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Looking at Tomorrow

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Abstract:

Predicting the future is very difficult, but examining trends and potential tipping points is useful as an aid to understanding the direction the building industry is headed, and where it might end up. Although some future changes can only be speculated upon, other trends are already occurring and causing changes. Below is a series of changes and possible changes that may influence the building industry and society.

A major trend is that the planets population is growing. The earth's population will grow by about three billion people (a 50% increase), in the next 50 years, one billion of whom will be in China and India. The citizens of these countries want more and better buildings (primarily housing), and the needs are tremendous. This trend will drive the demand for new types of high-performance buildings supported by rational design methods. Although most of the growth will occur in the developing world, even America's population is predicted to rise by 100 million by 2040, an increase of 25% in 35 years.

The demands that providing buildings for these people will place on nature's ability to supply the resources and absorb pollution will be unprecedented. Meeting these demands will require a significant increase in material efficiency, a switch to more renewable resources, (especially cellulose based), and materials that can be endlessly recycled. The cost to the world's economy and to the environment of poor choices in building design could be staggering because of the massive scale of the endeavor.

In response to these environmental challenges, some consumers are beginning to demand "green" or more sustainable built facilities. This trend is most evident in Europe, but it is becoming more common in North America as, for example, cities such as Vancouver, British Columbia, Portland, Oregon, and Austin, Texas, require that all new municipal buildings be "green." This trend will promote demand for new types of more resource- and energy-efficient and durable buildings and building enclosures, and will require more integrated systems engineering.

The combined challenges of a shortage of cheap fossil fuels (oil production will peak in the next few decades and may already have), geopolitical concerns regarding our dependence on Middle Eastern and Russian energy (America imports over 2/3 of its petroleum), and increasing concern about the growing current and future impact of global warming from carbon emissions will change the energy supply and consumption landscape. Although coal is reasonably plentiful in America (good quality coal is actually increasingly rare), the carbon dioxide emissions of even clean coal technology (yet to be adopted for most new coal plants) are twice that of natural gas burnt in a condensing furnace and coal mining has significant environmental impacts. Alternative sources of energy from renewable sources will need to be developed. The only question is which technology and when. Near to commercialization technologies in cellulosic ethanol, photovoltaics, and packaged CHP promise to reduce the costs of these energy sources by half or more making them competitive with increasingly expensive fossil fuels.

The manner in which power is produced, distributed, and consumed could be revolutionized by linking building-integrated power production (for example, photovoltaics, combined heat and power units, or mini wind turbines) to building operation and power consumption in a dynamic, two-way manner. Using this technology together with network communications, buildings and building enclosures will become active parts of the energy network that communicate with each other and with the community to produce power at the least cost. Power grids will become true two-way power distribution systems, with arbitrage and market pricing, as opposed to one-way, fixed price system. At the same time, rising energy production costs will mean that demands on the traditional power production and distribution systems will be reduced.

To forestall the need for new power production, means of reducing peak power consumption will grow in importance. Intelligent equipment and building integrated power production will play a role, but innovative energy storage technologies will also proliferate. Cold water and ice storage will be used more to shift the time of the peak load and reduce the capital needed for cooling and dehumidification and heat storage and phase change.

Changes in the transportation sector will likely result in plug-in hybrid diesel and gasoline electric vehicles. By enhancing the size and performance of their battery packs, such vehicles can drive for a longer period on electric power, often for most of a typical round trip 50 mile (80 km) commute. Combined with biofuels, this technology can dramatically (by a factor of 5 to 10) reduce petroleum consumption in the personal transport sector. This trend means that transportation with for the first time compete with electricity produced for use in buildings. Using off-peak power, intermittently generated renewables, and locally generated electricity can allow for very effective and low cost transportation energy when used in plug-in hybrids.

Skilled labor will continue to become more expensive and this will spur the development of labor-saving systems and equipment. Mechanical systems with very simple connections, structured PEX-based plumbing and structured wiring power and data systems will continue to grow.

