Heritage Building Preservation – The Ultimate in Green Building?

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Abstract

The trend towards building green is gaining momentum. Much of the early emphasis has been on new buildings but there is increasing awareness of the importance of 'greening' the existing building stock. A small but significant proportion of existing buildings are considered to be heritage buildings and the need to 'green' these buildings while protecting their heritage values is an additional challenge that needs to be addressed. This paper discusses the opportunities and issues related to the rehabilitation of heritage buildings in a 'green' fashion. It also explores the potential synergies between heritage preservation and sustainable development.

Green Buildings and Sustainability

In recent years a worldwide rise in environmental concerns has placed sustainability at the forefront of the political agenda. Many governments have introduced policies for the purpose of conserving energy, increasing renewable

energy sources while reducing carbon emissions. There has also been strong consumer demand for a wider based 'greening' of products and services. According to the US Green Building Council, buildings account for 12% of water use, 65% of waste output, and 70% of electricity consumption in the United States alone (Nicolay, 2007). In terms of global energy consumption, the built environment accounts for 40% of this (Kolokotsa et al, 2009). The Intergovernmental Panel on Climate Change (IPCC) projects that through cost effective mitigation measures in the building sector it is possible to avoid at least 29% of the projected global carbon emissions (IPCC, 2007). The property industry therefore offers significant opportunities to improve sustainability and sustainable or "green buildings" are now widely considered the way of the future for the property industry (Roper and Beard, 2006).

Definition of Sustainability and Green Buildings

As with all concepts in the process of establishment, there has been confusion over the term sustainability but it is coming into focus. The most widely accepted definition is that of the United Nations Commission who authored the Brundtland report in 1987. They defined sustainable development as

Development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs

In a study by Francesco and Levy, Australian & New Zealand respondents agreed with a definition of sustainability that included "alignment of (the natural) environment and social objectives with commercial objectives" (De Francesco & Levy, 2009). This reflects a widely accepted notion that the principle of sustainability embraces taking three important factors into consideration, economic prosperity, social advancement, and environmental protection also commonly referred to as the Triple Bottom Line.

In terms of sustainable/green buildings, there is currently no single agreed definition but they are commonly regarded as environmentally responsible buildings that increase the efficiency of use of resources such as energy, water, and other materials, while reducing the impacts of buildings on human health and the environment throughout the building's lifecycle, through better design, construction, operation, maintenance, and de-construction (Frej 2005).

Measurement of Green Buildings

There has been substantial recent development of tools to evaluate the features of green buildings. These assessment tools are becoming more widely accepted with most developed countries having at least an energy rating system (Schleich et al. 2009). Below are examples of commonly-used green building assessment tools in some countries:

- New Zealand: Green Star
- Australia: Nabers and Green Star
- United States: LEED, Breeam
- United Kingdom: Breeam, LEED
- Canada: LEED Canada
- Netherlands: Breeam Netherlands
- China: GBAS

These rating systems aim to provide an objective measure of how green a building is, but are not without their problems. Typically they use a point system covering various categories of performance and there are variations for application to different building types or to different stages in the construction and occupation of a building (CB Richard Ellis, 2009).

The two most commonly-used assessment tools worldwide are BREEAM (Building Research Establishment Environmental Assessment Method) and LEED (Leadership in Energy and Environmental Design). In some cases these have been adapted and used to rate buildings outside their country of origin but again not without problems.

These tools have some important differences one being that BREEAM schemes focus on the type of building (offices, school, industrial etc) while LEED focuses on the buildings being new or existing. The various assessment tools are evolving rapidly at the same time as their use is becoming more widespread. For example LEED 2009, also referred to as Version 3 has just been released and the next revision is already being planned to be released later this year. LEED 2009 is a comprehensive review that partly overcomes a number of concerns that LEED accreditation failed to consider adequately the benefits of rehabilitating existing buildings or that it failed to give sufficient recognition to site location. An organisation known as the "Sustainable Preservation Coalition" was formed to work with US Green Buildings Council to amend LEED to incorporate preservation, social, and cultural values into LEED. (Campagna, 2008). As a result LEED 2009 now has an increased number of points available and uses Life Cycle Assessment (LCA) so that LEED 2009 is better aligned to the goal of sustainable development than its predecessor.

