10 PRINCIPLES OF FUTURE-PROOFING

…and the story of the Arctic Building Walrus Heads

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Figure 0: Brick and mortar deterioration at an exterior site wall. Credit: Brian Rich, 2013

Our Objectives

- To learn the Principles of Future-Proofing
- To broaden our understanding of resilience
- To recognize the inherent sustainability of rehabilitating historic structures

The Problem

Figure 1: Spalled stone due to rust jacking at a railing. Credit: Brian Rich, 2013

Figure 2: Brick spalling due to mortar installed that was harder than the brick. Credit: Brian Rich, 2013

- Mild steel pins used to anchor stone balustrades and railings rust and expand ("rust jacking"), splitting the stone and causing irreparable damage
- When re-pointing a masonry wall, using mortar that is harder than the brick traps moisture in the brick. Freeze-thaw cycles cause the brick to spall.
- Mortar is intended to be sacrificial – not the brick

The Problem

Figure 3: Deteriorating brick, mortar and plaster at the barracks at La Citadelle de Quebec. Credit: Brian Rich, 2014

Figure 4: Mold caused by too much water vapor trapped within a building. Credit: http://media.kmvt.com/images/MOLD1.jpg_BIM.jpg

- Constant exposure to water and extreme freeze thaw cycles for decades is harsh on brick, mortar, and plaster – no matter how hard it is!

- When designed and built to prevent air infiltration, trapped water vapor can cause Sick Building Syndrome, including severe mold attack

Figure 5: Rotted wood due to improperly installed membrane or siding. Credit: http://www.moldknowledge.com/dry%20rot%20photo%206.JPG

Figure 6: Sandblasted brick removes the fire skin from the brick. Credit: http://www.permies.com

The Problem

- Incorrectly installed siding and weather barriers allow water penetration and lead to structural deterioration.

- Sandblasting and power washing brick removes the protective fire skin from its surface making it more vulnerable to deterioration

The Problem

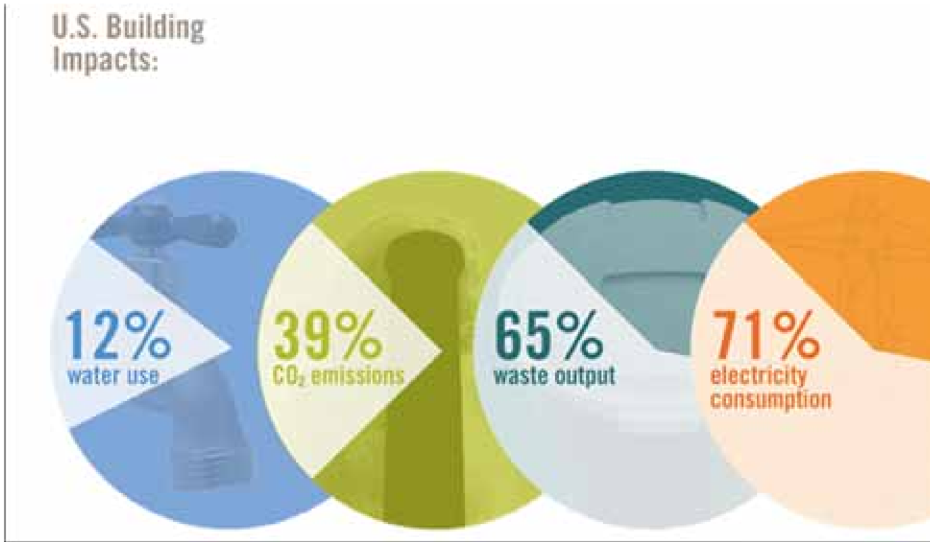

Figure 7: Environmental impacts of buildings on the environment. (Western Village)

This study finds that it takes between 10 to 80 years for a new building that is 30 percent more efficient than an average-performing existing building to overcome, through efficient operations, the negative climate change impacts related to the construction process. This table illustrates the numbers of years required for new, energy efficient new buildings to overcome impacts.

Building Type	Chicago	Portland
Urban Village Mixed Use	42 years	80 years
Single-Family Residential	38 years	50 years
Commercial Office	25 years	42 years
Warehouse-to-Office Conversion	12 years	19 years
Multifamily Residential	16 years	20 years
Elementary School	10 years	16 years
Warehouse-to-Residential Conversion*	Never	Never

Figure 8: Years Of Carbon Equivalency For Existing Building Reuse Versus New Construction. (Frey)

- Existing Building stock = most valuable human asset
- Buildings consume vast amounts of earth's resources
- New construction is worse for the environment than adaptive re-use, renovation, or preservation of existing buildings

Future-Proof – The Concept

Figure 9: The Belvedere Castle by Calvert Vaux, 1869. Central Park, New York City, NY. Credit: Brian Rich, 2013

Future-proofing: The process of anticipating the future and developing methods of minimizing the negative effects while taking advantage of the positive effects of shocks and stresses due to future events .

Related Industries

Figure 10: SERCOS – a future-proof standard: Broader, deeper, more universal. Credit: http://www.boschrexroth.com

Electronics:

- “flexible distribution systems”
- Telecommunications: system designers focus heavily on the ability of a system to be reused and to be flexible
- Teleradiology: open modular architecture and interoperability

Industrial Design:

- In industrial design, future-proofing designs seek to prevent obsolescence by analyzing the decrease in desirability of products.
- characteristics of future-proof products include: a timeless nature, high durability, aesthetic appearances that capture and hold the interest of buyers

Related Industries

Figure 11: Climate change will have significant impacts on our planet.
Credit: www.jordanmallen.com

Climate Change:

- ability to withstand impacts from future shortages in energy and resources, increasing world population, and environmental issues
- ability to resist the impact of potential climate change due to global warming
- flexibility and adaptability of structures… …may defer the obsolescence and consequent need for demolition and replacement

Figure 12: Lewis & Clark High School in Spokane, WA, received a major renovation several years ago. Credit: Brian Rich, 2012.

Related Industries

Sustainable Preservation:

- Jean Caroon states that “there’s no way to make a building that doesn’t have an environmental impact,” but that “you can lessen the environmental impact by taking existing objects and extending their service life”

2005 APT Halifax Symposium:

- understanding the importance of stewardship and planning for the future
- building to last, including material selection and treatment, craft, and traditional building techniques
- durability and service life of materials and assemblies and their implications for lifecycle assessment
- understanding extending buildings’ service lives and systems renewal

Related Industries

Figure 13: Steam Plant Square in Spokane, WA, is an excellent example of a place that has found a loose fit strategy. Credit: Spokane Steam Plant.

Sustainable Preservation:

- May Cassar, for example, suggests interest in sustainable rating systems if durability is incorporated as a metric for evaluating buildings. Cassar also argues that historic buildings must fully engage in the process of "adaptation to climate change," lest they become redundant and succumb to "environmental obsolescence"
- Cassar: "'long life, loose fit' strategy to managing historic buildings"
- The hygrothermal performance of the original building materials at the Hudson Bay Department Store in Victoria, British Columbia, was carefully analyzed to ensure that improvements would not reduce the "building's time-proven durability"

Related Industries

Figure 14: The collapsed I-5 bridge at the Skagit River was “functionally obsolete.” Credit: http://en.wikipedia.org/wiki/File:05-23-13_Skagit_Bridge_Collapse.jpg

Real Estate - Obsolescence:

- Physical
- Functional
- Aesthetic
- Sustainable?

Low energy consuming dwellings reduce the likelihood of a prematurely obsolete building design.

Utility Systems:

Forward planning for future development and increased demands on resources

Figure 15: Hanford High School was built for the contractors who built the reactor – and then abandoned. Credit; Brian Rich, 2012

A/E/C Industry

The Resilient Design Institute (2013) offers a broad definition of resiliency:

- Resilience transcends scales.
- Resilient systems provide for basic human needs.
- Diverse and redundant systems are inherently more resilient.
- Simple, passive, and flexible systems are more resilient.
- Durability strengthens resilience.
- Locally available, renewable, or reclaimed resources are more resilient.
- Resilience anticipates interruptions and a dynamic future.
- Find and promote resilience in nature.
- Social equity and community contribute to resilience.
- Resilience is not absolute.

