

Sydney Opera House
Facilities Management Exemplar Project

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The research described in this paper was carried out under the auspices of the Cooperative Research Centre for Construction Innovation (CRCCI). The research team comprised:

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1. Abstract

The paper presents an interim summary of research and case studies being undertaken in the Sydney Opera House FM Exemplar Project covering procurement, benchmarking and building information models. The final outcomes of the FM Exemplar Project will be presented through various forums open to all FM practitioners and published in Australia and elsewhere through relevant journals.

Sydney Opera House is an Australian icon, attracting some 4.5 million visitors per year who admire its built form and enjoy an evening of theatre. The building is the attraction, part of the experience. Therefore, facilities management is critical to the success of the Sydney Opera House enterprise and an ideal subject for the study of facilities management.

Significantly the three research themes are heavily intertwined – effective risk sharing in procurement requires historic information and benchmarks for future performance, benchmarking gathers vast quantities of data that can only be exploited if properly related to one another and a building information model provides the means to manage such data. The case studies are emerging as real-life examples of how one organisation is addressing FM issues common to many, and will provide useful lessons for practitioners pursuing similar strategies in their own organisations.

Introduction

The Sydney Opera House Facilities Management Exemplar Project is an initiative of the Cooperative Research Centre for Construction Innovation (CRCCI) in conjunction with Sydney Opera House, academic and industry partners¹. The project is aligned with the Federal Government's Facilities Management Action Agenda.

Sydney Opera House is a unique building, an icon of 20th century architecture and an iconic symbol of Sydney and Australia. The challenges of maintaining a significant building are immense, yet common to all facilities managers: access and budget constraints, aging machinery, targets to be set and achieved, incomplete documentation, changing business demands and so forth.

The opportunity to study facilities management (FM) at Sydney Opera House was both fortuitous and timely. Sydney Opera House is one of the world's most recognised buildings and by association brings obvious kudos to the FM Exemplar Project. Facilities management at Sydney Opera House has been, and is continuing, to change from a stereotypical culture of "secret engineers business", maintenance hidden in the basement, to a pro-active team directly contributing to the success of the enterprise. The FM Exemplar Project is undertaking following three lines of research: Procurement, Benchmarking and Building Information Modelling. Case studies are to document how each is being developed at Sydney Opera House:

- i. Procurement – how the tender process for two key contracts (building maintenance and cleaning) sought to identify contractors with a good understanding of the Sydney Opera House enterprise and a strong cultural fit with the organisation.
- ii. Benchmarking – the development of internal benchmarks, their use in procurement and the more challenging development of comparative benchmarks for unique buildings.
- iii. Building Information Model (BIM) – development of a specification for implementing a Building Information Model using interoperability standards to ensure compatibility of digital information allowing geometric, scientific, benchmark and other data to be shared between multiple software packages.

The case studies will provide a unique insight into how one organisation is tackling the challenges of facilities management. In a single paper and presentation it is only possible to report the highlights of the FM Exemplar Project so far. The final outcomes of the FM Exemplar Project will be presented through various forums open to all FM practitioners and published in Australia and elsewhere through relevant journals.

The benefits to Sydney Opera House have been to broaden the knowledge-base available to the organisation's FM team through contact with a wide range of colleagues in industry and research, and to encourage innovation particularly in building information modelling.

¹ CSIRO, University of Sydney, FMA, Transfield Services, Rider Hunt, Dept. of Industry, Tourism and Resources (Australian Government)

2. Sydney Opera House

2.1. Business Enterprise and Facilities Management

Sydney Opera House is recognised throughout the world as a building icon of 20th century architecture and an iconic symbol of Australia. As a performing arts centre (PAC) it is one of the busiest in the world staging some 1500 performances per year, attended by 1.1 million patrons, with a further 1000 non-performance related events ranging from exhibitions to corporate launches and weddings. An estimated 4.5 million people visit Sydney Opera House each year, many taking tours and enjoying any of five restaurants and bars.

As an enterprise Sydney Opera House engages in presenting and producing the performing arts, venue hire, tourism, conferences and exhibitions, retail, food and beverage, and a range of other market sectors. Although difficult to quantify, it has been estimated that Sydney Opera House contributes in excess of \$200m per annum to the economy. As a business Sydney Opera House generates some \$38 million per annum from sales, services and sponsorship, and receives \$34 million in annual NSW Government grants including \$19M for maintenance (excluding one-off capital renewal grants)².

