THE **BRITE** PROJECT

Innovation Case Study No 10

Twin-Coil Air Conditioning at the Art Gallery of South Australia

*This series of innovation case studies has been developed by the BRITE Project of the Cooperative Research Centre for **Construction Innovation**. The case studies demonstrate the benefits of innovation and successful implementation strategies in the Australian property and construction industry. Many highlight the strengths of small and medium-sized businesses in regional areas.*

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Twin-Coil Air Conditioning at the Art Gallery of South Australia

The locally developed Shaw Method of Air Conditioning (SMAC™) adopted by the Art Gallery of South Australia for their West Wing in 2004 appears to significantly improve energy efficiency and reduce variation in temperature and humidity levels.

Bypass Loop on the SMAC system

Selected Project Participants

Client:
South Australian Department of Administrative and Information Services (DAIS) on behalf of the Art Gallery of South Australia

Head Contractor:
Transfield Services (Australia) Pty Limited

Subcontractor (Commissioning/Programming SMAC):
Air Con Serve Pty Ltd

Subcontractor (Installing SMAC):
A. G. O'Connor Pty Ltd (trading as O'Connors)

SMAC Patent Holder/Commercialisation:
AirCon Design Today Pty Ltd

Design Mechanical Engineer:
Connell Mott MacDonald

Corporate Adviser for Facilities and Asset Management to the Art Gallery:
South Australian Department of the Premier and Cabinet - Arts SA (DPC-ARTS)

Organisations consulted in preparing this report: Art Gallery of South Australia, Air Con Serve Pty Ltd, A.G. O'Connor Pty Ltd, Connell Mott MacDonald, DPC-ARTS, DAIS and Energy Division, South Australian Department of Transport, Energy and Infrastructure..

Cover photo: Entrance, West Wing, Art Gallery of South Australia

The Project

The Art Gallery of South Australia holds a significant Australian art collection. Located in a heritage building, over time the Gallery has expanded to include new wings and services such as a restaurant, function rooms and bookshop. The scale and scope of these operations and the volume of visitors to the Gallery had combined to challenge the existing air conditioning system.

The patented SMAC twin-coil system of air conditioning was installed to modify the system in the new West Wing of the Gallery. The project team was engaged under a Design, Construct and Commission contract, and completed the installation in August 2004.

The Achievements

The SMAC system appears to be one of the first twin-coil systems in the world with series pipe circuiting, which optimises performance. The system installed at the Art Gallery of South Australia was only the third application of this type, world-wide.

Preliminary estimates related to the installation at the Gallery indicate:

- reduced energy consumption
- associated reductions in greenhouse gas emissions
- less variation in temperature and humidity levels

The Gallery project was completed in three months, inside the required time line. There was no interruption to Gallery activities and the project was completed within budget at a cost of $180,000 (which included repair work to the existing system).

Andrew O'Connor
Managing Director, O'Connors

'Innovation often comes from keeping things simple'

The Innovation

The new twin-coil system is the fifth and last of a number of air conditioning innovations developed by the late Dr Allan Shaw, formerly of The University of Adelaide. The innovations aimed to reduce energy usage and enhance air conditioning performance.

An ongoing relationship forged through common interests resulted in control of the innovation being handed from the inventor to the commercialising company. The key shareholders of the commercialising company are the inventor's family and the two project subcontractors.

The new system differs from conventional air conditioning processes in that, rather than drawing untreated outside air and then cooling it within the total air system, incoming outside air is pre-treated (dehumidified and cooled) by a separate, outside air coil before merging with inside air. Supply air is treated by the second coil, which belongs to the original conventional system.

The twin-coil system prevents the need to use energy twice to overcool and reheat air in order to maintain humidity in the occupied space, and monitors and adjusts humidity levels, providing better control.

The new technology appears to be the only twin-coil system patented world-wide using *series* pipe circuiting to maximise efficiency. It is based on earlier work of the inventor, which employed *parallel* pipe circuiting. The *series* system is more efficient, as the same water goes through both coils, halving the pumping energy required.

Three key components give the system its competitive edge:

- the dual coil that separates the process of treating latent loads (typically to remove moisture from outside air) and sensible loads (typically internal air which is dry)
- series pipe circuiting, which maximises the system's efficiency
- the control system that provides integrated control of humidity, temperature and chiller operation to ensure that air treatment processes optimise energy performance at all times.

The new twin-coil system builds on existing practices and has minimal impact on other components, while at the same time promising to deliver significant improvements in performance.

