I. Program Statement  This study of green living wall case studies reveals several product installations and results for indoor and outdoor applications in various climates. Project analyses will include detailed design criteria, costs, installation details, plant selection, maintenance, and challenges and solutions. Photos and time-lapse videos will enhance and highlight the project presentations.

Learning Objectives
1. Understand the challenges and successes from detailed case studies of a variety of installed green living wall systems.
2. Master the various project design criteria for architectural, structural, mechanical, electrical, plumbing, horticultural, and ongoing maintenance considerations and costs.
3. Discover the team approach and collaboration methods used with clients, landscape architects, architects, engineers, and design-build contractors.
4. Fully grasp the projects' best practices with photos and time-lapse videos.

II. Design Fundamental:
Criteria used to choose the ideal system
- Analysis of the building/support structure and site to determine best system for the client
- Analysis results will inform design limitations and opportunities
- Environmental Factors, i.e. sunlight hours, orientation to the sun, whether additional lighting is needed, wind direction and intensity, precipitation patterns (outdoor), shading, temperature range
- Structural Factors, i.e. weight capacity, structural integrity, ideal site location, access to green wall install and ongoing maintenance, access to utilities, i.e. water, drainage, electricity

Design intent
- Significantly reduce indoor air pollution and improve air quality
- Improve the health of people, work environment; reduce stress and increase productivity
- Provide thermal and sound insulation and mitigate uncomfortable extremes
- Capable of removing volatile organic compounds (VOCs)
- Significantly reduce urban heat island effect and remove excess atmospheric carbon dioxide

Design Considerations
- Indoor vs Outdoor
- Environmental Factors i.e. Temperate range, sun, lighting, wind
- Budget i.e. Installation cost, Maintenance- frequency, accessibility, Safety and Building Codes

New or retrofit
- Can be added to existing structures but advisable to engage other disciplines to determine opportunities and limitations of the building/site
- Applicable in new building, working with the multidisciplinary design team to execute

Structure, Location, Size
- Environmental and structural factors will dictate the size, location and structure
- Green wall façades and living walls don’t sit directly on the wall, they are anchored and hover to the surface or are independent structures
- Waterproofing to prevent degradation of the existing structure is essential
- Location’s limited by environmental and structural considerations
- Maintenance access and frequency will inform location, size and structure
Plant Palette, Plant Choice
  - Plant selection reflects the design goals for green wall, i.e. aesthetic enhancement, living art, food production, relaxation, air purification
  - Environmental factors sometimes limit or inform specific plant choices

Access, Utilities, Equipment
  - Access for maintenance and replanting
  - Additional lighting requires access to utilities
  - Access to water supply for irrigation for certain design systems
  - Access to plumbing for drainage needed for some systems, albeit not all
  - Equipment for monitoring moisture and automatic irrigation

Lighting
  - Measurement of available ambient light
  - Light requirements of the plants selected will affect their survival
  - Additional input of lights require access to an adequate power source

Drainage
  - Plumbing access for drainage can decide system type
  - Drainage access is a factor for the site location
  - Closed looped systems don't require additional drainage or plumbing access
III. Construction Installation

Pre-planted or planted on site
- Pre-planted: plants installed in modules and grown in a greenhouse or warehouse, then modules transported to project site for installation
- Planted on site: plants delivered to project site, removed from their growing medium, i.e. soil, and input bare root into the growing medium or set in tray systems with wicks
- Sown on site: plants intolerant of transplanting or root disturbance that must be sown into the growing medium after the modules/growing medium have been installed

Green Wall Types
- Modular Hydroponics: support frame for large panels or “tiles” with openings for plants, grown hydroponically or semi-hydroponically with drip, wick or spray irrigation/fertigation
- Bio filtration: system that integrates hydroponically-grown plants with an air-cleansing system – can be connected to HVAC system
- Fixed Hydroponics: support frame for soilless plants, grown hydroponically in non-decomposing medium using drip, wick or spray irrigation
- Vertical Display: plants in pots or trays supported by rack or frame, hand-watered or irrigated with drip, wick or spray system – could be used for event or seasonal display with plants rotated for color and pattern
- Plant Pockets: plants inserted into fabric pockets that provide support and moisture retention – can be used for display but somewhat long lasting for interiors or mild climates
- Trellised: Use vining and climbing plant where trellis is the medium for vertical growth
- Hybrid Installation: living wall system is integrated with green façade system such as trellises for vining or climbing plants; modular system can also be accented with display pots
- Artificial/Replica Plants: high quality, artificial plants can be used where live plants cannot be grown or maintained due to structural, environmental or maintenance limitations
- Retention/Retaining Walls: engineered green walls that use durable materials to create permanent stabilization of walls with steep slopes, while incorporating plant aesthetics, reducing erosion and run off

Access
- Impacts installation and maintenance cost.
- Affect the success of plant growth and lifespan of the plants
- Influences the equipment needed to maintain the living wall.

Weight load
- Structural engineer to determine the wall’s structural integrity
- Determine the weight load capacity and if additional reinforcement needed
- Weight load capacity defines the living wall type, planting medium, plant palette, irrigation and system design.

