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Some thoughts about the future of intelligent buildings and smart transportation

Peng Liu and Shumei Zhang[a]
Shijiazhuang University, China

Abstract. With the ever accelerating advances in science and technology, it seems that almost any dream in the science fiction can become true. This paper discusses two topics that are closely related to our daily life; buildings and transportation. Although the paper was inspired by Science-Fiction Prototyping (SFP), rather than using a conventional story based approach I have adopted an essay-style to extrapolate forward my thoughts on current living conditions and trends of technology development, to explore various possibilities for future buildings and transportation For example, I present ideas for an intelligent building concept motivated by the behavior of sunflowers to improve the regulation of natural light and heat absorption in buildings. In addition, I have mused on a possible solution to current traffic congestion problems. The motivation for these ideas is to make our life more convenient and comfortable in the future.

Keywords. Intelligent buildings, smart transportation, building architecture, earthquake resilience, climate change, energy conservation, product innovation, science fiction prototyping

Preamble

In China, it's mandatory for universities to include a module that teaches College English, as this is seen as an essential skill for creating successful scientists, and engineers to drive the Chinese economy forward. Additionally, after the College English course, a specialized English module called "Computer English" is also taught, in Chinese computer science departments, which combines elementary computing with specialized English learning. In this course, students learn a bit of technology, and the relevant aspects of English that describe it. While the aims are laudable, in the eyes of students, the process can sometimes prove somewhat tedious and boring, with students lacking motivation. This essay was written as an outcome of an experiment in teaching Computer English which explored the proposition that English could be taught in a more effective way, if it is set into an engaging and motivating context [9]. One topic that many engineers and scientists cite as having brought them into computing is science-fiction, as it connects with the human spirit of adventure and imagination. Moreover, imagination is seen as a key ingredient of engineering design, as it enables people to think 'outside the box' and create innovative concepts and products. In fact there is a new discipline deployed by one of the largest

[a] Corresponding Author.

computing companies in the world, Intel, who use science-fiction as both a product innovation tool and a language that connects their designers to their customers [10]. The area is called *Creative-Science* and the methodology is called *Science Fiction Prototyping* (or *SFP*, for short)[a]. Apart from the importance this topic has for science and engineering innovation, the methodology also involves the use of a rich (and technical) set of written and oral vocabulary that is at the heart of language learning. Thus, we decided to explore the use of SFP for teaching Computer English classes with the hope it would act a vehicle to better engage students learning 'Computer English'. There were 102 students taking these 3rd Year Computer English undergraduate classes at Shijiazhuang University in China; the following is one of those essays. It is important to note that the feasibility of the ideas is not the objective of the student's work, rather the aim is to feed the students imagination, enhance their motivation and exercise their technical command of English in an engaging and fun way as we hope this essay will illustrate. In that spirit, we hope you enjoy Peng Li's essay. More details of this venture are presented in a companion paper "*Using Science-fiction Prototyping as a Means to Motivate Learning of STEM Topics and Foreign Languages*" [9].

Vic Callaghan (Essex University, UK)

Introduction

At present, most homes are fixed in one place, and cannot be easily moved. Some people consider that this style of design is very stable and safe, because it can be fixed in the ground firmly. However, such a design has many shortcomings. For example, most buildings have opposite sides, while one side may be illuminated and warmed by sunlight, the other side may never see the sun! However, most people would like to buy a house that will have as much sunshine for them to enjoy as is possible, especially in the winter season. In addition, fixed buildings have little resistance to earthquakes as even the wooden buildings in Japan, that are designed to resist earthquakes, fall down if the earthquake is large enough.

Moreover, shortcoming of current transportation also causes social problems, such as traffic congestion and accidents. Beijing, the capital city of China, is case in point where severe traffic jams are a regular occurrence resulting in a huge waste of precious time. In order to reduce traffic congestion, the governments of many countries encourage people to take public transportation. Although a public transportation policy can reduce the number of cars on the road, with a consequent reduction of traffic jams and car exhaust pollution, it does not always reduce the journey time. For example, people need to wait for public vehicles to arrive and then the vehicles also have to stop many times to let people getting on/off. So the public transportation does not save people's time on the road efficiently, particularly if we cannot solve the problem of the vehicle's needing to stop and start frequently.

