MATERIAL MATTERS:
VINYL'S ROLE IN SUSTAINABILITY, RESILIENCE AND THE EDUCATION OF DESIGN PROFESSIONALS

George Middleton, AIA, CSI
George Middleton & Associates, Inc.
GreenGlobes® Assessor, LEED® Accredited Professional
September 1, 2015

ABSTRACT

Sustainability is a term that is widely applied today, and a full understanding encompasses three interdependent and overlapping aspects; environmental, economic and social. All three are embodied in the material the vinyl industry works with each day. Society must now also think about resilience, a term used to describe cities, systems, buildings, people, institutions and products. It refers to the ability of systems to bounce back from stress, spring back into shape, survive, adapt and grow regardless of the type of shock or chronic stress.

To understand resilience it is helpful to consider potential stressors and responses to them as short-term (shock) events, long-term (chronic) events, expected events and unexpected events. Additionally stressors can be divided into those that are primarily 'natural' and those that are primarily 'technology' in causation. Not all stressors can be treated equally, and the relative importance of these events should be evaluated in terms of hazards and risks.

Products and systems used in buildings and infrastructure should be selected using methods of design and construction that cause impacts from stressor events to be minimized. Examples of systems and desirable response attributes include PVC pipe, used in water distribution systems with an expected service life of over 100 years. Vinyl cladding systems are resistant to all but the most extreme weather exposure. Vinyl membrane roofing, noted for its solar reflectivity can have a dramatic effect on reducing building air conditioning loads and energy consumption. PVC is a high performing wire and cable insulation used in many applications. It is a material that helps make the Internet possible and enables our modern global digital economy to function. Vinyl products facilitate healthcare and disease control, helping to manage infection and PVC blood bags make a safe blood storage system possible. When considering the economic and social factors of resilience, vinyl-related manufacturing activity has many positive effects on local communities.

Today's architects are expected to know more about materials and the profession must be equipped to practice in an era when understanding traditional materials used 100 years ago is no longer adequate. Plastics are the most intensively engineered building materials today, but architects and designers are still in the early stages of understanding them. Examples of education and outreach include a student design competition that will focus on a public pavilion in Philadelphia to display the design, technology, and construction resources that will enhance

the resilience of American cities. In response to devastation from events like Hurricane Sandy, a multi-disciplinary student team at the Stevens Institute of Technology in New Jersey is designing and building a prototype coastal home suited to the risks of rising sea levels and severe storms.

Today more is known about what sustainability and resilience mean, and it is important that building choices be good ones; negative impacts should be minimized and positive impacts should be maximized. The vinyl industry recognizes that buildings have a significant impact on sustainability, especially when it comes to energy, water, carbon footprint and material usage. There are no 'good' or 'bad' materials, only more-sustainable or less-sustainable ways of using the materials available to solve design problems. Vinyl enables human needs to be met today with respect to the needs of future generations. Vinyl products can be depended upon to resist stressor events and to enable those affected to bounce back and recover, and future architects can be educated to provide the best design guidance to the clients they serve, assuring protection of the public's health, safety and welfare.

This paper was prepared for presentation at The Society of Plastics Engineers Vinyltec session on October 15, 2015 in Akron, Ohio.

SUSTAINABILITY

'Sustainability' is a label applied to almost everything today, from products and materials, to industries and organizations. We hear about it all the time, but what does the term sustainability really mean? Many experts, including the United Nations (UN Environment Program)[1] and the U.S. Federal Government (FedCenter.gov environmental stewardship and compliance for Federal facility managers and US EPA)[2][3] agree it is taking care of human needs today without compromising the ability of future generations to do the same. A full understanding of sustainability should encompass three interdependent and overlapping aspects that can help to understand a very complex idea. They are:

- ***Environmental* -** Including energy and water efficiency, material selection and resource conservation, emissions, indoor environments, land use, and other related methods of managing the environment we share.

- ***Economic* -** Dealing with the systems by which goods and services are produced, sold and purchased, productive employment, and the benefits it brings to people and society. It's about the way we manage money, materials and other resources on a local, national and global scale.

- ***Social* -** Relating to human society, the interaction of individuals and groups, and the welfare of human beings as members of society. It's about forming cooperative, beneficial and interdependent relationships in organized communities.

