CONTINUOUS COMMISSIONING
A NEW APPROACH TO EFFICIENT OPERATION

James Whiteley Ure
MSc CEng MIEE FCIBSE
Managing Director - ABS consulting, 6 – 8 Marshalsea Road, London, UK

ABSTRACT

There is convincing evidence to show that buildings which meet the occupier’s needs at the optimum of cost and performance are those that have been properly commissioned. Commissioning is generally seen as a process that takes place before the building is handed over to the owner or occupier. But to get the best from buildings the commissioning process should be managed and planned from feasibility through design, construction and operation. This process is known as Continuous Commissioning. When appropriately applied it will deliver substantial benefits in reduced: operating cost, energy consumption and environmental impact while providing better buildings for the occupants that are of greater value to the owner. The information and knowledge gained by the process provides rich feedback to design that will accelerate innovation and our progress to a sustainable future.

1. INTRODUCTION

Successful non-domestic buildings are those that meet the occupiers business needs while providing the occupants with a safe, efficient and comfortable environment. Buildings are not an end in themselves, they are there to serve the primary purpose of the occupier. The growing use of IT and the rising expectations of occupants have resulted in an increasing reliance on building services systems. To meet this challenge the building services profession must put much greater emphasis on operation and implement processes that will optimise cost and value. One such process is known as Continuous Commissioning (CC). It provides a new way of getting the best out of buildings and ensuring that the design will deliver what the occupier requires at handover and throughout the building life cycle.

CC as a concept is in its infancy but is receiving increasing attention from enlightened individuals and organisations in the UK. The Author’s firm is undertaking UK Government sponsored research on the development and application of CC. The main object of this paper is to show that a life-cycle approach to commissioning which takes account of all relevant parameters can provide the optimum of safety, occupant comfort, environmental performance, operating cost, capital cost, and asset value. To achieve this object, the paper reviews some of the early work that has lead to the concept of CC, discusses the current research work and summarises some case studies.
2. DEFINITIONS

The first two definitions quoted below are those for Physical Commissioning. That is, what happens, or should happen, prior to the completion of a project. The first two definitions suggest that commissioning is, at best, a once only process.

2.1 Physical Commissioning
CIBSE say “Commissioning” is *the advancement of an installation from static completion to working order to specified requirements (as envisaged by the designer).*

The CIBSE definition is very narrow and takes no account of the fact that the only reason the building is required is to satisfy the occupier’s needs. A better definition would be:

*the advancement of an installation from static completion to working order in accordance with the requirements of the occupier,* as this requires the designer and constructor to take account of the occupier’s needs, not simply their own.

A more recent definition suggests that “Commissioning” is *the process of ensuring that a building performs according to its design intent and its owner’s and occupants’ needs.*

This is a much better definition as it takes account of the occupants’ and the owner’s requirements. Though no doubt intended as a definition for Physical Commissioning, it implies that the process is not necessarily specific to the construction phase of a building. It therefore embodies the concept of CC. It also implies that commissioning includes any corrective action that is necessary to meet the owner’s and occupants’ needs.

2.2 Commissioning Management (CM)
*The management process by which commissioning is given due consideration during feasibility, design, construction, physical commissioning and handover of a building and its services.*

This is a process by which the Physical Commissioning is prepared for and managed. If commenced in the early stages of a project it can reduce capital cost, reduce the intensity of physical commissioning and deliver buildings that are capable of being commissioned. CM is still a rarity though its benefits are always greater than its costs.

2.3 Continuous Commissioning
*A process - focussed on operation - by which a building and its services are conceived, designed, constructed, commissioned, operated, maintained and decommissioned to provide the optimum of cost and value for the occupier.*
3. WHY COMMISSION?

There are two primary reasons for commissioning buildings and their services. These are:
- to meet legal obligations
- to meet the business need.

