Pholiota UNLOCKED

A pedagogical case study

Philip Goad

> Australia did not give Griffin anything like sufficient opportunities to develop his great talents. But then no other country gave him even as much as Australia did. He lived in hard times for a sensitive architect who felt compelled to find his own solutions to every building problem from the clay up, designing his own bricks and his own windows and his own tiles.
>
> Robin Boyd, 1963[1]

In October 2016, the exhibition *Pholiota UNLOCKED* was held at the Melbourne School of Design (MSD) at the University of Melbourne. The exhibition's intellectual focus was the 1917 invention by Walter Burley Griffin of his patented concrete block system, Knitlock. The exhibition's physical centrepiece was a full-scale reconstruction of Pholiota (1920–21), the Griffins' house in the Griffin-designed portion of the Melbourne suburb of Eaglemont. Constructed in new plaster versions of the original Knitlock blocks, the reconstruction of the house was complemented by documentary descriptions, reproduced archival images, photographs of the extended process of making new Knitlock blocks, and designs for a new Pholiota by MSD Master

of Architecture students. As a pedagogical exercise, students were involved from beginning to end: from initial research, object design and re-design, to fabrication, hands-on construction and exhibition installation. For the students, there were two main educational foci: first, to understand the original intentions, design and construction capacities of Griffin's Knitlock block, and critique them by proposing a new block design and fabrication system; and second, to understand the original intentions, design and lifestyle implied by the Griffins' Pholiota, and critique it by proposing designs for a new Pholiota and new subdivision patterns to accompany it.

This article examines the process and benefits of exploring an exemplar of architectural history through the media of archival research, documentation, fabrication, design and exhibition. It argues that a project like *Pholiota UNLOCKED* provides a useful model for object-based learning in architectural education, where project-based issues of research, design and execution are integral and analogous to the practice of architecture.

Genesis

The idea for *Pholiota UNLOCKED* emerged suddenly—in November 2015 at a meeting chaired by Jonathan Mills about Cultural Collisions: Grainger | Griffins, the University of Melbourne's contribution to the 2016 Melbourne Festival. I was asked what the MSD might contribute, not only to celebrate the Australian work of the American husband-and-wife architectural team of Walter Burley Griffin and Marion Mahony, but also to showcase our students' designs and the state-of-the-art digital fabrication

Previous page: Marion Mahony and Walter Burley Griffin gardening at Pholiota, 23 Glenard Drive, Eaglemont, Victoria, c. 1923. Eric Milton Nicholls Collection, National Library of Australia.

and workshop facilities in the new MSD building. Put on the spot, I had to think quickly.

The Griffins' work in Australia has been the subject of intense scholarship nationally and internationally, not least in the university's Faculty of Architecture, Building and Planning, namely through Jeffrey Turnbull and Peter Navaretti's monograph *The Griffins in Australia and India* and Turnbull's magisterial e-book *Walter Burley Griffin: The architecture of Newman College, 1915–18*.[2] So, there had to be something different—and in some respects unique—in offering any fresh interpretation to the Griffin cognoscenti, and also to the public who might know little about this pair of charismatic American architects, who arrived and settled in Australia ostensibly to complete their prize-winning design for Canberra, the new national capital.

So my first thought was to ask: what was something about the Griffins that not only the public but also the scholarly community didn't know or hadn't experienced? At the very least, most would know of the Griffins' masterful design of Newman College (1915–18) at the University of Melbourne, or the cavernous wonder of the Capitol Theatre's crystalline auditorium (1922) in Melbourne's Swanston Street. But few if any would know of Pholiota, the tiny little house at Eaglemont that Walter and Marion built, and lived in from 1920 to 1925. ('Pholiota' is a genus of mushroom, chosen because of the house's shape, and because it sprang up virtually overnight.) And few if any would be familiar with that house's unique concrete construction system—Knitlock—invented and patented by Griffin in 1917. So the idea was simple: to unlock Pholiota.

The proposal was to reconstruct Pholiota at 1:1 scale in the Dulux Gallery on the ground floor of the new MSD building. Complementing the reconstruction would be an exhibition of designs for a contemporary version of Pholiota undertaken by a group of 13 final-year students in the MSD's Master of Architecture program in Semester 1 of 2016.[3] The students were also asked to examine the Glenard Estate in Eaglemont, where Pholiota was constructed and which Griffin had laid out as a 120-lot suburban subdivision in 1916. Each student was allocated a different set of eight lots and asked, in addition to siting their new Pholiota, to double the density as a possible strategy to cope with Melbourne's need to consolidate its building stock and accommodate increased population.