In discussing sustainability, some tend to short-cut the concept and place emphasis only on environmental factors. Others go even further, attempting to select or de-select materials or products as being 'better for the environment' or purchased because they are 'environmentally preferable.' There is no formal, universally-agreed definition for sustainability so this has led to some confusion in the marketplace.

Durability is an asset in sustainability terms and depending on the design application, vinyl products can last for many years to many decades. Of the 15 billion pounds of vinyl resin produced in North America in 2013, 70% was used in durable products. However, while being durable in its finished state, vinyl is also a thermoplastic and is therefore inherently recyclable and 'molecule efficient.' Nearly 1 billion pounds of vinyl material is recycled annually, including recycling from post-industrial and post-consumer sources[4].

RESILIENCE

Today our society, governmental agencies, and design professionals who make the built environment possible have a new set of design criteria to consider. Sometimes referred to as the next step in sustainability we now also think in terms of 'resilience.' What does this term actually mean, and can it be understood using some of the things we already know about sustainability?

Resilience is typically used in connection with cities, systems, buildings, people, institutions and even products. Resilience has several meanings; classical definitions which come to mind and with which we need to be familiar in order to understand it. These include:

- ***Ability of a system to bounce back from stress*** *or spring back into shape*
- ***Ability to adapt to adversity*** *and recover quickly from difficulty*
- ***A measure of toughness and elasticity***
- ***Withstanding stress****, threats or catastrophe*
- ***Resistance to failure****, adversity, trauma, or tragedy*
- ***Being strong, healthy and successful*** *after disruption*
- ***Surviving, adapting and growing*** *regardless of the type of shock or chronic stress*

For more than 100 years, The Rockefeller Foundation's mission has been to promote the well-being of humanity throughout the world[5]. The Foundation pursues its mission through dual goals by "advancing inclusive economies that expand opportunities for more broadly shared prosperity, and building resilience by helping people, communities and institutions prepare for, withstand, and emerge stronger from acute shocks and chronic stresses." In order to achieve these goals the Foundation works at the intersection of four focus areas:

- ***Advancing health***
- ***Revaluing ecosystems***
- ***Securing livelihoods***
- ***Transforming cities***

In this way it hopes to address the root causes of emerging challenges and create systemic change. As it happens, these goals are very much in keeping with the well-accepted definitions of sustainability discussed above. They are environmental, economic and social in character and for this reason it is helpful to think in terms of a broad formative overlap between the objectives of sustainability and resilience.

According to The Rockefeller Foundation a working definition for resilience is “Helping cities, organizations, and communities better prepare for, respond to, and transform from disruption.” The Foundation further explains the boundaries of this concept as follows:

> *“We live in a world of increasing dynamism and volatility, where technology and greater interconnectedness have accelerated change and altered the way people live.* ***Resilience is the capacity of individuals, communities and systems to survive, adapt, and grow in the face of stress and shocks, and even transform when conditions require it.*** *Building resilience is about making people, communities and systems better prepared to withstand catastrophic events—both natural and manmade—and able to bounce back more quickly and emerge stronger from these shocks and stresses.”*[6]

In a recently-announced move to build on the Obama Administration’s Climate Action Plan[7] the Corporation for National and Community Service (CNCS), the Department of Energy (DOE), the Environmental Protection Agency (EPA), and the National Oceanic and Atmospheric Administration (NOAA), The Rockefeller Foundation and Cities of Service, announced a new commitment to launch a “Resilience AmeriCorps” pilot program. This is envisioned to be a public/private partnership between Federal agencies and others as part of the Administration’s effort to build climate resilience nationwide. The program was developed in response to a recommendation made by the President’s State, Local, and Tribal Leaders Task Force on Climate Preparedness and Resilience.

Resilience AmeriCorps will help communities plan and implement efforts necessary to become more resilient to shocks and stresses, including extreme weather and other impacts of climate change. Through the pilot program, AmeriCorps VISTA members will serve in up to 12 communities in 2015-2016 to support the development of resilience strategies that will both help communities “better manage the unavoidable” and “avoid the unmanageable.” AmeriCorps VISTA members will build volunteer networks to carry out program initiatives and create education and outreach materials to strengthen awareness and citizen engagement in low-income communities.