Figure 16: the resilient culture of South East Asia: Rain inundates the area and it is used to their benefit. Credit: http://blog.cifor.org

A/E/C Industry

MAFF laboratories at York, England were described in an article as "future-proof" by being flexible enough to adapt to developing rather than static scientific research

According to Applegath et al., a *resilient* built environment includes:

- Local materials, parts and labor
- Low energy input
- High capacity for future flexibility and adaptability of use
- High durability and redundancy of building systems
- Environmentally responsive design
- Sensitivity and responsiveness to changes in constituent parts and environment
- High level of diversity in component systems and features

Figure 17: Place Royale, where Samuel De Champlain founded his "abitation" in 1608, Quebec. Credit: Brian Rich, 2014

A/E/C Industry

In urban design, resilience:

- Includes an integrated multidisciplinary combination of mitigation and adaptation
- Is less dependent on an exact understanding of the future than on tolerance of uncertainty and broad programs to absorb the stresses
- keeps many options open, emphasize diversity in the environment, and perform long-range planning that accounts for external systemic shocks
- events are viewed as regional stresses rather than local

Preservation & Conservation

Figure 18: Saint Coeur de Marie Church in Quebec City, 1919, built by the Eudists is now a used bookstore. Credit: Brian Rich, 2014.

The concepts of future-proofing are present in preservation philosophy:

- Georg Morsch: “first, that historical evidence and vestiges must be decipherable; and, second, that evidence and vestiges must be decipherable by a broad public which requests flexible approaches on certain conservation concepts”
- James Marston Fitch argues that the “reworking of extant structures to adapt them to new uses is as old as civilization itself ” and has significant lifecycle benefits as the “characteristic mode of energy conservation”

Figure 19: A steam vessel at the Steam Plant Square, Spokane, WA with a patina documenting its passage through time. Credit: Brain Rich, 2012.

Preservation & Conservation

The concepts of future-proofing are present in conservation philosophy:

- Feilden also advocates rehabilitation by keeping buildings "in use - a practice which may involve what the French call *'mise en valeur,'* or modernization with or without adaptive alteration"
- Brandi goes on to say that while "patina documents the passage through time of the work of art and thus needs to be preserved," the patina should be an "imperceptible muting" of the original materials and must be brought into equilibrium with the original materials
- Appelbaum: "Treatments that improve aesthetics, usability, or lifespan of an object all increase its utility"

Figure 20: The historic Brooklyn Bridge in New York. Credit: Brian Rich, 2013

Historic Structures

Careful consideration of how interventions affect historic buildings - do no harm to the historic fabric

Historic buildings are particularly good candidates for future-proofing due to high durability: 50 to 100 year life prior to renovation is typical

On going use of historic buildings has a high degree of sustainability:

- reduces energy consumption
- decreases material waste
- retains embodied energy
- promotes a long term relationship with our built environment

10 Principles of Future-Proofing Historic Buildings

Figure 21: The sarsen trilithons of Stonehenge (ca. 2500 BC): A Future-Proof structure? Credit: http://hdw.eweb4.com

1. Prevent decay.
2. Promote understanding.
3. Stimulate flexibility and adaptability through diversity.
4. Extend service life.
5. Fortify!
6. Increase durability and redundancy.
7. Reduce obsolescence.
8. Consider lifecycle benefits.
9. Be local and healthy.
10. Take advantage of cultural heritage policy documents.

Figure 22 & 23: Exterior and Interior of the Lakota Middle School Gym, Federal Way, WA. Credit: Brian Rich, 2013

Principle 8: Consider LCA

Project concept is to compare 4 gyms of different design for 200 year life spans to attempt to answer these questions:

1. Propose the concept of "First Impacts"
2. Compare environmental impacts of wood and more durable building materials
3. Compare impacts of biogenic carbon in long service life structures
4. Do buildings considered to be more durable have lower long term environmental impacts?
5. What does this suggest for the existing built environment and historic buildings in particular?

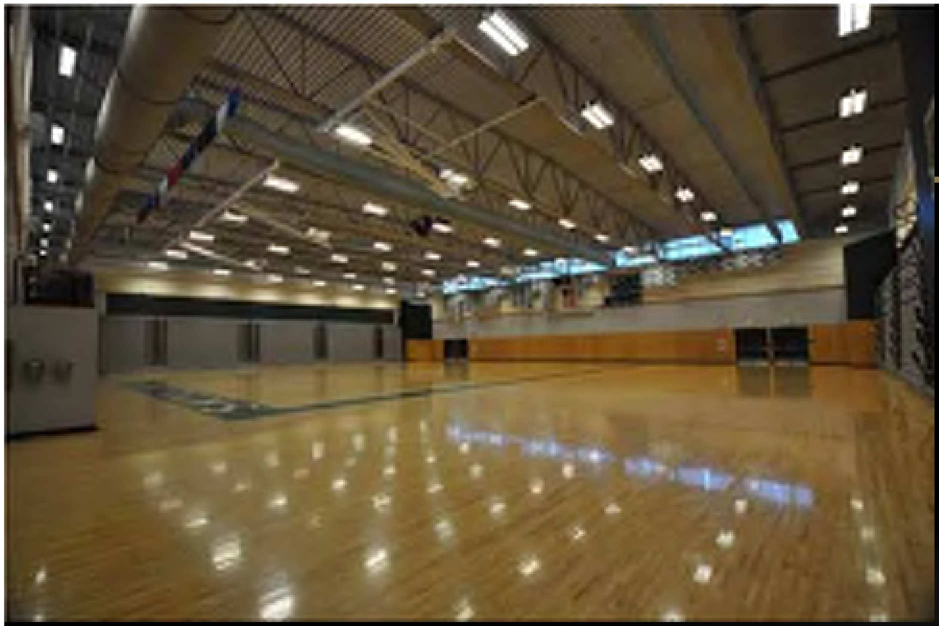

Figure 24: Skyline High School Gym, 2013. Credit: Brian Rich, 2013

Figure 25: Elon University Gym, 1950. Credit: http://www.elon.edu

LCA Methodology

1. Athena Impact Estimator 4.2 and 4.5
   1. Gym A, B, C, D modeled in 4.5
   2. Gym A1 modeled in 4.2 to eliminate biogenic carbon credits
   3. Buildings modeled for estimated service lives
2. Declared Unit
   1. (1) 12,150 SF MS Gym
   2. Not functionally equivalent due to maintenance and replacement of materials.
3. Allocations
   1. Default allocations from Athena accepted
   2. Note steel recycling and biogenic carbon in wood
4. Excel Spreadsheets
   1. Calculate cumulative impacts over 200 years in 10 year increments
   2. Graphs and bar charts developed in Excel

