AUSTRALIAN CONSTRUCTION ACHIEVEMENT AWARD 2013

TECHNICAL PAPER

RMIT SWANSTON ACADEMIC BUILDING

By Andrew Deveson, Brookfield Multiplex Project Manager

ABSTRACT

The $182 million RMIT Swanston Academic is RMIT Universities single largest capital expenditure in its history. The project was delivered by Brookfield Multiplex under a Design and Construct Guaranteed Maximum Price contract with the consultants novated to Brookfield Multiplex throughout upon award of the construction contract in September 2012. The building is a 35 000m2 state of the art learning and teaching facility complete with office space for over 850 staff. Which comprises over 12 large specialised teaching spaces, 64 smaller teaching spaces, the building now makes up 40% of RMITs teaching space across the campus. The challenging architecture, ambitious ESD performance and constrained inner city location required both innovative design and collaboration between all stakeholders. The project was ultimately delivered 108 days ahead of schedule on the 6/7/2012 (original contract date 23/11/12), with the opening of the facility being brought forward from February 2013 to the 16/7/2012. The project was delivered under budget with a saving of over 3.4million dollars being delivered to the shared savings. This paper will cover the:Contractual arrangements in place,

- Design enchantments identified by Brookfield Multiplex to both enhance the constructability
- Design enhancements to improve the safety of the safety of the facility for the end user
- Logistical constraints overcome throughout the project, and
- Achievement of early occupation of the facility.

