10 PRINCIPLES of FUTURE-PROOFING HISTORIC BUILDINGS

and
the Role of Computational Simulation Software in Future-Proofing

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The Problem

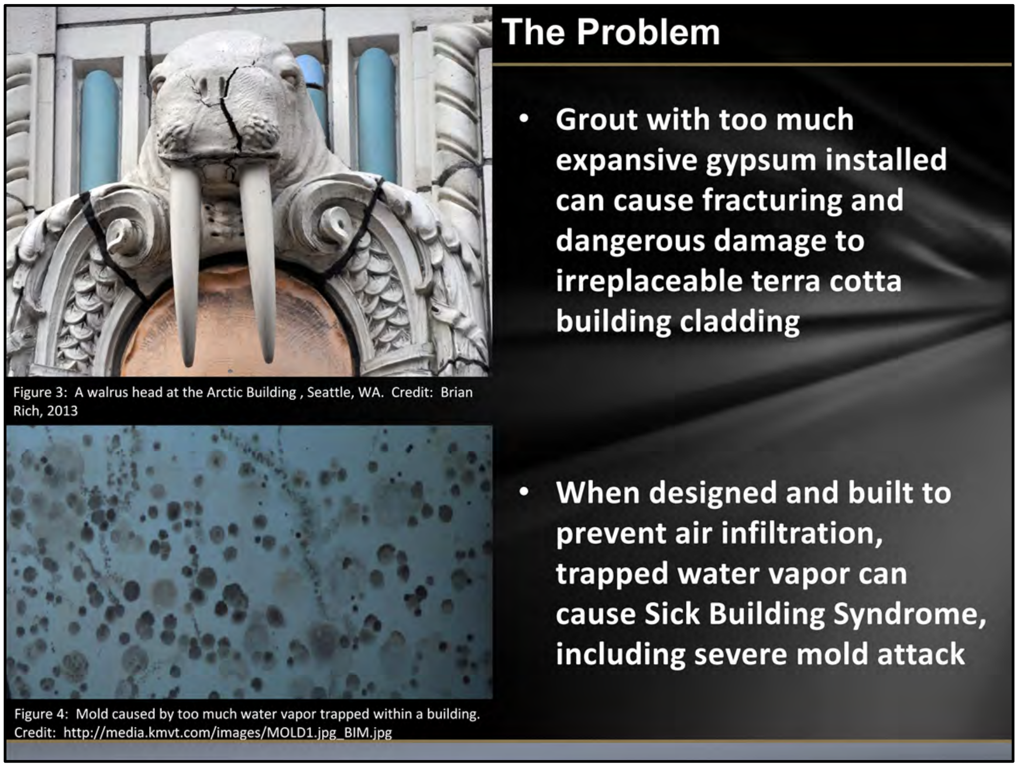
Figure 1: Spalled stone due to rust jacking at a railing. Credit: Brian Rich, 2013

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**

Too often mild steel is used for structural support and rusts when the building envelope no longer protects it. Proper maintenance, in some cases, would prevent subsequent rust-jacking and spalling. However, it is the original design that is at fault in the first place for not anticipating the problem.

In the second example, it is a maintenance intervention (repointing the brick) that caused the spalling of the brick. In both cases, original historic material is damaged and repair or replacement of difficult to source material must be attempted.



In these two examples, repair interventions caused irreversible damage to the building necessitating further extensive repairs to extend the service lives of these buildings.

The Problem

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

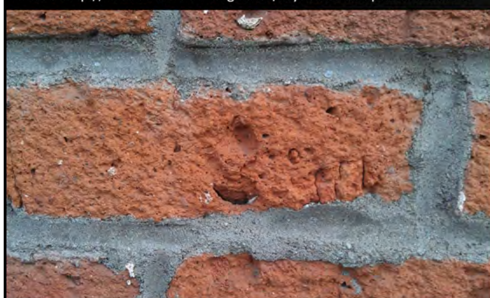


Figure 6: Sandblasted brick removes the fire skin from the brick. Credit: http://www.permies.com

- **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**

Again, interventions intended to repair and make the building viable and attractive for the long term future have caused irreversible damage to the building. Major repairs are necessary to mitigate the reduction of the service lives of these buildings. No matter how successful the mitigation, though, historic fabric has been lost and cannot be replaced.

