location with lighting-based software. ByteLight’s software uses the existing lighting infrastructure within large public venues, businesses, and retail outlets to offer information, redemptions, maps, and services to people at precise locations within the venue.

Qing Hu and Alan Lee of the Massachusetts Institute of Technology
TERAHERTZ QUANTUM CASCADE LASERS AND REAL-TIME TERAHERTZ IMAGING
THz radiation can penetrate optically opaque materials to allow for noninvasive imaging in biomedical and security applications. Previously, the process took many minutes to complete. Real-time THz imaging is made feasible with high power levels of THz quantum-cascade lasers.

B. Jackson Madnick of Pearl’s Premium, Inc.
LOW-MAINTENANCE LAWN SEED MIXTURE
Pearl’s Premium, a patent-pending grass seed mixture, grows very deep roots. As a result, the lawn taps into naturally-occurring moisture and nutrients to minimize watering and chemical treatments. The slow growing lawn minimizes mowing and nutrient treatments.

Museum Staff Favorite: Pratheev Sreetharan, John Whitney, and Robert Wood of Harvard University
MONOLITHIC FABRICATION OF THREE-DIMENSIONAL STRUCTURES, ALSO KNOWN AS “ROBOBEES”

Inspired by the biology of a beehive’s behavior, the RoboBees collaborators envision their nature-inspired research leading to a greater understanding of how to artificially mimic the behavior and intelligence of a bee colony to autonomously pollinate a field of crops, perform search and rescue missions, explore hazardous environments, conduct military surveillance, provide high resolution weather and climate mapping, and monitor commuter traffic.

By recognizing key innovators, their inventions, and the stories behind them, the Invented Here! program advances the Museum’s mission to transform the nation’s relationship with science and technology.
MUSEUM OF SCIENCE

INVENTED HERE!
2013 Selection Committee

Jeffrey Beir
Open Exchange, RoadAhead, seed2A,
Rick Burns, Chair
Charles River Ventures
Yet-Ming Chiang
MIT and A123
Maria Kussmaul
AGC Partners
Ted MacLean
Microsoft
Kurt Melden
Entrepreneur and Consultant
Kara Miller
WGBH
Elizabeth Riley
Babson College
Tom Spera
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OSRAM SYLVANIA

MEDIA PARTNERS
Boston Business Journal
Mass High Tech

INVENTED HERE! SERIES
SATURDAYS AND SUNDAYS,
12:30 P.M.

Museum visitors can find out about fascinating new innovations being developed right here in New England every weekend at the Museum of Science. Local inventors and their amazing inventions are featured live in the Gordon Current Science & Technology Center, with a new topic every month. Sponsored by Hamilton, Brook, Smith & Reynolds, P.C. and the Harvard University Office of Technology Development.
2013 New Trustees

The trustees of the Museum of Science are united by a strong commitment to support the Museum and its mission. They act as ambassadors, advocates, and solicitors for the Museum to connect to individuals and organizations representing a broad cross-section of professions, community, and cultural backgrounds. Trustees are responsible for ensuring the Museum’s overall well-being.

The Museum community welcomed three new members to the board of trustees in 2013. Each of these new members brings a wealth of talent and ideas to the board. They share a strong commitment to and passion for the Museum, and we are happy to welcome these new trustees to the Museum family.

Nancy Dempze
As a partner at Hemenway & Barnes LLP, Nancy serves as a professional trustee, executor, and estate planner for individuals and families. She also represents non-profits in connection with planned giving and development. A frequent lecturer, publisher, and leader on issues important to her practice and clients, Nancy is a fellow of the American College of Trust and Estate Counsel, past co-chair of the Boston Bar Association’s Trust and Estates Section, and a past moderator of the Boston Probate and Estate Planning Forum. Nancy is active in her community, Westwood, and in organizations across Massachusetts. She was past president, and is currently vice president, of the Westwood Land Trust. She is a trustee at Old Sturbridge Village and the Manomet Center for Conservation Sciences, and serves on the Boston Foundation’s Professional Advisors Committee. Nancy earned a BA from the University of Wisconsin, Madison and a JD from the Boston University School of Law. Nancy has served as an overseer at the Museum of Science for five years, and currently serves as vice chair of the Planned Giving Committee and chair of the Washburn Society.

Elizabeth G. Riley
Elizabeth was President and Co-Founder of Mazza and Riley, Inc., an international executive search firm. She is an adjunct professor of entrepreneurship at Babson College. She initiated and ran the Hatchery Program at Babson for seven years and was faculty advisor to the thirteen companies in the Babson and Olin College of Engineering incubation program. Elizabeth has taught entrepreneurship in the MBA program at Harvard Business School and is a longstanding member of the school’s Board of Dean’s Advisors. She is a former trustee of the Noble and Greenough School and the Weekapaug Foundation for Conservation. She is a board member of New Profit, a venture philanthropy fund, and an advisor to Teach for America’s Boston startup. Elizabeth earned an AB in Chinese language, history, and philosophy from Columbia University, Barnard College and an MBA from Harvard Business School. She has served as an overseer at the Museum of Science for five years and is a member of the Women in Science Committee.