The Benefits

1. Since its commissioning at the Gallery in August 2004, the performance of the twin-coil system has been closely monitored by the project's mechanical engineer, as well as through a recently developed computer-modelling program which tracks energy consumption, temperature, and humidity. Early results indicate that the application of the new technology to the existing air conditioning system in the West Wing has achieved the goals of reduced energy consumption and increased humidity control. For example, the Gallery has seen an average monthly gas consumption reduction of 30% over the period September 2004 to March 2005, which is believed to be attributable to the twin-coil system.
2. Through its temperature and humidity control processes, the new system has achieved improved control over temperature and humidity fluctuations in the Gallery. This is an important condition for protecting the artwork and is a key requirement to secure future, and especially more prestigious exhibitions. A related, but unexpected outcome accredited to the new system is its ability to limit the impact of outdoor air entering from large glass doors on humidity levels.
3. The installation of the twin-coil system did not interrupt the daily operation of the Gallery. This was important, as the Gallery was hosting an important international exhibition at the time, which could not be shifted or stored elsewhere.
4. Since the twin-coil system builds on other systems, and therefore requires limited modifications to existing infrastructure, the innovation has been described as 'simple and easy to install' by contractors and does not require additional skills or training for installation. By using much of the existing ducting and piping infrastructure, the technology keeps costs to a minimum, so that they can be more quickly recovered.
5. The twin-coil system can be used in the retrofit of existing air conditioning systems, as well as in new buildings and facilities.
6. The system is effective in dry climates, such as in South Australia, and in high humidity climates, such as in Thailand.

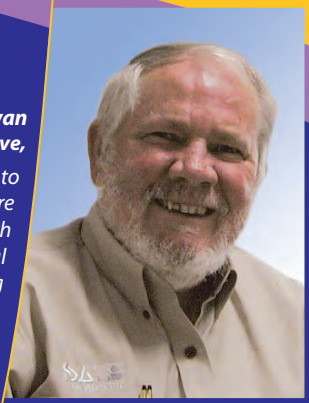
The patented twin-coil system was also installed at the Barmera Hospital in South Australia in 2002 and in the Headquarters Building of Siam Cement in Thailand in 2004, with energy savings and enhanced air conditioning performance being reported for both sites. The twin-coil system at the Barmera Hospital received the 2002 National Electrical and Communications Association Award of Excellence (Specialist Division) in Australia.

Lidia Rozman-Jones
Associate,
Connell Mott MacDonald,

'It is important that the solution is tailored to meet the requirements of the project and the Client'

Wayne Ryan
Air Conserve,

'A willingness to engage and share knowledge with others is essential to commercialising technology, and success can only be achieved through patience!



The Implementation Process

The Gallery pursued installation of the twin-coil system to reduce energy expenditure and to gain better control of fluctuating humidity and temperature conditions. This project was another stage of ongoing energy efficiency initiatives implemented by the Gallery's energy stakeholder committee. Reinforcing these internal drivers, and providing funding for the project, was a whole-of-government policy program, the *Energy Efficiency Action Plan (2002)*, which committed the South Australian Government to reducing energy consumption in all government buildings.

The company commercialising the new technology has extensive experience as an energy management contractor in South Australia, particularly in the arts community, and a reputation for developing energy saving initiatives. For these reasons, the stakeholder committee put a request to the company for an energy-reducing proposal, after considering other options.

In summary, the development and installation of the twin-coil system at the Gallery arose from the client's:

- desire to capture energy savings
- need to improve humidity and temperature control
- requirement to meet government policy and standards
- willingness to explore alternative methods of air conditioning.

The sub-contractors were responsible for the design, construction and installation of the twin coil system. The task of designing and building the new components was assigned to the consulting engineers, while installation was undertaken by the mechanical contractor. The design drew on the client's expertise and that of related stakeholder agencies. For example, since artwork is subject to strict humidity level requirements, the client suggested that the project team consult with a specialist art conservation agency, as input to the design process.

In effect, the above arrangements constituted a short-term joint venture between the stakeholders, which facilitated information sharing as well as enhanced problem solving and planning. Importantly, working in parallel rather than sequentially through the project phases meant that the new system was designed and built almost simultaneously, reducing lead-times and contributing to timely completion.

The project team acknowledges that successful progression of the project through the design, tendering, construction and installation stages was greatly facilitated by long-term working relationships between the stakeholders.

Finally, the commercialising company encouraged the adoption of the technology, which is in these early stages of diffusion, by waiving the normal licence fees. This is because these early projects help the company to demonstrate the benefits that can be realised. The company also reduced the client's risks associated with a new and relatively untried approach, by guaranteeing energy savings and by undertaking to rapidly return the air conditioning system to its conventional state, should any problems occur.

Kaj Lindstrom
Manager,
Art Gallery
of South Australia

'It can be useful for clients to accommodate reasonable risks in order to adopt new technologies - it can really pay-off'

Overcoming Difficulties

Despite increasing interest, the twin-coil system has not been widely adopted in Australia or overseas, being limited thus far to two South Australian government buildings and the building in Thailand. A key reason for this lack of uptake appears to be the highly competitive nature of tendering processes for construction projects, which means there is no time or incentive for exploring alternatives to conventional practices.

Credibility

The commercialising company has been frustrated by lack of opportunities to showcase the technology which has resulted in limited data to provide evidence of its claimed benefits. This is slowly changing and an evidence base is being built, by ongoing external monitoring of twin-coil installations and the commercialising company's specialist computer program, which models energy consumption. The data will help potential clients and designers compare costs and make decisions.

Promotion of the Innovation

The lack of a well-considered marketing and implementation strategy, particularly as it applies to commercial procurement, was also identified by the commercialising company as limiting the uptake of the innovation in earlier days.