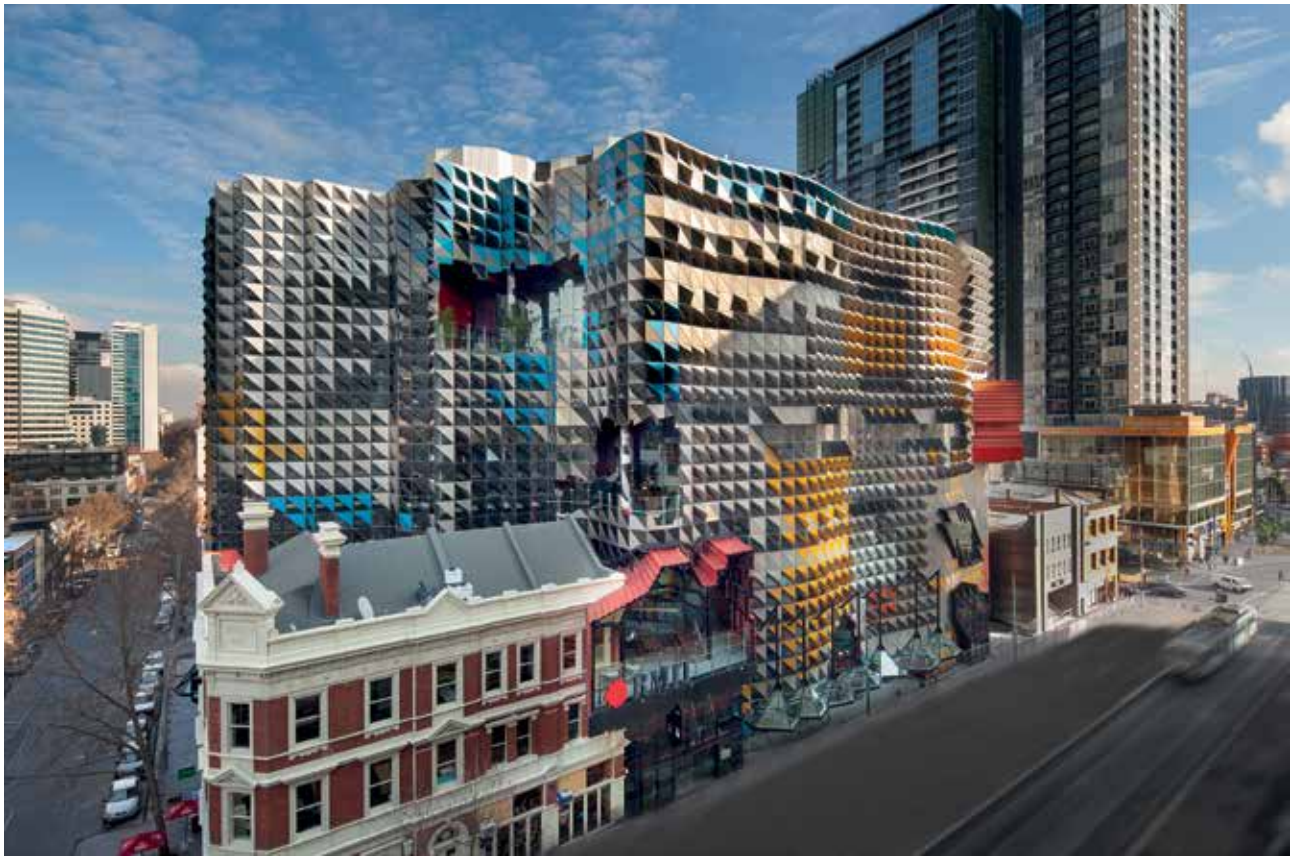
Introduction

The tertiary education sector now represents one of Australia's largest domestic and export industries: it is Victoria's second largest export industry. With the rising Australian Dollar and increased international competition, the Tertiary Education industry is challenged to attract and retain the best students, researchers and staff from around the world. RMIT University under the leadership of Vice Chancellor Professor Margaret Gardner (AO) embarked on a $600 million dollar capital works programme to enhance RMIT's reputation as a global leader in technology and design. The RMIT Swanston Academic Building at a total cost of over $200 million dollars was to be the centrepiece of this transformation.

The site at the corner of A'beckett Street and Swanston Street has been the subject of many different development options during the past 15 years, including the construction of multipurpose sports facility. The site itself was made-up over several properties over several titles that included a carpark, delapadated teaching facilities and courtyard to the Oxford Scholar Hotel.

The Swanston Academic Building was born when RMIT announced a design competition with the overall brief of delivering a large education facility "that put the students at the heart of the facility". Lyons Architects was appointed to the project and two-year documentation process began. The brief given to Lyons was to provide the University with a facility that would cater for the changing needs of students moving into the 21 century and that would be flexible to the way that teaching would occur in the future, to this extent Lyons consulted widely within the University to determine how a teaching space should.

