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THE SUSTAINABLE ARCHITECT 2.0

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SUSTAINABILITY – DEFINITIONS and CRITERIA

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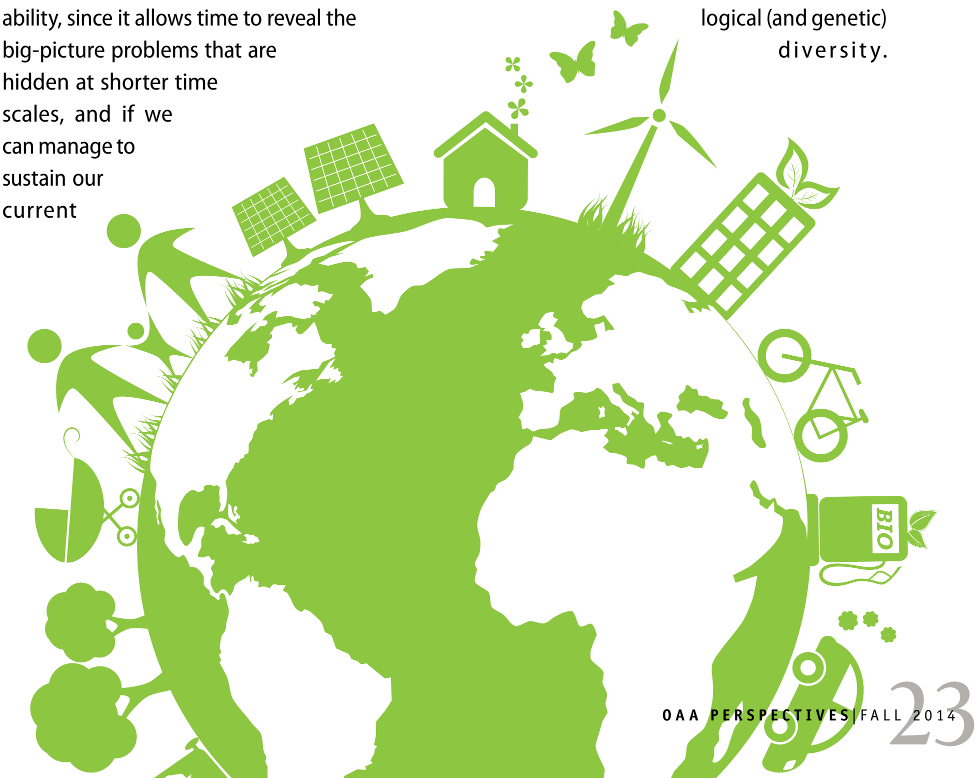
Human societies, with their accompanying needs for energy, water, materials and nutrients, can be regarded as "sustainable" if they can continue indefinitely. How long is indefinite? The ultimate limit is the expected remaining lifespan of a habitable Earth, which is limited to about one billion years, due to the inevitable expansion of our sun as it approaches its own spectacular end. However, planner Bruce Tonn has argued that adopting a 1,000-year planning horizon provides a sufficiently long timeframe to ensure sustainability, since it allows time to reveal the big-picture problems that are hidden at shorter time scales, and if we can manage to sustain our current civilization for 1,000 years, we can probably sustain it indefinitely.[1] Thinking on a 1,000-year time horizon forces the development of a whole new way of thinking, particularly regarding growth on a finite planet and the conservation of resources.

CRITERIA FOR SUSTAINABILITY

The most important condition for the long-term sustainability of human civilization is that we maintain the integrity of the life-support systems on which we depend. We are part of a complex, interconnected web of life that has evolved over the course of Earth's history. One of the keys to maintaining life-support systems is biological (and genetic) diversity.

The protection of global biodiversity requires that we reserve sufficient space for natural ecosystems to thrive and to be able to adjust to changing climate (which, over the next few centuries, will be dominated by human emissions of greenhouse gases).