Recognizing that "Crisis is increasingly part of the 21st century,” Dr. Judith Rodin, President of The Rockefeller Foundation believes “It is imperative that communities – large and small – place a premium on building resilience. With collaborative efforts across all sectors we can ensure our country is prepared for the inevitable shocks and gnawing stresses so that disruptions no longer become disasters.” The new Resilience AmeriCorps program will create a new generation of talented individuals who are committed to building resilience, and who can support cities today while “deepening the bench” for innovative leadership in years to come. “Resilience is a journey, not a destination, and the time to embark on it is now,” according to Dr. Rodin.

Other organizations and stakeholders have become aware of the importance of the issues defining resilience. As the country’s largest professional association of licensed architects, The American Institute of Architects (AIA) is committed to creating safe, secure, and resilient communities. “We provide our members with advocacy, research, and training to engage in all phases of disaster mitigation, response, recovery, and adaptation.” The AIA has recently adopted a broad and useful position statement on resilience, demonstrating its importance not only to its members but to society at large:

> *“Buildings and communities are subjected to destructive forces from fire, storms, earthquakes, flooding, and even intentional attack. The challenges facing the built environment are evolving with climate change, environmental degradation, and population growth.* ***Architects have a responsibility to design a resilient environment that can more successfully adapt to natural conditions and that can more readily absorb and recover from adverse events****. The AIA supports policies, programs, and practices that promote adaptable and resilient buildings and communities.”*
> *(Approved: December 2014 through December 9, 2017)*[8]

This statement recognizes that change is occurring in the built environment in response to many complex factors. It also makes clear that licensed architects will come under increased scrutiny because of their professional responsibility to protect the public health, safety and welfare. They should therefore recommend and specify materials and products carefully, so as to leverage attributes that are valued and desirable in terms of resilience. These may include flexibility, efficiency, economy, speed, strength and durability.

RESILIENT TO WHAT?

In order to understand the meaning of resilience, we could divide up potential stressors (and potential responses to them) into manageable categories. Such a strategy might include categorizing stressor events as:

- ***Short-term*** *(sudden or shock)*
- ***Long-term*** *(chronic or prolonged)*
- ***Expected***
- ***Unexpected***
- ***Natural causes***
- ***Technology causes***

The next step would be to consider the specific sorts of stresses or events that can potentially affect people and systems, creating the need to be resilient in the first place. Some potential stressors might include these, characterized by causation.

Mostly ‘natural’ causation:

- Severe wind and weather events
- Climate change
- Rising seas, flooding
- Seismic activity
- Volcanic activity

- Forest fires
- Solar flares
- Insect or animal migration
- Disease pathogens

Mostly 'technology' causation:

- Economic or market disruption
- Supply chain interruption
- Currency fluctuation
- Civil unrest, migration, refugees
- Chemical spills
- Structure fires
- Disruption of blood, medical supplies
- Disruption of power, communications, computer networks
- Disruption of food, fresh water production and distribution
- Air and water pollution

Practically speaking, there is almost always overlap among these categories. For example hurricane events are natural, they are relatively short-lived and they can be expected seasonally. However, the damage and devastation brought about by hurricanes can bring with it long-term duration to recovery and the unexpected magnitude of a variety of technology-related stressors accompanying the actual storm event, such as power and communications failure, fresh water and food disruption and long-lasting economic hardship.

HAZARDS AND RISKS

There is a tendency to simplify the concept of resilience, characterizing it as being only about 'floods and seawalls.' But this approach is very limited in value because it addresses only one stressor (with an undefined cause) and implies only one response. This might resonate well in New Orleans, but be a foreign concept in Wichita. As The Rockefeller Foundation believes, people and communities need to be ready to survive, adapt and grow regardless of the type of shock or chronic stress that might occur. Simplification misses the point that resilience is best understood in broader terms; not only in terms of climate change but in terms of many possible system stresses, whether they are natural or man-made, short term or long term, expected or unexpected.