Of note is the development of LEED for Neighborhood Development (LEED-ND) by the USGBC which is a rating system that combines the principles of smart growth, new urbanism and green building into a rating system for green neighborhood development. This recognizes that the context and location of a green building are important in terms of sustainability (Nowakowski, 2009).

Note also that some rating measures only consider specific aspects of building performance such as energy usage, i.e. Energy Star, while some take a holistic approach considering design and operational criteria. An example of the latter is

the Green star rating tool launched by the New Zealand Green Building Council in 2007.

Growing Importance of Green Buildings

Consciousness of environmental issues amongst businesses is becoming significant and many are implementing policy and initiatives to improve their environmental performance. A Colliers International office tenant survey found that 71% of all organisations surveyed said that they are conscious of reducing energy use and greenhouse gas emissions while 57% have implemented initiatives to improve the environmental performance of their workplaces (Colliers International, 2006).

The survey also found that, more businesses will seek to occupy buildings (new or refurbished) that reflect Corporate Social Responsibility values. Features that may be desirable include:

- Good environmental sustainability credentials, including Green Star ratings.
- Good building environmental performance monitoring systems to support corporate social responsibility or sustainability reporting.
- Expression of a positive relationship with the community through building attributes such as visual transparency (interior-exterior), public or semi-public spaces, and cafes and other public amenities within the building.
- Workplaces that support the development of organizational cultures suitable for embracing corporate social responsibility. This includes cultures of knowledge-sharing, innovation and teamwork.
- The ability to showcase high levels of employee wellbeing to external stakeholders such as clients.

According to the New Zealand Green Building Council, 50% of all new and major renovations in the New Zealand office sector are green buildings, and going

through the Green Star certification system (New Zealand Green Building Council 2009).

Adding impetus to the green building trend is the actions of governments around the world to impose mandatory green upgrades or provide incentives to promote green building practices. A trend for governments to require minimum green standards for buildings they own or lease is also providing a market stimulus for constructing new green buildings.

Building Factors Most Prevalent in Green Building Rating Systems

Employing more energy efficient building features can reduce the demand for the extraction, generation and consumption of energy and have a significant impact on the environment. Non-renewable energy demand can also be reduced by energy generation from renewable sources (New Zealand Green Building Council, 2009).

The 2006 Stern Review on the Economics of Climate Change reported that the built environment is a significant emitter of greenhouse gas emissions; if 'upstream' emissions from heat and electricity are included, emissions from buildings total 20% of global greenhouse gas emissions. At the same time, the Working Group of the 2007 Intergovernmental Panel on Climate Change (IPCC) noted that the built environment can provide a significant amount of cost-effective greenhouse gas mitigation; more than any other industry (New Zealand Green Building Council, 2009).

In terms of energy usage, the World Business Council for Sustainable Development (WBCSD) states that in OECD countries, the building sector accounts for 25-40% of the final energy demand globally.

Building shell performance has a large impact on the heating, cooling and illumination requirements for commercial buildings, currently accounting for 58% of commercial energy use. Improvements in the thermal, daylight and natural ventilation performance of commercial building shells will reduce emissions directly by lower energy consumption, and indirectly through lower cooling requirements (New Zealand Green Building Council, 2009).

Lighting luminance levels are an important factor in determining occupant wellbeing and health in an office. Lighting that is too dim or too bright can cause discomfort and strain for office occupants. A building owner and lighting designer usually provides office-standard lighting before the office space has a tenant and the usage of the space is known. For tenancies, lighting expenditures can represent two-thirds of total energy costs. By installing systems with inbuilt flexibility the occupants can modify the lighting system to their needs, adjusting the lighting intensity of different areas to provide efficient lighting levels that are suitable for the various activities of their office and minimising their energy consumption (New Zealand Green Building Council, 2009).

Efficient use of water in buildings can both reduce building operational costs and conserve increasingly valuable water for other uses. Demand for potable water can be reduced through recycling from rainwater, grey water and black water, installing water-efficient appliances and fixtures, behavioural changes amongst occupants and changes in irrigation methods. In combination these can reduce consumption by 30% or more.