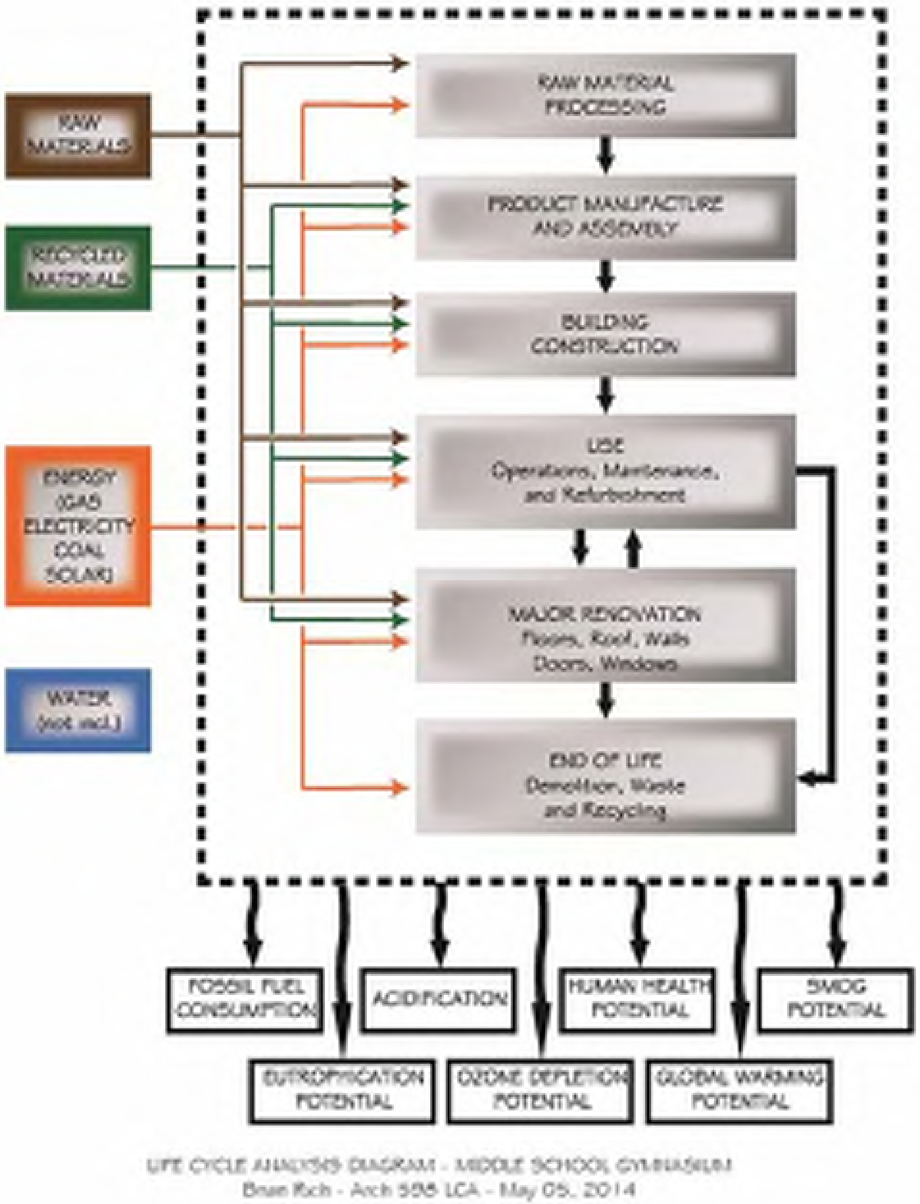

Figure 26: Life Cycle Analysis System Diagram. Credit: Brian Rich, 2014

LCA System Diagram

1. The LCA system diagram illustrates the default processes that are included by Athena in this analysis.
2. Water use is not included
3. Impacts are measures in summary impacts rather than raw data.

LCA Analysis: 4 Scenarios + 4 Gyms

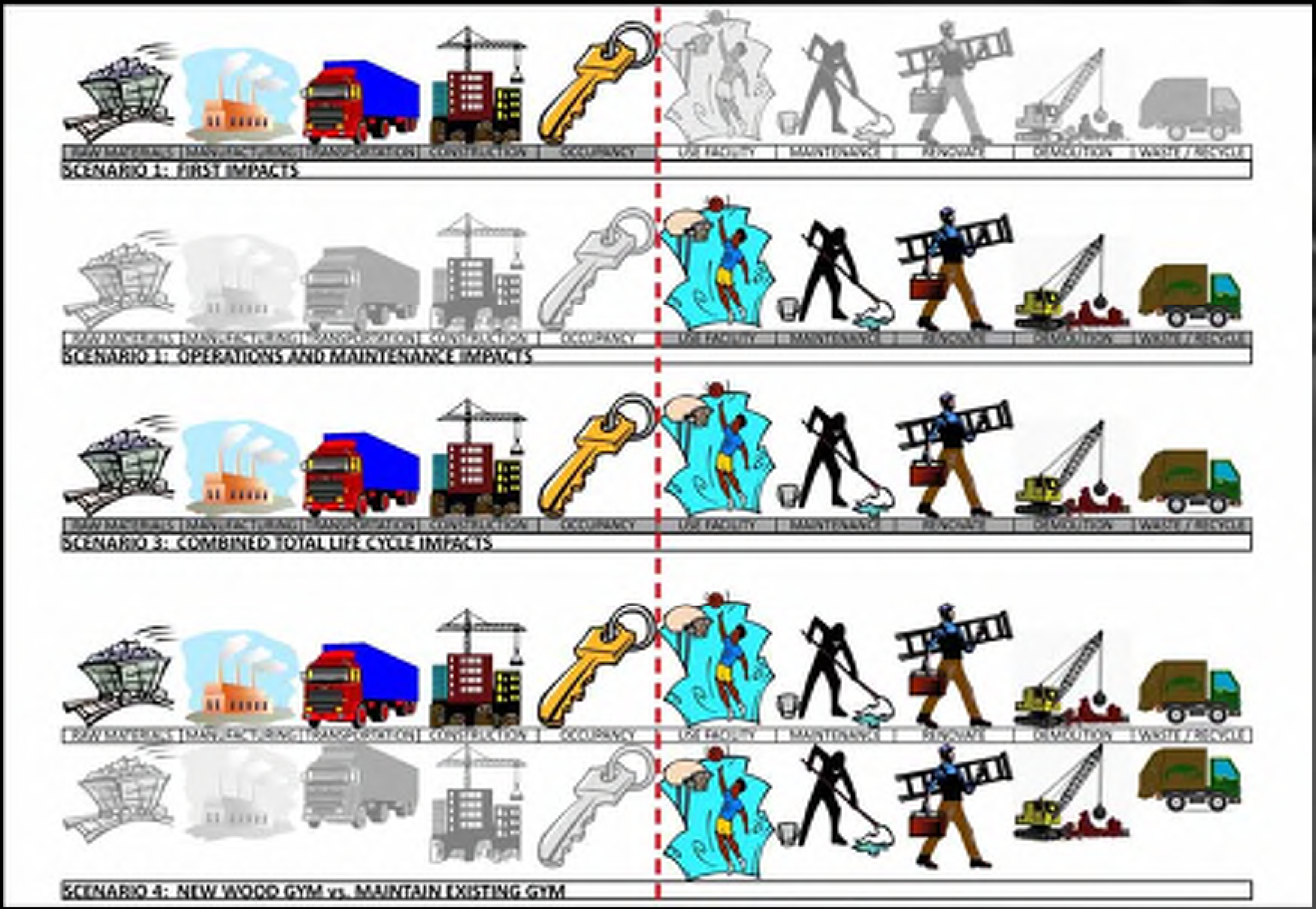

Figure 27: Diagram of the 4 different life cycle scenarios calculated in this project. Credit: Brian Rich, 2014.