It is also helpful to recognize that not all stressors can or should be treated equally. The relative importance of stressor events and the likelihood of occurrence can be evaluated in terms of hazards and risks. While many things in life are potentially hazardous, humans learn to deal with hazards by applying knowledge and judgment. They assess risk; they determine the likelihood of something bad happening (the probability of harm), and they determine an appropriate response. For example, a large asteroid strike would probably be a fatal hazard for some or all of the world's population. But the risk of such an occurrence over biological time is thought to be fairly low. A rational response might be "carry on with life and don't worry about it." The hazards of seismic and high wind events are understood to be very significant and also much more likely than an asteroid strike, especially when probabilities associated with geography are brought into focus. So it follows that an understanding of the risks associated with the use of materials is fundamental to a product response when considering stressors and resilience.

Here it becomes evident why design practitioners need to understand the difference between hazards and risks. Such an understanding is critical to fulfilling their role as materials experts for the clients they serve. This process has sometimes been clouded by individuals and organizations focused entirely on hypothetical hazards associated with materials who choose to deselect or red-list them with no consideration of actual exposure to potential hazards. The problem is that an understanding of science (including chemistry, toxicology and other fields) is necessary to make sound judgements, but architects are usually the first to admit that they don't have training is this area and so are at a disadvantage when confronted with highly technical information of this kind.

One illuminating example has been helpful in explaining this to a non-scientific audience, and that is to consider an automobile, which is a product that for many reasons can be very hazardous. About 3 feet (1 m) away from the passengers is a lead-acid battery. A battery containing 30 pounds (13.6 kg) of lead in a 3,000 pound (1,363 kg) car means the product is composed of 1 percent lead. When chemists, biologists and toxicologists commonly speak in terms of trace amounts of 1 part per billion or per trillion, many people would agree that 1 part per hundred is a fairly high concentration of lead in a product.

Lead is proven by science to be toxic even in small quantities and it has a demonstrably bad history with human health. It presents a significant hazard when ingested or fired from a gun. Should lead be banned from all products (red-listed) because it is hazardous? No, because lead batteries have been used safely for more than a century and are recognized to provide huge benefits to society. We agree to manage the risk of exposure to lead, not only in terms of human health but also in terms of environmental impacts, from the manufacturing process through resource recovery. The point here is that the likelihood of anyone being exposed to lead while using this particular product (an automobile) is just about zero. So the *risk* of any health consequences from lead exposure in this product is also effectively zero. That means the lead battery is a relatively safe ingredient, especially when compared to the very real, demonstrated and deadly risks associated with distracted driving, intoxication, excessive speed, and not wearing seatbelts**.**

Whether considering the risks associated with stressing events, or the products and materials chosen to respond, it comes down to practical, science-based trade-offs between hazards and risks to make the best choice for any given application. To short-circuit this rational process by red-lists and deselection based on a lack of understanding of hazards and real, practical risks can unnecessarily remove from consideration the very materials that can best respond.

VINYL APPLICATIONS AND RESILIENCE

Products and systems used in buildings and infrastructure should be evaluated so that the best methods of design and construction are used and potential impacts from likely stressor events are considered. Here are a few examples of various systems with emphasis on specific impacts and the desirable response attributes which can enhance resilience. This type of analysis should apply to all materials but for the moment we will consider vinyl (PVC) and some of the products made from it.

PVC pipe is used in water distribution systems as well as in drain, waste and vent applications. It can be used for storm water management and recovery systems. It is highly durable with a predicted service life of well over 100 years. It is flexible, sanitary and highly resistant to breakage, reducing water waste. It is potentially more resistant to seismic activity than systems made from brittle materials such as concrete or iron. Repairs are typically rapid and economical, minimizing disruption and cost to local communities.

Building cladding systems are potentially at risk in high wind events. When properly installed, vinyl siding is resistant to all but the most extreme weather exposure. Damage is relatively easy and economical to repair enabling rapid recovery of neighborhoods. Local housing stock can be inherently more flexible and adaptable, thus offering a long service life since building additions and modifications are more practical and economical than with other systems such as masonry. This product requires little maintenance over its service life and is immune to rotting and insect damage, which may be expected to occur with organic materials as insects migrate due to changes in weather patterns.

Vinyl membrane roofing is noted for its solar reflectivity which can have a dramatic effect on reducing building air conditioning loads and energy consumption, utility costs and electrical generation demand. Higher reflectivity can also help to minimize heat island effect in urban areas and is thought to have a positive effect on local microclimates. Roof systems are tested and approved to meet the strict wind-uplift criteria in building codes. This material is inherently self-extinguishing, enhancing its resistance to combustion and overall fire performance. PVC roof membranes can be the enabling technology in vegetated roof assemblies which can help to keep cities cooler, generate oxygen and absorb carbon dioxide.