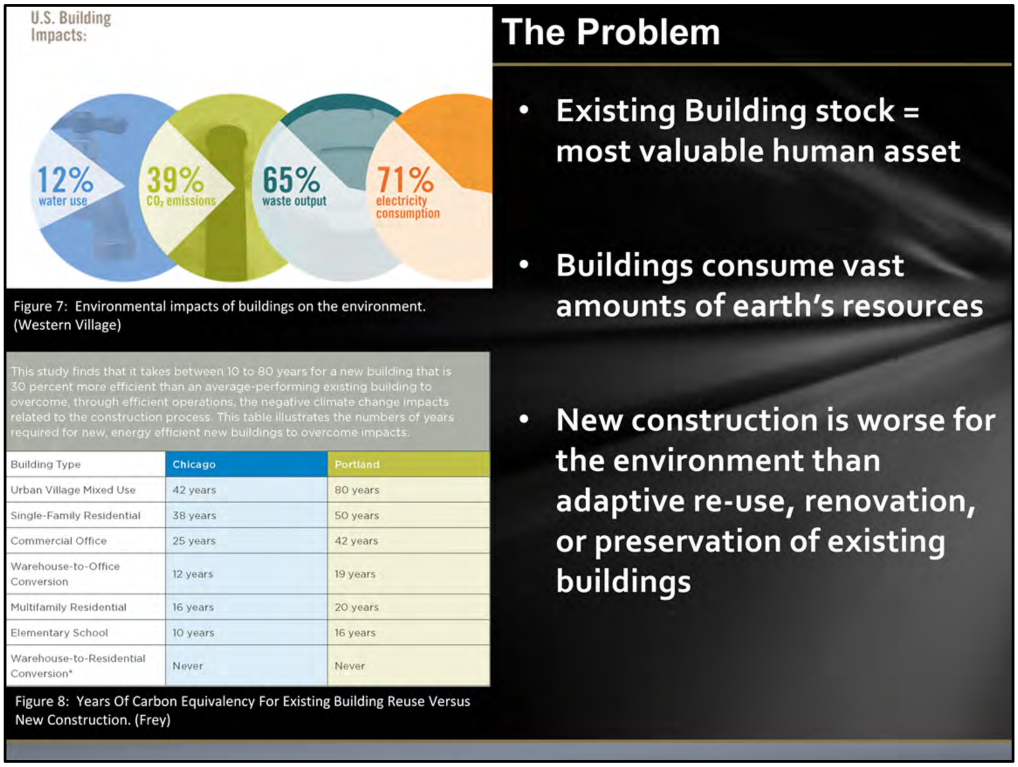


Figure 7: Environmental impacts of buildings on the environment. (Western Village)

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)

