Toward the production of future heritage structures: Considering durability in building performance and sustainability – A philosophical and historical overview

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Received 6 July 2012; accepted 16 February 2013

Abstract

Modern society values historic structures but makes no effort to build future heritage. Moreover, present construction, based on reinforced concrete and steel, lacks the durability of earlier eras. A focus on initial cost, the lack of long-term financing, and government policies have decimated the skilled trades, while unemployment in developed countries remains high. A renewed focus on sustainability would utilize materials more effectively to enhance the durability of modern construction, and would therefore justify greater use of skilled trades, thereby contributing to the reduction in unemployment and general well-being of society. The production of future heritage requires synergies that may imply changes in economy, public policy, and philosophy.

Keywords: Heritage; Durability; Sustainability; Construction; Unemployment rate

1. Introduction

In several modern historical towns in Europe, two types of buildings coexist: those built from stone, bricks and timber, which may be several centuries old, and those built in the last 40 years, typically of reinforced concrete, and unlikely to last more than 150 years (Mehta and Burrows, 2001). Some of the older buildings have been restored and are now serving modern needs, increasing their working life and contributing to sustainability through their restoration. Despite modern advances to increase the durability of reinforced concrete structures, expectations...
are limited, and it is unlikely that the durability of ancient structures will be attained. Modern construction is quickly built, supported using reinforced concrete and steel, and unlikely to last more than a century. As an example, the Alhambra (Spain) has towers from the 11th century that are still standing; these towers are composed of poor quality brick yet no significant repairs have been needed.

Today's society is unable to find a way to build beautiful, long-lasting, structures for the benefit of the present and future generations, while benefiting from the heritage structures built by previous generations. Maintaining heritage but not building heritage represents a change in social values and perspective on the role of society. Many current problems such as the lack of environmental sustainability, high unemployment, social alienation, and spiritual absence would be partially mitigated by increasing emphasis on durable construction.

Some of the façades of the old buildings took a long time to construct, in part due to the ornate embellishments of their façades and sculptural works. Today, this type of construction cannot be justified from an economic point of view—with high initial costs and short payback periods, such construction might be regarded as sheer madness. Yet, today we appreciate ancient construction, and such works form part of our cultural identity. Those works were paid for by one generation and are still being appreciated many generations later.

The notion that we should build durable construction to serve future generations is absent from present social and political discourse, and durable construction is not being built at present. Rather, today’s society is focused on minimizing initial (or up-front) costs without regard for durability. Consequently, the service sector (for repairs) is booming, displacing manufacturing and accounting for 60% of the economy in the United States.

The present era provides modern tools and contexts that must be considered to generate future heritage by the construction of extremely durable structures. Three main different areas have to be studied:

- **Structure and construction methods**—new building concepts are needed.
- **Financial**—new building concepts must be evaluated to establish that attractive financial outcomes can be found. New financial instruments and public policies may be needed.
- **Philosophical**—although these new building concepts are not a cure for all of society’s ailments, people contributing to the project must have the sense that they are building a long-lasting masterpiece to be cherished for many generations.

The ultimate solution must simultaneously address these areas. It would be desirable that the solution be competitive in the current marketplace.

### 2. Structural engineering and durability

The advent of reinforced concrete in the late 19th and early 20th century promoted the massive construction of reinforced concrete structures such as buildings and bridges, which replaced the masonry and timber structures used previously. As the passage of time shows, this reinforced concrete material—which was once believed to be eternal—shows durability problems mainly due to corrosion of the reinforcement, alkali aggregate reaction, freeze thaw cycles, continuing deformation over time (creep), and overloading. These problems associated with concrete structures have been well studied (Gebregziabhier, 2008).

As a result of these pathologies, many of the buildings from the 1950s, including the masterpieces from Torroja, Le Corbusier and so on, are now in states of disrepair. Unfortunately, future generations will only be able to see them in pictures.

Many advances have been made to improve durability, mainly with regard to materials. Certainly, we can turn to structural forms that have been used successfully for millennia, such as arches, domes and other variations. Still other shapes might be found through careful study, in some cases using modern computational methods (e.g. Hernández-Montes et al., 2005). These forms are used in concert with extremely durable materials such as stone, brick, unreinforced concrete, or even concrete in which non-corrosive materials are used as reinforcement. Use of pozzolans and
lower-strength concretes can reduce the environmental footprint of concrete, which already contributes some 8% of total CO₂ emissions worldwide. The durability of these shapes and materials have been demonstrated in historic constructions such as the Etruscan arch of Volterra (2600 years old), the Agripa’s Pantheon (2050 years old), the towers of the Alhambra (1000 years old), and several roman aqueducts, which are still in use.