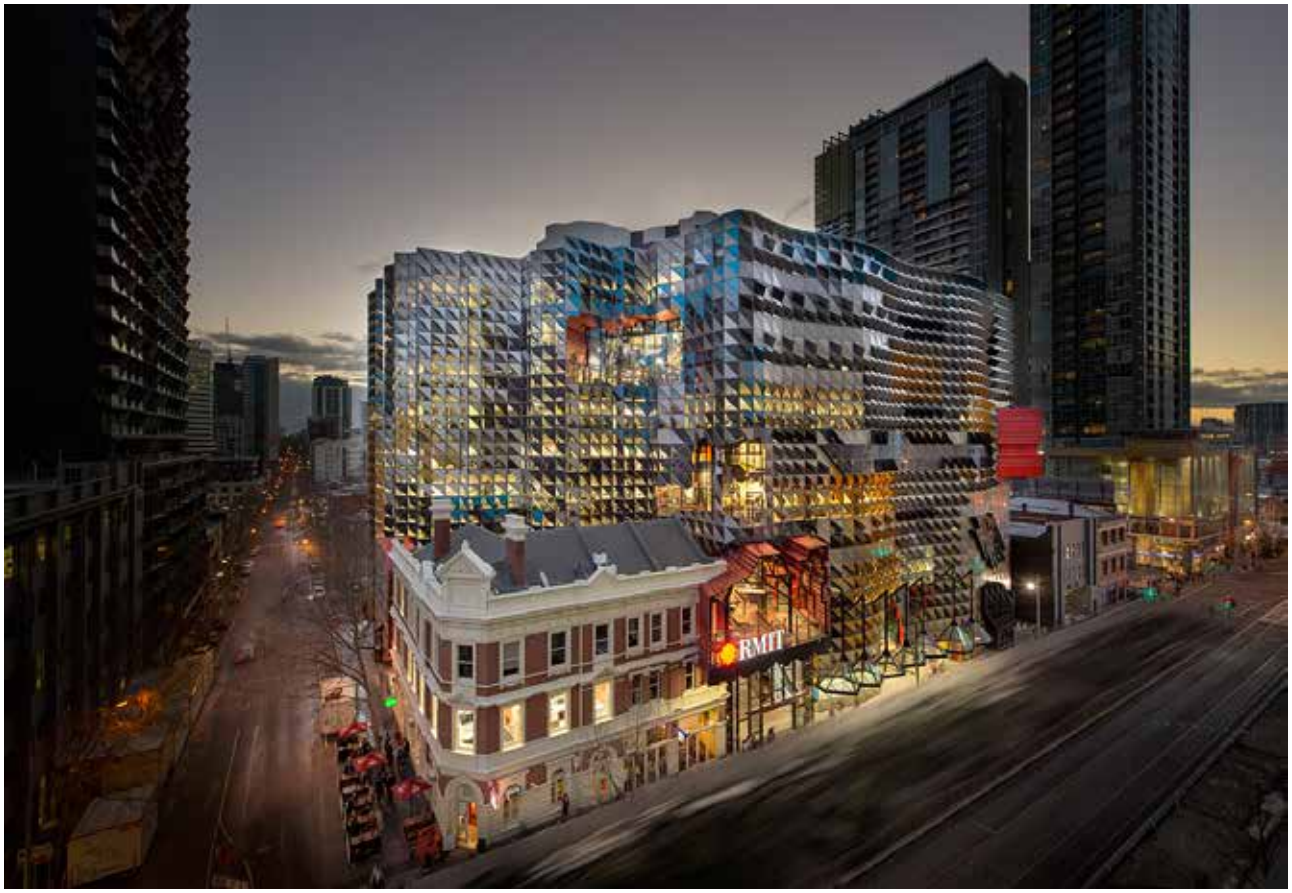
The documentation phase of the project, up to the release of the tender documents for the main works contract, was over two years and thousands of hours of consultation with user groups by the time the project was issued for tender in August 2010.



Scope of Work

The facility that Lyons designed was a 35,000m2 building spaning over 12 floors that incorporated the following features