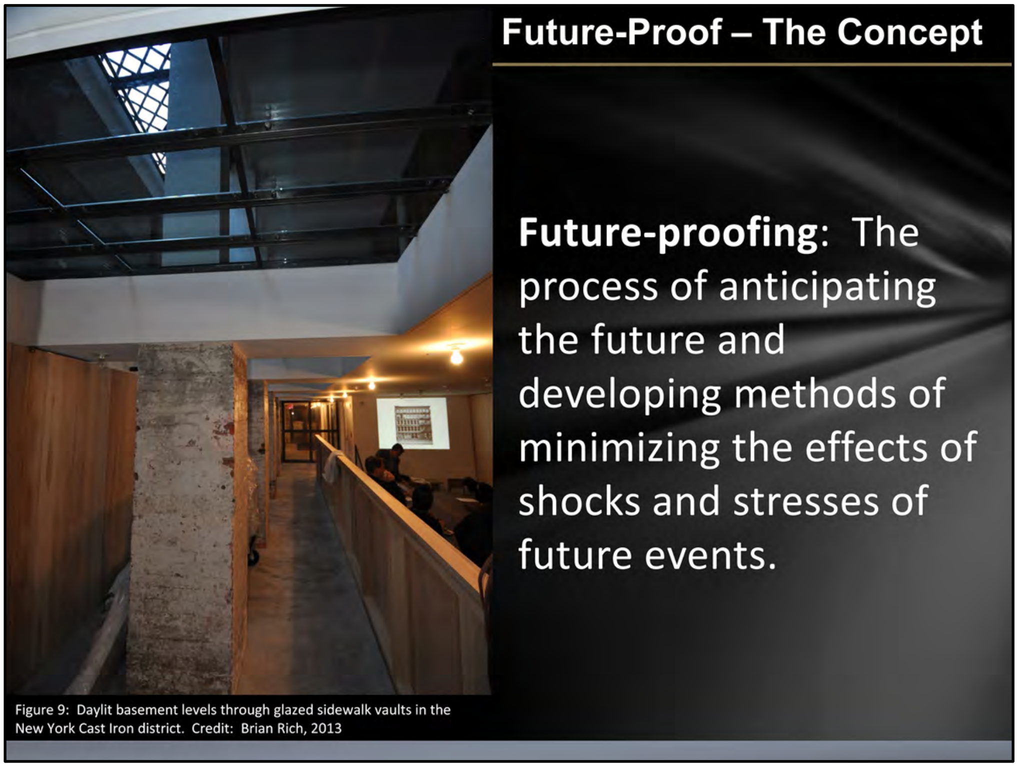
The environmental issues argue for sustainable development through renovation of our existing building stock rather than demolition and new construction.

There are also economic, social, and cultural reasons to support historic preservation as well, but that's another presentation.

Figure 8 makes clear that the loss of existing building stock exacts a heavy toll on our environment. Consider that most new construction is based on a 20 to 30 year service life compared to the average service life of 50 to 100 years in a renovated historic building. You may have to build 2 or 3 new buildings to replace one historic building.

Consider also the vast amount of embodied energy, materials, capital loss, and loss of social and cultural assets when you demolish an historic building. Ill-considered interventions in historic buildings are just as damaging as the wrecking ball, if only a little slower.

Enter the concept of future-proof.



Future-proof is generally described as noted on this slide.

It is a concept found in the AEC industry and many other related industries too. These other industries for a body of knowledge about the concept of future-proofing from which we can derive general principles that can be applied to historic buildings as well as many other aspects of our lives.

Let's see what future-proofing means in these other industries and what we can draw out of them.