3. Financing costs and benefits

The built environment serves many functions and a limited focus on minimizing construction costs misses many of the associated benefits or services, both tangible and intangible. Of course, the most obvious of these is sustainability—increased initial costs can produce a design more attuned to the environmental context that can greatly reduce resource (e.g. energy and water) consumption and environmental consequences (e.g. pollution and greenhouse gas emissions). But monumental and heritage structures also are edifices that provide a visual embodiment of societal values and concerns.

One modern illustration is the renaissance in real estate—fueled by rising affluence in recent decades—that focuses now on more enjoyable towns and suburbs, built of high quality materials and having various amenities that can be accessed on foot:

“A new age of real estate is upon us, where the quality and richness of our built environment can again mirror the quality and richness of our society” (Lister, 2007).

Thus, it is apparent that there is a market even in today’s economy to support higher quality design and construction. Leinberger (2007) recognizes the contribution that walkable neighborhoods have to health, and the time that it takes for the potential in such neighborhoods to be realized in terms of property values and return on investment:

“How patient equity contributed to the success of several such developments built over the past 15 years, illustrating untapped potential”.

Of course, walkable neighborhoods have further economic and environmental impacts owing to improved health (and thus, reduced medical expenses) and reduced greenhouse gas emissions associated with reduced use of fossil fuels for transportation. Such benefits are not normally included in the economic case that must be made for financing new construction.

High quality construction will cost more, but can have benefits including greatly increased durability, greater useful life of resources used in construction, reduced environmental impacts, increased employment of skilled artisans and craftspeople, and the embodiment of societal values in long-lasting, beautiful buildings and neighborhoods. These benefits can be realized over much longer time scales than are currently considered in construction financing. Neighborhoods of several hundred or perhaps a thousand years are not uncommon in Europe, whereas nearly all American construction is less than one hundred years of age.

Finally, none of the existing historical buildings could have been funded nor, therefore, built, with the current financial products available to developers. Today’s term of 30–40 years, would need to be extended to recognize the slower depreciation, or perhaps appreciation, characteristic of long-lasting construction. Perhaps there is a role for new financial products to enable “new” long-lasting construction to be built. Public policy could explicitly recognize the indirect benefits and value to society provided by long-lasting construction. For example, long-term financial instruments could be partially underwritten by the government, or perhaps special tax laws could be enacted to reflect the public interest.

4. Town planning—urbanism

The classic and fundamental principle in any territorial intervention or construction is to minimize costs (social, environmental, economic, etc.) while creating new value, McHarg (1969). The goal of increasing territorial heritage and territorial capital has to guide any action in the territory.

Historically, and particularly in recent decades, heritage matters have widely been studied and have become of high significance, (Choay, 2001). However the current consideration of heritage is limited to historical constructions.

To increase the existing heritage (i.e. beautiful long-lasting buildings) the area of Urbanism has to explore the possibility of erecting new heritage structures in the cities, identifying the most appropriate locations in order to promote territorial integration of new heritage structures in the overall planning area. Such development would increase what is now known as territorial capital, (European Parliament (EP), 2007).

In this context an additional step is needed: the preservation and promotion of future heritage. New considerations for the development of individual construction projects should be identified, as promoting new heritage for future generations as elements of urban and territorial regeneration.

5. Sustainability through durability

One principle of sustainable design is quality and durability: longer-lasting and better-functioning products will have to be replaced less frequently, reducing the impacts of producing replacements. Increasing the working life of a building from 100 to 1000 years, reduces the annualized environmental impact of its construction to one-tenth. This implies a reduction in the annualized embodied energy and the CO₂ emissions by 90%.
CO2 emitted from the production of Portland cement is considered to account for approximately 5–8% of global CO2 emissions; approximately 1 tonne of CO2 is emitted per tonne of cement produced (Cement CO2 Emissions, 2012). The production of steel also contributes to global warming, with an average of 2 tonnes of CO2 (equivalents) emitted per tonne of steel produced, even accounting for the fact that the recycled content of steels used in construction is quite high, (ArcelorMittal, 2012). In this context, the use of traditional construction materials such as stone, masonry and timber appear to be inherently more sustainable, if used to achieve durable construction.

Furthermore, it is necessary to consider the ethical aspect of the use of different materials, mainly in relation to the use of fossil fuels and their sustainability (Hagan, 1998). The increasing focus on sustainability is reflected in the focus of the US National Science Foundation (NSF) of the USA, which has designated approximately 1/3 of its budget to sustainability research.1

6. Social life cycle assessment

Today’s building systems require engineers and architects but, except for some specific processes such as welding, highly skilled workers are not utilized. Skilled labor (e.g. in building trades and crafts) has been decimated in recent decades. Building system components are increasingly manufactured in centralized plants rather than fabricated on site.2 As a consequence, trade people such as stonecutters, quarrymen, glaziers, carpenters, etc. have become nearly extinct, since they are rarely needed these days. Skilled artists such as sculptors, leaded glass makers, decorative tile setters are difficult to find today. As a result, training of future generations is compromised and trade skills and knowledge may be lost. Skilled labor has been replaced by industrial processes that so far are unable to mimic the look and feel of the products made by these craftspeople, especially in the construction of new heritage. In this sense, social implications and potential impacts on society can be assessed using a new approach, termed Social Life Cycle Assessment, which is now being developed (United Nations, 2009).