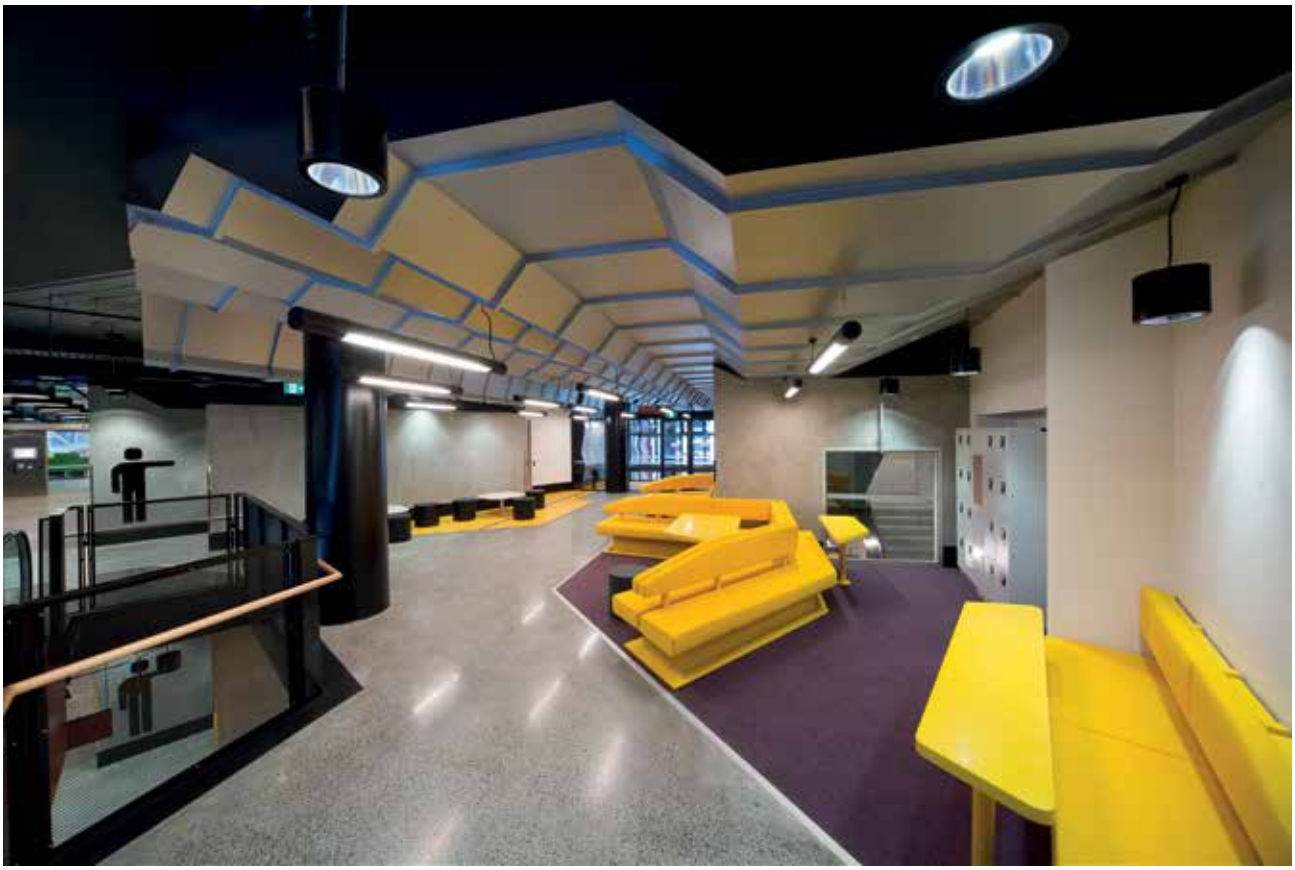
- 12 specialised teaching spaces ranging from capacity of 90 to 360 people, complete with under floor displacement mechanical systems
- 64 specialised teaching spaces with capacity from 30 to 60 people
- Open plan office space over seven floors for over 850 staff for the facility of business, with active chilled beams for mechanical cooling
- 5 star green star design
- Central Atrium complete with escalators between levels 2 and 7 and interconnecting stairs between level 7 and 11
- 11 double height student common spaces, designed to recreate the “university lawn” experience that RMITs urban location did not allow, complete with mixed mode ventilation to reduce energy consumption
- Innovative aluminium façade complete with sunshades to maximize shading and reduced solar heat gain
- $6m state of the art IP addressable AV system



Contractual Arrangement

On the 16th of September 2010 Brookfield Multiplex was engaged on a D&C GMP contract for the delivery of the SAB project. The key items in contract were:

- Share of Savings to the GMP
- Novation of Consultants
- Consultants obligation to provide monthly report to PCG including summary of departures from the brief
- Open book tender process
- Contractors obligation to complete Life Cycle analysis and to consider life cycle costs, and
- Facilities Management Contract. As part of the Tender the main contractor had to provide a facilities management partner, which RMIT had the option to take up within one-year of contract award.



Design Enhancement for optimisation of construction process

When the design consultants were novated upon award of the main works contract, the design was statused at 90% complete: at this stage RMIT did not want any large scale deviations to the design nor did they want to see value management or simplifications to the design. To this end the Brookfield Multiplex project team approached the design management process to complete the design and to find design improvements that would provide superior construction outcomes without reducing or modifying the overall design intent. The below listed design enhancements / innovations developed by the Brookfield Multiplex team contributed to the project achieving a $3.4 million saving to the GMP and its ahead of schedule completion:

- **Modified Sequence of the Structural Steel Installation**

  The structure of SAB is 2/3 conventional post-tension structure and 1/3 structural steel. The steel is between grid A and C and span 20m to form the large spaces for the lecture theatres. The original structure layout had a temporary movement joint at grid C, the connection between the steel and the conventional PT structure not to occur until 56 days after the PT concrete was poured. Brookfield Multiplex identified that would cause the entire structure to be delayed and as such the Post tensioning was redesigned so the temporary movement joint could be relocated to Grid D and could be done with a proprietary joint that only required to be grouted after 56 days, this changed allowed the structural steel to be brought up with the PT structure and provided significant time savings