Adding to the students' challenge was the requirement to make a detailed investigation of Knitlock: to study the Griffins' special construction system, make some of the tiles at various scales in the MSD fabrication workshop, work out ways of making the tiles afresh, and then—in some cases—invent a new Knitlock tile or system. In pedagogical terms, this meant that a rich vein of learning techniques could be explored. Guest presentations were given by Dr Jeffrey Turnbull on the Griffins and Knitlock, and by Professor Paolo Tombesi on prefabricated reinforced concrete systems designed for the SARAH Network of Rehabilitation Hospitals in Brazil. Design critics during and at the end of semester included Jonathan Mills, Dr Turnbull and Dr Alex Selenitsch of the MSD, Marika Neustupny (NMBW Architecture Studio), Tobias Horrocks (Fold Theory) and Chris Haddad (Archier). Students undertook historical and archival research on the Griffins. They re-drew the original plans of Pholiota according to the Knitlock construction system, constructed it digitally, made moulds using digital fabrication techniques, and experimented with various materials to perfect a moulding system.

Together, we visited Pholiota in Eaglemont, the Herborn House in

Walter Burley Griffin and David Charles Jenkins, patent drawings for Knitlock, 1917. Source: IP Australia.

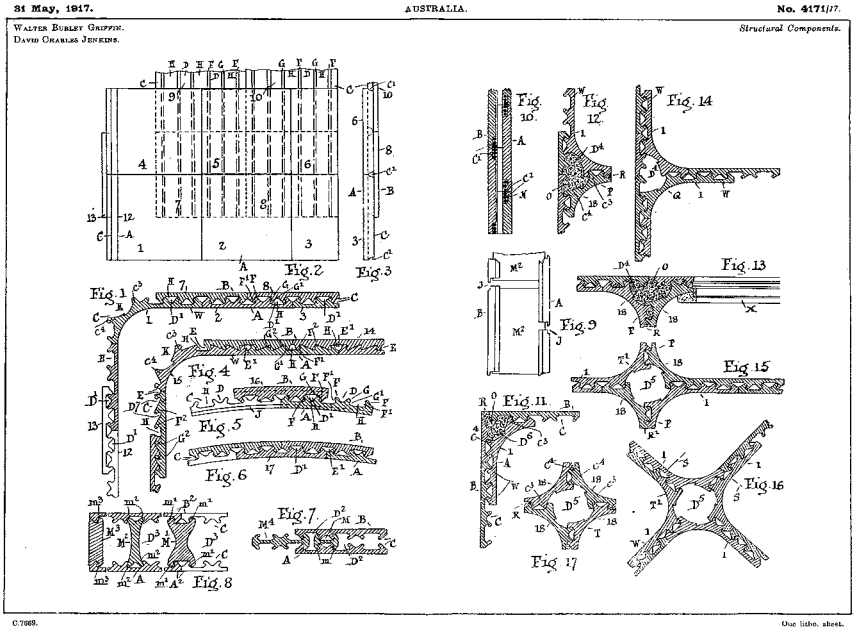
East Hawthorn (Eric M. Nicholls, 1929), which employed pre-cast concrete pipe columns, and the Vaughan Griffin House in Heidelberg (1924), built using the Knitlock system and now owned by the University of Melbourne's Professor Graham Sewell. At the same time, the students were designing their new Pholiotas and subdivisions for the Glenard Estate. In a twelve-week semester, they had begun to unlock Pholiota.

The next step was to bring all this material together to make an exhibition. Crucial to this second stage (July–September 2016) was the involvement of student Manjit Patil, who, with industrial designer and sculptor Alex Goad, devised a way to fabricate the entire suite of Knitlock tiles and then work together to produce the more than 2,300 tiles required to build Pholiota. Another student, Mengyan Wang, worked with Travis Cox from Microsoft SocialNUI at the University of Melbourne to transform her Semester 1 design into virtual reality. Professor Sewell generously lent us original Knitlock blocks and roof tiles for the exhibition, and Peter Navaretti helped compile a complete list of built and unbuilt Knitlock structures across Australia. Another student, Ali Eslamzadeh, supplied the three-dimensional animation of his new design for Pholiota, and all students reformatted their work for exhibition. In the Dulux Gallery, MSD's James Rafferty set up time-lapse photography to record the whole construction process. All through this, Italian filmmaker Giulio Tami was recording everything on film.