As with any successful business Sydney Opera House has a corporate vision and corporate goals³:

“Our vision is to excite and inspire the imagination”

Our promise is to take people on a journey from the ordinary to the extraordinary into a world where the inspiration of the building outside is reflected in all we do.

Goals

- I. Be Australia’s pre-eminent showcase for performing arts and culture and an international leader in the presentation and development of artists and their work.
- II. Attract and engage a broad range of customers and provide compelling experiences that inspire them to return.
- III. Maintain and enhance the Sydney Opera House as a cultural landmark, performing arts centre and architectural masterpiece.
- IV. Create a customer focused workplace where people are recognized for their contribution, realise their potential and inspired to achieve outstanding results.
- V. Invest in the performing arts, cultural activities and audience development by maximizing business results of the Sydney Opera House and leveraging its assets, resources and brand.

Since the mid-1990’s Sydney Opera House has purposefully sought to develop its commercial activities in the presentation of performers, retail, food and beverage and other areas. The success of Sydney Opera House and its many partners ranging from performing arts companies to restaurateurs, retailers and business partners is intimately linked to the world-famous building and therefore to the standard of facilities management at Sydney Opera House. The corporate vision and goals reflect the synergy between

² Sydney Opera House Trust, “From Inspiration to Execution, Sydney Opera House Trust Annual Report 2005”, Sydney Opera House Trust, Sydney, 2005

³ ibid

business, building and facilities management through such references as “inspiration of the building”, an “architectural masterpiece” and “leveraging its assets”. Perhaps more than in many buildings facilities management at Sydney Opera House is a core business function directly contributing to visitor experience and therefore to the success of the building. For many visitors to Sydney Opera House, including those who “tread the boards”, the building is the attraction, part of the experience.

The FM Exemplar Project comes at a pivotal time in the history of facilities management at Sydney Opera House and of Sydney Opera House itself. Facilities management is delivered by a Facilities Portfolio that is undergoing a process of change from a somewhat secretive team slightly separated from the Sydney Opera House enterprise to one that is fully engaged in the core business activities of performing arts and tourism. The three components of the Exemplar Project illustrate the changes being made in facilities management at Sydney Opera House.

Procurement – a process has been adopted that engages key stakeholders in developing specifications, aligns outcomes with business activities and seeks service providers who can relate to and enhance the Sydney Opera House organisation and enterprise.

Benchmarking – the introduction of Building Condition Indices contributes to improving visibility and transparency in facilities management. The benchmarks are aligned with the needs of the enterprise, reported monthly and led to an openness in facilities management that gives stakeholders confidence in maintenance planning and delivery.

Building Information Model – the development of a BIM should be seen in the context of a suite of base building documents, or Total Asset Management Plan (TAM) being developed by Sydney Opera House. From the Utzon Design Principles published in 2002, the Conservation Management Plan (2003) and a Strategic Building Plan of future developments to strategies for individual asset groups such as lighting, a model for the future facilities management of Sydney Opera House is being constructed. Like benchmarking, this work is driven by the needs of the enterprise, supported by an open, collaborative, approach to facilities management.

Attaining best-practice standards in facilities management will make a significant contribution to the future success of Sydney Opera House. The FM Exemplar Project is a timely opportunity to study the evolution of facilities management in one of the world’s best known buildings and introduce new ideas to an enterprise that is itself founded on the innovation of architects and engineers.

3. Procurement

3.1. Introduction

The procurement case study follows the tender process for two key contracts: Building Maintenance and Cleaning. Both contracts have been out-sourced for a number of years with the incumbents in place of eleven and five years respectively. In the context of a strategic FM procurement review a decision made to continue to out-source these contracts.

The case study documents how Sydney Opera House's FM team sought to

- i. Link each contract specification to business needs using Building Condition Indices to define performance requirements; and
- ii. Identify contractors with a good understanding of the Sydney Opera House enterprise, a strong cultural fit and the ability to contribute to SOH's on-going success.