In order to improve people's future quality of life, this paper focuses on how to build intelligent buildings and smart public transportation systems, based on intelligent environment technologies.

[1] http://www.computer-science.org

1. The Intelligent Sunny Building

In order to deal with light exposure in buildings, many architects and builders are constantly seeking new methods. The ancient designers invented the roofed courtyard where the center of a building's roof was hollowed out, making it easier for sunshine to enter the house. They also designed triangular roofs, like those used in older western churches, which work by expanding the area.

Many countries have introduced standards for regulating a building's light exposure. British Standard (BSI) "The Architecture Lighting Design Standards GB-50033-2012" stipulates there must be sunshine in a bedroom, sitting room and kitchen [1]. Designers also found the shape of windows is important for enhancing light exposure, with floor-to-ceiling widows, allowing the most light through.

Apart from light exposure, another important issue is that many current buildings cannot withstand earthquakes. When a big earthquake takes place, there are still many people injured. In order to improve resilience to earthquakes, one study [2] invented "Design-less Design" that advocates design should depend on the nature of the terrain and obey the laws of nature. Toyo [3] has looked at the problem from a building structure perspective, in which he uses a set of hyperbolic shaped seamless steel-pipe latticed columns for the main structure, taking advantage of a steel sandwich structure to make up non-beam thin floor (as shown in the Fig.1). Most of this design reflects a type of bionic thought, which will also be applied in this paper to design our architectures.

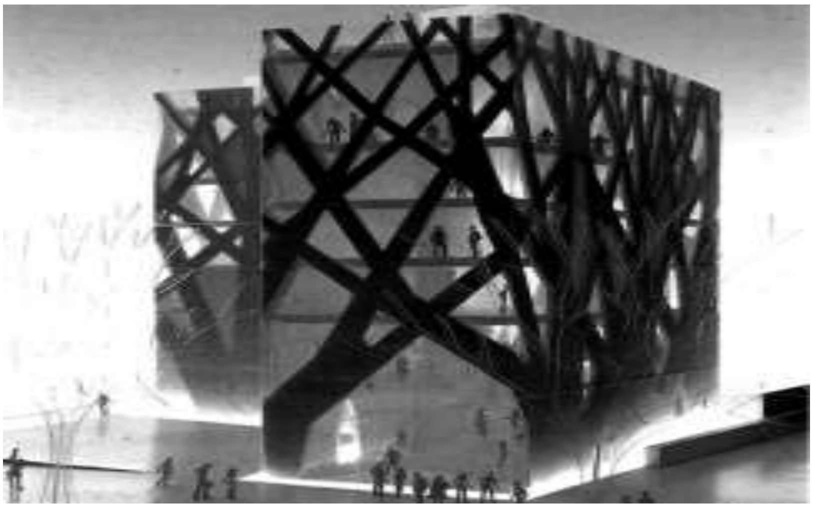

Figure 1. A design by Toyo that reflects bionic thought

However, whether considering light exposure or resistance earthquakes, there are many shortcomings in the modern design which this essay seeks to address.

1.1. Required Preconditions

In terms of light and heat regulation, the core concept this essay explores is based on the behavior of sunflowers which rotate their heads to track the sun. Based on this concept, it would be possible to make future buildings rotate to follow the sun and, thereby, gain more light and heat energy (or the opposite, if that was desirable). In addition I would also want to make it able to withstand a big earthquake. In order to achieve this aim, it is desirable to use lightweight but strong material to provide a safe structure, which can withstand a large earthquake. In addition, an effective power system is required to provide the large rotational force the building would require to follow the sun.

1.2. **Methodology**

The key principle is that building will rotate to follow the sun, giving it a “sunny characteristic”. Thus the building can be made to always face towards (or away) from the sun so as to manage the light and heat levels in a more natural way.