LCA Results – First Impacts

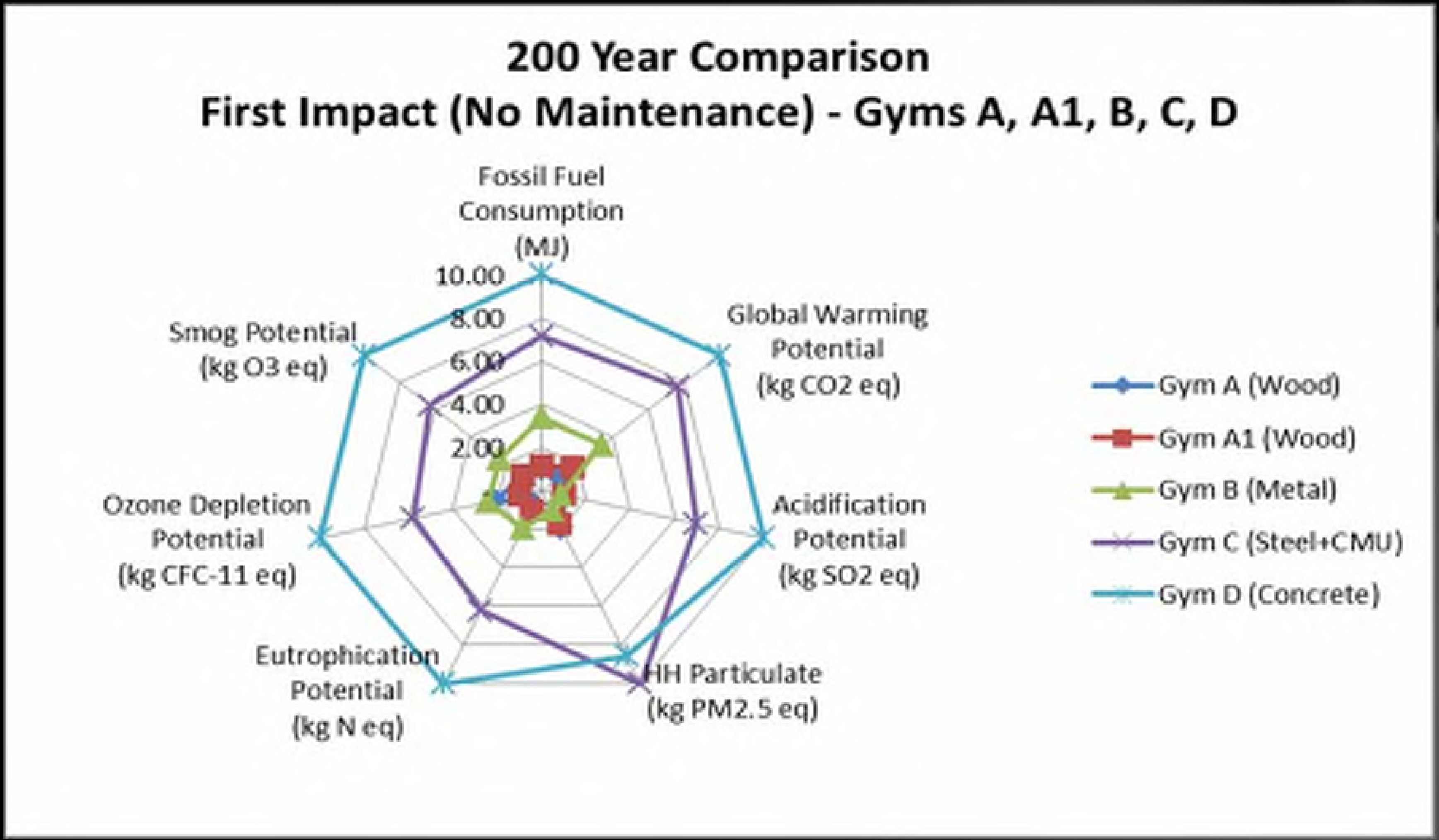

Figure 28: First Impact Comparison, normalized on a scale of 10. Note that the buildings involving masonry and concrete (Gym C and D) have the most significant first impacts and wood (A and A1) the least. Credit: Brian Rich, 2014.

LCA Results – Maintenance and Operations Impacts

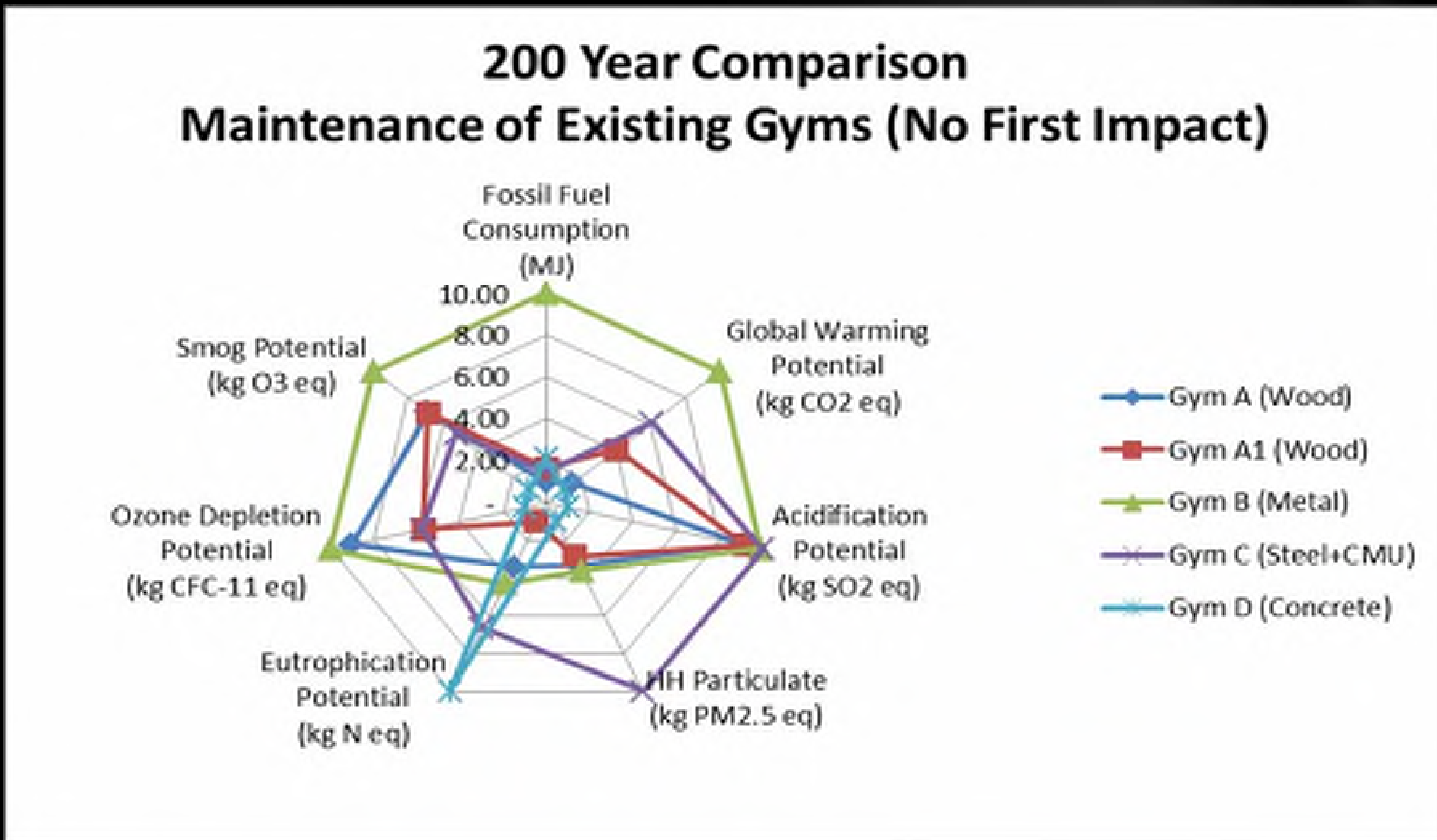

Figure 29: 200 year comparison of maintenance requirements, not including first impacts, normalized on a scale of 10. Note that the Gym D has the least maintenance impact in most categories and Gym B has the largest impacts in most categories. Credit: Brian Rich, 2014.