- **Propping of Precast Retaining walls**

  The basement at the SAB is divided by a 3m retaing wall that accommodates the difference in street levels between Swanston and Stewart Street. The original structural drawings were detailed such that the precast panels were to be installed once the lower level slab was poured, the panels were then to be tied in at the top by the suspended slab that was at the same level as the top of the retaining wall. This design meant that from a programme point of view the foundation and slab works to the lower level and the suspended slab had to be 100% complete before the works to the upper level could commence. This was a significant constraint to the programme, as such temporary propping footings were introduced with mega shore props that allowed the upper level works to independent ot the status of the lower level.

- **Conversion of Core from conventionally formed walls to jump form**

  The main lift core at SAB is offsite so that the lift lobby is parallel with Swanston Street as it faces toward Carlton: this decision was made by Lyons Architects to ensure the view was maintained. This presented the engineer with significant issue as the band beams and bondeck floors were intercecting the core at 45-degree angle. This made the detailing of the reinforcement for a jumpform very difficult, as such the walls were shown as conventionally formed so that the reinforcement detailing could be achieved. Brookfield Multiplex identified that conventionally forming the walls would significantly delay the structure. As a result, and in consultation with the structural engineer, offset couplers were developed to ensure the 45-degree intersection of the band beams could be achieved

- **Precast Slab Edge**

  The slab profile of the SAB follows the façade line and as such is made up of 184 discrete lines all intercepting the other at a different angle. Forming this edge in formwork presented a significant risk to both the programme and also the required quality. The design of the structure was modified so that Post tensioning was converted from end stressed to pan stressed and precast modules were introduced to the perimeter, this negated the need for complicated edge formwork to be done on-site, it was all shopdrawn and completed offsite.

- **Precast minislabs to form the edge of perimeter of the steel floors**

  The northern end of the structure between grids A and C was a composite steel structure, however due the complicated slab profile there was a 2m perimeter of traditional formwork, as such the benefit of the steel structure was greatly minimised as form workers were still required to form and strip at the edge of the building. There was also many double height spaces on top of each other that meant that traditional three-level screens would have been insufficient for protection as the formwork would be left in position for five levels, this would have provided a significant risk of falling, or falling materials. To eliminate this risk precast minislabs were used with an edge form built into them, the precast slabs had the perimeter handrails fixed to them before they were lifted in place. This eliminated the need for any back propping

- **Construction of level 7-student portal above occupied building below.**

  The level 7 student portal cantilevered some 4m over the existing Building 39. This building remained occupied seven days a week during construction. The structural engineer determined the condition of the existing roof and it was established that the roof could not support the load of a scaffold. The design of the steel cantilever was changed so that entire canter lever could preassembled offsite with the bondeck and the edge form already in position, the connections of the cantilever were all relocated so that they were inside the boundary line and not above Building 39.

- **Prefabrication of level 4 and 7 Student Commons**

  The cladding to the soffit of level 4 and 7 student commons allowed he cladding to craned directly into position fixed from below, the original design would have required the installation crew to work from above to fix the panels, this would have required significant more time and would have presented greater fall risk

- **Stick built facade converted to Curtain Wall**

  The original design had large areas of stick built facade around the student commons and theatre windows, these areas were reduced by 80% and converted to curtain wall, this reduced the amount of works that had to be done from boom lifts in the street. The external façade louvers design was changed from individual blades to a panelised system, this reduced the exposure to working at heights and manual handling due to the tower crane carrying out the install.

- **Prefabrication of the hanging Lantern Canopy**

  A redesign of the Lantern canopy allowed the offsite prefabrication, thus allowing the canopy to be installed in two parts, taking one day to complete. The alternative stick built system would have taken up to two weeks. The prefab system significantly reduced exposure to working at heights and working amongst the general public.