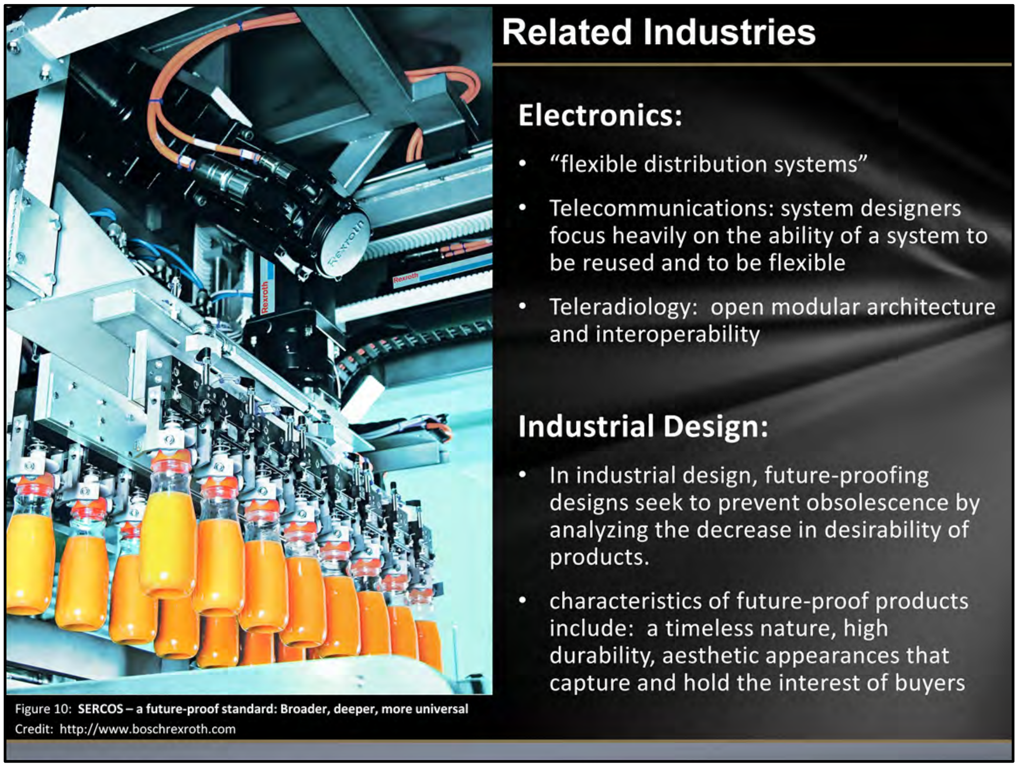


Figure 10: **SERCOS – a future-proof standard: Broader, deeper, more universal**
Credit: http://www.boschrexroth.com

The electronics industry offers flexibility, reusability, and interoperability as principles of future-proof

Industrial Design offers timeless nature, durability, holding (and ideally increasing) interest over time

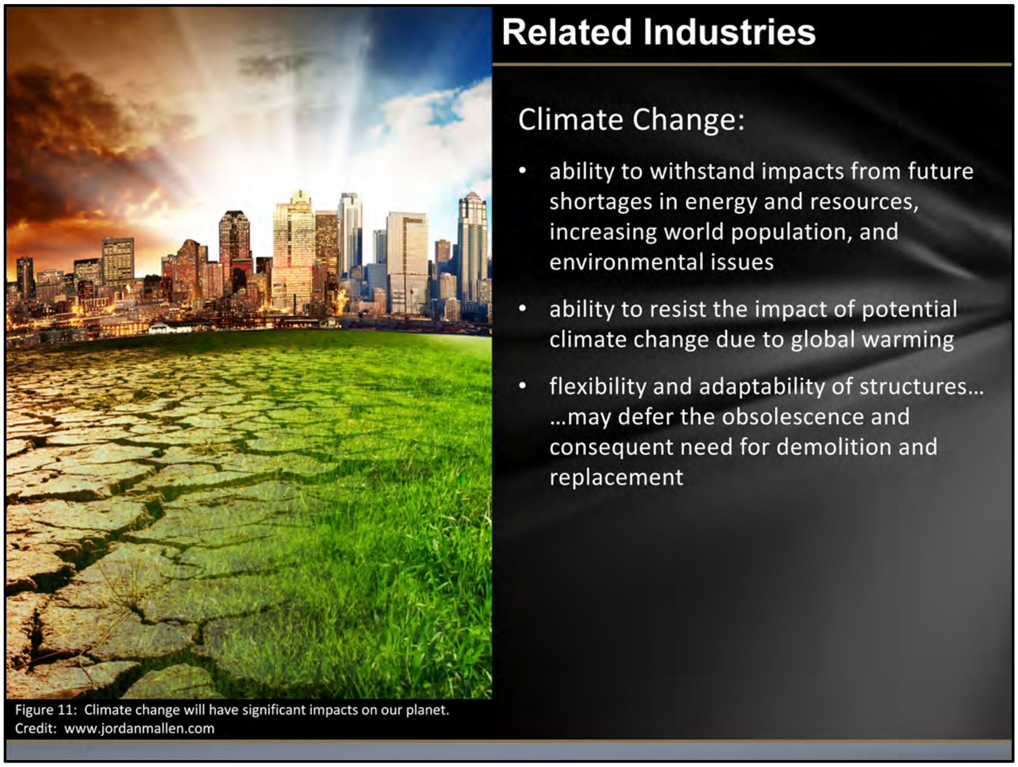


Figure 11: Climate change will have significant impacts on our planet.
Credit: www.jordanmallen.com