1.2.1. The design of the building’s foundation

According to above ideas, we can take advantage of special lightweight but strong material to design the base of the house so that it can support the weight of the whole house and the rotational forces. Our ideas have a bionic inspiration which is continued in the design of the foundations by considering how a plant is fixed in the ground using firm roots. Our house's foundation is also designed in a similar way using suspensions between the foundation and the superstructure. So this design should be able to survive an earthquake using a combination of fixed foundation and suspensions.

This design aims to simulate the shape of plants' roots using steel tubes driven into ground deeply (reflecting bionic ideas of plant roots). After the steel ‘roots’ are set into ground, an exploding nail (as shown in the Fig.2) will be unfolded from the steel’s tips using compressed air released into the steel tubes, resisting them being withdrawn from the ground (as shown in the Fig.**3**), thereby making the buildings' foundation firm.

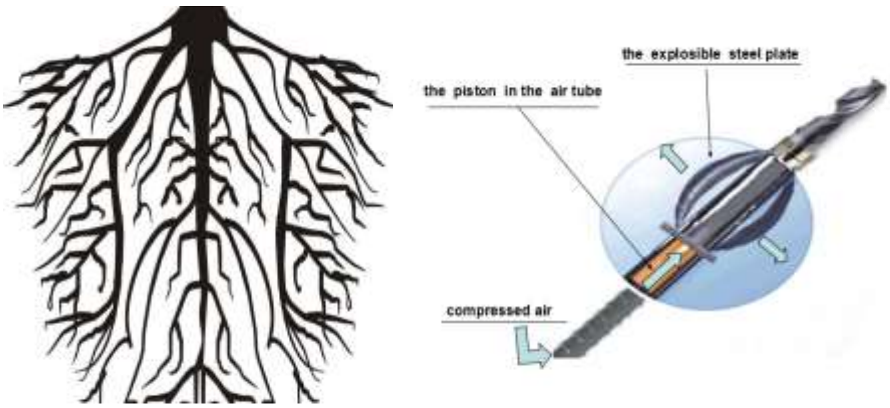

Figure 2. The design of building's foundation

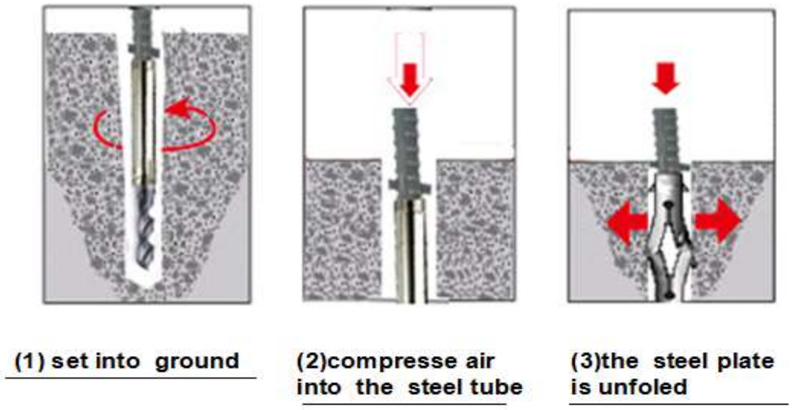

Figure 3. The flow chart of operating this design

The foundation's suspensions should be firm enough to support the buildings weight while resisting a big earthquake effectively. An axel will support the whole building, and allow it to rotate using high power motors (as shown in Fig.4).

