
The Conference Convenors received a total of 44 abstracts. Abstracts underwent a double-blind peer review by two members of the Conference Organising Committee. Authors of accepted abstracts (32) were invited to submit a full paper. All submitted full papers (18) were again double-blind peer reviewed by two reviewers. Papers were matched as closely as possible to referees in a related field and with similar interests to the authors. Sixteen full papers were accepted for presentation at the conference and a further 6 papers were invited to present based on submitted abstracts and work-in-progress. Revised papers underwent a final post-conference review before notification of acceptance for publication in these conference proceedings.

Please note that papers displayed as abstracts only in the proceedings are currently being developed for submission to a digital cultural heritage special edition of an academic journal.
Abstract

Africa Hall is highly significant to Ethiopia, the African Union member states (52 countries) and the UN as the founding building for the UN in Africa. It played a key role during the formation of the African Union and the UN mission, which oversaw the decolonisation of Africa. A modernist architectural work (1958-1961), designed by Italian Architect Arturo Mezzedimi, it was built to be a symbol for contemporary Africa moving forward. The building is now in dire need of upgrade to remain relevant and functional. In 2014 Conrad Gargett was commissioned to lead a multidisciplinary project team. The mandate of the project was to renovate and upgrade Africa Hall’s facilities to achieve modern conference standards and provide a UN visitor centre for the public and conference delegates. The project’s scope included conservation works, major upgrades to conference functionality, along with technology-rich interpretative displays and experiences presenting the building’s place and its role in African history to visitors. Conrad Gargett used multiple emergent digital technologies, including 3D laser scanning to generate a point cloud and video recordings, to record the building and site. The 3D BIM drafting software and presentation software were used to produce existing drawings, then design and document the project. With the project in Africa, the client and project team in four continents, various contemporary technologies enabled day-to-day communication. This paper critically examines the challenges and opportunities experienced by Conrad Gargett’s team applying emergent digital technologies in heritage practice - using Africa Hall as a case study, a major heritage conservation project in Addis Ababa, Ethiopia for the United Nations (UN). Throughout this remote project’s development, the team adapted to use multiple emergent technologies and with agility they upskilled quickly. This paper posits that projects such as this offer a chance to close the inventor-practitioner gap.

Keywords: Africa Hall; Arturo Mezzedimi; Conrad Gargett; digital technologies; heritage practice; modern architecture.
Introduction
This paper critically examines the challenges and opportunities experienced by Conrad Gargett’s architectural team applying emergent digital technologies in heritage practice – using Africa Hall, a major heritage conservation project in Addis Ababa, Ethiopia for the United Nations (UN) as a practice case study. The multiple emerging and evolving technology platforms used during this project have required education and commitment from the client, user groups and wider consultant team to develop a shared understanding of the benefits to the project, ahead of each technology’s application and use. The Conrad Gargett team’s adaption to multiple emergent technology use and their agility to upskill quickly, became both a necessity and an opportunity for what can arguably be described as a ‘risky venture’ due to the project’s remote location, high profile and complexity.  

During the project, Conrad Gargett used Zebedee 3D laser scanning to generate a point cloud and GoPro video recordings to record the building and site. 3D BIM (building information modelling software – Autodesk Revit) drafting software and presentation software (Lumion 3d fly-throughs) were used to produce existing drawings, then design and document the project. With the project in Africa, the client and project team in four continents, video conferencing (client lead technology) and information management software (Newforma) have enabled day-to-day communication.

Drawing from the research undertaken by the project team, reviewing the documentation produced, and interviewing project team members - this paper shares the team’s experiences, highlights opportunities, identifies the current challenges of these emergent and evolving digital technologies to demonstrate how this high profile, remote project afforded Conrad Gargett the ability to close the inventor-practitioner gap. The paper is divided into five parts: the first two sections briefly describe Africa Hall’s cultural heritage significance and the project Conrad Gargett has been commissioned for. The latter three sections will critically examine the use of technology to record the existing building, to document the proposed project and lastly to facilitate the team’s communication.