Indoor Environment Quality (IEQ) is critical to productivity, workplace satisfaction and self-reported worker wellbeing. Fanger (1999) has estimated that the overall performance of office tasks is estimated to increase by 1.9% for every two-fold increase in ventilation rate at constant pollution load. The World Health Organisation (WHO) estimates that up to 30% of new and remodelled buildings worldwide may be subject to excessive complaints related to indoor air quality

(New Zealand Green Building Council, 2009). Employers, building owners, product manufactures, engineers, architects and builders are all at risk of litigation arising from claims based on indoor air pollution and poor IEQ.

Management is also a very important component of sustainability. Once a building is in operation property commissioning and tuning can ensure that all systems meet their design potential and training and ongoing information management are essential to enable building users to contribute to the building's environmental performance.

The Greenest Building Is The One Already Built?

Based on the concept that a green building will balance long term environmental, social and economic considerations the terms "sustainability" and "green" should be able to be used interchangeably. However, closer analysis of many new green buildings or green building upgrades would indicate that green building does not always meet the criteria of sustainable development.

A common catch cry amongst heritage preservation advocates such as Elefante and Rymeka is that "the greenest building is the one already built" (Elefante, 2007). This assertion is based on the following arguments:

<u>An existing building does not create waste</u>

The construction process inevitably creates waste which must then be dealt with in some way. Traditionally this has been by dumping in a land fill. Adding to the environmental problem is that some of the material can be toxic such as treated timber.

If the new construction requires demolition of an existing structure then the problem is increased as significant amounts of demolition material must also be disposed of in some way.

It has been estimated by the Organisation for Economic Co-operation and Development (OECD) that the construction industry contributes approximately 40% of all waste going to landfill. This is despite the fact that much of the waste can be a valuable resource and re-used or recycled. As the implications of waste become more widespread, re-use and recycling practices will increase. A 1997 Auckland study showed that by simply sorting construction industry bin waste, it was feasible to reduce the amount going to landfill by 50-55%, using off the shelf equipment and technology (New Zealand Green Building Council, 2009).

An existing building conserves embodied energy and human capital

Inevitably any new building places high demands on the environment and it has been estimated that the building and construction sector globally accounts for 40% of energy use; 40% of greenhouse gas emissions; 16% of fresh water withdrawals; and 25% of wood harvest (Sustainable Buildings Day: Summary Report, 2005).

The concept of “embodied energy” has been around since the 1970’s when case study analysis was commissioned by the National Trust and the Advisory Council on Historic Preservation. Embodied energy is defined as the amount of energy associated with extracting, processing, manufacturing, transporting and assembling building materials but does not include use or disposal.

The loss of embodied energy when an existing building is demolished means that any new replacement green building starts with a handicap in terms of energy usage. It may well take an entire lifetime of energy ‘savings’ produced by energy

efficient design of the green building to make up for the loss of embodied energy that was contained in the original building. In addition the process of demolition also uses energy.

Based on Life Cycle Assessment, Rehabilitation is more Sustainable

The process of Life Cycle Costing has long been used in the construction industry as a method of evaluating all the relevant financial costs associated with a building project or building material throughout its life. This process involves evaluating the 'true' cost of a material or project by considering not just the initial capital costs involved but also the costs of maintenance, operation and disposal throughout its life.

In a similar way the true cost to the environment of a building project can also be evaluated using the process of Life Cycle Assessment (LCA). This process evaluates the direct and indirect environmental impacts associated with a building, and is considered superior to other forms of environmental assessment as it is a "whole of life" concept rather than focusing on a particular stage of building.

The use of life cycle assessment reveals that retaining and rehabilitating buildings is more environmentally friendly than new construction (Frey, 2007).

Many existing buildings are well designed and already energy efficient

Existing buildings in many instances are examples of vernacular buildings which are well adapted to their particular site and local climate. Older historic buildings in particular, had to rely on natural light and ventilation before the advent of modern heating, air conditioning and lighting systems. Such buildings may also

have a high thermal mass when they have been constructed out of masonry providing passive heating and cooling.