To ensure that Pholiota might be unlocked and, nearly 100 years after it was built, be seen and appreciated by a new community, the students and the public also needed to understand the story of Knitlock and the Griffins: this story also had to be told in the exhibition.

Griffin and Knitlock

On 31 May 1917, architect Walter Burley Griffin of 395 Collins Street, Melbourne, and builder David Charles Jenkins of 5 Hawthorn Road, Caulfield, lodged a patent with the Commonwealth of Australia's Department of Patents.[4] Griffin was named as the inventor and Jenkins as his assignee. The title of their patent was 'Improvements in and relating to structural components'. This was Griffin's contribution to developments in 20th-century concrete construction. He would shortly call his system 'Knitlock'.



Griffin had made his first trip to Australia in 1913, to begin supervising the development and implementation of the Canberra plan. Griffin and Mahony then both came to Australia in 1914, moving from Chicago to start a new life and embark on the next stage of their already significant early careers.[5] Living first in Sydney, then moving to Melbourne in 1916, they soon became interested in affordable small house types and their construction.

The rationale behind Griffin's invention was the desire to develop a system of construction that might revolutionise house-building techniques in his newly adopted homeland. Griffin scholar James Weirick has argued that Knitlock (or 'segmental architecture' as Griffin also called it)[6] was his response to the need for inexpensive workers' housing in Canberra, where material and labour costs were exorbitant.[7]

Assisting Griffin in his venture was Jenkins, who built a Knitlock house for himself at 139 Manning Road, Malvern. Jenkins was later a shareholder in the Greater Sydney Development Association (GSDA), the company formed by Griffin in 1919 to purchase and develop the 263 hectares of land in northern Sydney that comprised large portions of Castlecrag, Castle Cove and Middle Cove.[8] Jenkins, like the Griffins, would later move to live and work in Castlecrag.

Griffin's modular reinforced concrete construction system comprised two types of blocks: vertebral elements, which locked together to create a structural skeleton, and tesseral elements, which formed the 63.5 mm walls in between. Staggered by 150 mm in both directions, the system required no mortar to seal the components. The full system was composed from eight different types of blocks: five vertebral and three tesseral components. To stagger the tiles vertically, the full- and half-tiles were produced in extrusions 300 mm and 150 mm high.

The benefits of Griffin's 'segmental architecture' were that Knitlock blocks required no cutting, bedding or plastering. They could be handled easily and didn't require skilled labour—in essence, almost anyone could build with them. Given the small scale of the overall planning module—three foot, six inches (1067 mm) determined by the need for a vertebral vertical—great diversity of plan form was available, so long as each wall length was either not too long or had return walls to give structural stability. Other advantages were that standardised window- and door-frames could be inserted into place during construction.

On 2 March 1918, Griffin and Jenkins lodged another patent, this time for concrete roof tiles;[9] like the wall elements, these were soon given the name Knitlock. Unlike the terra cotta Marseilles-pattern tiles that gave Melbourne's suburbs their distinctive orange skyline, the Knitlock roof tile was silver-grey and its shape was completely different: a 13 inch (330 mm) square that was laid diagonally, essentially a flat surface (top and bottom) with downturned and upturned lips along adjoining sides. The roofing system had a full tile and a half-tile, three-quarter tile, eaves tile, and special ridge tile. Griffin believed his Knitlock roof tiles had a special advantage over orthodox tiles:

> The tile roof is in keeping with the tesselated [*sic*] walls, with its interlocked segments of the same scale, disposed diamond fashion, and is a third lighter than terra cotta, and being glazed, does not become damp and heavier still through absorption.[10]

While Griffin's invention of a roof tile was clever, it bore no necessary structural or tectonic relation to

Stacked pieces of new plaster Knitlock blocks, ready for construction, Mentone, September 2016.

his Knitlock wall system. He relied instead on a conventional timber-framed roof as the mediating structural connection between the two systems. In Griffin and Mahony's Melbourne Knitlock houses—all of which have pitched roofs—the timber-framed roof is a necessary element, serving as a cap or lid that ties the whole system together. The weight of the concrete tiles above gives the entire structure an almost monolithic status.