Africa Hall’s history
Africa Hall (Figure 1, 3 & 4) is highly significant to Ethiopia, the African Union member states (55 countries) and the UN as the founding building for the UN in Africa, a place that assumed a key role in the forming of the African Union and the UN mission, and saw the decolonisation of Africa. A modernist architectural work (1958-1961), designed by Italian Architect Arturo Mezzedimi (1922-2010), it was built to be a symbol of contemporary Africa moving forward. As a venue for the African Union (the first African Parliament Building), Africa Hall’s design facilitates international, political, economic

Figure 1. Africa Hall and the Office Building soon after completion. (Source: UNECA collection).
on the site were key components in establishing the symbolic importance of the building, providing the landscape atmosphere Mezzedimi sought (Commemorative booklet 1961, 17). Unfortunately, Africa Hall is now in dire need of conservation and upgrade to remain relevant and usable.

To mark its fiftieth anniversary, UNECA, in collaboration with the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the African Union Commission (AUC), launched the current project to renovate Africa Hall in recognition of its role as a ‘monument to modern African history’ (UN General Assembly resolution 65/259 2011).

Seeking to conserve and revitalise history

The mandate of the current project is to renovate and upgrade the facilities to achieve modern conference standards and a UN visitor centre for the public and conference delegates. The project’s scope includes building fabric conservation and repair works, and both renovation and major upgrades to the conference facilities. The proposed project for Africa Hall – for it to continue functioning as a UN conference venue (and public conference venue) and as a major visitor centre utilising contemporary digital media
The renovated and upgraded conferencing facilities will include: new conferencing fitout and infrastructure; new security infrastructure (as expected for a building used by heads of state and diplomats); new digital displays for conference programmes and information; new interpretive elements throughout the building; new audio and video displays for visitors highlighting key and defining moments in the life of the building; and a new permanent exhibition using a range of media (including technology-rich interpretative displays and experiences) to present the place and its role in African History (CGRAMW 2014).

To ensure international best practice conservation methodology is undertaken, the project team has employed UNESCO and ICOMOS international protocols, including the ICOMOS Burra Charter. The project team produced a Conservation Management Plan, measured drawings, and undertook a condition survey, to inform the design and construction documentation (Figure 5). However, different from its work in past projects, the team has utilised multiple emergent technologies as tools to do so.

Creating the dots: using emergent technology to record the existent

Given the organic form and size of the building and its surrounding site, the complexity of the project was well recognised from the outset. Furthermore, the global nature of this project meant that the time the architects could spend onsite measuring (and the ability to return to the site frequently to ‘fill in’ gaps in the measurements) was limited. The use of emergent digital technology was thus seen as a necessity by Conrad Gargett to achieve a time-effective means of collecting accurate data for Africa Hall’s measured drawings.
The Zebedee scanner enabled access into areas of this building previously not recordable (heights, confined spaces) including voids, ducts and risers. No ladders or scaffolding were needed. The point cloud achieved accuracy of +/- 10mm, suiting 1:50 scale drawings and was considered reliable when used up to a maximum of 15 metres from scanner to building element. Hand measures were completed for detailed and significant joinery to be conserved and/or altered in the project’s scope (Boundy 2016). A 30-minute tutorial and then some practice was all the training that is required prior to using a Zebedee scanner for project work. However, being a hand-held device, it is pertinent that time is invested to map out the walking route and to think through level transitions, extent of single scan, inform building security, advise all occupants onsite on the day(s) and ensure that all doors are open in advance. The person scanning then needs to be mindful of how they move and their extent of movement to ensure the required detail is obtained. ‘It is interesting to watch Simon walk as he scans — there is a Zebedee walk.’ (Gole 2016) When interviewed for this paper, Simon described his walk:

You need to walk slow and deliberately, oscillate the scanner with your wrist, walk backward through door openings…corrupts if you are too fast. The scanner triangulates as you move around, so walking straight can lead to dimension errors. I have found walking in closed loops enables the software to correct itself and remove running errors. Putting an object in a featureless space, a plain corridor, provides a reference object for the scanner to triangulate. (Boundy 2016)

Further learnings to date, from this project and others, include: the need to occasionally scan a space two or three times and then merge these scans together to have enough dots to draft from; to be mindful of reflective/mirrored surfaces that the laser cannot map; to take more scans than perceived to be needed (Boundy 2016). Other hand-held technologies used onsite furthered the paperless, straight-into-
errors, identification of out of plumb and out of square walls (and other building elements), varying wall thicknesses, uneven floor levels, ceiling height variations and void variations, differences between sourced reference drawings by others and the built building (to list just a few examples). Without the point cloud, some measurements are invariably missed, leading to subsequent site visits being required. Reducing these project risks, has the potential to shift inherent project delivery complexities which can frustrate heritage conservation, renovation and adaption projects. The increased ability to identify idiosyncrasies of the construction early on – discrepancies between the as-drawn and the as-built – has, for this project, mitigated some of the issues that might have (previously) arisen when recording a building constructed in the mid-twentieth century in Africa (Boundy, Blake & Pendergast 2016).