Data from the U.S. Energy Information Agency finds that buildings constructed before 1920 are actually more energy efficient than those built at any time afterwards – except for those built after 2000. In 1999, the general Services Administration examined its building inventory and found that utility costs for historic buildings were 27% less than for modern buildings. (Moe, 2009)

Preserving existing buildings supports "smart growth" objectives

Smart growth aims to reduce sprawl and thus reduce the loss of farmland and natural habitats. By keeping urban area compact reliance on private cars is reduced as is the need for costly new infrastructure. For example studies have shown that preservation projects that utilize existing historic buildings save between 50 and 80 percent in infrastructure investments relative to suburban green field development. (Evans 2009). There are also substantial environmental benefits that are attributable to reduced vehicle miles travelled (VMTs). Economic development consultant Donovan Rypkema makes the point that additional VMTs caused by building a new green development in the wrong location will result in environmental harm despite the supposed benefits of the green building. He uses this as one example to show why he considers green buildings are not synonymous with sustainable development (Rypkema,2006).

Investment in existing buildings has economic advantages

Numerous economic studies have shown that rehabilitation work uses less materials but more labour than new construction. This creates more employment and this means that there is a greater multiplier effect within communities,

particularly due to the high local content of the employment created. As Moe points out an economy that is more labour intensive and less materials intensive is a greener economy. (Moe, 2009)

Based on the above arguments it would appear that the strategy to achieve sustainable development should be based around greening the existing building stock rather than building new 'green' buildings. However there are some challenges with this approach. For example:

Existing development may be low density

Existing building developments may be situated in localities required for high density development in order to promote smart growth and contain urban sprawl. In order to implement sustainable development strategies there may be a need to replace existing low density development with high density development. However, there are planning tools that can be used to retain existing buildings while increasing average building densities. For example, transferable development rights can be used to achieve a range of densities within a growth catchment while achieving high average densities. Another alternative is to use in-fill development where possible to increase development density by using under- utilized sites.

Existing buildings may be poorly built and planned.

Within the existing building stock there are many examples of poorly planned and built buildings that are not energy efficient and are likely to be difficult to maintain or rehabilitate. Elefante considers what he terms modern-era building stock to be particularly problematic. These are buildings constructed in the 1950's, 60's, 70's and 80's of materials and assemblies that often lacked the durability of their

predecessors and tended to rely absolutely on equipment that uses fossils fuels. It is estimated that such modern era buildings represent 55 percent of the existing non-residential building stock in the USA. (Elefante, 2009)

Existing buildings may be perceived as obsolete

The perceived benefits of green buildings and the traction that green marketing is getting in the market place may mean that existing buildings suffer a loss in value. This loss in value may encourage the owners to demolish existing buildings and replace them with new 'green' buildings. This situation may be made worse by mandatory requirements in terms of upgrades or in terms of leasing by public organisations and governments. Green rating systems have become a powerful marketing tool and facilitate 'green washing" strategies that do not necessarily promote sustainable development.

Can Heritage Buildings Go Green?

Within the stock of existing buildings are those buildings that have been identified by their communities as being heritage buildings. A heritage building is one that has a heritage value that typically springs from the following attributes:

- Aesthetic Value
- Architectural Value
- Cultural Value
- Historical Value
- Scientific Value
- Social Value
- Spiritual Value

- Technological Value
- Traditional Value

They are often already ‘green’ for the reasons discussed earlier in this paper. They enjoy the advantages of embodied energy and due to their age they have often been built with superior craftsmanship and materials that support a long physical life. They have often been well designed in terms of passive heating and lighting and ventilation and are in often in good locations. Rypkema states that you are either a fool or a fraud if you say that you are an environmentally conscious builder because you have demolished a historic building and replaced it with a new one. His states that such actions result in a “triple hit on scarce resources” because you lose the embodied energy in the existing building, the new building uses energy consumptive materials like plastic, steel, vinyl and aluminum and finally that the new building may only last 40 years before needing another environmentally costly replacement. (Rypkema, 2007)

The process of heritage building preservation is by definition the ultimate in sustainable development as it is driven by the goal to preserve an asset so that it be enjoyed by both present and future generations. It is built on the ethos of stewardship and seeks to extend the useful life of buildings as much as is feasibly possible, including recycling them to alternative uses when necessary. In addition to the sustainable benefits attributable to existing buildings in general, it has addition social and economic benefits. In a social sense heritage buildings create a sense of place and help educate and provide social cohesion and identity. Thus they build and maintain ‘social capital”.

In an economic sense heritage buildings can provide additional economic benefits to a community by promoting heritage tourism. They also create a “sense of place” that attracts and retains immigrants.