While such craft may be an indulgence for a modern building of limited life, it becomes feasible for extremely durable construction, where the benefits are sustained many times over. Extremely durable construction can enliven a new era of craftsmen and artists who will use modern tools and fabrication methods.

At the present time, the unemployment rate is high in Europe and North America (e.g. over 20% in Spain), with young people hit particularly hard. It is evident that jobs are needed, but the current market is unable to create them. A focus on extremely durable structures would rejuvenate employment among the crafts and trades. Work is more than just being paid for one’s effort. The social dimension is important as well—work allows an individual to feel they are making a contribution to the society, develops their skills and self esteem, provides social relations, and allows that individual (and his/her family) to stimulate the economy further through their own consumption. Thus, job creation contributes beneficially to society in many ways; this societal benefit may justify changes in public policy that would promote the construction of extremely durable construction.

Given that society is not presently building anything durable to last for centuries ahead and the large number of unemployed people that, in one way or another, are being supported by the rest of society until they obtain employment, providing opportunities to recover the various trades needed for long-lasting construction can be an option.

7. Philosophical perspective

The philosophical significance of the word “work” has many different interpretations, as discussed in the previous section, including some that cannot be evaluated in economic terms. Several aspects related to the construction of long-lasting structures should be treated on a more philosophical level.

The current economic crisis has led to an increase in financial debt without a counterpart increase in real goods. The low level of real income has led inexorably to an increase in poverty, while the increased debt has led to currency devaluation and inflation.

To date, all government efforts to tackle the current European economic crisis have failed. The effort to adjust costs and reduce consumption has provoked a rise in taxes that has impoverished the middle and lower class. The credit is dedicated purely to cover the countries’ financial debt and the consequence of this lack of credit is that any increase in productivity is hampered. The solution to this economic crisis is difficult because the debt cannot be reduced because doing so creates a vicious cycle of reduced productivity and therefore reduced tax collections and therefore less money with which to pay the debt; meanwhile concern about possible insolvency raises the interest rate that must be paid on new debt, further perpetuating the problem. At the same time, savings and investment are reduced because they feed the debt.

Perhaps today’s society is experiencing the birth of a new historical cycle, which implies a change which is not merely economic or political. The debt problem does not have a solution because it is the corollary of the consumer mentality, which was born in the sixties and has lasted over

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1 The 2012 proposed budget of $7.77 billion includes $998 million for the Science, Engineering, and Education for Sustainability program (NSF, 2011), while Suresh (2012) notes significant portions of other NSF programs fund projects with significant sustainability components (e.g. 40% of the 170 IGERT awards).

2 The lack of skilled labor has progressed to such an extent that even manufacturing companies proclaim the lack of skilled labor as the primary barrier to building new manufacturing facilities in North America.
half a century. The ideologues of the Cultural Revolution of Berkeley or French May (Marcuse, Fromm, Adorno, etc.) contributed to the move from an economic framework based on productivity to consumption (Horkheimer, 1967): “make love not war” may be viewed as an invitation to live without working. At this time the consumer mentality emerged and over time technology has been put at the service of consumption, with an ever-improving standard of living fueled largely by non-renewable sources of cheap energy.

The constant and increasing desires of consumers are satisfied by rampant credit flow, which has gone unchecked by both governments and central banks. The corrupt democracy, haunted by electoral processes and special interests preoccupied with short-term profits, is not willing to forgo the profits if the process were to be slowed. Even when international agencies offer solutions to the specific problems created by debt, they are unable to solve a problem that is fundamentally cultural, ideological and spiritual.

In this economics context, the creation of new heritage or long-lasting structures implies a return to fundamental notions of value. Real value is generated by the intelligent use of land and labor. The creation of neighborhoods or buildings in which the designs are not based on real estate speculation but rather as a repository of value for the medium and long term implies a deeper respect for humanity in the specific work and the economy, more generally.

Just as in the Marshallian model of the car, the entrepreneur as well as capital and credit should be focused on increasing the value, quality, durability, and sustainability of the project in question, rather than being concerned with short-term profit.

8. Concluding remarks

The challenges involved in making construction of long-lasting structures feasible in this modern era draw on many inter-related fields (e.g. Fig. 1). The most significant challenge is establishing financial tools and incentives, to the extent justified by societal goals, to recognize value and allow repayment over longer terms. The remaining aspects can be reasonably solved by the society that, disenchanted by the existing economic crisis, recognizes a need for a change of mentality. Perhaps the XXI century will be the beginning of a new historical cycle, with cultural and ideological changes occurring that allow society to move away from the consumerism and preoccupation with short-term profits that have prevailed in the second half of the XX century.

References