The Knitlock blocks and roof tiles were made by special machines invented and designed by Griffin[11] and developed by a young Melbourne engineer, Malcolm Stewart Moore.[12] Manufactured by Robison Brothers at their South Melbourne foundry,[13] the four-legged metal contraptions involved the use of rudimentary metal and timber moulds that could form the complex rounded teeth of the Knitlock blocks and tiles, and a very stiff concrete mix so that the blocks and tiles, when formed, could be mechanically slid out from the machine and laid onto a flat pallet for drying. The intention, it appears, was that a builder or prospective homeowner might be able to buy the machines, set up a local production workshop, and essentially self-build, making as many blocks and tiles as needed and progressively storing them on site.

The public launch of Knitlock took place at the Royal Melbourne Agricultural Show at Flemington in September 1919. The Griffins designed a promotional kiosk using vertebral and tesseral elements as well as the patented Knitlock roofing tiles. At the corners of the modest three-bayed structure, which rose above the eaves line, were buttress-like elements out of which emerged poles supporting a banner that read 'Knitlock Construction'. It is not clear how successful this venture was, but it is certain that Shepparton builder John Sandy bought rights to its production. Shortly thereafter he advertised in the *Goulburn Valley Stock and Property Journal* the building of a demonstration Knitlock house in Knight Street, Shepparton, by the Knitlock Syndicate Company. The house was complete by April 1921.[14] The Griffins also convinced real estate agent William A. Towler that it might be worth building two demonstration cottages at Oliver's Hill, Frankston. Towler financed the construction of the two tiny prototype houses, Gumnuts and Marnham (1919), the first completed Knitlock houses in Australia, and the model for Pholiota.[15]

Between 1919 and 1935, when Griffin left for India, he and Marion Mahony designed an estimated 49 projects in Knitlock: 19 realised and 30 unbuilt. Notable among these were non-residential projects like the Barwon Heads Golf Club (1925, competition entry) and the Victor E. Cromer Sanatorium (1927, project) at Covecrag in Sydney, which demonstrated the Griffins' confidence in their new system.

In Victoria, all of the Griffin Knitlock designs were intended to be constructed entirely in the patented system, and with pitched or hipped roofs. Of these, the Salter House, Toorak (1922–24) is the best known. But in Castlecrag, the Griffins altered their approach, often adopting flat roofs and combining Knitlock with Sydney sandstone base walls and supporting corner buttresses, a design strategy of composite construction dictated by Castlecrag's sloping and rocky sites, where a flat or near-horizontal building surface was often not available. Another difference in the Sydney designs was the Griffins' use of Knitlock columns that rose above the parapet line as picturesque crenellations, evidenced by the Duncan House at Castlecrag (1933).

The Griffins were not the only ones designing and building in Knitlock. There was a small following among his employees, such as J.F.W. Ballantyne, whose design for Stokesay (1922) in Seaford on

the Mornington Peninsula remains almost intact, and Edward Fielder Billson, who sometimes included a Knitlock garage adjacent to a house of his own design. In Lorne, one of the largest Knitlock houses to survive is not by the Griffins, but by Melbourne architects Klingender and Alsop: Jura (1919) on Mountjoy Parade is a huge bungalow-style house with a vast orange terra cotta tile roof. Geelong architectural firm Laird & Buchan was involved in the Knitlock design of the Winchelsea Memorial Grandstand (1920–25). Builders also took an interest in the system, most notably Winchelsea's H.E. Warner, who was involved in building a Knitlock Sunday school (1923) in the tiny town of Barrabool outside Geelong. Part of Knitlock's appeal for these country Victorian buildings was the lack of easily available clay bricks and the ability to make the Knitlock elements literally anywhere. A batching plant could be set up in a country town or on a large farm, which may account for a Knitlock brick-making machine as far away as Perth being put up for auction in 1934.[16]