Historically Sydney Opera House's maintenance contracts have used traditional prescriptive specifications. Contract performance has tended to be measured by inputs such as response times rather than outputs. Tender processes similarly been traditional though using commercial and non-commercial criteria - with particular emphasis placed on heritage and public building maintenance experience. An assessment of the existing contracts found that both had, in general, achieved their goals, though these were now several years old. A criticism that could be levelled at the in-house FM team as much as the incumbent contractors was that the service provided had not developed in-line with the Sydney Opera House business model. Whilst the previous approach to contracting was probably appropriate when the contracts were let, by today's needs it underplays the importance of facilities management to the Sydney Opera House enterprise. Discussions with customers (i.e. other SOH departments) found an expectation of a more responsive, more clearly defined and higher standard of maintenance – particularly in the area of site presentation.

The adopted tender process sought to reinvigorate the approach to service delivery and align this with the evolving Sydney Opera House enterprise. For Sydney Opera House the tender process included a number of innovations with particular emphasis placed upon a pre-tender workshop held with each short-listed contractor. Through a survey of tenderers and tender evaluation committee members (TEC) the case study has assessed the effectiveness of the procurement process from both perspectives. Essentially the same procurement process was used for both tenders, which are considered as one in a single case study. It is concluded that the innovative use of a pre-tender workshop added value to the procurement process. Ideally the Case Study will return to the contracts after a period of operation (say 12 months) to assess whether or not the original expectations have been met.

3.2. Specification Development

Prior to formally documenting a specification the procurement team supplemented their own knowledge with site visits to comparable organisations and interviews with the existing contractors and key internal stakeholders. Three key lessons emerged from the consultation process:

- i. A methodology was needed that defined maintenance and cleaning standards in terms understandable to service providers and stakeholders, and which related to SOH business operations;
- ii. The engagement of stakeholders throughout the procurement process would engender whole-of-organisation confidence in the contract, specification and the appointed service provider; and
- iii. A generational change in contracting would need to be championed by SOH's Director, Facilities with supported by external expertise provided by Currie & Brown.

Sydney Opera House's FM team responded to these issues by developing Building Condition Indices (BCI) to measure building fabric condition, cleanliness, tidiness, and overall presentation. The indices all use a percentage-based scoring system with 100% equalling "as new" and defined standards below this in 10% decrements (see page 11 "Benchmarking").

Through a series of workshops and meetings with customers, the Sydney Opera House FM team developed and agreed benchmarks for cleaning and building fabric maintenance using the BCI methodology. To fully align with Sydney Opera House operations the benchmarks were then linked to the flow of business; for example toilets were to be at the stated cleaning standard when a foyer was first opened to patrons and at the start of each interval. In a further elaboration, benchmarks were set for immediately after cleaning and a minimum standard at all other times.

Whilst the use of indices enabled current and expected standards to be defined, historical data was incomplete and covered a relatively short time span. Consequently, it was difficult to provide tenderers with sufficient information on which to assess the risk associated with each benchmark. In finalising the contract specifications it was necessary to limit performance targets to those assets and activities that could be reasonably assessed from an historical perspective.

The use of BCI's underpinned the performance requirements in both the Building Maintenance and Cleaning contracts. However these were not the only requirements of tenderers and Sydney Opera House's primary contract expectations can be summarised as:

- i. An understanding of how building maintenance and cleaning impact on the Sydney Opera House experience for patrons, presenters, visitors and staff.
- ii. A compatible organisational culture based upon a commitment to inspire, to work as equal partners and a willingness to innovate.
- iii. Ability to understand and use BCI's as a measure of contract performance and reporting tool; using systems developed by Sydney Opera House.
- iv. Value for money.

These requirements were subsequently reflected in the contract specification, Expressions of Interest (EOI), Request for Tender (RFT) and evaluation criteria.

3.3. Procurement Process

In basic terms the procurement process followed a traditional route of an Expressions of Interest to produce a short-list companies invited to tender, a Request for Tenders, tender evaluation and appointment. However, this conceals a number of innovations that enabled Sydney Opera House to initially identify companies that demonstrated a high probability of understanding the organisation's needs and eventually to appointing two contractors that met all the evaluation criteria.

Expressions of Interest

In preparing the EOI documentation the procurement team drew on its experience to identify two areas that could result in unsuitable companies being invited to tender:

- i. A large volume of EOI's creating difficult and time consuming evaluation task; and
- ii. Companies invited to an EOI interview sending with a well-rehearsed, articulate and persuasive sales and marketing team bearing no resemblance to the skills and attitude of the contract management team.

The first issue was addressed by including within the EOI four key questions to which inappropriate answers automatically eliminated a company. Having reduced the initial number of applicants the remaining EOI's were evaluated in detail to produce a final list for interview. Invitations to EOI interviews addressed the second concern by making clear that each company's representatives should include contract management staff rather than a sales and marketing team.