On top of this there are the social and productivity benefits for the occupants of heritage buildings relating to “feeling good” about occupying and helping preserve something of value to the community, as well as the businesses bathing in the reflected glory of being socially as well as environmentally and economically responsible.

However, it must be recognized that where it is necessary or desirable to ‘green’ a heritage building additional challenges may be faced.

A heritage building is often the subject of planning controls that seek to protect the building from inappropriate development. The ultimate aim of such controls should be to facilitate the conservation of the building which is defined by the International Council on Monuments and Sites (ICOMOS) as “the processes of caring for a place so as to safeguard its cultural heritage value”.

ICOMOS also promotes the concept that the least intervention that is carried out to achieve conservation the better. The ICOMOS New Zealand Charter states that conservation should involve the least degree of intervention consistent with long term care

In order to green a heritage building, may well require that invasive intervention is necessary, particularly with mandated upgrades. The challenge is to rigorously debate whether such intervention is warranted and if it is what is the most appropriate way of doing this. As Kooles points out, the preservation community should continue to research and highlight best practices on how to incorporate green building technologies into rehabilitation projects (Kooles 2009).

Greening heritage buildings may also require subsidies in order to put in place interventions that conserve the heritage value of the building, while achieving the environmental outcomes required. In some situations, to achieve a good heritage result may be more expensive than an alternative method. For example

refurbishing existing timber windows may be more expensive than replacing then altogether with cheap replacement windows.

The requirement to conform with additional planning constraints may add to the cost and time involved in greening a heritage building and in some circumstances an application to green the building might be declined altogether. This might be for aesthetic reasons such as inappropriately sited solar panels or for technical reasons. For example, in some circumstances adding insulation to old buildings can cause problems where it prevents the building from breathing in the way it was designed. There may also be a loss of heritage value as a result of the greening process. For example, there is heated debate in the USA currently over the replacement of traditional timber windows with aluminium or vinyl replacements.

In general however, where heritage buildings suffer from weaknesses in green building performance these weaknesses can be corrected as part of a rehabilitation process. There is now a growing body of case study examples to illustrate how this can be done in ways that respect the heritage value of the buildings.

Conclusions

The assumption is generally made that building green is the same as "sustainable development". Much of the early focus for the green building movement has been on improving the environmental performance of new buildings and developing evaluation tools to measure this. In simple terms the focus has been on what or how we build.

Clearly if there is a need to build a new building then the goal should be to strive for green attributes. We need new buildings to test new design ideas and

technologies, to inspire people and to provide proof of performance and benchmarks to aspire to.

However, there's scope to do a lot more with the existing building stock. Only three per cent of total office space is being replaced each year, and other building sectors are likely to have similar turnovers. If the focus is only on new buildings it will be a very long time before we see any real impact on environmental measures. The law of diminishing returns also tells us that it should be relatively easy to get an existing building with a very poor sustainability rating up to the level of at least one star or two stars, but it is much harder to get from four stars to five stars. However, the established rating systems do not operate at this lower end of the scale.

At a fundamental level, green building should not just question how we build but should also question why we need to build and where we need to build, as these questions are vitally important to achieving sustainable development. When these questions are asked then the need to retain and recycle our existing buildings comes into sharp focus. Evaluation methods such as LEED are gradually evolving in a way that seeks to address these questions. Similar evolution is required for Australasian green building rating systems.

The assertion that the greenest building is the one that is already built is one that is hard to dispute. If it is accepted that a truly green building is one that contributes to sustainable development then the comparison between a new building and an existing building should be done in a meaningful way that looks at the net impact over the life of the buildings and considers all the environmental costs and benefits.

Governments in particular should be more responsible than to needlessly build new while ignoring sound rehabilitation or adaptive re-use alternatives. They

also need to be careful that they don't introduce mandatory upgrades that don't promote the goal of sustainable development.

Communities are putting a lot of emphasis and resources into recycling their rubbish. Similar emphasis should be put into recycling their buildings.

Heritage preservationists promote conservation. Their relationship with the green building movement has sometimes been one of conflict when clearly they should be allies. There will be specific occasions where there will be conflicting approaches to achieving sustainable development but this should not prevent both parties from exploring and developing synergies between the two movements.

