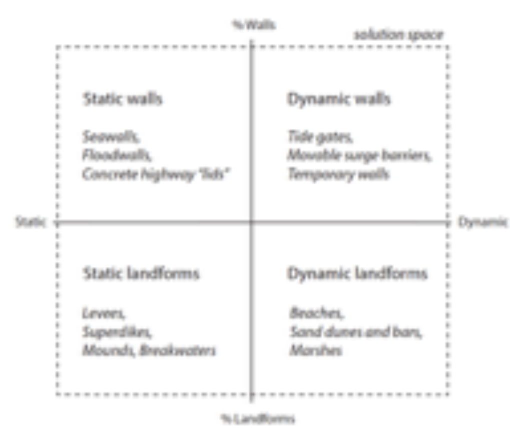
Shaun Lien
ED4C
20 Apr 2016

Synthetic Response

Traditionally, what people notice immediately about a specific building is its form; by definition, form is destined to be perceived before function, so it is only natural for popular culture to closely connect architecture to aesthetics, rather than function, or its relationship with the environment. But that's the essence of the course *Future Ecologies* — to make an emphasis on function, how buildings can be machines that interact with their surroundings, and how the manmade world in general is related to the natural one. There are a few sub-themes that branch out of the essence of the course. To determine the order of significance of the sub-themes, a greater context must be considered, namely, the crisis of climate change. Perhaps for the first time in human history, we have realized the limits of our own planet and the reality that resources will inevitably run out. Here, I have tentatively listed the sub-themes, based on their impact on climate change and sustainability, from less to more significant: thermal experience, armatures, building metabolism, energy use and generation at the building scale, and urban metabolism.

Although I listed thermal experience as less significant, to me it carries the most emotional weight. Lisa Heschong, in *Thermal Delight*, stresses that often times thermal comfort creates an emotional connotation for buildings (Heschong 1979). That deeply resonates with me because it humanizes the design of function, instead of merely stressing on the conservation of energy. Her four stages of thermal appreciation are necessity, delight, affection, and sacred. I am most interested in sacredness, because it implies that thermal qualities can provide transcendence. Take the Sarabhai house, for example, it is located in one of the most extreme climates in the world, but it provides comfort without consuming a huge sum of energy. This is achieved by the genius designs of Le Corbusier, who used different strategies to cool down the occupants without using a mechanical system.

Armatures, as defined by professor Hill, are "biological and physical structures, including vegetation, that influence the flow of energy, organisms and materials." With a rapidly rising sea level, perhaps the most relevant armatures would be coastal ones that protect human properties. In her work, professor Hill offers a rudimental introduction to different types of adaption designs (Hill 2014). In the lectures, I noticed that the professor favored a hybrid system that includes wetlands, marshes, and static walls. This preference is realized in the LEAP project, where vegetation is used heavily (Kauffman 2016). The project not only works as a boundary that protects our cities, but also work as carbon sequestration fields, which is a response to the demand of sustainability.



At a smaller scale, and closely related to thermal experience, building metabolism focuses on the heat transfers between the building and its surroundings. Dahl and Kristensen start with describing the heat balance of the human body and uses it as a metaphor for the heat balance of buildings. They introduced an idea that categorize buildings in to tents, cabins, stone houses, and caves (Dahl and Kristensen 2010). Each category responds to temperature change differently, serving different purposes, but in the end they are measures to provide thermal comfort, and I think it is important for architects to have thermal balance in mind when designing a house.

A good thermal design would save energy, but sustainability implies that sometimes it is necessary for buildings to generate energy too. We thus reach the sub-theme of energy generation on a building scale, specifically generation through solar power. However, solar power has its limitations: it is extremely hard to support a building through solar power alone, since the taller a building is, the more unlikely it is possible to fully sustain it with solar power (as demonstrated in figure 2). The Packard foundation efficiently uses solar power and conserves energy through automated systems. The building features large glass panels that let in natural light and what is called "California living:" a workspace that is outdoors, with shadings provided by trees. In 2013, it successfully reached zero net energy, which is an impressive achievement, considering its scale (Knapp 2013). Nonetheless, we face another issue: the notorious duck curve. Perhaps an unexpected side-effect of solar power, the duck curve outlines the risk of over generation during the day, since when buildings are autonomous during the day (because of solar power), there is a low demand of power from the grid. However, this can be solved, through the development of battery technologies that would store power generated from the day and release it at night.

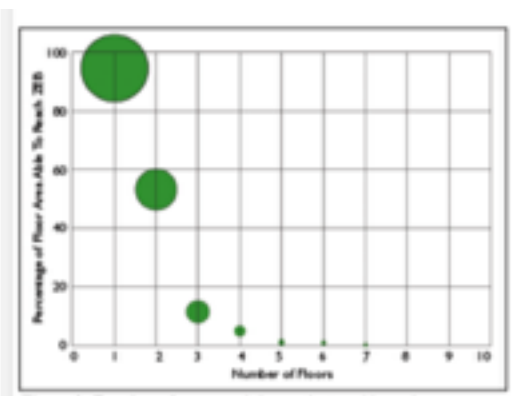
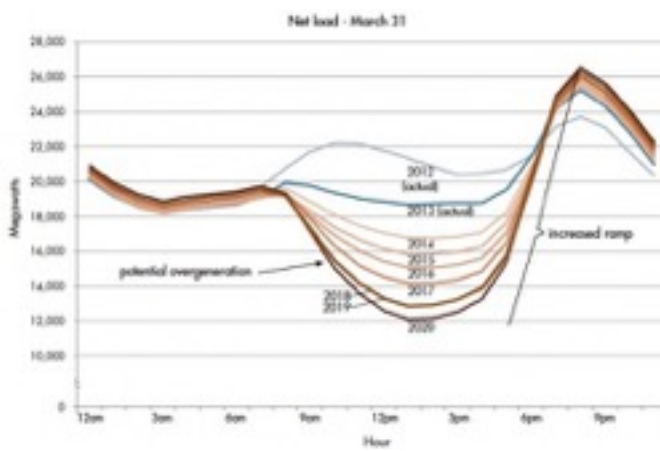


Figure 2: Fraction of commercial area that could reach zero energy in the LZEB 2025 scenario as a function of the number of stories.



When it comes to battling climate change, the most important thing to do is to look at things on a grander scale, and that brings us the to last sub-theme: urban metabolism. Viewing cities as huge machines, the notion of urban metabolism invites us to rethink the material and energy flows of a city. After examining those flows, we can thus decide what is redundant, and what can be reused. A more circular economy, the idea of industrial symbiosis, are both ideas consider urban metabolism. Take industrial symbiosis, for example, the waste from one factory may be useful for another, and the excessive heat generated from a plant can be used to power machines in another one. Another way to consider urban metabolism is through the placement of residential, commercial, and industrial areas. Through planning, it is possible to reduce emissions of toxins and maximize efficiency. The Suzhou industrial park succeeds at minimizing carbo footprint to a tiny fraction of China's national average (Chandra-Putra et al. 2015). I believe that examining urban metabolism is the most potent way to combat climate change, since it synthesizes facets of urban material and energy flows and strives for maximum efficiency, and that is something that could change the current trajectory and lead us to a better future.