Both EOI's elicited considerable interest. Using the agreed evaluation methodology the number of applicants was reduced to a provisional list of six in both cases (a numerical coincidence). These companies were then interviewed - providing each with an opportunity to present their own modus operandi and to demonstrate their understanding of the Sydney Opera House enterprise. On completion of the EOI process the TEC short-listed eight companies who had the potential to provide high-quality, innovative tenders that would meet Sydney Opera House's expectations.

The initial approach to culling through key questions succeeded in efficiently reducing the number of EOI's. All companies responded positively to the request to send a contract management based team to interview, although at some interviews conversation was dominated by a sales-orientated representative. Overall the procurement team was confident that it had seen the genuine face of each contender.

The evaluation committee noted a number of characteristics that separated those invited to tender from the other companies interviewed:

Those invited to tender demonstrated:

- A personal passion for Sydney Opera House, the icon.
- Comprehensive research via web, annual reports, informal site visits (including public tours and attending a show)
- An adaptability to tailor corporate systems to client needs.
- An understanding of “inspiring experiences”
- A team culture with most or all attendees participating in the interview.

Those not invited to tender:

- Lacked personal affinity for Sydney Opera House.
- Had not attempted to view Sydney Opera House from the patron or tourist point of view.
- Offered a corporate “service package” with expectations of client compliance.
- Allowed one person to dominate the interview (essentially a sales pitch).

Request for Tender

Preparation of the RFT documentation incorporated the most innovative aspects of the procurement process. A draft RFT was circulated to all tenderers who were then invited to attend individual workshops to discuss and develop the document. To encourage free and open discussion the workshops were informal and did not form part of the evaluation process. Similarly, participants were asked to highlight any discussion that included ideas unique to their operations so that a potential competitive advantage belonging to one company was not inadvertently included in the RFT.

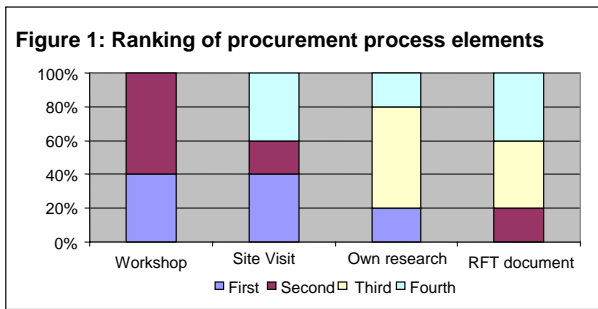
The workshop agenda focused on a review of the draft RFT documentation with a particular emphasis on understanding the use of BCI's and the importance of appreciating Sydney Opera House's culture and business. For the procurement team the workshops were a critical stage in enabling and encouraging tenderers to understand the Sydney Opera House enterprise. An additional anticipated benefit was a reduction in requests for information and extensions of time, which for the procurement team can be time-consuming and expensive to manage.

On completion of the workshops the RFT document was finalised and formally issued to tenderers. During the tender period two site visits were held to enable tenderers to familiarise themselves with the Sydney Opera House premises. Tenders were submitted without an extension of time and evaluated using a combination of commercial and non-commercial criteria. The survey of participants enables an assessment to be made of the effectiveness of the procurement process in securing tenders consistent with Sydney Opera House's aims and objectives.

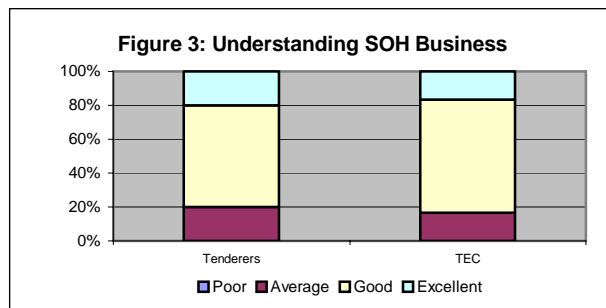
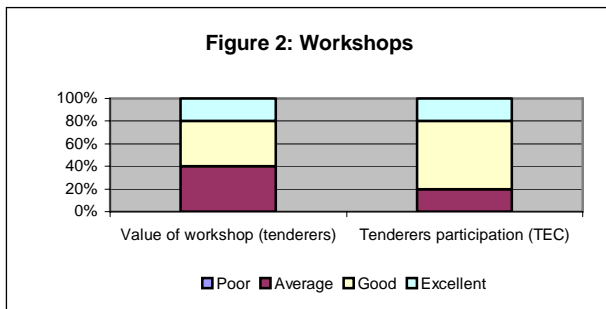
3.4. Survey Results