Clearly not all historic building can be considered good examples of sustainable building and are far from green. Some will ultimately need to make way for new green buildings but an increasing number of case studies demonstrate that historic buildings can successfully be made green.

In addition, the heritage value of existing buildings is a factor in the social dimension of triple bottom line sustainability and while old buildings often suffer by comparison on some aspects of environmental and economic sustainability, such as energy efficiency they often have offsetting benefits such as thermal mass, natural ventilation and lighting, higher site coverage and proximity to public transport and other amenities.

References

Campagna, B A 2008. How Changes to LEED Will Benefit Existing Buildings and Historic Buildings. *Forum News* National Trust For Historic Preservation, November/December 2008, Volume XV No. 2.

CB Richard Ellis (2009). *Who Pays for Green? The Economics of Sustainable Buildings.* EMEA Resarch, 2009.

Colliers International Lifeblood Survey, 2006, Sustaining the Vitality of Australian Business, Corporate Social Responsibility, pp32-37.

De Francesco, A. and Levy, D. *A comparative study into the effect of sustainability on corporate property investment drivers in the UK, Australia and New Zealand.* Presented at the 16th Annual European Real Estate Society (ERES) Conference in Stockholm, 24-27 June, 2009.

Elefonte, C 2007. The Greenest Building Is …One that is Already Built, *Forum Journal* National Trust for Historic Preservation, Summer 2007, Vol. 21 No. 4, pp. 26-38.

Evans, P 2009. Quantifying the Environmental Benefits of the Maryland Historic Tax Credit Program. *Forum Journal* National Trust for Historic Preservation, Fall 2009, Vol. 22 No. 1 pp. 12 -23.

Frej, A. *Green Office Buildings: A Practical Guide to Development*. The Urban Land Institute, Washington, D.C, 2005 pp. 4–8.

Frey, P 2007. *Making the Case: Historic Preservation as Sustainable Development.* Draft White Paper, Released 15 October 2007 National Trust for Historic Preservation.

IPCC. *Climate Change 2007: Mitigation. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (UK).* Cambridge University Press, 2007.

Kolokotsa, D. Diakaki, C. Grigoroudis, E. Stavrakakis, G. And Kalaitzakis, K. *Decision support methodologies on the energy efficiency and energy management in buildings.* Advances in Building energy research 2009 pp. 121-146.

Kooles,K 2009. Adapting Historic District Guidelines for Solar and Other Green Technologies. *Forum Journal* National Trust for Historic Preservation, Fall 2009, Vol. 22 No. 1, pp. 24 - 30.

Moe, R 2009. Historic Preservation and Green Building: Finding Common Ground. *Forum Journal* National Trust for Historic Preservation, Spring 2009, Vol. 23 No. 3, pp. 8 -16.

New Zealand Green Building Council. *Climate Change and the Built Environment.* Discussion Paper, 2009.

New Zealand Green Building Council, Green Star NZ Technical Manual: Office Design & Built 2009, Energy, pp. 91

Nicolay, Claire. *The greening of real estate appraisal: as sustainable building gains momentum through standards, legislation and public desire, the appraisal community responds.* Valuation Insights & Perspectives, Vol. 12.2, Spring 2007.

Nowakowski M, 2009. Historic Preservation and LEED for Neighborhood Development. *Forum Journal* National Trust for Historic Preservation, Spring 2009, Vol. 23 No. 3, pp. 32 - 37.

Roper, K. and Beard J. *Justifying sustainable buildings - championing green operations.* Journal of Corporate Real Estate, Vol. 8 No. 2, 2006.

Rypkema,D 2006. *Sustainability, Smart Growth and Historic Preservation.* Keynote Address to Historic Districts Council, New York 2007.

Rypkema,D 2007. *Downtown Revitalization, Sustainability, and Historic Preservation.* National Main Streets Conference, Closing Plenary Session, Seattle, Washington, March 28th 2007.

Schleich, H. Lindholm, A. and Falkenbach, H. *Environmental sustainability - drivers for the real estate investor. University of Regensburg,* 2009.

Sustainable Buildings Day: Summary Report, 2005 Auckland Sustainable Cities Programme, http://www.sustainableauckland.govt.nz/download/sustainable_buildings_day_with_presentation.pdf (Accessed Sep.2009)