Future-proof is a term used fairly commonly in climate change discussions today.

It offers a few more key concepts: withstanding or resisting future impacts, flexibility, adaptability, and deferring obsolescence.

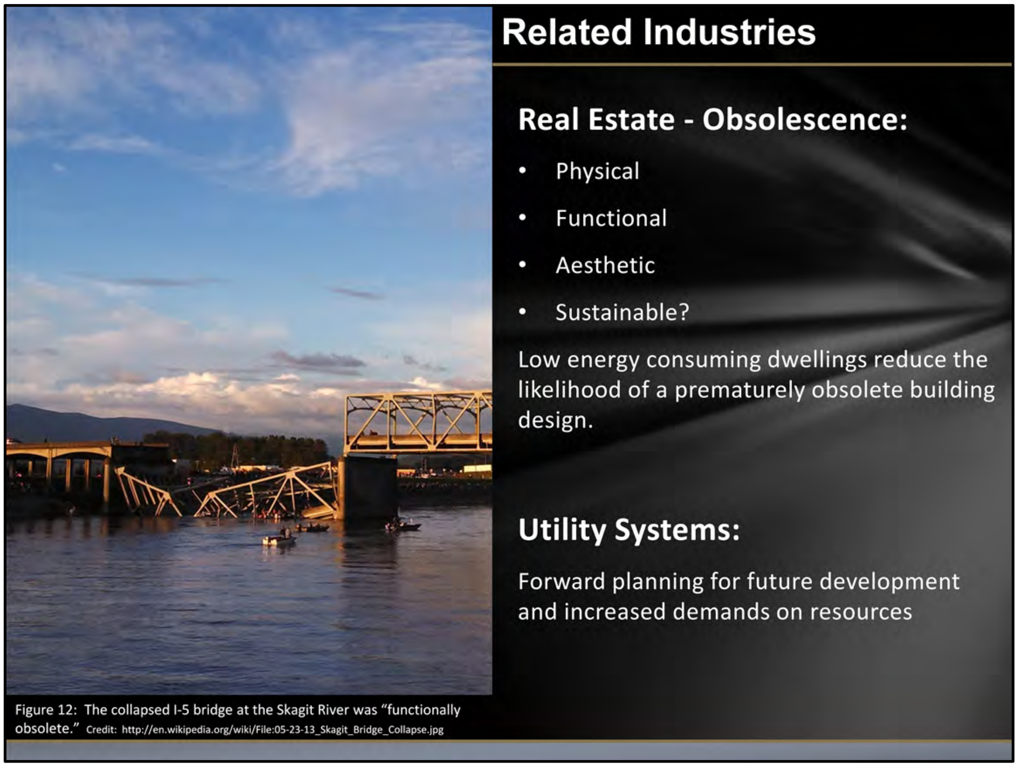


Figure 12: The collapsed I-5 bridge at the Skagit River was "functionally obsolete." Credit: http://en.wikipedia.org/wiki/File:05-23-13_Skagit_Bridge_Collapse.jpg

In the valuation of real estate, there are three traditional forms of obsolescence which affect property values: physical, functional, and aesthetic. A potential fourth form has emerged as well: sustainable obsolescence.

The I-5 Skagit River Bridge was classified as functionally obsolete, in this case because the bridge does not meet current design standards for lane widths and vertical clearance in new highway bridges. The bridge is not Future-Proof due to obsolescence rather than lack of maintenance.