Advanced civilizations also require energy and resources, which imposes additional constraints. In light of these and other considerations, the following overarching conditions would seem to be the minimum required to ensure long-term sustainability:

- protecting global biodiversity and maintaining functioning ecosystems
- maintaining the composition of the atmosphere and the oceans within ranges that will allow life to thrive in the long term
- managing the human population – at the least limiting further growth and possibly managing a slow decline over the next few centuries
- managing nuclear and hazardous wastes (ensuring their long-term isolation from the biosphere)
- preventing the accumulation of toxic materials in the biosphere
- maintaining adequate access to all of the elements needed to maintain an advanced civilization, including metals used in a wide array of technologies and the nutrients needed to maintain food production at levels sufficient to support human population.

The protection of global biodiversity requires that we reserve sufficient space for natural ecosystems to thrive and to be able to adjust to changing climate (which, over the next few centuries, will be dominated by human emissions of greenhouse gases). This requires, among other things, building compact cities and using materials that are not extracted from natural ecosystems in a destructive way or in ways that undermine their long-term viability. To maintain a suitable composition of the atmosphere and oceans requires severely limiting the further buildup of greenhouse gases in the atmosphere and most likely reversing some of the increase that has already occurred, by the end of this century. This requires a rapid (within decades) shift away from fossil fuels to a completely carbon-free energy system.

IMPLICATIONS FOR ARCHITECTS AND THE DESIGN OF BUILDINGS AND COMMUNITIES

Specific conditions that would have to be satisfied for a building or community to be regarded as "sustainable" include:

- reducing energy demand to levels that can be supplied from truly renewable energy sources
- reducing the net consumption of non-renewable materials over the entire lifecycle of the building to essentially zero
- minimizing the consumption of water in buildings and facilitating the infiltration into the ground of rainwater falling on the building and its property
- facilitating the complete recycling of all nutrients in human and food wastes.

To elaborate briefly, a measure of energy use in buildings is the *energy intensity* – MJ or kWh of energy use per square metre of building floor area per year (MJ/m^2yr or kWh/m^2yr). The product of energy intensity and floor area gives the total energy requirement. Some of this energy could be satisfied through on-site renewable energy systems, such as photovoltaic modules or building-integrated wind turbines, but the balance will have to be supplied by off-site renewable energy that is transmitted to the building site. The building energy intensity that can be regarded as "sustainable" on a regional basis therefore depends on the ultimate building floor area, which in turn depends on the long-term regional population and floor area per person, and on the capacity to supply energy from sources such as wind, hydro, centralized solar electricity generation, and biomass.

As population and per capita floor area in particular are subject to change, and the truly sustainable energy supply is uncertain, there is not a hard and fast definition of what would constitute a "sustainable" energy demand. However, it is clear that any sustainable energy intensity will be several times smaller than that which is typical of new buildings today. As transportation energy use is a significant share of our total energy use, appropriate site selection – and in particular, the proximity to urban transit systems – is another element of truly sustainable buildings.

Buildings are a major consumer of most of the key materials that we produce or extract from the earth, including cement, steel, copper, aluminum, plastics and wood. We need to minimize the use of these materials in new buildings, but also design buildings to be as long-lasting as possible (by designing for adaptive re-use as needs change) and to make it possible to easily separate and recycle all of the building materials (except cement, which cannot be recycled) when the building finally reaches the end of its life. In this way, the net material use – from construction to demolition and recycling – will approach zero.

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Finally, long-term sustainability of the human population requires that adequate food production be maintained, and this in turn requires that all nutrients taken from the soil be ultimately replaced or returned to the soil. As the supplies of minable nutrients (phosphorus in particular) are limited, this ultimately requires close to 100 per cent recycling of nutrients back to the soil. This has massive implications for the entire food production system, but also has implications for the design of human waste systems in buildings. In particular, toilets and plumbing systems designed to separate urine (where most of the excreted nutrients end up) and solid matter will have to become standard, with minimal dilution of liquid wastes so as to facilitate extraction of nutrients with minimal energy expenditure. This will have to be integrated into much larger nutrient recycling systems that are yet to be designed.

NOTES:

1. Bruce Tonn, "Integrated 1000-year planning," *Futures* Vol. 36, pp. 91-108 (2004).

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