The survey was completed after the tender outcome had been announced. All participants were invited to contribute, six out of eight contractors and six out of six TEC members responded to the survey. There were no significant differences in the responses from successful and unsuccessful tenderers. The following data

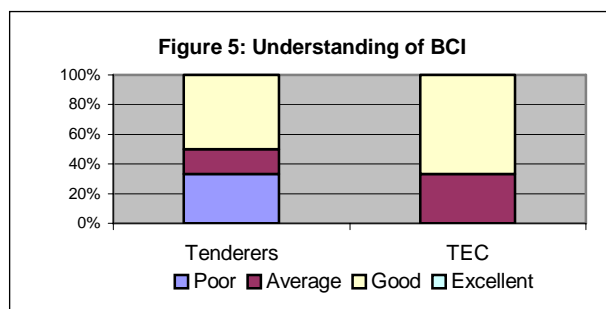
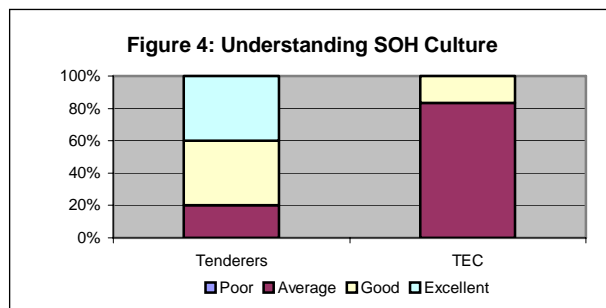
has been extracted from survey responses to assess the effectiveness of the tender process, in particular the innovative use of workshops.



When asked to rank four elements of the procurement process for usefulness in preparing a tender the workshop process was clearly seen by tenderers as the most useful part of the process. The majority of tenderers ranked the workshops as good to excellent (figure 2). The results from figures 1 & 2 are consistent with TEC members' assessment of good participation in the workshops by tenderers (benefits being related to the level of participation). The low value placed on the RFT document is surprising given that this and the site visit were the only formal parts of the tender and typical components of many tenders. It is interesting that the elements involving face-to-face contact (workshops and site visits, and possibly own research) ranked more highly than the RFT document. Clearly personal contact was important to the tender process.



However, when the outcomes are taken into account the workshops can only be considered as partially successful. Figures 3, 4 & 5 illustrate how tenderers evaluated their own understanding of three aspects of the tender and how the TEC assessed tenderers understanding. From figure 3 it can be seen that tenderers recognised that an understanding of the Sydney Opera House business was important and TEC members confirm that the tenders demonstrated this understanding. Less clear was the understanding of cultural fit (figure 4), which although recognised as important by tenderers was not, in the TEC's opinion, matched by the quality of the tenders. Understanding of the BCI received a mixed assessment from tenderers (figure 5). Interestingly the TEC rated tenderers understanding higher than tenderers rated themselves.



Figures 1-5 demonstrate that the innovative use of workshops was valued by participants and enhanced understanding of Sydney Opera House's business. The workshops were less successful in explaining Sydney Opera House's culture and the BCI concept, possibly due to the degree of subjectivity.

3.5. Conclusion

The case study has demonstrated that the inclusion of a workshop in the tender process can assist tenderers in understanding the Principal's expectations. More generally, face-to-face contact with the Principal through workshops and site visits is clearly valued by tenderers. As might be expected it is more difficult to put across subjective and esoteric concepts such as performance indices and culture than objective business information. The implication for procurement teams is that greater effort must be made to explain these concepts when they are important to the tender outcome.

The value of the case study must be viewed against the short period in which the contracts have been in place (2-3 months). The real test of the procurement process will be in the long term success of the Building Maintenance and Cleaning contracts. Therefore it is recommended that the case study be resumed in 12 months time with an assessment of contractor performance.

4. Benchmarking

4.1. Introduction

Benchmarking involves the organised collection of relevant data in the form of Key Performance Indicators (KPI's). Benchmarks can be used by organisations to measure internal performance, measure continuous improvement and to compare performance with other organisations.