LCA Results – Total Life Cycle Impacts

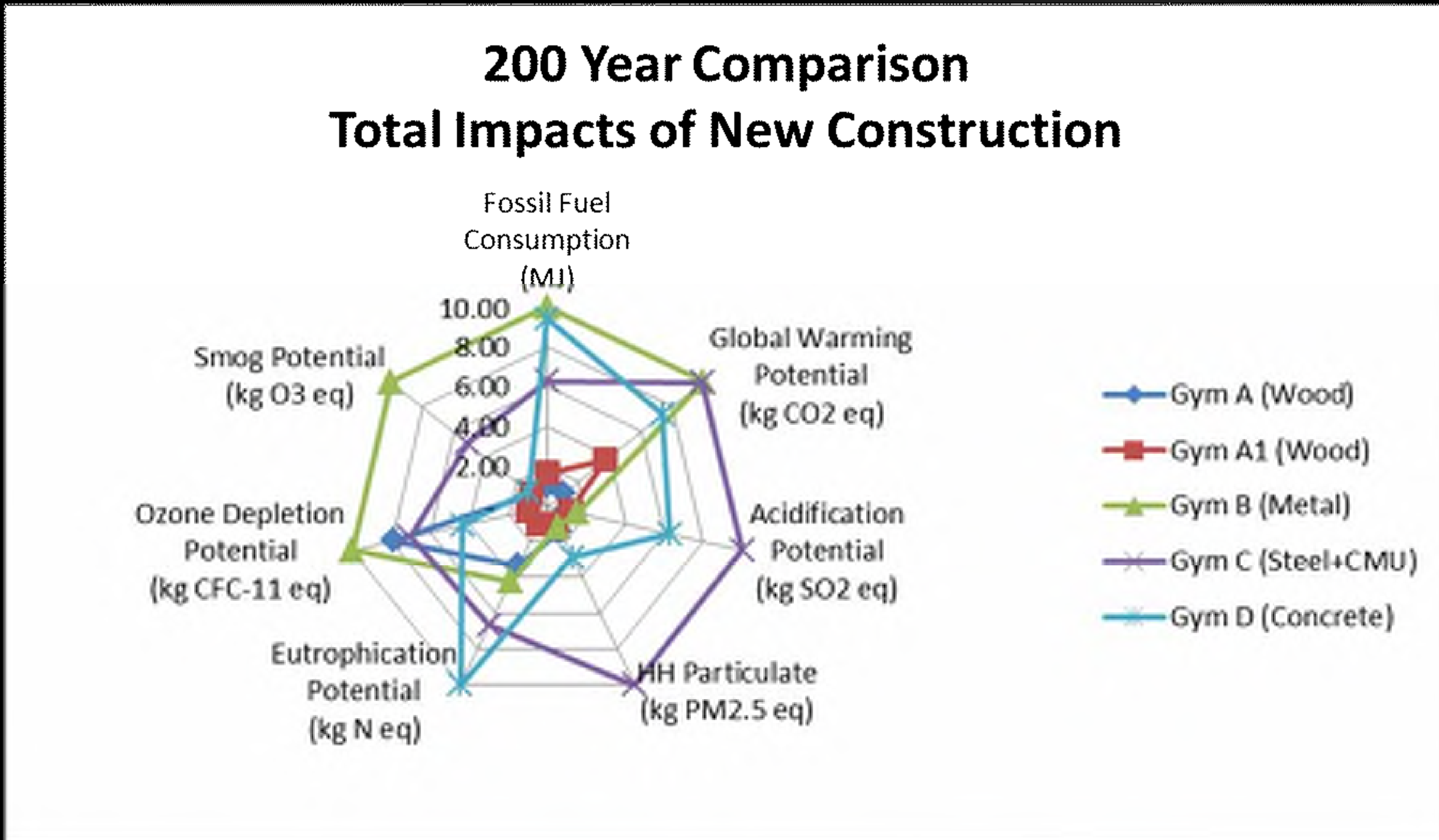

Figure 30: 200 year comparison of total environmental impacts including first impacts and maintenance, normalized on a scale of 10. Gym B and C typically have the largest impacts while Gym D has mixed total impacts and Gym A and A1 the least total impacts. Credit: Brian Rich, 2014.

LCA Results – New Gym A vs. Existing Gym B, C, and D

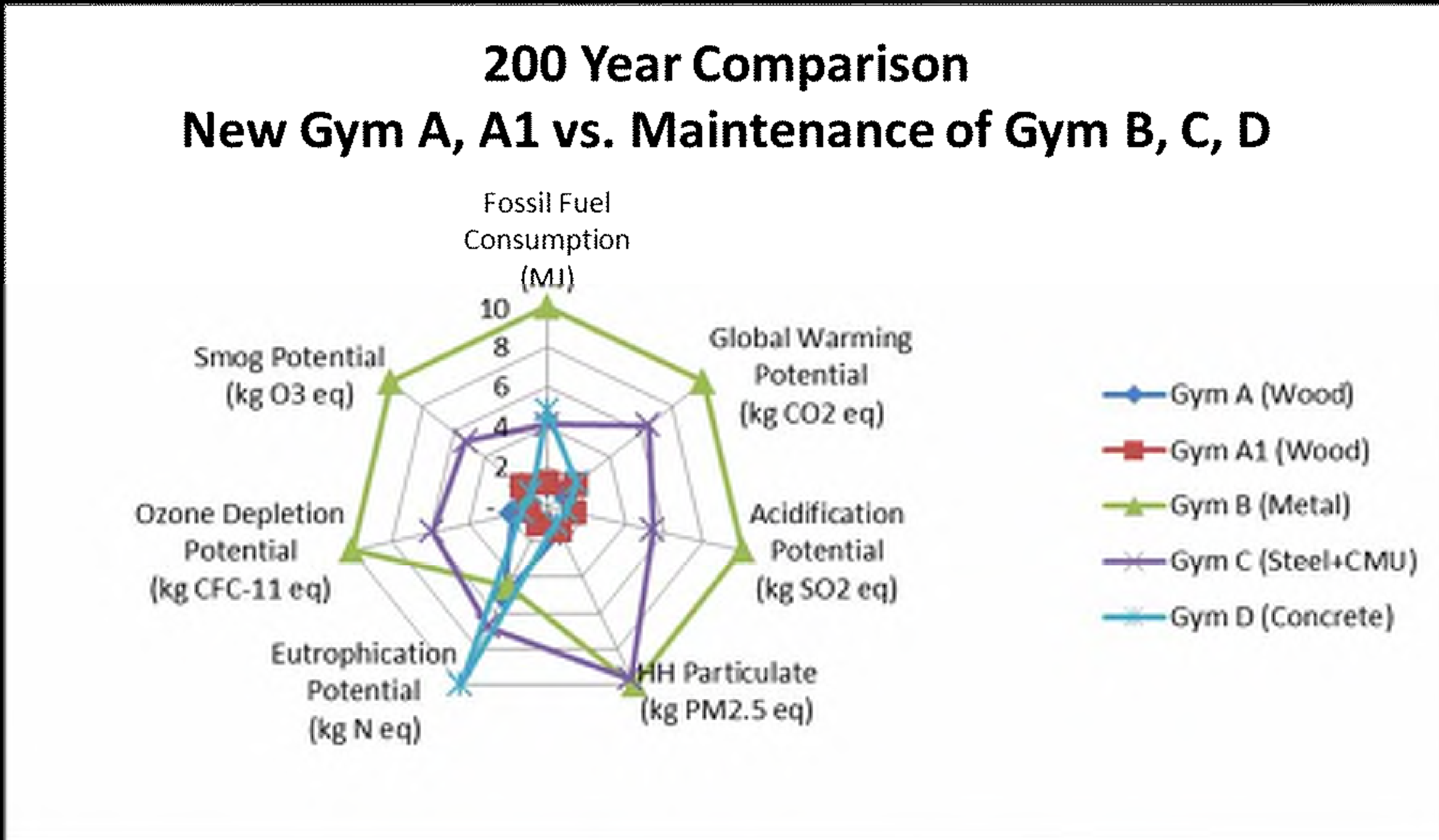

Figure 31: 200 year comparison of total environmental impacts, normalized on a scale of 10. This answers the question: If I am considering a new Gym, should I build a new wood gym or continue to maintain my existing concrete or masonry one? Note that there are many respects in which Gym A and A1 have lower impacts, Gym D has moderate impacts, and Gym B and C have the largest impacts. Credit: Brian Rich, 2014.

LCA Conclusions & Additional Observations

1. The concept of "First Impacts" is introduced in this Life Cycle Analysis
2. Wood structures appear to have the lowest short term and long term environmental impacts, regardless of how biogenic carbon is accounted for
3. More durable CMU, structural steel, concrete, and brick materials pay off when ongoing maintenance is compared to wood structure replacements.
4. Biogenic carbon only affects Global Warming Potential and is eventually released (and thus non-beneficial) if the service life under consideration is approximately 200 years. Biogenic carbon sequestering is a good short term CO2 reduction strategy – if more trees are planted.