Thus, real estate offers the idea of obsolescence

Utility Systems also offer the idea of planning ahead.

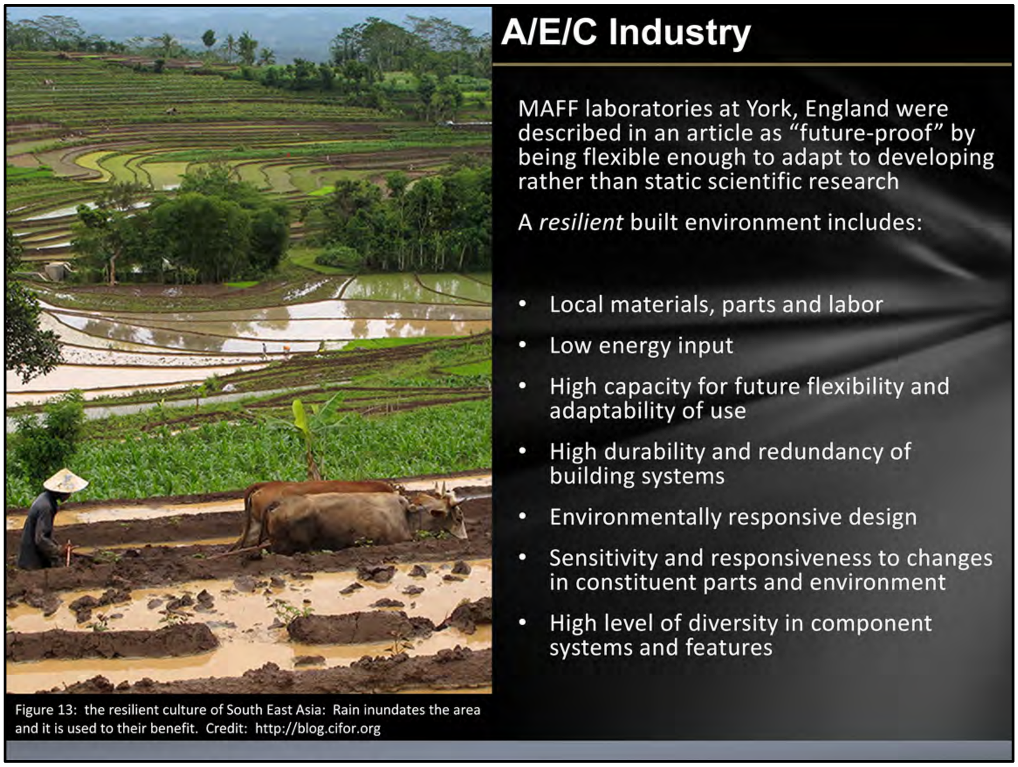


Figure 13: the resilient culture of South East Asia: Rain inundates the area and it is used to their benefit. Credit: http://blog.cifor.org

In the AEC industry, future-proof means flexibility in the design of a facility.

A concept closely related to future-proofing is "resiliency." Here are a few of the basics of a resilient design.

While not as broad as the concept of future-proofing, it does offer valuable suggestions for the principles of future-proofing.

So how does future-proof apply to historic buildings?

Historic Structures

Figure 14: The historic Brooklyn Bridge in New York. Credit: Brian Rich, 2013

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

The original design of the Brooklyn Bridge by Roebling was intended to carry four lanes of traffic. Today it carries 6 lanes of traffic, pedestrians, and two train tracks.

Demolition of this bridge would be contrary to the intent of sustainable design and would also tear at the hearts and memories of New Yorkers and others around the world.