The method of championing the technology also needed to be changed, moving from a reactive, confronting approach to a more patient, consultative way of overcoming structural and cultural barriers. There is now a more concerted effort to engage with prospective users, including consulting engineers, and provide information on the product at an early stage in the design process.

This has been coupled with a new marketing strategy that means the twin-coil system can be used by a client, without ties to the patent-holding organisations. In the past, the commercialising company tried to enforce a tied arrangement, where their contracting arm had to be used to install the system. This lack of flexibility may have hindered adoption.

It appears that an expanding support base is currently spreading responsibility for championing the technology and this has contributed to broader industry acceptance of its potential.

Commercialisation & Intellectual Property

Although a university provided the educational environment and technological resources necessary to research and trial earlier versions of the technology, another type of vehicle was required to take the twin-coil system to the market. Much of the development and financial commitment for marketing the twin-coil system has been provided by a private company dedicated to its commercialisation.

The technology is patented, but it is also relatively simple, which increases the chance of other companies copying it. As the commercialising company is a very small multiple-family business, there is some risk of a deliberate breach of their patents, on the assumption that a family company could not afford to protect them. The commercialising company is managing this risk by trying to rapidly build its reputation as a leader in the field and by seeking partnerships with larger firms more capable of protecting the intellectual property.

Making the most of Opportunities

Rising energy costs globally, and the South Australian Government's policy for reduced energy consumption, provide strong incentives for consultants to explore alternative air conditioning options.

Further, the implementation of the technology at the Gallery was possible because repairs were needed on the existing air conditioning system. Repair and upgrade work is problematic because the chilled water system usually needs to be turned off, potentially exposing the art works to great temperature and humidity variations. This work needed to be scheduled in cold weather, and the Gallery reduced its risks by undertaking repair and upgrade work together.

Finally, the relationship that the commercialising company had previously built up with the Gallery contributed to their appointment.

Lessons Learnt

Local firms, innovators and advocates

- Small, local companies can be innovation leaders.
- Innovation requires both champions (those people prepared to work at supporting a new idea) and sponsors (those people linked to resources, influence and legitimacy).
- Aggressive championing and negotiation is often less effective than a relationship-building approach to innovation diffusion.
- Persistence in championing an innovation until the idea achieves broader acceptance is an important, but also wearying, requirement.
- Effective prior working relationships between key stakeholders can provide a basis for exploring innovative options.
- A marketing strategy that provides flexibility may contribute to the uptake of the innovation – innovators and their representatives can often be too controlling.

Clients

- Knowledgeable and engaged clients facilitate the adoption of innovation because they can cross-check information and make informed decisions.
- Involving specialist third parties or stakeholders in design decisions can make innovation more relevant in a particular application, enhancing outcomes.

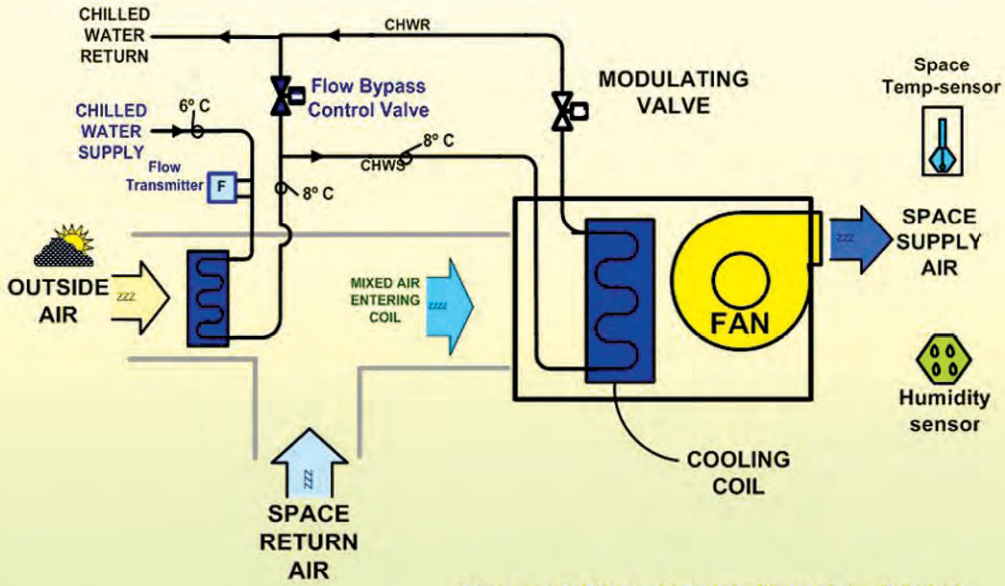
Innovation process

- Innovations don't have to involve major costs or significant disruption to existing system components to produce extensive benefits.

Innovation Environment

- Government policy changes are a key contributor to the uptake of innovation.

Patented SMAC Air Handling Method



Upgrade from Conventional to SMAC

Post-tensioning cables

Fresh air dehumidifier coil on the SMAC system

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'to lead the Australian property and construction industry in collaboration and innovation'