Additional Observations:

1. Durability of all components of a building system should have equivalent service lives or allow for disassembly in order to maintain the shorter service life materials.
2. Proper maintenance of a building is critical to long term service life. Maintenance prevents deterioration of less durable materials and can significantly affect the service life of a building.
3. Historic buildings have value that go beyond the environmental impacts of their materials and construction. Historic buildings have social, cultural, economic, and aesthetic value, beyond the environmental impacts. Historic buildings form the core identity of many places and provide stability and increased personal and community resilience because of the way people identify with their "homes."

Figure 32: A typical Hmong house-building technique in the tropical climate of Vietnam. Credit: http://en.wikipedia.org/wiki/Rammed_earth

Traditional Building Methods & Materials (TBM&M)

- Rammed Earth
- Bamboo
- Mud Brick
- Straw Bale
- Adobe
- Thatch
- Reeds
- Wood
- Stone

- Steel?
- Concrete?

TBM&M: Questions

Figure 33: The Belvedere Castle by Calvert Vaux, 1869. Central Park, New York City, NY. Credit: Brian Rich, 2013

When is a material or building method considered “traditional”? How long does it have to be used?

Carved Stone has been used for centuries in Europe and even the US. Is it a “traditional building material”?

Does a building material have to be “traditional” to be Future-Proof?

TBM&M: Questions

What part of a system has to be ‘future-proof”? The stone façade looks to be in pretty good shape and is keeping weather out… …but the details of the stone are deteriorating. Is this “future-proof”?

Figure 34: Philopatrian Literary Institute @ 1923 Walnut Street, Philadelphia, PA.   Credit: Brian Rich, 2013

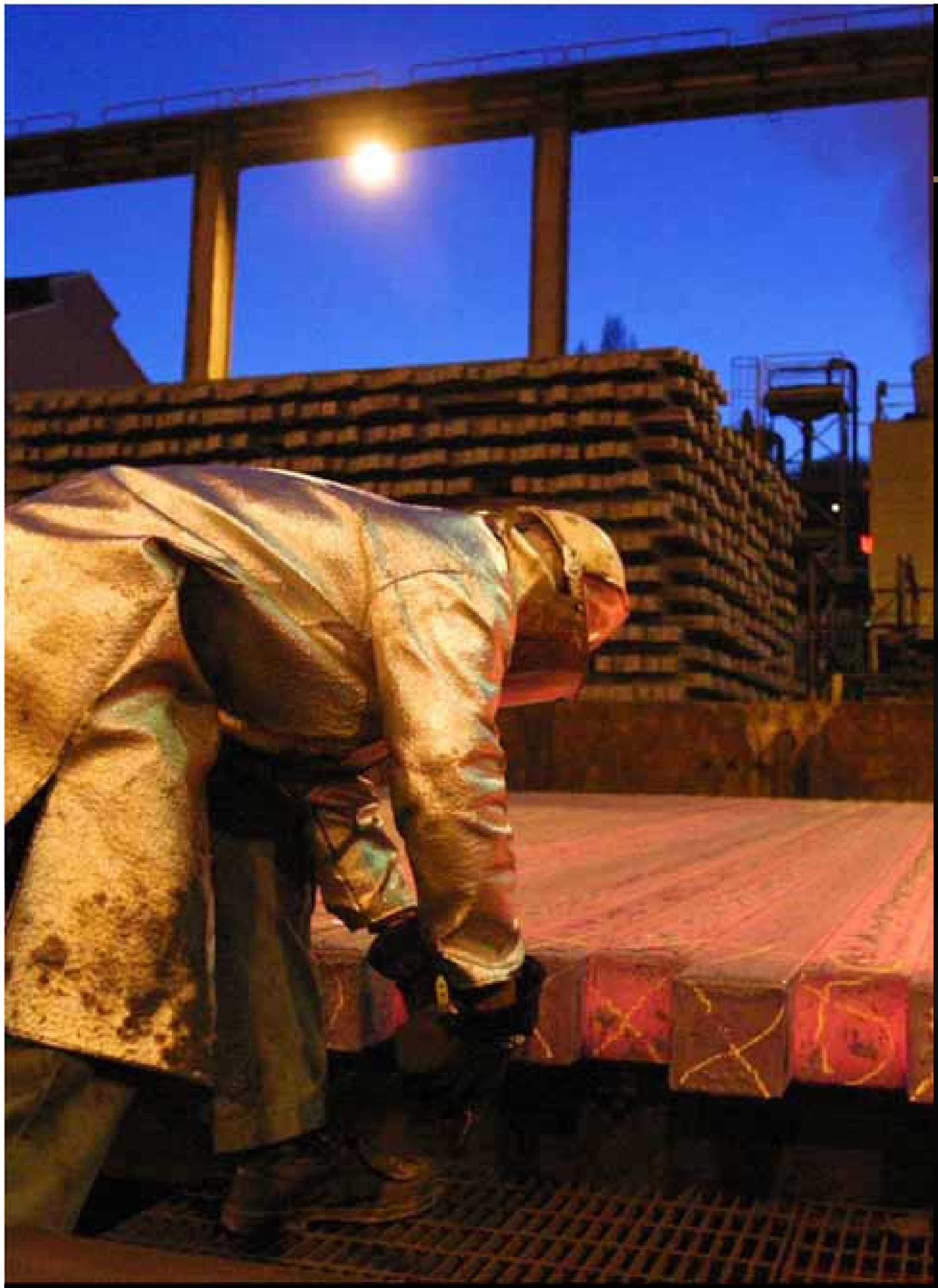

Figure 35: Steel ingots at Nucor Seattle. Credit: http://www.seattleindustry.org/images/SP_08_ExportSurge/SP08Nucor.jpg

TBM&M: Questions

Industrialized regions:

Are materials manufactured in industrialized regions of the world “Future-Proof”?

What part of the manufacture of a industrialized material has to be local to qualify to be “Future-Proof”?

Figure 36: Soe Ker Tie House, Noh Bo, Tak, Thailand. Credit: Photo: Pasi Aalto / Tyin Tegnestue

TBM&M: Findings

Research Findings:

- Service life of TBM&M varies, but can usually be extended easily through maintenance and repairs when used in appropriate climates and designs
- Less technologically dependent materials are often more future-proof
- Future-proof building methods are not necessarily low cost when they are employed in developed regions
- Hybrid building systems take the best of both TBM&M and industrialized materials
- Environmentally responsive building design is critical to making TBM&M work in each region
- Intent of future-proofing is not to prevent use of manufactured materials

TBM&M: Findings

Research Findings:

- TBM&M in industrialized regions is viable
- Use of TBM&M in industrialized regions is heavily affected by real estate economics (highest and best use)
- TBM&M is not possible in some areas where highest and best use results in extremely dense development (i.e., Manhattan)
- TBM&M may be contrary to sustainable goals of preventing urban sprawl (i.e., Mexico City)
- Building codes are significant factor in the viability of TBM&M as future-proof building systems – codes still being developed and adopted.

Figure 38: Crosswaters Ecolodge, reflection pool, and bamboo bridge.
Credit: http://www.edsaplan.com/en/node/651

TBM&M: Findings

Research Findings: Are locally manufactured materials future-proof?