PVC is a reliable and high performing wire and cable insulation used in line voltage and low voltage applications in buildings and infrastructure. It is durable, resistant to damage in service, has high electrical resistance, wide thermal range and is self-extinguishing. Used in server farms, local networks and other digital applications, this material is a contributor to making the Internet possible. This in turn enables our modern global economy to function. It also has many applications in radio communications networks, renewable energy generation and power distribution.

Vinyl facilitates healthcare and disease control through products that help to control infection, impacting the health of millions of people and the resilience of communities around the world every day. Vinyl flooring and other interior environmental surfaces in medical care facilities can be easily cleaned and disinfected. It is a well-known fact that PVC blood bags make a safe blood storage system possible, a resilience factor which is of no little importance in the event of a major stressor event. Vinyl is also used widely in the clothing and protective gear of first responders and emergency workers such as head ware, clothing, boots and gloves. It is used in many forms of food and water storage containers.

The economic and social factors of resilience should be considered when evaluating materials and the products made from them. Vinyl-related manufacturing activity has many effects on local communities beginning with providing steady employment. The many thousands of jobs along the entire value chain from manufacturing to transportation, sales and distribution, installation, maintenance, repair and remodeling, disposal and recycling are all integral to the production and use of vinyl building products. Add to that community development and provision of services made possible by the significant financial contribution of industry to local, state and Federal taxing entities. There are also potentially large global export and balance of trade impacts. As a general rule it can be said that communities that are healthy economically are likely to be more resilient, enabling them to adapt to adversity and to recover quickly from difficulty when required.

EDUCATING DESIGNERS FOR A RESILIENT FUTURE

Today's architects are expected to know more about materials than ever before, and young people joining the profession must be equipped to practice in an era when understanding traditional materials used 100 years ago is simply no longer adequate. Computer processing power now enables buildings to be designed like sailboats and new design tools demand new materials including high performance polymers. It is becoming clear that a working understanding of design now calls for a working understanding of science and chemistry, too.

There is a long history of working relationships between industries that produce materials and the design professionals who select and specify them. There exists a natural co-dependency between designers who choose products and building owners who demand products that perform as expected at a cost they are willing to pay. The objective is to solve design problems and achieve the environmental, economic and social goals of sustainability with as little negative impact on the planet as possible.

Findings from a recent materials conference at Columbia University Graduate School of Architecture, Planning and Preservation (GSAPP) point to the importance of supporting and student design professionals and their academic institutions with regard to materials education. ***Permanent Change***[9] was held on Columbia's campus March 30 through April 1, 2011. Bringing together more than 300 registrants and 45 presenters including a wide range of leading architects, engineers, scholars, students and faculty, the conference explored the boundaries between architecture, engineering and material science through symposia, studios, and exhibitions in intensely focused investigations. Containing information that probably doesn't exist anywhere else in the world, a detailed timeline of the history of the development of plastics filled the walls of a display room on the way into the auditorium at Columbia's Avery Hall. The main goal of the conference was to ask the questions 'How is a new generation of professionals and manufacturers fusing engineering and architectural practices?' and 'How do new materials and material concepts change our professions?'

As the main sponsor of the event, The Vinyl Institute sought to build new and durable alliances with influential partners in design and materials through a highly credible path into a world-class university system. Utilizing Columbia's position to help set the benchmark for the higher education of architects and engineers in design, materials, applications and innovation, the conference associated the PVC industry with some of the best and brightest minds in the field**.** Other sponsorship goals were to facilitate and foster innovation and the dissemination of new ideas for growth of markets and product development. Some important takeaways from the conference included these:

1. ***Architects and designers, both on the professional and student levels, receive limited instruction about polymers***. A common belief is that plastic is basically one material, rather than a complex and talented family of many different materials made possible not by geometry, but by chemistry. This often leads to misunderstandings, misapplications and underutilization.

2. ***Architects 'synthesize' concepts and ideas, and they tend to operate toward the riskier side of design. Engineers 'analyze' concepts using the principles of physics and science, gravitating toward safety***. While both professionals tend to think differently about a problem and assimilate information differently, amazing and useful outcomes are possible when they work well together.