- **Lift Motor Room change from Insitu to Precast**

  The redesign from insitu to precast eliminated the exposure to working in confined spaces, working at heights and manual handling. The precast install took a total of two days as compared to the programmed insitu system of 12 days. The pre mentioned exposure was reduced by ten days.

- **Rain Sock to atrium roof**

  As there was a significant amount of work at the top of the atrium, there was a significant amount of time where the building could not be water tight, as such a BMC engaged a shade Structure Company to design and install a “rain sock” that connected to a drain that covered the 5m x 5m atrium. This prevented water from entering the building and also acted as a catch deck for any falling. This allowed the finishes to the atrium to be completed below.

- **Prefabrication of mechanical riser pipe**

  The mechanical riser pipes were prefabricated into 12m lengths and installed with the tower crane, this greatly reduced the amount of work required within the shafts and also eliminated the need to use block and tackles on each floor, which greatly reduced the manual handling. It also reduces the number of joints and possible failure locations

- **Balustrade fixing**

  The original detailing of the balustrades to the atrium was a continuous top rail made from flat plate with fixings into the edge of the slab; these details would have meant that a lot of work would need to be done from within the atrium and also the amount of time taken doing the welds would have been significant. The detail was changed to a top fixing into the slab and the gap was introduced in the top rail at each staunchen, This allowed the balustrades to be made as fully completed sections that could be installed from behind the construction handrail. This reduced the fall risk and also reduced the installation time by 80%

Design Enhancements for improved safety outcomes for end users

The following design enhancements were initiated to improve safety outcomes:

1. Increased Parapet Heights

The parapets heights to levels 3, 5 and 12 were raised. This negated the need for static line systems and created a much safer solution both during construction and during maintenance

2. Increase Capacity of passenger lift.

The passenger lift specified did not have the capacity to take an articulated EWP, this would have made the access for maintenance and future fitouts very difficult due to the geometry of the spaces with double height and numerous voids. Lift 3 was upgraded to a class C lift that has the capacity to take 2200kg EWP with an articulated boom.

3. Upgraded capacity of raised floors

The raised timber floors were all redesigned so that they could take the load of a star 10 articulated EWP of total weight 2200kg, this provides future capacity for RMIT to use large EWPs within their double height spaces

4. Oxford Scholar Window

The windows in the oxford scholar were original documented to be refurbished and repainted; the glass was specified to be left in position. As the glass was 2.7mm float glass there was a significant risk that during construction and post construction the glass could shatter and fall down to Swanston Street below, as such Brookfield Multiplex to the replaced all of the glass with 6mm laminated safety glass.

5. Introduction of BMU

The project was originally documented without a BMU and all facade works were intended to be carried out of the with abseilers and swing stages. Brookfield Multiplex carried out a detailed facade access review and determined that swing stages would not be a suitable solution as they did not have any location land on the ground due to the canopies. Brookfield Multiplex worked in conjunction with E.W.Cox to develop a BMU solution that would provide access to the entire facade

6. Location services within atrium

Brookfield Multiplex worked with the consultants and services contractors to relocate as many services as possible from the edge of the atrium or balconies so that the risk of falls during maintenance was reduced

7. Lights to fire stair

The lights within the fire stair were relocated from the soffit of the mid landing to the wall at 2400mm above FFL, this reduces the risk of falls from ladders as all future globe changes can be carried out at low level

8. Stairs to Plantroom roof

In the original documentation there was a ladder access documented to the plantroom roof. On the plantroom roof here are many items that require future maintance, fans, solar hot water. As such a ladder access was deemed not suitable as would be very difficult to climb a ladder with tools and maintain three points of contact. The ladder was deleted and a stair was introduced.

9. Access panels

A decision was made to use only 600mm x 600mmm access panels to ensure that the best possible access was provided to all services within ceilings.

10. Fire valves with stair

The RMIT standard design was to have the valves for the fire hydrant within the stair at 3m above the floor. Brookfield Multiplex identified this possible risk for falls and as such the valves were lowered to 2400mm and a 003 padlock was introduced to reduce the risk of sabotage

11. GPO location within workstation

In the original workstation design all of the GPOs were located below the desk within the cable management basket, Brookfield Multiplex identified that this was not suitable as people will need power outlets to charge personal electrical equipment; as such a GPO was moved above the desk, as such reducing the need for people to crawl below the desk.