As has occurred in the last half century, and likely will continue into the next, consumers will be more demanding in that they expect dry, healthy, comfortable (warm or cool), durable and energy-efficient buildings that are delivered more quickly and economically. The increased chance of legal claims (partly due to collective action by condominium owners and class-action law suits) and rising insurance premiums have increased the sensitivity of designers and builders to the risks associated with poor performance.

Building materials, elements and systems continue to develop and change to reduce cost, reduce resource use, to increase recyclability. They are likely to become more sophisticated and will be designed for specific uses. In fact, the first generation of designer smart building materials are already available, such as a vapor control layer that changes its permeance with relative humidity. Advanced materials such as electrochromatic films offer the potential to control solar radiation with unprecedented ease and efficiency, while offering very significant energy savings and comfort. Nanoporous and aerogel insulations promise very high insulation values in much thinner layers than before—flexible, nanoporous foam insulations with a thermal resistance of R20 per inch are already possible on a commercial (albeit expensive) scale. An increasing proportion of building materials will be manufactured from rapidly renewable plant material with complex moisture and mechanical properties. Designers will require a better understanding of materials if they are to be used to their best advantage.

Underpinned by biotechnology and pressed by non-renewable resource limits, biofuel, rapidly renewable materials, and natural-sourced polymers will support the increasing convergence of the energy, chemical and agricultural industries. The use of agricultural land for the production of food, fuel, building materials, and chemical feedstocks will mean capital will be invested in a wider range of natural based systems that can supply the highest bidder. Hence building uses will compete with many other uses.

Mechanical systems will continue to become smaller, more sophisticated, and with more capabilities. Mechanical systems are already available with modulating output (such as variable speed fans and modulating boilers) and enhanced sensing (particularly lighting controlled by light levels, temperatures varied by outdoor temperatures, and ventilation adjusted based on human occupancy levels) and control systems that quickly respond to changes in the weather and how buildings are used. Simple, robust versions of such systems can dramatically reduce the cost of both installation and operation while improving comfort. HVAC systems that are interconnected via wired and wireless networks to other systems and to service providers also promise better comfort at lower capital and operating costs. Solar-regenerated desiccant dehumidification will be developed to deal with the growing proportion of air conditioning load that is humidity control and the desire to use recycled energy.

The types of buildings are also expected to change. Multiple residential buildings and mixed-use commercial buildings will become more important sectors. Office space will transform into highly flexible workspace as more people work on the road, in coffee shops, and at home, supported by ever cheaper and higher bandwidth data transmission. As real estate in urban centers becomes more valuable, and people expand the use of their homes, we will expand into the attic and basement spaces. This will demand solutions to making these spaces comfortable and functional. An aging population will also demand more accessible homes, with few obstacles to mobility and perhaps more co-housing of extended families.

Retrofit and repair will grow to dominate the building industry. As the building stock matures, it will be necessary to improve the functionality and energy efficiency of the over 100 million buildings in North America. This will require new products and systems, and new design and delivery processes.

Information technology is likely to be used to assist the design and delivery process as well as being used in the measurement of building performance on site. Temperature and humidity are routinely logged in commercial buildings, and energy consumption and air quality are increasingly being measured. However, or experience with building automation systems has been that The increase in the quality and quantity of in-service performance data is likely to stoke the desire for buildings with improved and more reliable performance.

The potential for effective performance simulation remains largely untapped. In addition, there is likely to be more real-time monitoring of buildings which would complement the advances in simulation. Simulation will be needed to allow for high-performance, integrated designs that make the best use of materials and design time while resulting in the most reliable enclosure assemblies. However, simulation remains a tool. It must of course be used in the context of practical experience, a sound theoretical understanding, and awareness of the cultural, historical, and social forces that drive building designs.

As a result of these trends, there will be a need for a better understanding of the technical performance of buildings and their components, so that improved performance, or better defined and more reliable performance, can be delivered more economically.

None of the trends described above need continue, and none of incipient technologies may be adopted, but many will be in one form or another.

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