In 2005 Sydney Opera House launched a project to develop and implement Building Condition Indices (BCI) as a KPI for building maintenance standards. The chosen methodology uses a percent scale wherein 100% equates to "as new", against which current condition is measured using a descriptive system.

As data is accumulated it becomes possible to use the BCI's in a variety of ways, including:

- Internal benchmarking: as a measure of the condition of various assets;
- Continuous improvement: to measure changes in condition over a period;
- Specification: as a means of stating required performance internally in customer service agreements and externally in contract specifications; and
- Value of money: to calculate the cost of maintaining assets to a given standard.

External benchmarking is a well-established practice in the FM industry often using a cost per square metre basis to compare the effectiveness of service delivery between similar buildings. Such an approach is of limited value when the building is unique – such as Sydney Opera House. Whilst it is relatively easy to compare number of performances, patron attendance and similar data between performing arts centres, there are inherent difficulties in comparing unit costs of facilities management when the design of a building is one of a kind and presents its own set of challenges.

The FM Exemplar Project is investigating to what extent performing arts centres and iconic buildings collect facilities management KPI's and how these might be compared between organisations. It is possible that BCI's could be used to establish common criteria against which to make comparisons.

4.2. Implementing Building Condition Indices

The benchmarking case study follows the introduction of Building Condition Indices at Sydney Opera House for fabric maintenance and cleaning. BCI's are used in a number of organisations; Sydney Opera House being introduced to the concept by FM staff from Parliament House, Canberra. The Case Study provides an insight into the challenges facing those considering a similar approach and how the implementation of BCI's is closely linked to the initial stages of constructing a Building Information Model.

Establishing any form of KPI requires three key questions to be addressed:

What to measure?

The Sydney Opera House FM team chose, in the first instance, to establish BCI's for fabric maintenance and cleaning. This choice was driven by a combination of factors:

- Feedback from patrons disappointed with building presentation (a combination of fabric maintenance and cleaning);

- the forthcoming tendering of building maintenance (fabric) and cleaning contracts;
- Confusion amongst stakeholders and FM staff as to what standards were acceptable; and
- Willingness of the building maintenance contractor (Lucas Stuart) to support the development of a building fabric index.

It was believed that implementing condition indices would establish easily understood maintenance standards.

How to measure it?

When collected in a systematic fashion maintenance data can be meaningless to the non-specialist (e.g. power consumption or vibration levels). Or, when collected by other means produces a simple list of defects. Neither can be presented in a simple form which clearly articulates the level of maintenance being achieved and its contribution to the enterprise. The Building Condition Indices developed by Sydney Opera House all use a percentage scale wherein 100% equates to “as new”, against which current condition is measured using a descriptive system as illustrated below:

BCI - Cleanliness

- 100% as new, no signs of wear and tear
- 90%+ Totally free of dust, litter, stains, odours
- 80%+ Minor signs of dust, no litter or odours
- 70%+ Appearance affected by dust, minor litter or odours
- 60%+ Obvious dust, litter, stains, odours
- 25%+ Significant dust, litter, stains, odours
- 0%+ Hazardous dust, litter, stains, odours

The “100% as new” scenario is one that can easily be visualised by all stakeholders and applied to a range of situations. Facilities staff and services providers use BCI’s to assess asset condition, Front-of-House managers use the same scale to record condition prior to opening the House pre-show and Sydney Opera House’s on-line visitor survey uses a comparable 1-10 index to collect feedback on site presentation. Similar scales have been developed for fabric condition, tidiness and overall impression, and will be developed for electrical, mechanical and theatre systems.

How to collect the data?

It is essential that the effort put into collecting KPI data is proportional to its value and organised for easy and flexible analysis. Otherwise, the collection of data becomes cost-inefficient in terms of its benefit to the organisation. Facilities managers have to acquire, update, process and evaluate a diverse range of data from condition indices, operational costs, usage and availability, to contractor performance and logistics. Within these variables Sydney Opera House identified two constants: building assets (element, plant) and location (room). That is to say data is acquired against specific assets, elements or plant located in a certain place. Assets can be viewed as unchanging until disposed of and whilst physical location may occasionally change it is necessary to attach a location to assets so that they can be found and the properties of various locations described.