Drainage availability
- Limits the site location and design system type for access to plumbing for external drainage
- Closed loop systems do not require additional access to plumbing for external drainage.
- Size, growing medium and plants selected can demand additional drainage.
IV. Maintenance
Qualified Contractor
- Qualified contractor is essential for executing a successful green wall installation
- Provide some warranty for their service
- Be insured for any damages to the property and reduce potential occupational hazard
- Have previous experience installing living walls; high degree of familiarity with system

Record keeping
- Crucial for green wall contractors to track costs/determine billing
- Organized and concise records for determining the cost per square foot

Technology
- Emerging technology includes automatic drain valves, moisture and nutrient sensors, remote monitoring
- Technology to combat winter conditions i.e. freeze sensors, radiant heat mats, polycarbonate panel covers and polyethylene row crop covers for insulation and wind protection
- Wind screen covers can be placed over exterior green walls to prevent wind damage

Maintenance, plant replacement costs
- Aggregate of labor, material, equipment and consultant costs, i.e. skilled labor vs degreeed horticulturist, percent of total plants and/or growing media to be replenished annually, equipment purchased/leased/rented, professionals consulted, etc.

V. Team and Client Expectations
- Initial consultation to outline clients design goals and commitment
- Living wall design & installation team works to meet goals and exceed client expectations

Your partners in Green!
Presenters

McRae Anderson, ASLA
McRae Anderson, ASLA, CLP is President of Greenwalls Modular Planting Systems and Principal Designer of McCaren Designs, which he founded in 1977. McRae has been an industry leader in design and development of unique indoor plant systems and displays. He is immediate past-president of the Green Plants for Green Buildings and a member of the American Society of Landscape Architects. He is an active member of the National Interiorscape Network, Plantscape Industry Alliance, ASLA, OFA, BOMA and IFMA.

Scott Mehaffey, FASLA
Sage Vertical Garden Systems, Chicago, IL  [http://www.sageverticalgardens.com](http://www.sageverticalgardens.com)
Scott Mehaffey serves as Executive Vice-President of Sage Vertical Garden Systems, overseeing project development and operations for this Chicago-based manufacturer of hydroponic vertical garden systems. Formerly Landscape Coordinator for the City of Chicago, Scott is a recognized leader in green infrastructure solutions for 21st century urban challenges.

Kathryn O'Donnell, GPGB trainer
Botanicus Interior Landscaping, Tonawanda, NY  [http://www.botanicus.com](http://www.botanicus.com)
O'Donnell received the Top Platinum Award from Plant Industry Alliance for presenting the most CEU's on Living Walls & Green Roofs in 2013. O'Donnell's extensive experience in horticulture and aquaculture provides an excellent background to lead the new trend for Vertical Living Walls. Past officer of Green Plants for Green Buildings, active member of National Interiorscape Network, Center for Entrepreneurial Leadership, Toastmaster International, National Association of Women Business Owners.

Resources:
Green Plants for Green Buildings - communicating the aesthetic, environmental, productivity and health benefits of plants in the built environment. www.greenplantsforgreenbuildings.org

National Interiorscape Network is an international alliance of elite companies who have united to set the standard for ethics, integrity, and premier service in the interior landscaping industry. www.interiorscapenetwork.com

Green Roofs for Healthy Cities is a non-profit working to promote industry growth of green roofs, walls and living architecture through education, advocacy and professional development. www.greenroofs.org

Suppliers and Manufacturers:

- AgroSci www.agrosci.com
- Bright Green www.brightgreenusa.com
- Eco Walls www.greenecowalls.com
- Filtrexx www.filtrexx.com/livingwalls
- Green Over Gray www.greenovergrey.com
- Green Screen www.greenscreen.com
- Green Walls www.greenwalls.com
- G-Sky www.gsky.com
- Grey to Green www.greytogreenconference.org
- Live Wall www.livewall.com
- Living Wall System www.livingwallsystem.com
- Mark Laurence Design www.marklaurence.com
- Nedlaw Living Walls www.nedlawlivingwalls.com
- Patrick Blanc verticalgardenpatrickblanc.com
- Plant Connection www.myplantconnection.com
- Plants on Walls www.plantsonwalls.com
- Sage Vertical Garden Systems
- Seasons Natural Engineering
- Semper Green www.sempergreen.com
- The Living Wall Company
- Wall of Life Bill Lyon www.thewaterboy.net
- Woolly Pocket www.woollypocket.com

Interesting Links

How 'vegitecture' and green infrastructure are saving our cities, one rooftop and wall at a time

Living walls could replace concrete sound barriers along Edmonton roads
http://www.edmontonjournal.com/Living+walls+could+replace+concrete+sound+barriers+along+Edmonton+roads/10336366/story.html

Who doesn't love a living wall?
http://wgsoffice.com/who-doesnt-love-a-living-wall/

6 Amazing Living Walls Redefining “Greenspace” in Portland

Wonder wall: a vertical city garden

Changes in office design are clear

Patrick Blanc Paris April 2013  L’Oasis d’Aboukir
http://wallplay.com/vive-lagreen-wall/

North America’s Largest Living Wall by Green Over Grey