The cost of commissioning should be no more than is necessary to satisfy these two reasons and to achieve this, a process that optimises cost and value is required. This means that the commissioning process must be designed to meet the needs of the business that operates from the building and not relate to the building as an end in itself. The deliverable should therefore focus on meeting the needs of the building occupants and the business rather than the assets.

Many believe that the commissioning of buildings is rarely carried out properly in the UK. Poor commissioning is often due to inadequate planning and a lack of time. Typically this results in increased energy consumption, occupant discomfort and shortened plant life.

Recent UK research suggests that 90% of heating and ventilating systems in buildings are ‘out of control’, consuming more energy than is required and costing industry and commerce £500m per annum in additional energy costs\(^1\). Improving the energy performance of buildings and achieving ‘Good Practice’ yardsticks will benefit building owners, occupiers and individual occupants as well as benefiting the environment.

Increased commissioning effort will reduce energy consumption and its associated cost as shown by Figure 1. To realise the opportunity for energy efficiency, ‘optimum commissioning effort’ will be achieved when increased commissioning effort costs more than the resulting energy cost savings. Figure 3 illustrates this point of ‘diminishing returns’ for the building life-cycle cost (cumulative ‘present value’ costs of the building over its life).

Over the building life, increased commissioning effort can optimise occupant satisfaction, plant control, and maintenance costs as well as energy costs, in accordance with their priority in support of the main purpose of the organisation. Consequently, it is often more appropriate to commission beyond the point of optimum effort for energy efficiency and thereby add value from these other benefits.
No commissioning may increase energy costs by some 40% while poor commissioning can typically result in increases of 10 to 20%.

4. CURRENT RESEARCH

The current research is supported by the UK Government under the Partners In Innovation (PII) programme. The project commenced in April 1999 and will be completed by March 2001. A brief outline of the project follows.

4.1 The Case for CC

Very few buildings work as initially intended by their design teams. As responsibility passes from client to architect to contractor to operator to the maintenance team, there is significant opportunity for things to go wrong, for misunderstandings, and for strategy to give way to practical expediency.

It is estimated that typically poor commissioning results in increased energy costs of 10 – 20%.

Failure to commission may increase energy costs by 40% or more.

Commissioning (and re-commissioning) is an often overlooked professional activity that can help extract maximum benefit from a building for minimum resource input. The disciplines of good commissioning practice will have a renewed significance over the coming decades as facilities and
estates managers attempt to extract more from less. To ensure that their buildings achieve best practice standards, they need to prioritise the management of commissioning, particularly through good planning and good time management.

This project supports a current ABS led PII project Realising Quality Energy Efficient Buildings and also builds on the success and popularity of a national series of workshops on Commissioning that ABS delivered on behalf of the UK Government during 1998. This project will address commissioning issues that these two projects have highlighted but did not include. Both projects showed the importance of the hand-over and commissioning phases for efficient operation and that there is a need to investigate and address the benefits of commissioning and the current way it is carried out. The process that ABS has started to develop is based on continuous commissioning, with a focus on building operation and the important role of the client in encouraging effective commissioning and re-commissioning of their buildings.

These issues have also been highlighted by the Y2k audits that ABS has been carrying out for many clients over the last year. Implementing new strategies for commissioning can take maximum advantage of the building and plant details that have been collated for Y2k purposes and the skills that have been developed for tackling the problems.

Most organisations realise the importance of good commissioning but many do not see it as a priority. This project will:

- make maximum use of the current enthusiasm for improving commissioning
- allow organisations to utilise the appropriate Y2k skills that they have developed to implement a continuous commissioning process
- ensure this opportunity to help organisations improve their building performance is not lost.

4.2 Major Outputs

This project introduces an innovative way to approach and market the need for better commissioning of our buildings throughout their life-cycle. The aim is to develop a practical, effective and continuous technique for clients to manage the commissioning process. The focus will be on building operation, with improved methodologies and enhanced communication of benefits so that the technique will be adopted in practice.