3. ***There is a fundamental shift going on in design and construction made possible by computers***. This includes not only form-giving design, but also the design of new and unique materials made possible through the selection of high performance polymers and fiber reinforcement.

4. ***There is a trend today for design professionals to look to 'checklists' like green building rating systems as they design***. But that is becoming more difficult to do as the requirements for materials knowledge become deeper and more nuanced.

5. ***Materials efficiency equals molecule efficiency, and durability is a virtue in terms of sustainability***. So a durable, recyclable bundle of molecules, bound up in a product made of plastic may in fact be a better environmental choice than a product that ends up in the solid waste stream.

6. ***The way young design professionals are educated is important***. They benefit when they are exposed to new ideas and have experiences that go beyond the traditional.

7. ***The terms 'natural' and 'synthetic' are not as they first appear.*** All building materials have some aspects of 'nature' as well as inputs from the hands of people, whether through mining, processing, cutting, shaping, formulating, coating, laminating, or other manipulation.

8. ***There is a growing focus on reducing carbon pollution***. Materials that reduce dependence on carbon by limiting their carbon footprint across entire life cycles and help to reduce carbon emissions by performing well in intended applications are probably the best choices.

Plastics, including vinyl, have become the most ubiquitous and increasingly permanent materials in construction. The material capabilities of plastics, both as a generic material and as specific polymers, and the processes that underlie them, suggest a potential to reshape construction and the roles of architects and engineers in construction. While plastics are perhaps the most intensively engineered building materials today, architects and designers are still in the early stages of understanding them in terms of their potential applications and uses.

THE AMERICAN RESILIENCE PROJECT

The vinyl industry has had much success in reaching out to future design professionals through design competitions. Sponsored by The Vinyl Institute and administered by the American Institute of Architecture Students (AIAS) these programs challenge students to learn about materials, specifically vinyl building products and systems, in the design context of small-scale public facilities. The objectives of the competitions are to:

- ***Encourage and reward design excellence*** at a small scale, integrating function, aesthetics, structure, and detail
- ***Build knowledge about materials***, products and assembly, primarily of vinyl products, contributing to resilient and sustainable design
- ***Integrate the project*** into the location of the AIA National Convention
- ***Encourage designers to employ resilient and sustainable design principles*** in this and all their future work

A design competition underway at this writing[10] is known as "The American Resilience Project" and it is focused on the design of a hypothetical public pavilion in Philadelphia. Beginning in early September, 2015 interested architecture students, their professors and recent graduates were invited to participate in the competition with the following descriptive message and design challenge:

> *"The resilience of the United States of America was first on display in Philadelphia when leaders in the Continental Congress worked to survive and endure colonial pressure from the British Crown. Since that time, American resilience has enabled our people and our cities to withstand many challenges and to recover with strength. Chicago survived and prospered after its fire in 1871. San Francisco has survived numerous earthquakes. New Orleans survived and rebuilt after the devastation of Hurricane Katrina.* ***Challenges like these are inevitable and will occur again; some will be caused by natural forces, but some may be caused by humans. Some will arise over time, but some may be sudden and surprising. Architecture, and the materials and systems which make it possible, can be a part of solutions in our future. They are part of our path to readiness today.*** *For a site in Philadelphia, design a public pavilion that displays the design, technology, and construction resources available today, to enhance the resilience of American cities tomorrow."*

Competition participants will have the opportunity to:

- ***Understand how system stress can be caused*** by natural forces as well as by humans, and how some stresses will arise over time and some may occur suddenly
- ***Investigate applications for existing and new construction materials*** with the goal of contributing to resilience and sustainability
- ***Develop awareness of the life cycle of vinyl building products*** and the criteria to be used in evaluating all building materials
- ***Understand the impacts of construction methods***, joinery and material choices on function and aesthetics

As part of their design submission the student architects will be asked to provide a brief essay describing the most important concepts of the design solution. The essay will explain what was learned about designing using vinyl and the use of existing or envisioned products made from it including key material properties like embodied energy, carbon footprint and recyclability. The essay will also explain the types of stress on resilient systems that were considered, from both natural and human causes, and of short term and long term duration. The design solution should be conveyed graphically to the extent possible and not rely entirely on the design essay to communicate an understanding of the project to others.