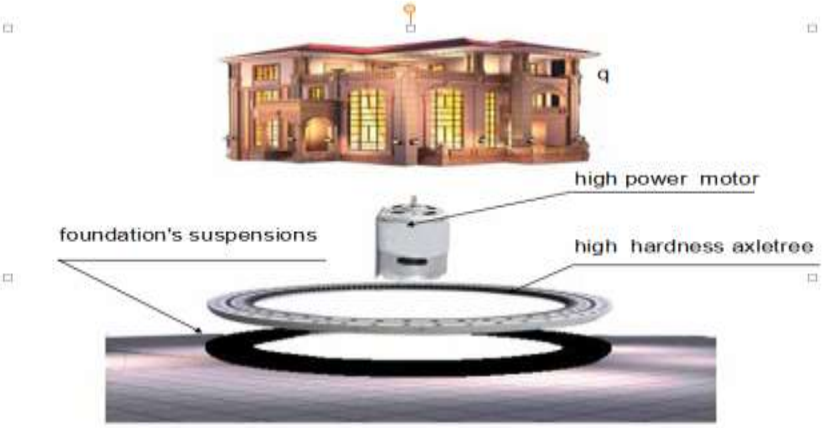

Figure 4. The foundation’s suspensions and power system

1.2.2. The design of the wall

The walls of the building would include a photoesthetic material, as shown in figure 5. This photoesthetic material would absorb sunshine as energy which could be stored and used for applications such as rotating the building. The photoesthetic wall would also reduce the building’s weight. The conversion efficiency of flexible CIGS solar cells can achieve at least 17. 4% [4] so the energy of light that the wall absorbs should be enough to provide the building’s rotational needs.

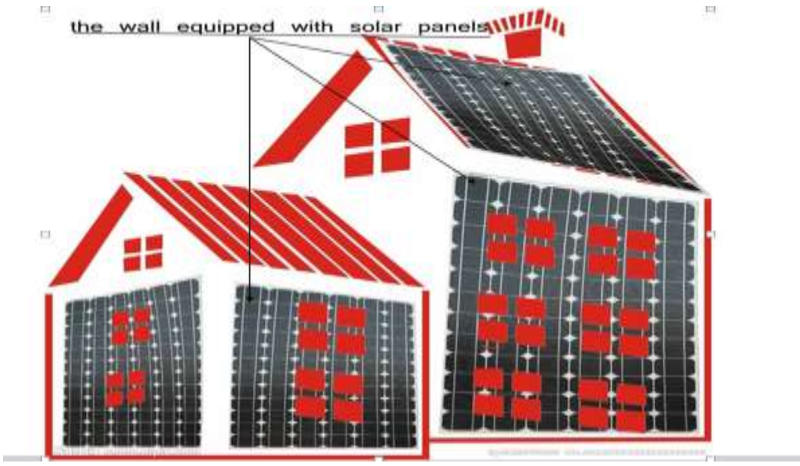

Figure 5. The wall of the building is constructed from lightweight photoesthetic material

If such a house could be constructed the light and heat from the sunlight could be controlled to better match the occupant's desires. Because the house can rotate and follow the sun, it can absorb sunshine and heat energy as much as possible. Therefore, the living area of a house could face to the sun (or the opposite) all day. In summary, we could live in a house facing to the sun all day and enjoy the well lit and warm house.

2. The Smart Transportation

There are more than 1.3 billion people in China; which many regard as overpopulated. Overpopulation may be thought of as over-crowding: too many people in a given area or too high a population density. However, "overpopulation" does not only exist in China, but also in Japan, India and other countries. For example, Monaco has the highest population density in the world. This over-crowding frequently leads to traffic jams. Statistics show that car collisions associated with lane-change maneuvers are more likely to occur on wet roads, while rear-end collisions are more likely to occur on dry roads during daylight [5]. So different weather, conditions will be result is different types of problem. We all know both rain and snow will hinder normal transportation, such as icy roads, fallen trees, and so on. Crossroads' can be another cause of slow moving traffic various solutions have been introduced, such as the traffic light, overpass and underpass [6]. However the traditional traffic light is inefficient as cannot schedule the rate of traffic flow. More advanced smart traffic light can adapt to traffic flows, thereby reducing the problems from crossroads. The design of overpass or underpass is more convenient than traffic light but can introduce its own problems. As an alternative to public transport, walking or cycling are popular ways to promote 'green travel', especially when public transportation does not work normally due to traffic accidents caused by the weather. Therefore, there are numerous reasons to investigate the design of alternative transportation systems. In the following section, I explore one such alternative transportation system.

2.1. **The Intelligent Strategies**

Figure 6. ST-I Transportation system - People enter the 'ST-I' in stage (1), stage (2) accelerates the passengers to match the subway speed, finally at stage t(3) passengers will transfer to the subway.