3D BIM was utilised as the drafting software from the onset of the project, firstly to create the record drawings for the existent Africa Hall. It was then used to develop design strategies in 3D for approaches to the use of space, furniture arrangements and strategies for upgrades for fire and equitable access. It was also used to develop strategies in 3D for the integration of new services – in particular the modelling for new mixed-mode mechanical ventilation systems. Once design development was completed with the broader consultant team, 3D BIM drafting software was used to produce the tender and construction documentation as 2D drawings and detailed schedules. Engineering consultants documented the project and tested their design utilising 3D modelling software.

The use of 3D BIM is now an industry standard for new buildings and many heritage conservation projects led by medium to large Australian architectural practices. Where this project’s delivery has varied from standard practice is in the use of emergent technology onsite - testing these technologies’ commercial benefits for ‘everyday’ architectural and heritage conservation practice. The point cloud and the video recording...
records of the existing building have continued to be used almost on a daily basis for the documentation of Africa Hall, providing a readily available reference, resulting in highly accurate documentation, beyond that previously achievable (Gole, Pendergast, Blake & Boundy 2016). With construction scheduled from 2017, it is envisaged that point cloud and the video recordings will be referenced relatively frequently as construction progresses, with further video taken as the works progress (Pendergast 2016).

Technology rich communication for a global project

The emergent digital technology used for this project not only gave the Conrad Gargett team the tools and confidence to do the project, but it is believed they significantly contributed to achieving and maintaining client confidence. The multiple technologies used have required the education and commitment of the architectural team, client groups and the wider consultant team to develop a shared understanding of the benefits to the project ahead of each technology’s use. Time upfront was spent by the architectural team leaders explaining what and how technology could be used, how each would help the team and client, and both time and cost implications (Gole 2016).

Day-to-day communication was aided by the use of technology, not emergent technologies, but tried, tested and known to be the best software available of their type. The video conferencing (client lead technology) enabled the client and consultants to get to know each other quickly and easily, compared to what would have otherwise been limited, in-person meetings or meetings with reduced team representation. The client’s software choice has enabled greater connectivity than software generally utilised for other Conrad Gargett projects (Gole 2016). Newforma provided a live database for the whole of the team. This technology tracks all correspondence (incoming and outgoing, with automated tracking, thereby avoiding labour intensive transmittals); transfers large file packages of information to the global team; tracks changes or mark-ups, task assignments, requests for information and ‘punch lists’/defects lists (Boundy, Pendergast & Blake 2016).

Lumion software was used to prepare 3D fly-through design presentations initially to the core client stakeholders, highlighting the key aspects of the building upgrade and it was also used to secure funding approval from the UN General Assembly. A 3-minute presentation enabled all client stakeholders to understand the project quickly, surpassing 2D presentation formats of past projects. The use of 3D presentation software was considered to be the most compelling way to illustrate a complex project and is believed to have been fundamental to the project’s receiving full funding with approval from UN member states (Gole 2016). The presentation was prepared as a single video using fly-throughs of the 3D BIM model combined with sourced early imagery, recent photos and embedded pop-up text to explain the design intent; an architect from Conrad Gargett was not needed to personally present the video, as the text succinctly explained what would have been relayed in person [view video at https://www.youtube.com/watch?time_continue=2&v=clZHiGByEbI]. Lumion is an easy to use and relatively fast ‘real time rendering’ presentation software package, run by a gaming engine, linked to Revit. The retained link to Revit enables all design updates to be readily viewed in the presentation without the need to re-work the presentation, which is common to other software packages. The graphics are not photorealistic or glammed-up, but this suited the project and still enabled an accessible and considered presentation to the clients, imparting the details of the changes proposed and how these changes were going to be done in a sensitive and sympathetic way (Gole, Pendergast & Blake 2016).

