

# Improving the Sustainability of Existing Buildings

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## **Abstract**

Achieving the goal of sustainable development continues to be one of the major global challenges of our era. To date the vast majority of work has focused on improving the sustainability of the design and construction phases of the building life cycle. Whilst the outputs from this work are beginning to have an effect on the sustainability of new buildings, because of the legacy of the existing building stock, it is unlikely that it will produce a sustainable urban environment in the short to medium term.

In reality only a small percentage of the worlds built environment is replaced each year, over the next 20 years much of the built environment will comprise that which already exists or is in the planning stage. If the built environment is to address the changing needs of society in a more sustainable manner, then the construction industry will have to work largely with buildings that already exist. Thus the challenge facing built environment professionals is to find ways of improving the sustainable performance of existing built facilities. This paper will examine these challenges and outline a new initiative being undertaken in the UK to address them.

## **1. Introduction**

Achieving the goal of sustainable development continues to be one of the major global challenges of our era. The UK Government (DETR, 1999) produced a strategy for sustainable development which identified four aims:

- social progress which recognises the needs of everyone;
- effective protection of the environment;
- prudent use of natural resources; and
- maintenance of high and stable levels of economic growth.

‘Building a better quality of life – a strategy for sustainable construction’ (DETR, 2000) identified the role that the construction industry could play to improve the collective quality of life of UK citizens. The report drew attention to the fact that:

- the UK construction industry accounts for approximately 10% of the UK’s GDP;
- employs around 1.5 million people;
- creates structures and buildings that permanently alter society and the environment; and
- produces 10 million tonnes of waste per year.

In addition, domestic and commercial buildings account for a third of the UK’s CO<sub>2</sub> emissions.

In challenging the UK construction industry to develop more sustainable practices ‘Building a better Quality of Life’ (DETR, 2000) identified 10 action areas:

- reuse of existing built assets;
- design for minimum waste;

- aim for lean construction;
- minimise energy in construction;
- minimise energy in use;
- do not pollute;
- preserve and enhance bio-diversity;
- conserve water resources;
- have respect for people and their local environment; and
- set targets to monitor performance and to better manage/reduce the impact of buildings on the environment.

Whilst the construction and research communities have begun to address these challenges (e.g. the Green Building Challenge, the Construction Industry Environmental Forum, The Housing Forum, the development of sustainability toolkits etc), the majority of the work to date has focused on the design and construction phases of the building life cycle. Whilst the outputs from this work are beginning to have an effect on the sustainability of new buildings (Rethinking Construction Ltd, 2003), because of the legacy of the existing building stock, it is unlikely that they will produce a sustainable urban environment in the short to medium term.

The challenges faced by the UK construction industry in producing a sustainable built environment over the next 20 years were further highlighted in the report of the UK Government's Built Environment and Transportation Foresight Panel (Constructing our Future, 2001). One of the major recommendations for action contained in the Foresight Report was to improve existing built facilities through developing innovative processes, technologies and components for the maintenance, repair and refurbishment of existing built assets. The report particularly identified the potential for new technologies and 'intelligent' products to improve living and working environments and enable information feedback to improve construction quality. The report identified the culture change, from 'up-front' considerations to 'whole-life principles' that would be required amongst all built environment stakeholders if a truly sustainable built environment is to be achieved.

The concerns over the ability of existing research and development initiatives to underpin significant improvements in the sustainability of the urban environment in the short to medium term are not limited to the UK. A summary report of the outcomes of the conference on Sustainable Buildings 2002 (Rovers, 2002) identified that, whilst there was a strong international emphasis on the design and construction of new buildings, it was the existing building stock and the rehabilitation of neighbourhoods that should be the starting point for improving the sustainability of the urban environment. In particular the report outlined the need for revolutionary concepts and radical changes in the management of resources to provide an urban environment which not only improved the quality of life for existing inhabitants but also anticipated the effects of climate change. In an attempt to move the work forward the organising committee for the 2005 Sustainable Buildings Conference were asked to give increased importance to issues relating to the existing building stock.

The remainder of this paper will outline a major research initiative being undertaken in the UK to address some of the key issues that relate to improving the sustainability of the existing building stock. The project was developed in response to a new initiative launched by the Engineering & Physical Sciences Research Council to establish research consortia to undertake fundamental research to underpin the development of a more sustainable urban environment. As a result of the initiative 14 consortia have been established of which IDCOP (Innovation in the Design, Construction and Operation of buildings for People) is one. The IDCOP consortium comprises 5 academic institutions and over 40 industrial partners. The consortium has funding for 4 years from the 1<sup>st</sup> of January 2004.

## **2. Focus and Aims of the IDCOP Consortium**

Existing buildings are complex entities which are interwoven into the fabric and culture of society. Their management and use involves a multitude of stakeholders (e.g. owners; occupiers; managers; tenants; legislators; financiers; insurers; politicians; and conservationists etc) and over their life cycle they consume resources that far exceed those associated with their original construction (Evans et al, 1998). Improving the sustainable performance of existing buildings (i.e. reducing the impact of buildings on the environment and improving the quality of life for occupants in an economically viable manner) demands an understanding of the:

- impact that the use of buildings have on the environment and quality of life of occupants/users;
- changing demands being made of existing buildings (e.g. life style changes, climate change etc);
- potential for technical/operational developments to improve the performance of the building; and
- barriers to implementation (i.e. stakeholder reticence, the role of whole life thinking etc).