William H. Swanson
Bill is chairman and CEO of Raytheon Company—a technology and innovation leader specializing in defense, security and civil markets throughout the world. Before adding the responsibilities of chairman to his position in January 2004, Bill was CEO and president of the company. Prior to that, he was president of the company, responsible for Raytheon’s government and defense operations. Bill is a member of the Congressional Medal of Honor Foundation board, the NextEra Energy, Inc. board of directors, and is vice chairperson of the John F. Kennedy Library Foundation board of directors. He is active in the field of education as vice chairman of the California Polytechnic State University Foundation board of directors, a member of the University of Massachusetts President’s Advisory Council and the Business-Higher Education Forum executive committee, and the honorary chair of MATHCOUNTS®. Bill graduated magna cum laude from California Polytechnic State University with a bachelor’s degree in industrial engineering, and he has been awarded an honorary Doctor of Laws degree from Pepperdine University and an honorary Doctor of Science degree from Cal Poly.
NEW OVERSEEERS

Overseers are a community of leaders and friends of the Museum who have a special interest in science, technology, and education. We welcome the following new overseers:

Betsy Washburn Cabot
Tim Delaney
Kim Goldinger
Barbara Hughey

Greg O’Shaughnessy
Leslie Shaff
Krishna Yeshwant
John Stafford

Overseers (FY 13)
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Patricia M. Lassiter

Vice Chairs, Board of Overseers
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Ann Merrifield

Priscilla Anderson
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Peggy Johnson
Philip T. Johnson
Salim Kabawat
Susan Kaplan
Brian T. Keane
Michael E. Kolowich
Joshua M. Kraft
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Stephanie Behrakis Liakos
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Thomas L. Pappas
Elisabet de los Pinos
Joyce L. Plotkin
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Johan Pontin
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Elizabeth G. Riley
Carmichael S. Roberts
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Andrey J. Zarur
Xiaohua Zhang

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Albert M. Creighton Jr.
Mrs. Tarrant Cutler
Boruch B. Frusztajer
Owen J. Gingerich
Marvin C. Grossman
Arrest Henderson III**
Gardner C. Hendrie
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Ralph C. Sweetland
Barbara P. Washburn
Joanne Weaver
John P. Weitzel
Charles V. Willie
Anne B. R. Witherby

* Resigned
**Deceased
ABOUT THE COVER IMAGE

Kids in Guangdong Province, China kick a soccer ball in the dessicated rice fields of their village, which harvested no rice during an extended drought. From the exhibit Climate Change in Our World.

The Museum is a place where everyone can participate equally in the excitement of science and technology. To receive more information about accessibility in the Museum or to express a concern about accessibility: 617-723-2500, 617-589-0417 (TTY), communityrelations@mos.org, mos.org/accessibility.

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5th Annual Signature Event

Tuesday, April 29, 2014 | 6:00 p.m.
Museum of Science, Boston

Join us to show your support for Boston's beloved Museum of Science and help us honor our 2014 Star of STEM, Biogen Idec, with their CEO, George Scangos, PhD, accepting. Celebrate the success of our Hall of Human Life, and enjoy a lively evening of dinner, entertainment, and fun interactives.

Honorary Event Co-Chairs:
Amy and Joshua Boger | Henri and Belinda Termeer
Believe in the power to change lives.

Each year the Museum of Science offers 100 paid internships, all of which are funded by philanthropy, representing just half of the internship opportunities for young men and women to work side by side with staff and educators. Engineering, life sciences, and technology are just a few of the many areas where our talented interns can gain real world experiences that often inspire life-long careers in science and education.

Meet Lucy Green...

I discovered my true passion interning at the Museum of Science. The opportunity I had to intern at the Museum was the most valuable experience of my life. My work as a paid intern in the area of education and underserved community outreach gave me the inspiration and focus to understand my true calling. Today, I am the youth programs coordinator at the Museum, working to develop outreach and education programs for at-risk student groups. My work helps to empower the next generation of informed citizens by bringing them opportunities, job readiness skills, and awareness of science, technology, engineering, and math. My work allows me to give back and honor my heartfelt appreciation for the internship opportunity I received because of the Museum’s generous supporters.

These invaluable internship opportunities are made possible by forward-thinking donors who understand that each great generation relies on the support and help of those who came before.

For further information on endowment supported programs, including our goal to fund more paid internships, and ways you can help, please contact Jim McDonald at jmcdonald@mos.org or 617-589-4482.
Climate Change
A Local and Global View

Celebrations
2014 Colby Honors and Hall of Human Life

On Mentoring
From Letters to a Young Scientist by
Two-time Pulitzer-Prize-Winner Edward O. Wilson

Of Note
Engineering is Elementary® in Uganda