Conclusion

To conclude each interview, we asked the Conrad Gargett heritage team what might be the future for documenting renovation and adaptive-reuse projects. This interview question elicited a return question from interviewees: ‘Is there a way of making
2D documentation even easier and quicker for others to read? Maybe the future is documentation by video... using video and point cloud in combination and lessening reliance on the 2D’ (Gole 2016). Imagine using video technology to communicate through all project stages - from site recording, design, documentation, construction, visitor interruptive displays and then facilities management – we are currently at three out of six.

Hearing the Conrad Gargett project team share their experiences, it is apparent they hope this project will provide inspiration for the conservation and adaptive re-use of other notable modernist architectural buildings within Australia and abroad. It is with this aspiration, and the team’s focus on both best practice heritage conservation methodology and progressive technologies, that they chose to upskill and take up the challenge of using emergent and evolving digital technologies for Africa Hall. The project’s remote location and high-profile client, beckoned the use of these emergent digital technologies to reduce a variety of risks (some too often perceived as inherent to heritage conservation projects) and to ensure the confidence of the client was captured, maintained and rewarded.

The project’s unique set of circumstances allowed the inventor-practitioner gap to be closed. Conrad Gargett cleverly combined different technologies to work remotely and work on a complex building varying from the original architect’s drawings. Through this paper it is hoped the experiences shared might give those developing scanning/drafting/facilities management technologies increased understanding of what is required in contemporary heritage practice, and might offer ideas for how the digital world can further improve the work process from start to end.

Notes

1. This paper has been prepared as a practice case study. Theoretical case studies and literature reviews of other papers discussing the use of scanning in academic and architectural practice have not been covered in detail. Publication alongside the other digital cultural heritage: FUTURE VISIONS papers provides some theoretical context for this paper.

2. ‘Remote location’ defined as remote to Conrad Gargett in Brisbane.

3. Client facilities management and consultants in Addis Ababa, Ethiopia; Client (leads and funding) in New York, USA; Conrad Gargett and consultants in Brisbane, Sydney and Perth, Australia; and consultants in Valence, France.

4. For this paper, ‘gap’ is defined as the lag time from invention to use in everyday practice.

5. Mezzedimi was to undertake numerous projects in Addis Ababa, other parts of Ethiopia and in neighbouring Eritrea (Mezzedimi 1992), while working with Emperor Haile Selassie (1892-1975) for approximately 23 years (Magada 2016). 1624 buildings are attributed to this working relationship, with Africa Hall a highlight. (Albrecht, Galli 2014).

6. Zebedee Zeb1 was shown to Conrad Gargett’s heritage team by CSIRO and UQ late 2013. Conrad Gargett then hired (from 3d Laser Mapping Rental) a Zebedee, project by project, for about 18 months, before purchasing in 2016 (from Geoslam) after frequent use and the desire to have it on hand to use at short notice (Blake 2016).

7. Conrad Gargett purchased a GoPro in 2013. Africa Hall was the first project it was used for. (Blake, Gole 2016). Long battery life, wide angle, media type, file size, equipment size and cost to achieve a ‘good enough’ quality made this type of video equipment more suited to project work than older technology video recorders (Boundy, Blake 2016). Videos were taken during the onsite work (including condition survey work and walk throughs, attached on-architect), not as a separate task. Videos were taken in shorter takes, to enable filing by individual spaces etc., making it easier to find later (Pendergast 2016).

8. For this project (13,800m² useable floor area) one architect took 6 days onsite to scan. Each scan was transferred to the Brisbane office overnight for back-up and for a Brisbane team member to check the files. Ethiopian internet speed (limited broadband
width) and dropouts did slow this down, unfortunately necessitating regular checking during the night to ensure the connection was still working. Corrupted scans were redone within the same 6 days. This timeframe was tight for the project’s size. Prior site measures by Conrad Gargett (and formerly Riddel Architecture) were done using a point to point laser device (Leica) plans annotated/drawn onsite by hand and still photography taken. For Africa Hall the low-tech approach is estimated at 2 staff members for several weeks, plus time to recheck and collect missing measurements (Boundy 2016).