Sydney Opera House has developed hierarchical structures for both assets and locations. Though this process was not without challenges and required the adoption of a discipline that would ensure continuity in, and acceptance of, the referencing system. There was extensive debate around the number of tiers required in the plant structure, how to identify rooms, how to access the database and how to make the data available to technical and non-technical personal. For example the engineering fraternity argued for a flat plant structure identifying individual components. Conversely customer job requests come in vague terms such as “it’s too cold in the Concert Hall” that could be linked to a location but not a specific plant item.

To address both needs the upper level of the asset and location structures both use general descriptors and are synchronised at the top two levels as illustrated below:

Asset structure	Location structure
0000 Sydney Opera House 0004 Concert Hall 1700 Sanitary systems 2600 Electrical systems 2603 Distribution boards Dis.b'd 24 (plant ref. 5768) 2605 Lighting (internal)	Sydney Opera House Concert Hall (a functional space) Dressing Room 74 (room id 1456) Opera Theatre Staff facilities Staff canteen (room id 0978a)

This approach requires a discipline that is based upon location and then allows facilities staff to drill down through the asset structure to building elements and specific assets. The identification of specific plant items is determined by maintenance planning and statutory needs, and generally descends only to complete items rather than individual components (e.g. a winch rather than winch motor, brakes, ropes etc). The location hierarchy descends through functional spaces that are defined by business operations to individual rooms. These structures are replicated in Sydney Opera House’s maintenance management system (Mainpac) and a newly developed BCI database.

When used for the collection of BCI data the maintenance officer carries “tough-book” tablet PC and enters the condition index, noting specific defects and adding photographs in real-time. The officer identifies which room s/he is in using the room id, the room’s common name or the door number and is presented with a choice of indices (presentation or fabric condition). The presentation index is entered for the room as a whole, whilst selection of the fabric index calls up a list of elements present in the room that can each be scored separately. At the end of each day the data is loaded into the Sydney Opera House computer network and becomes accessible to all.

An approach based on asset and location can be taken beyond asset condition monitoring and applied to maintenance scheduling, asset tracking, bookings & reservations and many other aspects of facilities management. For Sydney Opera House the parameters of asset and location will underpin the future development of a Building Information Model (see page 15).

4.3. Comparative Benchmarking

The BCI's established by Sydney Opera House provide a means of measuring internal performance. The Exemplar Project research team is attempting to establish the extent to which performing arts centres and iconic buildings collect qualitative or quantitative FM data and if it is possible to use such data to compare the performance of different buildings.

A two stage survey instrument is being used. Stage one invites potential benchmarking partners to register their interest and provide general information. The second stage will involve a detailed assessment of existing benchmarking practices and the development of comparative tools. In the first stage over eighty potential partners were contacted, of whom fifteen have so far expressed an interest in participating in the research project.

An initial assessment of stage one responses has identified six key areas of key performance for performing arts centres, status drivers and preferred focus areas for a benchmarking framework:

Key Performance Areas	Status Drivers	Benchmarking Framework
i. Recognition for excellence	i. Functionality	i. Condition assessment
ii. Value for money	ii. Landmark status	ii. Energy management
iii. Pride in a key symbol	iii. Operational efficiency	iii. Accessibility
iv. The experience	iv. Cultural heritage	iv. Contractor's performance
v. Artistic and industry development		
vi. Access and equity		

Stage 2 will explore these themes with participants and seek more details particularly in the areas of condition assessment and energy management. It is conjectured that it may be possible to develop relatively simple formula by which to compare performing arts centres and building icons. For example:

$$\text{BCI cost} = \text{maintenance cost} \div \text{BCI score} = \$ \text{ per } \% \text{ point}$$

$$\text{Overall weighted energy cost} = a.W + b.X + c.Y + d.Z = \$/\text{m}^2$$

where a,b,c & d are energy costs and W,X,Y & Z are m² of floor area for different functions

The comparative benchmarking research will continue to explore these themes and to expand the number of participants from Stage 1 so as to increase the robustness of the data.

4.4. Conclusion

Sydney Opera is beginning to use BCI's as a benchmarking to measure internal standards and continuous performance. The concept has been applied to maintenance contracts and is being linked to enterprise measures such as customer satisfaction. Further work is required to develop BCI's that cover all building elements and to demonstrate that the achieved standards represent value for money. The latter will be assisted by the development of comparative benchmarks with other performing arts centres and iconic buildings.