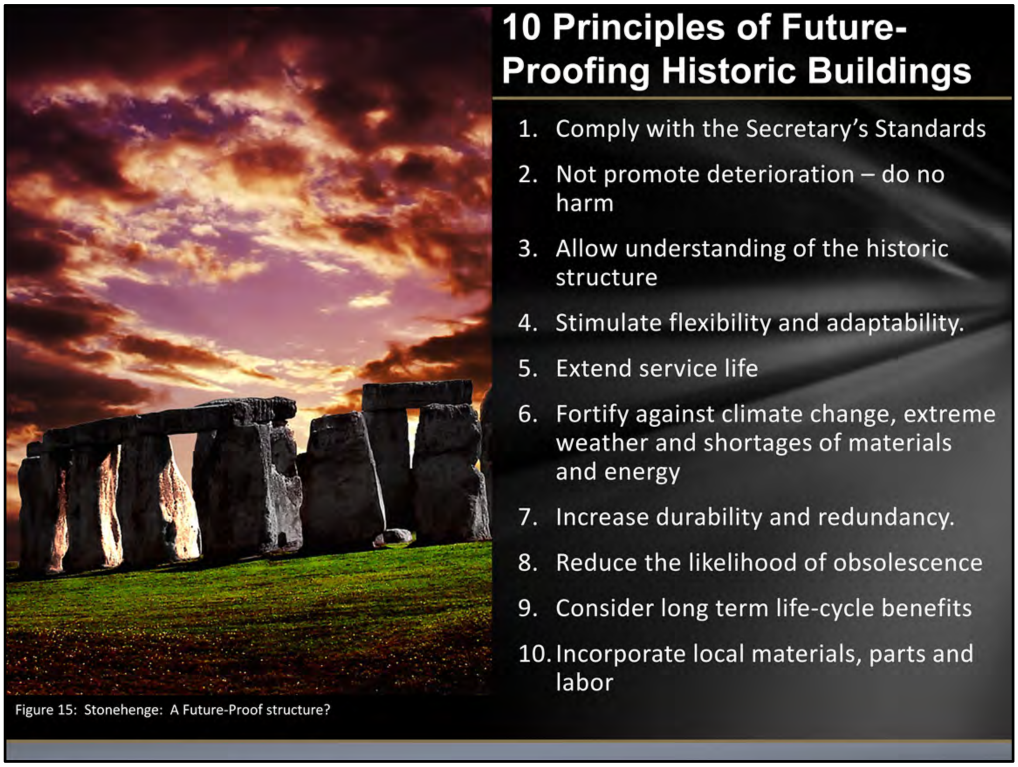


Figure 15: Stonehenge: A Future-Proof structure?

10 Principles of Future-Proofing Historic Buildings:

1. **Comply with the Secretary's Standards.** The Secretary of the Interior's Standards for the Treatment of Historic Properties provide excellent guidance for the long term retention of an historic building.

2. **Not promote deterioration – do no harm.** It is natural for all building materials to deteriorate. Interventions in historic structures should not accelerate the deterioration of the existing building fabric.

3. **Allow understanding of the historic structure.** Interventions in historic structures should allow the students of history in our future to understand and appreciate the original historic building as well as the interventions which have kept it viable.

4. **Stimulate flexibility and adaptability.** The interventions in an historic structure should not just allow flexibility and adaptability, but also stimulate it. Adaptability to the environment, uses, occupant needs, and future technologies is critical to the long service life of a historic building.

5. **Extend service life.** Interventions in historic buildings should help to make the building useable for the long term future rather than shorten their service life.

6. **Fortify against climate change, extreme weather and shortages of materials and**