9. Africa Hall has an accessible/walkable roof.
10. It is understood that a fixed scanner is +/- 1mm. This was observed by the team when a fixed scanner was used for a 2011 project.
11. 15 minutes is needed at the beginning of each day to plan walking routes. It then took approximately half the time of a scan to pre-walk the route, opening doors, advising occupants (a third of the time on site).
12. It is understood that the next version needs less human movement – the operator does not have to use their wrists to oscillate the scanner. Objects were placed every 5-metres in featureless corridors (Boundy 2016).
13. The current user interface is limited to 3 LED lights (red, green and yellow) and data needs to be uploaded post-scan to obtain point cloud data, so it is not clear if the data has been corrupted until data is returned. Currently done through the scanner’s supplier (Geoslam), as part of their ongoing customer service. This has also been a beneficial feedback loop. Software has recently been made available to do this in house. The ability to see the quality of scan data while scanning would be a welcomed future improvement to the user interface.
14. The construction knowledge and experience of the architect/technician is still important to know what the dots might represent–for example, to recognise dots as a skirting and draw as a Revit wall sweep–and cannot be replaced by the point cloud.
15. Hard to estimate, as a greater level of details was drawn, but 10 percent faster is thought to be the time improvement (Blake, Boundy 2016). The Revit model took approximately 4 weeks to draw (Boundy 2017).
16. Sourced records include an extensive drawing collection (architectural, structural and service drawings) held by UNECA. A commemorative booklet published by the Ministry of Information of the Imperial Ethiopian Government provides a valuable record of the building including detailed descriptions, drawings, photographs and testimonials (Commemorative booklet, 1961).
17. A detail and contour survey was commissioned and was needed as it picked up information not duplicated by the point cloud (e.g. n ground services).
18. Assumptions that had been made from the original drawings included: column sizes, wall thicknesses and beam locations – the point cloud enabled these to be accurately and quickly picked up and the 3D BIM modelling adjusted.
19. Varying local construction methods, consultant and trade contractor skill base, compared to what the team is more familiar with in Australian buildings.
20. Level of detail 200. (Blake 2016) The consulting engineers model their own existing and new works in line with them, taking responsibility for their own discipline’s scope (Gole 2016).
21. Navisworks was used by the team for clash detection and as a design checker/improver (Blake, Boundy 2016).
22. All 2D design and documentation drawings present information contained in the 3D BIM model. The 3D model was used by the Quantity Surveyor The architectural specification was prepared using separate word processing software. Fabric conservation/repair documentation is still largely dependent on 2D drafting.
23. For example, the mechanical engineers tested air flows and the electrical engineers tested lighting levels using 3D modelling - presenting these as 3D imagery in their design reports.
24. Riddel Architecture (merged with Conrad Gargett late 2012) have used this software for heritage conservation and adaptive re-use projects from 2006. The first documented project with the consultants modelling in 3D BIM software was completed by the office in 2009-2010, with the first built project documented with this software completed in 2012 (Boundy, Blake 2016).
25. Conrad Gargett is aware of others using point clouds to record sites, lasers from fixed stations, drones and robots to record the current status of listed sites, and archaeologists using point clouds to forensically investigate change. The team is aware of smaller practices using the consultancy service of the UQ School of Architecture, to obtain point cloud surveys and of
one other local (Brisbane) architectural practice offering point cloud scans as an in-house service.
26. Actual time spent was similar to that for past projects.
27. Postage took up to 8 weeks for one of the mailed documents (Pendergast 2016). Conrad Gargett is one of a number of larger Australian architectural now using this software.
28. A lot of non-construction industry people do not understand 3D drawings and for those that do, significantly more time (than 3-minutes) is typically needed to explain equivalent design content and obtain approval for complex projects with multiple client stakeholders (Gole 2016).
29. Lumion was first used by Conrad Gargett in 2012 (Blake 2016). ‘Real time rendering’ refers to the retained link to the Revit BIM 3D model. Lumion outputs stills, movie and panorama.
30. Not marketing imagery quality typically now used for selling real-estate or in design completion entries. Lumion does not have shadows and lighting effects, but Conrad Gargett can do all production in-house (Pendergast, Blake 2016).
31. L. Daunt interviewing Blake, Boundy, Gole & Pendergast. Conrad Gargett is currently testing: iPhone Google cardboard to create virtual reality; Oculus to show local clients their project as virtually walk throughs; and a 360-degree camera (Boundy 2016). “Quick and Dirty” design work can be (and is being) done from a point cloud, but this is limited (to concept or preliminary master-planning studies). For costing, coordination with engineers and to enable architectural documentation, a 3D BIM measured drawing set of the existing building is needed (Gole 2016).

References
"Modern Africa Tropical Architecture". (2013/1). Docomomo Journal 48
"Modern Heritage in Africa". (2003/1). Docomomo Journal 38