12. Coordination of access panels within joinery and workstations

The services were coordinated so that the minimum amount of access panels were installed above workstations, this will make future maintenance much easier

13. Additional drainage and bunds around key items

Bunds were introduced around all risers on the level 12 plantroom riser so that in the event of a water leakage within the plantroom the lower floors will not be affected. Floor wastes and bunds were also introduced around the main switchboard room to minimise the risk to the building infrastructure of any flooding.

Site Logistics and Constraints

The location and nature of the project presented several challenging constraints that the project team were required to overcome as listed below:

- Contaminated soil: The soil on the site was classified as CAT A, as it was contaminated with lead. The basement was designed such that all of the spoil could be “cut and filled” as such there was no need to dispose of any CAT A soil. Brookfield Multiplex took the risk on any overrun, as such during construction it was required that the soil was stockpiled and then filled behind retaining walls.
- Cantilever Construction over public spaces: The level 4 and 7 portals cantilevered over Swanston St and Building 39 respectively. The level 4 portal was Concrete structure that was constructed off tradition formwork on top of a Gantry, this ensured that Swanston St was never disrupted during construction
- Boundary to Boundary construction: the footprint of the building was effectively hard to all property lines, this meant that all external façade works were being carried out above a footpath, public road or adjacent building. To achieve this with minimal disruption and no safety incident Brookfield Multiplex engaged in a detailed construction management and traffic management plan with the Melbourne City Council and with the adjoining property owners
- Completion of the Swanston Walk Project: In February 2012 the Melbourne City Council advised Brookfield Multiplex that they were revoking the gantry permit for Swanston St as they were intending to commence there Swanston Walk Project on the 9/5/12, the scope of which included upgrading the existing services, lowering the tram lines, widening and paving the footpaths. The façade works that required access from Swanston St still were programmed and expected to be ongoing until late June. In response to this Brookfield Multiplex accelerated the external façade works through additional shifts, additional resources, the council also assisted through providing Brookfield Multiplex with permits for extended hours of construction
- Construction within the Oxford Scholar: The iconic Oxford Scholar hotel on the corner of A’beckett and Swanston St is an integral part of the SAB, with the school of graduate research occupying levels 3 and 4. Brookfield Multiplex was required to fully strip and refurbish the top two floors of the hotel without disturbing the operation of the pub on the floor below. The demolition and refurbishment included the removal of lead render, asbestos and rotted floor beams

Early Occupation of the Facility.

In the first 12 months of the project Brookfield Multiplex had made significant gains against the construction programme to the point in which in November 2011 the programme status was +60 days. Having completed the University of Melbourne Neuroscience project six months previous 77 days ahead of schedule Brookfield Multiplex was acutely aware the University would need significant preparation time if they were to occupy the facility early, to this end Brookfield Multiplex approached Mr Darren McKee Executive Director of Property Services for RMIT to question if there was any appetite for an early occupation in August 2012. Mr McKee confirmed that RMIT were interested in an early occupation but do the restrictions of time tabling and moving the administration staff that the relocation of staff could only occur between semesters, as such the new completion date would be no later than 6/7/12 10 days prior to the start of semester on 16/7/12.

Brookfield Multiplex carried out a detailed reforecast of the programme to determine if feasibility of the 6/7/12 could be achieved, this was also carried out in consultation with key subcontractors to gain their commitment to the revised date.

Brookfield Multiplex and RMIT jointly drafted a Deed for the Accelerated Completion. The deed was executed on the 22/12/11. The Vice Chancellor issued an announcement in January 2012 to the RMIT staff and students that the SAB would be open for Semester 2 2012. The commitment from RMIT to move their staff and students in for semester 2012 was significant as the effect on timetabling and the reputation risk would have presented considerable problems for the University

A key factor of the deed agreement was that Conditions of Practical Completion would not be relaxed or relieved, with exception for the obligation for a hand over the retail cold shells 12 weeks prior to practical completion.