The most appropriate published format of the technique will be determined through the project but will most probably be a guidance document on the management approach alongside a training package, potentially linked to an interactive internet web-site.

The main output will include the following modules:-

- **What, why & how** – the secrets of ‘Continuous Commissioning’ including enhancing client awareness of the benefits of the approach.
- **Illustrated case-studies** – feedback on successful approaches.
- **The management approach** – decision method to help devise real-time recommendations and quantify the benefits for a particular building.
- **Briefing** – for design teams for new-build and refurbishment projects.
• **In-house training** – training package & tips for building operators.

Dissemination activities for maximum impact are an important output throughout this project. Major dissemination outputs will include:

- Two workshops for clients and building operators
- Launch seminar
- Postal distribution of 50 fact-sheets
- Two journal articles for journals predominantly read by ‘end-users’ (e.g. *HAC* and *Energy in Buildings & Industry*)
- A conference paper.

4.3 **CC and Electronic Communication**

One way of managing the process of CC (whilst simultaneously promoting the benefits to the client) is to use an extranet – a network based on an interactive web-site. Such a web-site could form the basis for publishing the training outputs and case-studies for the project but also could act as an interactive vehicle for an occupier to manage the commissioning process in their building. Registered building occupiers could be able to receive automatic and immediate feedback on their current building performance and appropriate actions, by answering a number of questions on operational aspects about their building. The web-site could help ascertain whether their building performance currently meets the requirements of their operating brief and whether they can add value by fine-tuning, re-commissioning, refurbishment or even replacement.

The web-site could also facilitate simple proactive ongoing performance tools to be used regularly by building occupiers – for example a simple occupant satisfaction questionnaire such as *Overall Liking Score*\(^2\). For more reactive and detailed performance evaluation techniques and reactive troubleshooting procedures, it could illustrate basic indicators and explain procedures to help building occupiers procure and co-ordinate with building consultants and/or commissioning specialists. If a demand was found for such a web-site, the project would develop the procedures to be used – in a simple and practical manner - as an extranet, a managed network of ‘Continuously Commissioned’ buildings.

5. **THE CONTINUOUS COMMISSIONING PROCESS**

The concept of CC was developed by the Author as a result of many years experience in the evaluation of buildings in operation. From this work it became apparent that energy efficiency, maintenance costs and occupant satisfaction are linked. It was also found that where a building is not meeting the occupier’s needs or the design intent, the most logical way to find the cause of concern is to go through a commissioning process.

Furthermore, the poor performance of many buildings was found to be caused by inadequate commissioning prior to completion. Therefore, occupiers are often left with the problem. There are no satisfactory short cuts to solving this problem and the most cost-effective solution is likely to be a thorough commissioning exercise. Commissioning will tell the occupier whether or not the building can be tuned to its needs and will identify fundamental design or construction defects. Corrective action can then be taken and subsequently commissioning could be concluded. This led to the idea that if commissioning were a continuous process, rather than a once only process, substantial
benefits would be achieved throughout the building life cycle. Hence the concept of CC. Figure 2 illustrates the CC process which, put simply, is that of optimising cost and value. CC achieves this by:

- Identifying what the occupier needs from the building and its services systems.
- From the application of CC, determine what the building and its services systems can deliver and make good any shortfall in performance.

**Figure 2:** The Continuous Commissioning Process

6. THE APPLICATION OF CC

After a relatively short period in operation, the occupancy costs of commercial buildings become substantially greater than the capital costs. Typical costs for an office in London are shown in figure 3. The application of CC will ensure that the building is designed with operation in mind and that operating costs are kept to the minimum needed to meet the occupier’s needs. Furthermore, the greatest impact on the environment occurs during operation when the building and the business it serves consume energy and create waste. CC will provide a fundamental understanding of operation and provide feedback to design that will help to optimise the financial and environmental impacts of constructing and operating buildings.