- Recommend that entire manufacturing process be completed locally
- Local expertise in installation and repair of materials is required
- Locally manufactured highly durable materials may be considered future-proof despite manufacturing process – long term life cycle benefits
- Embodied energy and long term life cycle design may make highly durable manufactured products future-proof – trade off to replacement impacts (straw and rammed earth vs. steel)
- Future-proof materials should ideally be regionally appropriate

The Arctic Building

Figure 39: Aerial photo of the Arctic Building from the Southwest. Credit: City of Seattle Archives, SPU Fleets and Facilities Department "Imagebank" Collection. Item No: 120399

Figure 40: The Third Ave and Cherry Street corner of the Arctic Building. Credit: Brian Rich, 2013

- Designed and built in 1917
- Originally the home of the Arctic Club
- Finest example of a multi-colored matte glazed decorative terra-cotta building in the Northwest
- Original use as offices for the Club, leasable offices, private rooms, and flexibility for the tenants
- Adaptively used through the mid-20th century as offices for the City of Seattle
- Sold to the City of Seattle in 1988

The Arctic Building

The 2005 Renovation

- L-shaped Building with the lower floors covering the entire parcel
- Upper floors allow light into all of the rooms
- 9 stories tall, plus an added modern penthouse level

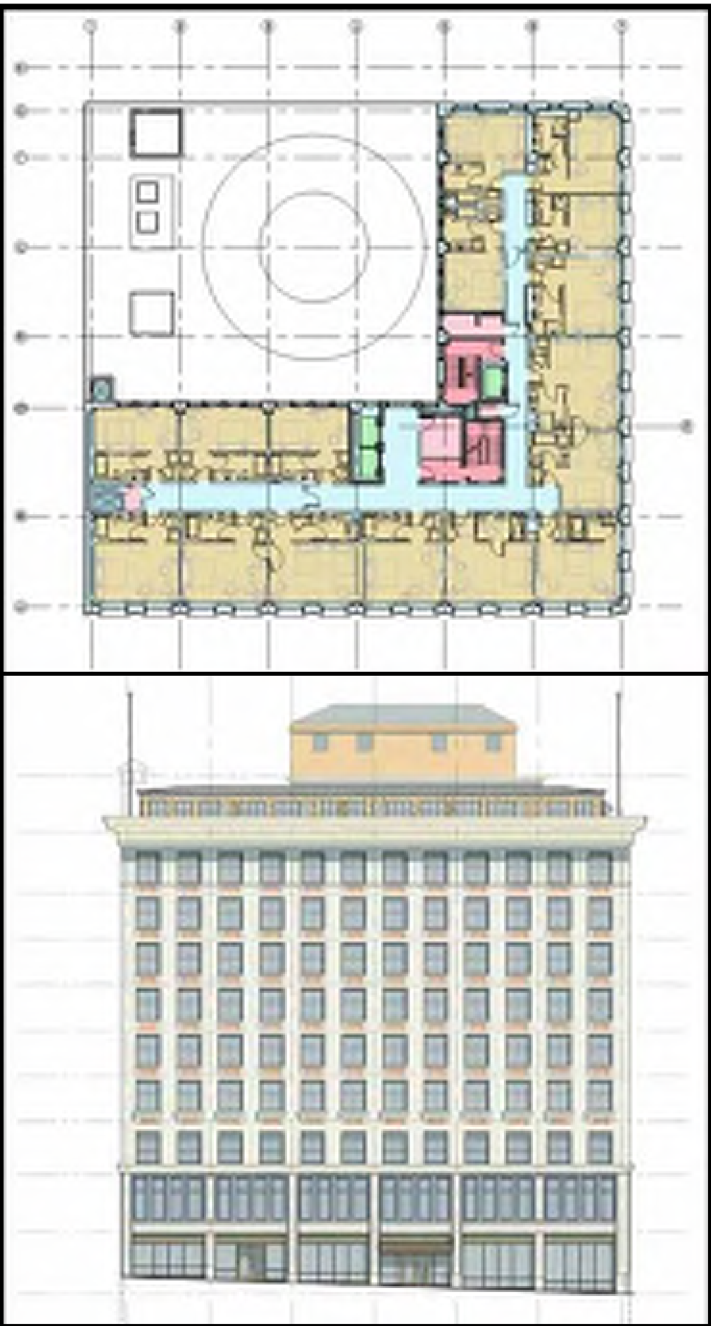

Figure 41 & 42: Typical upper floor plan and elevation for the hotel configuration of the Arctic Building. Credit: Weaver Architects, 2005.

The Arctic Building

Figure 43: 2005 Rehabilitation of the Arctic Hotel. Credit: Weaver Architects, 2005.

The 2005 Rehabilitation:

- Complete seismic retrofit
- Restoration of interior details and finishes
- Very little exterior work except anchoring of parapet
- Complete window replacement

Figure 44: The double walrus head at the corner of the Arctic Building, Seattle, WA. Credit: Brian Rich, 2013

The Arctic Building

- Walrus heads decorate the Third Floor frieze
- Walrus tusks held in place with mild steel reinforcement
- Corrosion of the steel led to failure of the tusks in the 1970's and early 1980's

The Arctic Building

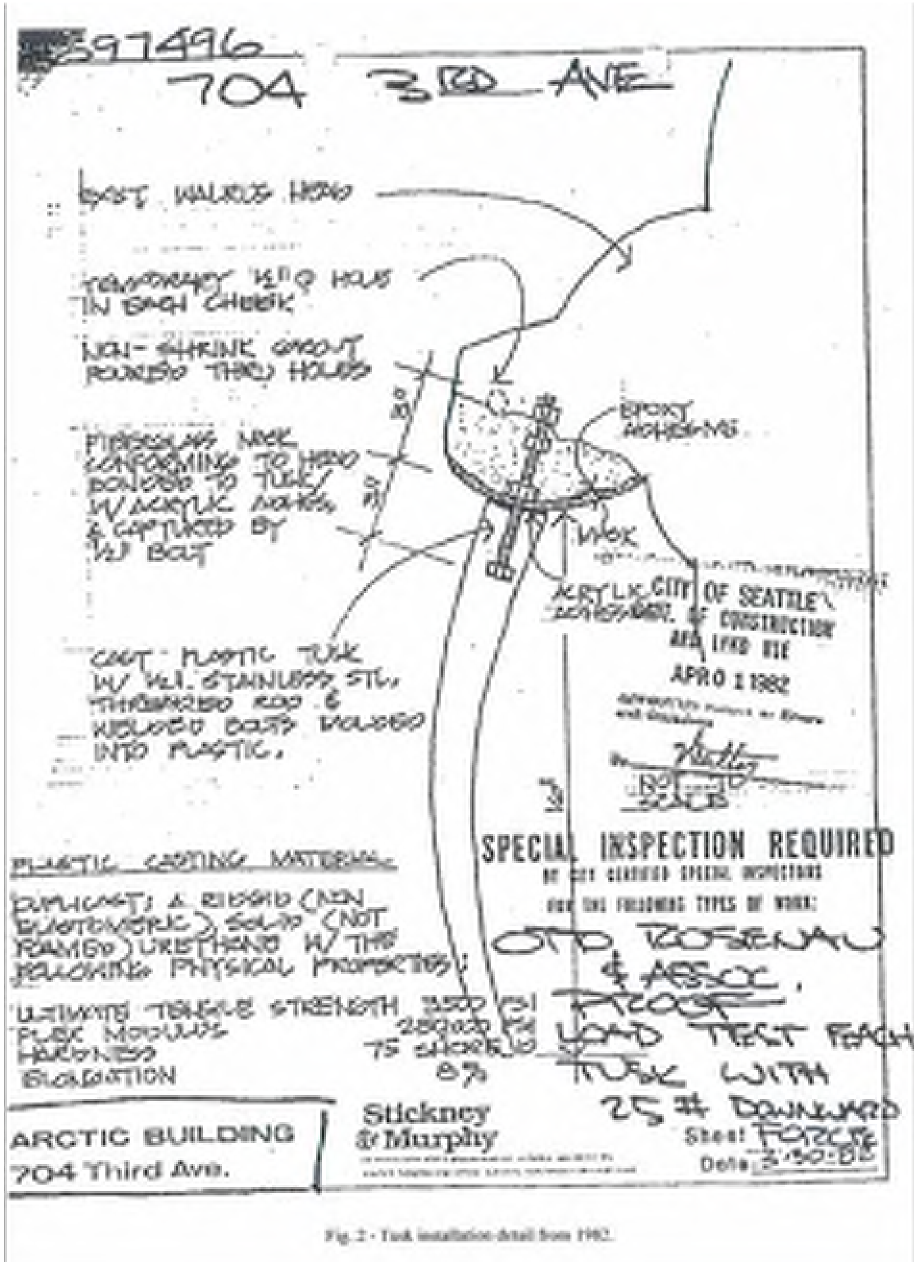

Figure 45: Repair detail for the walrus tusks at the Arctic Building. Image obtained from the files of the City of Seattle Landmarks. Original Detail by Stickney Murphy Architects.