RMIT also provided a clear directive that the revised date was in now way to reduce the quality of the final outcome or the thoroughness of the inspection and defect rectification process. Prior to practical completion over 14,000 defect items were raised, logged and closed out.

The planned procurement of the FFE items was also modified such that in place of RMITs procurement department procuring the FFE Brookfield Multiplex was responsible for the sample review, signoff process and the procurement and installation. These works were not previously part of the scope of works for main work construction, however under the deed of agreement the FFE installation became a Practical completion requirement.

Another key factor for the successful completion of the project was the completion of the IT and AV systems for the 16/7/12. The new teaching spaces were solely reliant on the information technology and AV systems, as such if the systems did not function or where defective they facility would be unusable.

The AV and IT systems are significant with Brookfield Multiplexs AV package worth over $6 million. The AV system was at the time the largest IP addressable system installed in Australia. IP addressable AV equipment is the next generation of AV equipment, with the difference being that individual AV equipment communicate over the It networks and servers in place of traditional copper cables. The ability to address each piece of equipment over the IP network presents significant additional functionality, however it also significant increases the complexity of the system.

An offsite prototype teaching space was established offsite and mock classes began being conducted as of January 2012, this identified that there was a problem that was causing an intermittent fault that was resulting in the system crashing randomly. After over two months of troubleshooting it was identified that LCD screens were faulty and were causing the issue. The screens were a brand new Mitsubishi product with an inbuilt PC, as the product had not been used in an IP addressable system anywhere else in the world this defect had not yet been identified. Mitsubishi sent a team of six programmers from Taiwan and Japan to Australia for 10 days where they tested the panels and rewrote the firmware for the screens.

Prior to IP addressable systems the AV contractor has commissioned AV systems without the need for any interface with the permanent IP network. Brookfield Multiplex had a originally planned to commission the AV system of temporary network switches and once completed and witness tested hand them to RMITs ITS department to connect to the permanent network. It was however found that the complexity of the system could be reproduced through the temporary network, as such the process for commissioning had to be completely altered and the tradition method of commissioning had to be totally redeveloped. The sequence of commissioning was altered to the following

- Brookfield Multiplex complete construction of the communications room
- Communications room handed over to ITS
- Network equipment installed and patched
- AV system commissioning put on hold whilst awaiting network commissioning
- RMIT IP network commissioned
- AV system commissioned
- RMIT ITS proof test AV system (this included pushing buttons repeatedly for up to 100 times in a row to cause a crash or freezing, if this occurs 1 time in 100, the room was rejected)

This alternative sequence of testing now meant that Brookfield Multiplex was reliant on RMIT ITS commissioning the IP network in sufficient time to allow Brookfield Multiplex to commission the AV system. To manage this risk Brookfield Multiplex Project Manager and RMIT ITS Project Manager jointly chaired a status meeting at 7pm each night where the status of the AV and IP network was reported and the appropriate remedies were identified and actioned for any areas that were falling behind.

This level of cooperation was paramount to the successful completion of the project and the fact that on the 16/7/12 when the facility was opened that all of the AV and ITS systems were operation was a testament to the ability of a client and a contractor to work together to achieve a complex and unprecedented task.

Conclusion

Brookfield Multiplex's delivery of the Swanston Academic Building demonstrates the capacity with the construction in the industry to deliver challenging architectural projects. It has also shown the ability of construction contractors to manage the novated consultants to manage the design risk whilst maintaining the design integrity and still adding value to a developed design to optimize construction, safety and ESD outcomes.

The Swanston Academic Building Project deliver will also provide new benchmarks and long term legacies for the construction industry in regards to the ability to integrate client information services departments into the commission of large and complicated AV systems and to achieve a compressed time frame between completion of the construction contract and occupation of the building

The Swanston Academic Building Project will provide future benefit the education industry and wider community through both improved teaching and wider economic impacts

" We are a global university of technology and design, and the new Swanston Academic Building showcases our investment in cutting-edge educational facilities. It's an iconic structure, imaginative and invigorating. It was brought to life by Brookfield Multiplex. It is excellence in construction."

- Professor Ian Palmer, Pro Vice-Chancellor Business and Vice-President of RMIT University