In 1917, when Griffin lodged his patent for Knitlock, he was not alone in the world as an architect with an abiding interest in the relatively new construction material of reinforced concrete. Scholars such as Andrew Saint, Adrian Forty, Roberto Gargiani, Jeffrey Turnbull, Donald Leslie Johnson and Miles Lewis have all contributed in the last 15 years in different ways to contextualising the global interest in the myriad and diverse structural and material applications of reinforced concrete in the first decades of the 20th century. It is important to remember, for example, that Le Corbusier's famous Maison Dom-ino of 1914–15 was a very simple scheme of flat concrete slabs and thin concrete columns, far from the integrated tectonic sophistication of Griffin's Knitlock, and that Frank Lloyd Wright's equally famous 'Textile' blocks post-dated Griffin's invention. It is also important to note that the Knitlock system and Pholiota would catch the attention of Viennese émigré architect Richard Neutra in his 1927 book *Wie baut Amerika?*.[17] Knitlock can thus be seen as internationally significant in its contribution to the complex story of concrete design and construction in the early 20th century.

At the same time, Knitlock was not a runaway success, neither commercially nor in terms of a sustained take-up by other architects and builders, despite a grandstand in Winchelsea and a golf clubhouse in Oatlands. There are many reasons for this, not the least being regulatory resistance to a new and untried system, relatively poor thermal efficiency (the ingenious knitting together of the inside and outside tiles provided an immediate hot and cold thermal bridge), problems with waterproofing (during installation, the bitumen layer was often inadvertently scraped off) and the lack of immediately large-scale batches for ease of putting into construction. Another reason was that the hoped-for leap into wider use through a very large commission necessitating a massive commitment to such a new system—such as Griffin hoped for in his unrealised ideas for workers' housing in Canberra—never eventuated.

There were also other problems. Griffin's position as Federal Capital director of construction and design was terminated in 1920. For the next 15 years, the Griffins soldiered on, designing and building, but never with a commission large enough to send Knitlock into large-scale production. By 1935, Griffin had left Australia for India. Marion Mahony joined him there in 1936. They never returned.

Miles Lewis has described the Knitlock system as 'a patent system which was used for only perhaps

Interior of Pholiota, 23 Glenard Drive, Eaglemont, Victoria, photographed by Walter Burley Griffin, c. 1925–26. Eric Milton Nicholls Collection, National Library of Australia.

a couple of dozen buildings, and is one of the least influential aspects of the use of concrete in Australia. But it is one of the most interesting in terms of sources and overseas connections'.[18] That may be. But it is interesting to note that, as recently as September 2016, *ArchDaily* reported on Block ARMO, developed in Mexico, as a way of solving the housing problem in that country's most disadvantaged areas. More than 300 homes have been built in Sierra Negra, Puebla, in a project developed by the Ministry of Social Development.[19] The Mexican system bears a remarkable likeness to Knitlock. Nearly 100 years on, it seems that Griffin's idea continues to offer a new way to think about building homes for ordinary people.

Unlocking Pholiota

In 1920, the Griffins planned to build their own two-storey Knitlock home on a steeply sloping site at the end of Kooyong Road, Toorak, above the railway line and overlooking the Yarra River. Not able to get a building permit, they on-sold the site, which was later occupied by the Griffin-designed Paling House (1922–24), also in Knitlock.[20]

Still needing a home of their own, the Griffins decided instead to build at 23 Glenard Drive on the Glenard Estate, on a block they owned next door to the Lippincott House (1917) at 21 Glenard Drive, owned by Griffin's sister Genevieve and her husband, architect Roy Lippincott. This time, they were given a building permit, but for a 'doll's house' (like a giant cubby house) associated with the Lippincott House. As Marion Mahony recounted in *The magic of America*, she and Walter and a local chicken farmer built the diminutive Knitlock bungalow Pholiota over many weekends in 1920–21.[21] Walter and Marion lived at *Pholiota* from about 1922 until 1925, when they moved to Castlecrag in Sydney.

The plan of Pholiota was almost identical to the Griffins' designs for Gumnuts and Marnham, the two demonstration houses they had built for William Towler, who let the Griffins use Gumnuts as a weekender. It was a perfect square, 21 feet by 21 feet, based on a six-by-six module, each module measuring three foot six (1067 mm). There were no corridors and no internal doors, only openings leading off the main central living space—another square.