- Initial 1982 repairs sought to replace all of the terra cotta tusks
- New tusks were anchored into place with stainless steel threaded rods and a gypsum/Portland cement grout mix that filled the cavities of the terra cotta walrus head
- Cracking appeared almost immediately….

The Arctic Building

- 1995 Condition Photos

Figure 46: 1995 photo of the deteriorated walrus head at the Arctic Building. Credit: Wiss, Janney, Elstner, 1995.

The Arctic Building

- 1995 Condition Photos

Figure 47: 1995 photo of the deteriorated walrus head at the Arctic Building. Credit: Wiss, Janney, Elstner, 1995.

The Arctic Building

- 1995 Condition Photos

Figure 48: 1995 photo of the deteriorated walrus head at the Arctic Building. Credit: Wiss, Janney, Elstner, 1995.

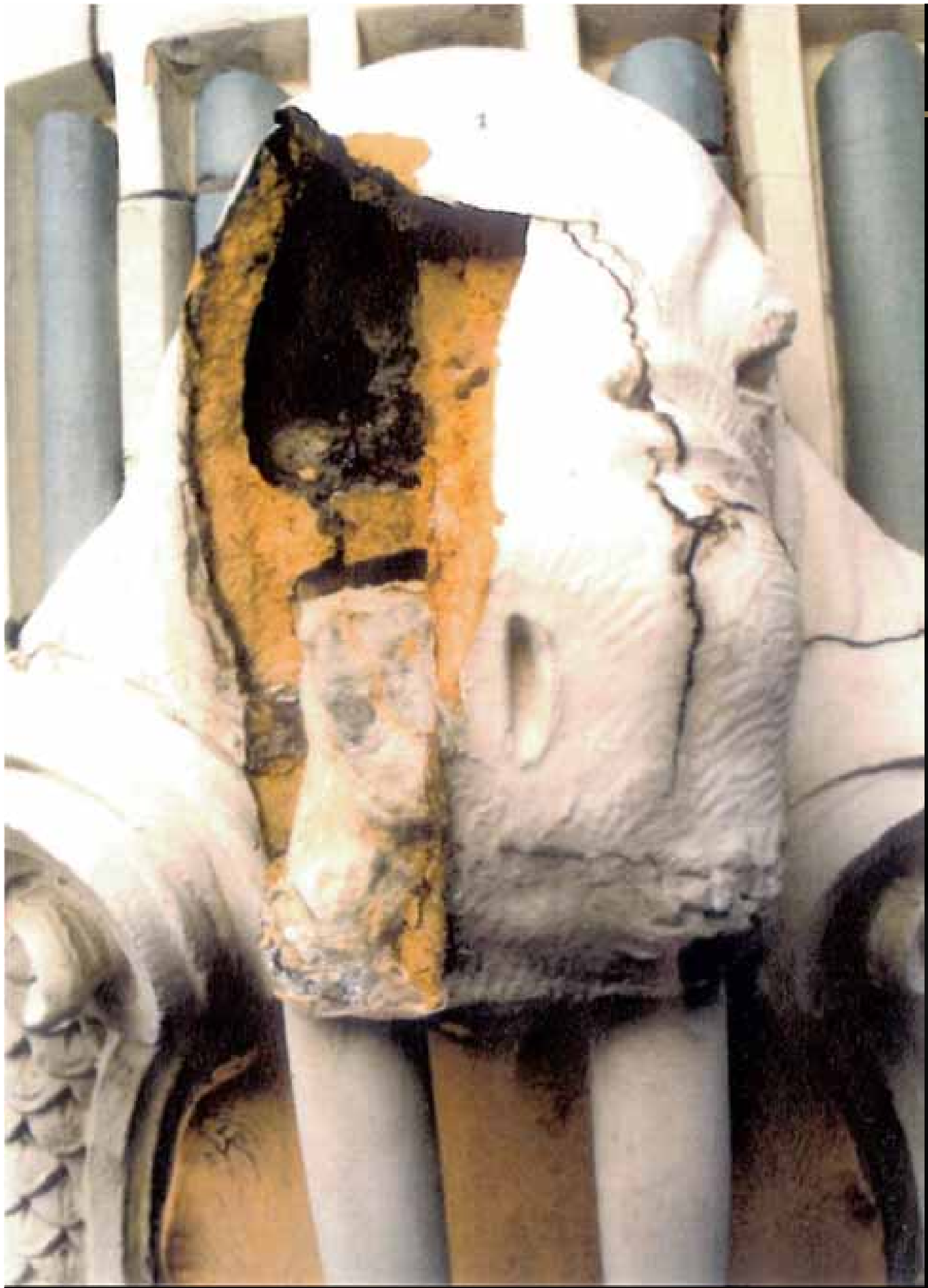

Figure 49: Fractured terra cotta walrus head. Note the degree to which the grout fills the terra cotta void. Credit: Wiss, Janney, Elstner, 1995

The Arctic Building

- A 1995 investigation found that the gypsum reacted to water penetration forming ettringite.
- Ettringite expanded uniformly and put pressure on the terra cotta.
- Flaws in the 1982 repair also included drilling the grout hole on top of the head rather than on the vertical face of the snout

The Arctic Building

Figure 50: New walrus head replacement pieces from Boston Valley terra Cotta. Credit: Boston Valley Terra Cotta, 1996.

- One Walrus head was patched together enough to send back to Boston Valley terra Cotta
- A new mold was carved for new walrus heads
- The new mold was enlarged by about 10% to account for shrinkage of the new pieces during firing
- New pieces were glazed to match the original heads

The Arctic Building

Figure 51: Installation of a replacement terra cotta head. Credit: Wiss, Janney, Elstner, 1995

- 15 of the 27 walrus heads were replicated and replaced
- 7 additional heads were anchored together using helical pins
- Terra cotta repairs were crucial to maintaining the building envelope and historic appeal of the building for future investors
- The building was eventually sold to private investors and converted to a boutique hotel

Figure 52: Cherry Street Entrance to the Arctic Hotel. Credit: Weaver Architects, 2005

The Arctic Building

Was the 1982 repair future-proof? No.

- Led to further damage to the building (Principle 1)
- Decreased the Service Life of the building (Principle 4)
- Decreased durability of the building (Principle 6)
- Increased physical and aesthetic obsolescence (Principle 7)

The Arctic Building

Figure 53: The lobby of the Arctic Hotel after the 2005 rehabilitation.
Credit: Weaver Architects, 2005.

Are the 1996 and 2005 rehabilitations future-proof?

- Yes!
- The rehabilitation, while undoubtedly doing demo damage, revived the use of the building (Principle 1)
- Sensitive rehabilitation acknowledges the historic fabric of the building (Principle 2)
- Adaptive re-use of the building from a club to offices to a hotel demonstrates adaptability and flexibility (Principle 3)

The Arctic Building

Figure 54: The Dome Room at the Arctic Hotel after the 2005 rehabilitation. Credit: Weaver Architects, 2005.

Are the 1996 and 2005 rehabilitations future-proof?

- The rehabilitation has extended the service life of a building in an area with high demand for density through height
- The structure has been fortified again seismic events and climate change with thermal envelope improvements
- The terra cotta rehabilitation has returned the natural durability of the terra cotta

The Arctic Building

Figure 55: The new bar and main waiting area at the Arctic Hotel after the 2005 Rehabilitation. Credit: Weaver Architects, 2005.

Are the 1996 and 2005 rehabilitations future-proof?

- Functional obsolescence has proven to not be a problem as evidenced by the multiple different uses the building has accommodated
- Physical and sustainable obsolescence were addressed in these rehabilitations

The Arctic Building

Figure 56: The Third Avenue Entrance to the Arctic Hotel after the 2005 rehabilitation. Credit: Weaver Architects, 2005.

Are the 1996 and 2005 rehabilitations future-proof?

- Life cycle benefits were realized through retention of the historic structure (Principle 8)
- Local labor was used for the project (Principle 9)
- The Secretary's Standards for rehabilitation were followed (Principle 10)

End

Thanks!