The basic way to improve traffic flow is to reduce the number of times public transport stops and starts. This is a difficult problem to solve. One approach might be to adapt the passenger's speed to the public vehicle's speed at stations, thereby avoiding the need for vehicles to stop. So, for example, there might be a mechanism to allow every passenger's speed and location to align with the public vehicle. That is to say, the public transport keeps travelling at a uniform speed meaning passengers do not need to waste time waiting for a few people to get on or off. To achieve this idea, we need to provide a special accelerator, which I call ST-I (means saving time), which would be a special kind of vehicle, used to assist people boarding public transport. This design is not suitable for surface-transportation because it will introduce pedestrian safety issues, thus it is better suited to a subway, as in our example.

To illustrate the ST-I operation, assume that there is an 'ST-I' at every home, with sensor networks installed within the subway stations. The sensor networks manage movement of people and ST-Is in the subway. The 'ST-I' connects to the subway, as shown in Fig.6. The 'ST-I' returns to the owners' home when the people enter into the subway safely. If an 'ST-I' encounters other users, it will simply be queued until the route is clear. Accordingly, the subway can operate continually at full speed. If this design was implemented, people would save much time and eliminate queues for the subway. This design is compatible with other high technology. For example it would be easy to use this with an electronic smart map on a smartphone or computers displays embedded into the vehicles.

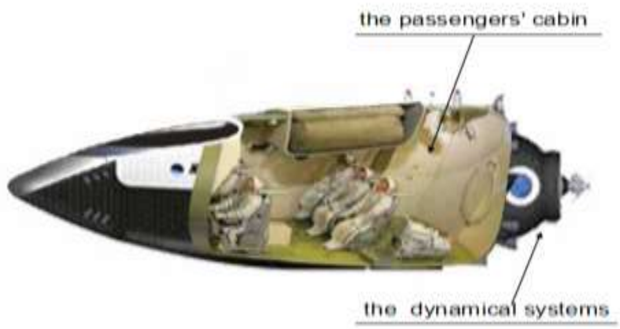

Figure 7. The inside of an ‘ ST-I’

Concerning the subway vehicle technology, they might work based on the theory of structural dynamics and aerodynamics, the non-compressible viscous fluid Navier-stokes formula and k-ε 3D turbulence models, which are treated as the foundation to establish the aerodynamics model of the ‘ST-I’ [7]**.** This design should be good at reducing air resistance. The inside and outside of the ST-I are shown in Fig. 7 and Fig.8. To be comfortable the ‘ST-I’ should also aim at reducing the feeling sudden acceleration, which is also an issue in manned spaceflight technology (although our ‘ST-I’ will be travelling slower). In addition to speedier movement, the effect from bad weather is smaller, further reducing people’s traveling time. If this system could be built my hope is the problems from traffic will disappear from earth.

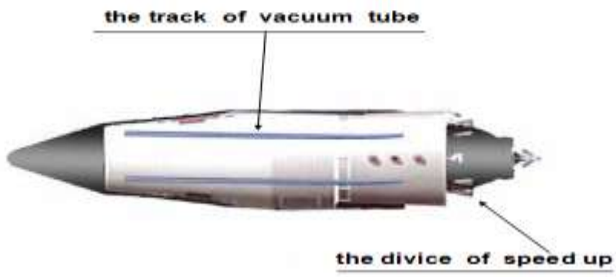

Figure 8. The outside of the ‘ ST-I’

3. Conclusion

The future is impossible to guess, as the possibilities are too large. As long as you dare to think, all our dreams become a possibility. From this writing it is clear that university education not only pays attention to develop cultural, professional and physical attainment, but also gives importance to imagination and the creative abilities of university students. For example, Michel Godet argues [8]:

1. The world changes, but the problems are the same;

2. We tend to overestimate technological change;
3. Simple tools are suitable for complex problems;
4. We should ask the right questions and quash conventional thinking.

So we should always keep one heart about creating and be good at discovering something strange. Only lifelong learning is able to maintain the brains of young people. In addition, science is at its most useful when the science serves the public. Although all the designs I have described are from my imagination and do not exist, I believe this approach is important because, if we all try to think in creative ways about the future, education will be more engaging, our countries will prosper and we will all enjoy better products and lifestyle in the future.

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