The floor was rammed earth with bricks laid directly over the top—a daring example of geothermal design at the time. The roof, clad in conventional terra cotta tiles, was timber-framed, and in structural terms acted like a securing lid to the Knitlock walls below. There was no gutter: the timber roof beams extended out to a deeply angled fascia board. The eaves became, in effect, an encircling pergola. The external doors were another Griffin minimalist invention: three lapped Californian redwood boards and nothing else![22]

The interior of Pholiota was radical: it was essentially a one-roomed house. In 1947, Robin Boyd described it as 'square with a central living space, radial screens, no doors, and great opportunities for an informal holiday: a static Dymaxion house 12 years before Fuller'.[23] Today it would be labelled open-plan. The focus was a cruciform-shaped shared living and dining space, with three of the cruciform arms acting as alcoves. Two of these alcoves housed double beds and acted as giant window seats. Griffin scholar Jeffrey Turnbull has argued that these bed alcoves were similar to the alcove-bed slept in by statesman, slave-owning planter and architect Thomas Jefferson in his self-designed villa Monticello.[24] Pholiota's third alcove had a piano. The fourth arm of the cruciform housed the fireplace, forming an ingle. The other spaces of entry, dressing, bathroom and kitchen were all accessible at the corners of the square-shaped living space.

The Griffins used this central living space in a multitude of ways. It could be open and public, or closed and private. Burlap (hessian) curtains could be drawn across the bed alcoves and also across the openings to the kitchen, bathroom, dressing room and entry, essentially creating a snug, square living room focused on the fireplace and the centrally placed circular table, where Marion and Walter would have eaten their meals. Suspended above was a fabulous plaster light-fitting of their own design that they had retrieved from Palais Pictures (not Palais de Danse as Marion says),[25] one of their architectural commissions in St Kilda. An interior photograph of Pholiota shows the Knitlock tiles around the fireplace to be coloured—alternating henna and gold stripes—and at the ceiling line there is a continuous henna band. Above this, the ceiling stepped upward, ziggurat-like, giving a sense of modest grandeur: its hint of monumentality a private echo of the Griffins' plans for a great public ziggurat—the Capitol or National Memorial—that would have formed the symbolic centre of Canberra and the nation.[26] But here it was in their home.

In today's terms, there are some things missing from the Griffins' Pholiota. There was no space for a refrigerator; nor was there a laundry. One imagines that this vegetarian couple must have had an icebox. Perhaps they did their washing next door. In floor area, the entire house occupied 41 square metres—the equivalent of a typical one-bedroom apartment today. The Griffins had always imagined Pholiota as a model house that might be adapted elsewhere for different household sizes and, depending on requirements, added to over time by simply constructing another square (or more than one), equivalent to Pholiota; in many respects, taking the organic analogy as read. When Marion Mahony was asked how to provide for a family in the one-roomed house, she responded:

> Quite easy, …. There are windows all round the house, but you will observe that each corner is solid. All you have to do is to add another one-roomed house to your corner—as you would another leaf to an extension table—and you have a dormitory for the children, when the family grows to any size. You can add four of these dormitories if you wish, and then you will be able to present one each to the eldest son and daughter on their marriage. Oh no! You eliminate the mother-in-law problem—each house is self-contained, and has its own entrance.[27]

Today, one can see Pholiota as an example of lifelong planning, as a potentially growing house, and as a model of minimal living. As an exercise in maximising light, air and amenity, as a demonstration of Knitlock and its beauty as a material and as a construction technique, and as a philosophical concept about dwelling, community, and the delights of human-scaled space, Pholiota remains an exemplar.

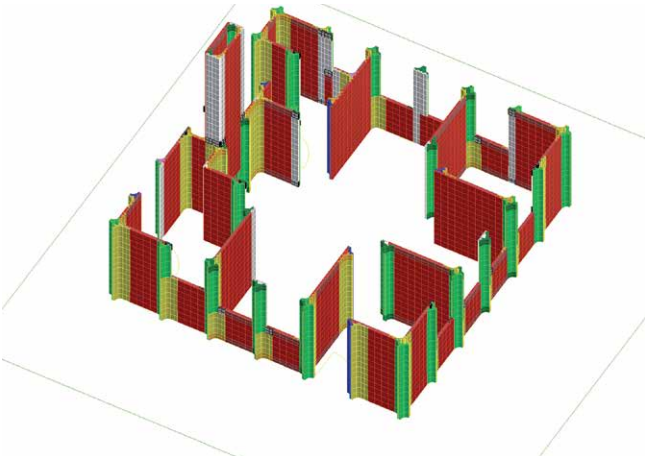
Remaking Knitlock

The task of remaking Pholiota at 1:1 scale became a collaborative design and research exercise from start to finish. In Semester 1 of 2016, the students made careful studies of the Knitlock patent drawings, re-drawing each vertebral and tesseral element digitally, and understanding how each piece 'knitted' together, vertically and horizontally: they digitally reconstructed Pholiota in plan, section and elevation, and in three dimensions. In doing so they began to understand the seamless, even elegant, interrelation of aesthetics and structure that Griffin had achieved with his system.