This project aims to establish fundamental knowledge to underpin the development of new products and processes for upgrading, maintaining, and improving existing buildings for the benefit of society.

Within the broad aims of the project its focus will be on the role of the building façade or envelope, as a mediator between internal and external environments. The façade of a building acts as a climate moderator. It receives impacts from the sun and wind whilst controlling the amount of air, sunlight and sound passing through to occupants. The impact of future climate change on the performance of building façades is likely to have considerable implications for their design, production, operation and maintenance. Thus the objectives of this research are to explore technical, economic, social and environmental implications for the development and use of building façades as ‘environmental mediators’, developing new rules, standards and procedures for design, production and maintenance. The research will be conducted in the context of changing social attitudes and behaviour towards building use – particularly in housing. It will take account of new national and global performance targets for energy and emissions control, as well as the results of predictive models of climate change.

### **3. Research Themes to be Addressed by the IDCOP Consortium**

The research project is a multi-disciplinary project based around the interactions of three research themes and the key drivers of People, Product and Process (Figure 1). In an attempt to achieve a more sustainable urban environment it is necessary to first establish the baseline knowledge, for each of the key drivers, from which improvements can be made (Theme 1). Whilst this will ostensibly involve the study of Products, People and Processes it will also be necessary to examine how People relate to both Products and Processes. Once the baseline knowledge has been established innovative solutions need to be developed to meet the opportunities for improvement (Theme 2). However these solutions must not solely focus on the technological development of new Products and Processes but must also examine how People will relate to the Products and Processes. In this way People’s concerns/desires can be addressed during the development of the new Products and Processes. If the new Products and Processes are to have a positive impact on the sustainability of the urban environment then they will need to be widely adopted. Theme 3, which is ostensibly People focused, will examine alternative implementation strategies to ensure that the new Products and Processes that emerge from the project will indeed make a demonstrable improvement to the sustainability of the urban environment.

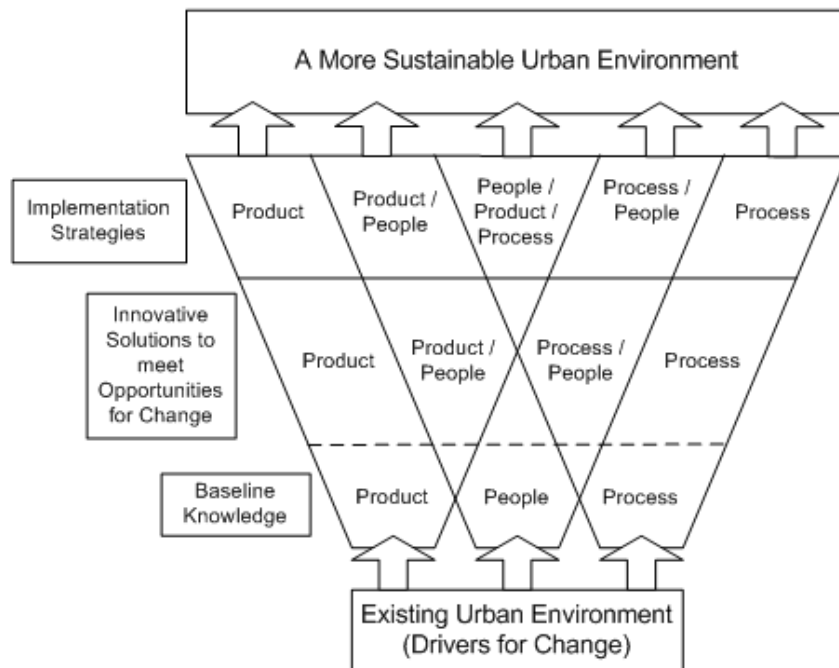


Figure 1: Interaction between research themes and key drivers

#### 4. Details of the IDCOP Work Programme

To address its overarching aim IDCOP has developed an integrated work programme (Figure 2).