**Figure 3.** Office Occupancy Costs
There is now an increasing requirement for Facilities Managers to be involved in the procurement, design and construction of buildings as well as their operation. This is a consequence of the demand side of the construction industry (building owners and occupiers) becoming more aware of its needs and being less willing to accept what the supply side (developers, designers and constructors) have provided in the past. As the Facilities Management profession matures, its influence on design and construction will increase. After all, the sole purpose of commercial buildings is: to provide a safe and comfortable environment in which the occupants can maximise their contribution to the overall purpose of the organisation. The application of CC will improve existing buildings and enable Facilities Managers to provide better briefing to designer of new build and refurbishment projects.

Political and economic pressure to reduce the environmental impact of buildings is increasing globally and we ignore it at our peril. Improving energy efficiency will, for the foreseeable future, play a major part in reducing environmental impact and the opportunities here are enormous. The technology and management procedures are well developed but, as Figure 4 suggests, their application is rarely applied.
Figure 4: Energy Efficiency Comparisons

Type 1 – Natural ventilation with mainly cellular accommodation
Type 2 – Natural ventilation with mainly open plan accommodation
Type 3 – Comfort cooling or air conditioning with a mixture of cellular and open plan accommodation
Type 4 – Prestige HQ office with full air-conditioning

Of the twenty-one office buildings in Figure 4, only the building represented by the dark grey histogramme is consuming energy at less than the UK Government’s recommended good practice standard published by Building Research Energy Conservation Support Unit (BRECSU) and represented by the black histogrammes. This building also has the greatest occupant satisfaction and scores highest on the occupants’ liking for temperature, air quality, lighting, noise and overall comfort. These results support the argument that sensible greening creates financial, environmental and social benefits that together are greater than the sum of the individual parts. They will often be achieved by the application of CC.

7. CASE STUDIES

In this section examples of some of buildings that have been studied by the author are discussed. Figure 5 shows three buildings where the actual consumption is significantly greater than it needs to be. In all cases it was possible to reduce this consumption at or near to the good practice figure.
by commissioning the building services systems and tuning them to meet the occupiers requirements. The financial and environmental savings are considerable. The expenditure and environmental impact will be contained within that needed to meet the occupier’s needs by regularly checking the building by the process of CC.

**Figure 5:** Energy Use in Three Building which were Poorly Commissioned

Figures 6 shows the results of analysis of three buildings in which some form of CC is included in the operating strategy. This provides powerful evidence that CC can deliver substantial cost savings. In addition, there are other worthwhile benefits of greater occupant satisfaction reduced maintenance costs and reduced environmental impact.

**Figure 6:** Energy Use in Three Building in which CC was Applied

None of the six buildings in Figures 5 and 6 were designed with energy efficiency as a priority. They are all conventional air conditioned office buildings. The difference in energy performance between the building in Figures 5 and 6 is the way in which the buildings are managed. The management strategy for the buildings featured in Figure are managed with energy efficiency as a high priority and benefit the application of elements which are part of the CC process. These finding support previous research that it is not the application of technology that results in energy efficient buildings but the ability of the management.

8. CONCLUSION

To ensure that a building achieves the performance expected by the users, commissioning should be considered as a continuous process throughout the building life-cycle. When applied to new & existing buildings, it should focus on optimising the operation and maintenance of the building plant in accordance with the relevant business priorities. This is achieved by initiating suitable management processes to specify, evaluate and revise the procedures as necessary. That process is CC.

This paper has shown that the Application of CC can bring substantial benefits to building owners occupiers and occupants. The increasing pressure on all organisations to become more sustainable will require those responsible for the design and operation of buildings to introduce continuous improvement strategies. CC provides such a strategy. It application will provide a wealth of information that, when fed back into the design process, will improve design significantly. The current research will provide detailed guidance on the application and benefits from CC. It will also raise the awareness of the importance of commissioning generally, resulting in greater prosperity and recognition for the building services industry and profession.

REFERENCES

The following three drawings are figure 6.
The following three drawings are figure 5.