5. Building Information Model

5.1. Introduction

Facilities management generates, and is dependent upon, a vast array of information that begins with as-built documents and Operation & Maintenance manuals, and extends to include maintenance schedules, room data sheets, asset performance data and cost data. As the hierarchy of data develops it transcends the specific needs of the maintenance department and aligns with data reflecting the performance of the organisation as a whole. The value of data is enhanced by its currency, accessibility and the ability to correlate one data set with another. There are number of major challenges to achieving this ideal, including:

- Effort involved in maintaining currency;
- Range of (non-compatible) databases in which information is held; and
- The lack of consistent data formats and references.

Building Information Models (BIM) seek to bring together all information needed for facilities management (and its connections to business management) by establishing a high level of interoperability between software packages. The BIM concept recognises that it is unlikely that one single software package will meet the needs of all parties involved in building management from the design team and constructors to maintenance staff and facilities managers and the upper levels of organisational management.

Although a unique building, Sydney Opera House is by no means alone in holding its building data in a range of formats, often incompatible and occasionally out-of-date. These are challenges that face facilities managers in many buildings. The FM Exemplar Project is supporting Sydney Opera House in the development of a generic specification for the presentation of building data that will allow the progressive development of a complete Building Information Model as funds become available and maintenance/upgrade works provide the opportunity to bring up-to-date existing information.

5.2. Establishing an Interoperability Standard

Interoperability is defined as the seamless sharing of building data between multiple applications (or disciplines) throughout the lifecycle of a building. Members of the FM Exemplar Project and CRCCi partners⁴ have been active in promoting the development of Industry Foundation Classes (IFC) as a standardised building information model based on an ISO standard through membership of the International Alliance for Interoperability (IAI). The IAI is a worldwide alliance of construction industry organisations including architecture, engineering, construction and facilities management (AEC/FM). The mission of the IAI is to integrate the AEC/FM industry by specifying a universal language that improves communication, productivity, delivery time, cost and quality throughout the design, construction, operation and maintenance life cycle of buildings.

Combing the experience of project members in interoperability with Sydney Opera House's tentative steps towards a building information model through the collection of benchmarking data (page 11) has led to the development of a "Building Information Model Standard Specification" for Sydney Opera House (BIMSS) and a parallel generic document available to all organisations. The specification documents a standard language to be used when documenting assets (e.g. location, asset structure), whether as a part of a design phase or

a maintenance upgrade. It also requires documentation that can range from drawings to manuals to be presented in interoperable formats preferably using open, IFC compliant, software. The BIMSS document will become part of Sydney Opera House's growing suite of base building documents and be incorporated into new maintenance and construction contracts. In this way a BIM will be progressively built without incurring the significant costs associated with updating and converting all existing data as a separate venture. The FM Exemplar Project will continue to follow the development of Sydney Opera House's BIM as an on-going case study.

5.3. Conclusion

The use of BIM offers numerous advantages for the FM industry by integrating data from many sources. The IFC approach to open, interoperable, systems will allow software to be chosen for specific purposes in the confidence that data can be shared between systems. The implementation of a BIM will require organisations to establish a standard language by which to reference assets, locations and other factors. The BIMSS developed by the FM Exemplar Project team will provide a core specification that many organisations will be able to adapt to their particular needs.

⁴ The assistance of Stuart Bull, Arup, is acknowledged

6. Conclusion – an Exemplar Project

Cooperative Research Centres were established to bring together researchers and research users, to promote collaboration and the transfer of research to industry. The Sydney Opera House FM Exemplar Project is taking this a step further by sharing the experience of one FM practitioner with the FM industry whilst at the same time bringing the benefits of academic research to Sydney Opera House. The procurement methodology being studied is not of itself innovative however the case study will be invaluable in documenting the challenges faced by an organisation in managing change. The development of a comparative benchmarking method for performing arts centres and unique buildings will enable organisations that manage these buildings to better understand the effectiveness of their facilities management and its contribution to the enterprise. The BIM concept has the potential to pull together all aspects of facilities management, indeed all components of a building's life cycle. The completion of a generic BIMSS and a study of its application at Sydney Opera House will encourage the development of interoperable standards and provide useful lessons for other organisations intending to adopt a BIM.

The benefits to Sydney Opera House have been to broaden the knowledge-base available to the organisation's FM team through contact with a wide range of colleagues in industry and research, and to encourage innovation. The benefits to the Australian FM industry will be a series of case studies presented through various forums open to all FM practitioners.