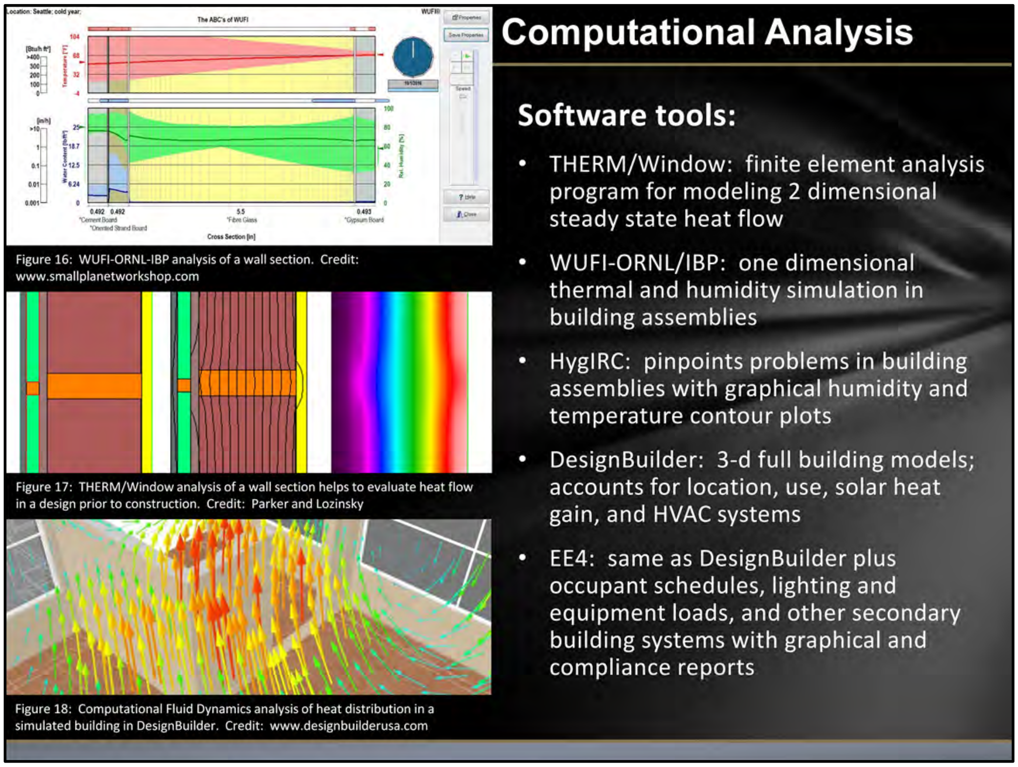
energy. Interventions should prepare the building for the impacts of climate change by reducing energy consumption, reducing consumption of materials, withstanding extreme natural events such as hurricanes and tornadoes.

7. **Increase durability and redundancy.** Interventions in historic buildings should use equally durable building materials. Materials that deteriorate more quickly than the original building fabric require further interventions and decrease the service life of the building.

8. **Reduce the likelihood of obsolescence.** The building should be able to continue to be used for centuries into the future. Take an active approach: regularly evaluate and review current status in terms of future service capacity. Scan the trends to provide a fresh perspective and determine how your historic building will respond to these trends.

9. **Consider long term life-cycle benefits.** The embodied energy in existing structures should be incorporated in environmental, economic, social, and cultural costs for any project.

10. **Incorporate local materials, parts and labor.** The parts and materials used in historic building interventions should be available locally and installed by local labor. This means that the materials and manufacturing capabilities will be readily available in the future for efficient repairs.



Computational simulation software can assist in the analysis of a design before it is constructed and puts significant efforts at creating a built environment at risk.

Simulation tools are not the only tool to help understand if a design is future-proof. Indeed, they are but one tool in a collection of many for understanding whether an intervention in an historic building is future-proof or whether it will do further damage to the building.

Each of the tools above have their strengths and their limitations. There is no one program that can do full building analysis at the detailed level of WUFI or at the overall scale of DesignBuilder and EE4 with the accuracy of THERM/Window or HygIRC.

IN CONCLUSION:
The Principles of Future-Proofing can be developed from it's usage in the AEC and related industries. The 10 Principles of Future-Proofing can be used to guide future designs and are useful in consideration of interventions in historic buildings.

Computational analysis tools are an integral part of designing future-proof interventions, but have specific applications and are only part of a collection of tools needed to successfully create future-proof designs.

Credit Where Credit is Due!

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