Participants will also be asked to submit a design analysis, requiring them to provide a matrix identifying how the key elements of sustainability (environmental, economic, and social) are incorporated into the design, and how they improve the health, safety, and welfare aspects of the user's experience. A material analysis should demonstrate the value of each primary material used in the design. In particular, the submission will show why vinyl was selected when alternatives were compared. This may include conventional inputs and outputs of a life-cycle assessment, performed to evaluate and reduce the environmental impact that the design is expected to have on its site and surroundings.

A design jury will be selected prior to the project deadline on November 29, 2015. Juries typically consist of architects and academics, with representation from industry, ownership and sometimes government agencies. The number of jurors varies depending on project complexity and expected number of entrants, but for this type of competition, five or seven members might be considered optimal. The jury will award recognition and prize money to winners in first, second and third place categories as well as to local AIA Student chapters affiliated with the winning teams. The jury will have the option to give additional recognition for projects demonstrating exceptional creativity, uniqueness or showing other special effort.

THE STEVENS INSTITUTE SU+RE HOUSE

When Hurricane Sandy[11] blew across the Northeast in 2012, it left behind a $65 billion price tag, including damaging or destroying almost 350,000 homes in New Jersey alone. Much of that destruction happened in the state's famous shoreline communities which three years later are still recovering. In response to events and devastation like this, a multi-disciplinary student team at the Stevens Institute of Technology in Hoboken is currently entering the construction phase of their plan to design and build a different kind of coastal home, better suited to the risks of rising sea levels and increasing frequency of severe storms which may become associated with building close to the shoreline[12].

"We wanted to challenge ourselves to build a house that was able to withstand a storm comparable to Hurricane Sandy," according to A.J. Elliott, a graduate student in electrical engineering who serves as the spokesperson for the SU+RE House. In addition to Elliott, the SU+RE House team includes graduate students from the Product Architecture and Engineering (PAE) program and undergraduates in Mechanical, Civil, and Electrical Engineering; Computer Science; Engineering Management; and Business.

As its name implies SU+RE House is designed to be both sustainable and resilient. The Stevens Institute collegiate team has merged the inherently efficient indoor/outdoor spaces and open floor plan of a prototypical 1960's style modern beach cottage with state of the art building science, the latest renewable energy technologies, and fiber-composite materials transferred from the boat building industry. The house will be a net-zero energy structure, solar powered and using 90 percent less energy than the average home. The students' goal is to create a model for sustainable, resilient housing in coastal communities. To achieve this goal, the SU+RE House team realized it would need a responsive design coupled with durable building materials, enabling the house and its occupants to bounce back and recover from serious storm events.

One of the materials they have chosen to use is vinyl. SU+RE House incorporates several core vinyl elements including a reflective vinyl roof and vinyl decking. In addition, the project uses PVC water pipes and vinyl wiring and cable insulation. The students negotiated with a window manufacturer with a plan to include vinyl windows into their design solution because of their superior insulating qualities and rigidity of the window frames. PVC's durability is an important environmental benefit in construction since longer lasting products enable more efficient net energy and resource consumption in manufacture and installation.

The SU+RE House is one of 17 entrants selected to compete in the U.S. Department of Energy's Biennial Solar Decathlon. This event is an award program that challenges collegiate teams to design, build, and operate solar-powered houses that are cost-effective, energy-efficient, and attractive. The winning team will be the one that best blends affordability, consumer appeal, and design excellence with optimal energy production and maximum efficiency.

New for 2015 is a requirement that the design teams factor in the energy used in a daily commute. Participating teams will need to drive an electric vehicle 25 miles a day (200 miles total for the duration of the competition) recharging it each night from their house. That energy use will be factored into their home's overall sustainability as teams work toward achieving net-zero emissions. Charging a BMW i3, the car of choice for the SU+RE House, will equate to about one-third of the house's total energy consumption. The Stevens Institute of Technology has participated in the Solar Decathlon in the past, including placing fourth overall and second place in Architecture in 2013, and first place in Affordability in 2011.