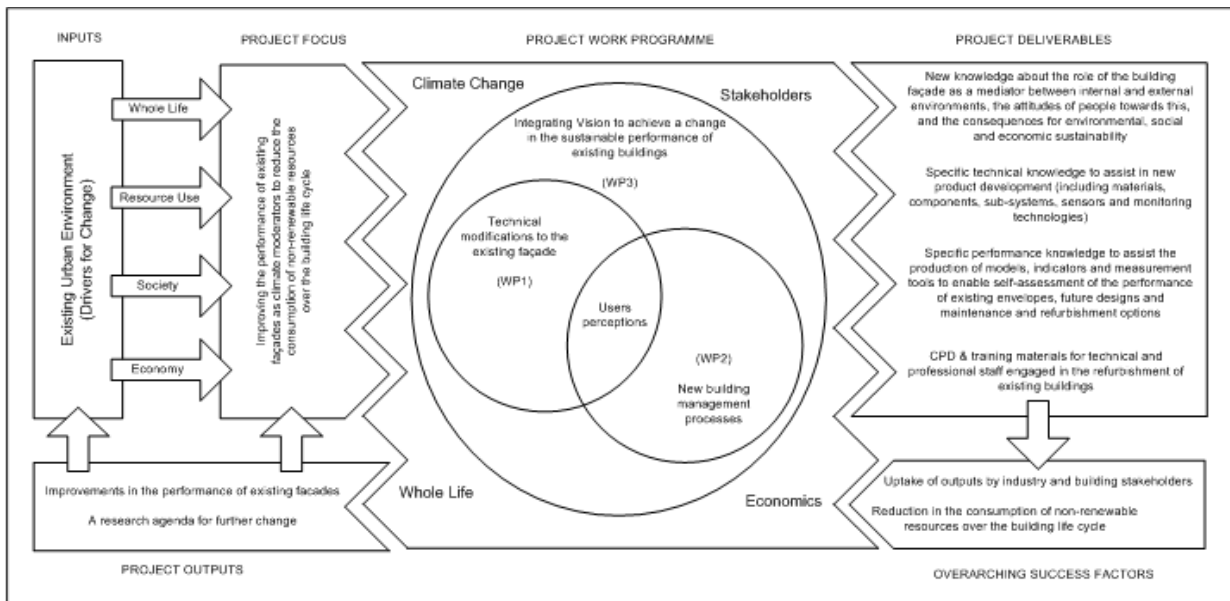
Work Programme 1 focuses on developing prototype components that can be fitted to existing façades. The research will examine the potential of integrated solar gain control and natural lighting into a building façade to improve the thermal performance of the building, and of the use of sensors and monitoring technologies to better inform operational decision making. The development of the façade components will be undertaken in conjunction with a study of desires, needs and concerns of the various building stakeholder groups (e.g. owners, managers, users, etc). The performance of the prototype components will be assessed against economic, social and environmental parameters.

Work Programme 2 focuses on developing new processes for the management and use of existing buildings that reduces their adverse impact on the environment (reduce waste and consumption of energy) whilst improving living and working conditions (Jones et al 2002, Clement-Croome et al, 2003). With regard to the management of buildings, the research will examine how sustainable current building management processes (maintenance and refurbishment) are and will seek to develop a Through Life Environmental Business Model which should result in more efficient and effective maintenance / refurbishment planning and provide a mechanism for incremental improvements to be made to the sustainability of existing buildings. With regards to the use of buildings the research will investigate the extent to which embedded sensor technology, retrofitted to existing buildings, can be used to covertly manage energy consumption and overtly provide information on the performance of buildings which stimulate changes in occupier behaviour to consume less energy.

Work Programme 3 will integrate the work of IDCOP by providing the infra-structure for the exchange of ideas and identification of cross cutting issues both within the IDCOP team and between the IDCOP team and other researchers. The research will develop indicators for mapping and measuring the robustness, resilience and adaptiveness of outputs from Work Programmes 1 and 2. Work Programme 3 will also

examine the fundamental issues that need to be addressed if routine maintenance and refurbishment is to act as a vehicle for improving the sustainability of the existing built environment.

All the work programmes are subject to annual review and modification may be made to reflect research findings and changing external conditions.



**Figure 2: IDCOP Project Rationale**

## 5. Expected Outcomes from the IDCOP project

The IDCOP mission is to study people focussed systems, derive models and theories that explain and describe these systems, and investigate how innovative technology can be used to provide new/improved products and process that reduce any adverse effects of buildings on the environment and improve the quality of life for those who occupy buildings. The outcomes from IDCOP will include:

- a greater understanding of the performance of existing façades and of stakeholders views regarding options for improvement;
- a greater understanding of interactions between people and the buildings they own, use or occupy;
- development of prototype technologies (façade and control) that reduce the consumption of non-renewable resources to provide a high quality indoor environment;
- development of prototype technologies to provide performance data for a more sustainable building maintenance and refurbishment model;
- the assessment of the uptake of the technologies by industry and end-users;
- establishment of performance thresholds for sustainable buildings;
- development of whole life building performance models and toolkits;
- explanatory models to evaluate the impact of new products and processes to improve the sustainability of existing buildings; and
- the development of training/dissemination materials for built environment decision makers.

The success of the IDCOP project will be judged against the above outcomes.

## 6. Conclusions

The project outlined in this paper is one of 14 related projects being funded by the Engineering and Physical Science Research Council to address the wide ranging issues related to achieving a sustainable urban environment. The focus of this project is on the micro (building) level where the researchers believe a better understanding of the fundamental relationships between buildings, people and the environment is required if real improvements in the ‘sustainable’ performance of the urban environment are to be achieved. It is hoped that the fundamental knowledge resulting from this project will be taken up by the various built environment stakeholder groups and that demonstrable improvements to the existing built environment will be seen in the short to medium term.

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