The 2015 Solar Decathlon is scheduled to take place October 8-18, 2015 at the Orange County Great Park in Irvine, California. The Vinyl Institute is sponsoring the SU+RE House to highlight the role of vinyl in sustainable and resilient building and construction, and also its durability, versatility, energy and thermal efficiency. Just as with the AIAS design competition discussed above, it is expected that the Stevens Institute of Technology team and all those who touch the SU+RE House project will come away with a better understanding of the design and material requirements associated with sustainability and resilience, and how vinyl can be a play a significant part in achieving the goals of both.

CONCLUSION

We are learning more about what sustainability and resilience mean in a complex and technology-dependent world economy. All human activity impacts our planet, so it is important that the choices we make with regard to those impacts be good ones; negative impacts should be minimized and positive impacts should be maximized. This balancing of impacts and choices should lead to the best and most sustainable outcomes. The vinyl industry recognizes that buildings have a significant impact on sustainability, especially when it comes to energy, water, carbon footprint, emissions and material usage. So it is important that choices made for the products and materials used in them are positive ones. In fact, there are no 'good' or 'bad' materials. There are only more-sustainable or less-sustainable ways of using the materials available to solve the design problems at hand.

The Rockefeller Foundation pursues its goals of advancing economies that expand opportunities for prosperity and building resilience by helping people, communities and institutions prepare to withstand and emerge from shocks and stresses. It is important that those affected recognize that stressors can be short-term or long-term events, which might be expected or entirely unexpected, and natural or technology-related in causation. Not only is good system design required to respond to these stresses, but so is the selection of appropriate materials and the products made from them.

In summary, the vinyl industry and the products made from this important material contribute in many ways to achieving the goals of sustainability and resilience. When looked at through the lens of environmental, economic and social impacts, vinyl enables human needs to be met today with respect to the needs of future generations as well. When the full scope of possible stressors to communities, buildings and people are considered, vinyl products can be depended upon to resist those stresses and to enable affected people and communities to bounce back and recover. And when educated to these facts, future architects and other design professionals can benefit so as to provide the best design guidance to the clients they will soon serve, assuring fulfillment of their responsibility to protect the public's health, safety and welfare.

AUTHOR BIO/CV

George Middleton is President of George Middleton & Associates, Inc., a construction industry consulting firm based in the Chicago area. The firm's work is focused primarily on the technical, marketing and training needs of its building product manufacturer, industry trade association and publisher clients. George is a licensed architect, a member of The American Institute of

Architects, a member of The Construction Specifications Institute, a USGBC LEED® Accredited Professional and a Certified Green Globes® Assessor through The Green Building Initiative. His firm has Fortune 500 product experience, developing continuing education content and sustainability strategies, conducting training seminars and market research, preparing manufacturer guide specifications, product information tools, whitepapers, and communications plans other technical writing. He has served as Chair of CSI's GreenFormat™ Task Team.

REFERENCES

1. IUCN, UNEP, WWF (1991): Caring for the Earth. A Strategy for Sustainable Living and Brundtland Commission of the United Nations, March 20, 1987.

2. U.S. Federal Government, FedCenter.gov environmental stewardship and compliance for Federal facility managers.

3. U.S. EPA. "What is Sustainability?" http://www.epa.gov/sustainability/basicinfo.htm#what

4. V.I. /Tarnell 2014 Recycling Survey.

5. The Rockefeller Foundation mission to promote the well-being of humanity: www.rockefellerfoundation.org

6. The Rockefeller Foundation definitions: www.rockefellerfoundation.org and https://www.rockefellerfoundation.org/our-work/topics/resilience/

7. U.S. EPA. (Enesta Jones jones.enesta@epa.gov) July 9, 2015. "Public – Private Partnership Launches New AmeriCorps Program to Help Communities Build Resilience."

8. The American Institute of Architects (AIA). "Directory of Public Policies and Position Statements" http://www.aia.org/aiaucmp/groups/aia/documents/pdf/aias078764.pdf

9. Columbia University Graduate School of Architecture, Planning and Preservation. "Permanent Change: Plastics in Architecture and Engineering." Princeton Architectural Press, 2014.

10. The American Institute of Architecture Students (AIAS). www.aias.org/vinyl/

11. The Weather Channel: http://www.weather.com/storms/hurricane/news/superstorm-sandy-anniversary-20141029

12. Stevens Institute of Technology. www.surehouse.org

END