Various moments in the making of Knitlock blocks, July–September 2016. Photographs by Linus Tan, Philip Goad and Alex Goad.

The next task was to try and understand how the blocks were made. Using the MSD's workshops, groups of students made moulds using digital fabrication techniques and experimented with silicon and MDF (medium-density fibreboard) to perfect a moulding system. They also made blocks themselves, through 3D-printed miniatures, some in plaster and some in concrete.

In the second stage (July–September 2016), Manjit Patil and Alex Goad devised a system that comprised mould tiles (MDF facsimiles of the original Knitlock elements), mould shells (MDF) and silicon moulds. Instead of the cumbersome machines devised by Griffin, this was a different technique—a form of prototyping—that could be refined in the future. The tiles and shells were drawn by Patil, cut in the MSD's digital



Left: Rhino three-dimensional model of Pholiota by Master of Architecture student Manjit Patil, July 2016. Courtesy Manjit Patil.

Opposite: Anne-Marie Randall (Master of Architecture student), designs for new Pholiota, May 2016. Courtesy Anne-Marie Randall.

fabrication workshop, then put together with the help of the other students. The silicon moulds and the casting of the 2,300 plaster Knitlock elements took place in Alex Goad's studio in Mentone. These mould tiles, shells, silicon moulds and photographs of the fabrication process were also displayed in the exhibition.

The decision to use plaster rather than concrete was based on time and weight. Concrete tiles would have taken longer to cure, and handling and engineering in the gallery would have presented problems. The plaster tiles were thus intended to be read as an abstraction of the original.

To ensure correct construction of Pholiota, Patil constructed a three-dimensional digital model using Rhino (short for Rhinoceros, a three-dimensional computer-aided design application), where all the different Knitlock tiles were colour-coded for easy assembly (see above). Using Rhino also meant that the model could be turned around on a laptop screen, making doubly sure that no tiles were incorrectly placed. Remarkably, construction of Pholiota's walls, chimney and fireplace took just two days, due partly to the ingenuity of Griffin's system and partly to the students' newly developed understanding of the logic and intricacies of the system. They had become experts, confident in their ability to manage and manipulate the elements.

During construction and upon completion, the replica Pholiota was a revelation: elegant in its simplicity, with the plaster blocks taking on the quality of marble thanks to their low sheen and the minor imperfections in laying. We had created a little domestic temple!

Reimagining Pholiota and the Glenard Estate

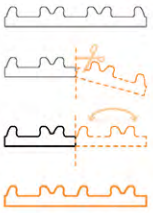
Walter Burley Griffin laid out the Glenard Estate subdivision, then described as 'Mount Eagle', for developer Peter Ernest Keam in 1916. The site was a very beautiful one, overlooking the floodplain of the Yarra River and containing a series of majestic mature eucalypts. Distinctive features of Griffin's urban design included curving streets aligned with the site's contours, two communal parklands located at the rear of the allotments, and a series of footpaths that led through the estate to the Yarra River.

One hundred years later, each of our Master of Architecture students was allocated eight lots, with different site conditions, and asked to design for them a series of contemporary one-, two- and three-bedroom versions of Pholiota. Students were required to show respect for the Griffins' regard for indigenous landscape and for their shared public reserves. Increased population density was also to be achieved, without sacrificing the Griffins' utopian ideals of building with nature.

The students' designs were hung along the east and west walls of the linear section of the Dulux Gallery. On the gallery's northern end wall was mounted a large-scale facsimile of the original sales brochure for the Glenard Estate created by the Farrow Falcon Press in 1916.[28] The aerial view of the subdivision had Griffin's signature and title as 'Landscape Architect' in the bottom right-hand corner. In the centre of this gallery space, aligned on a long, low, black Perspex table, were the mould shells, tiles and silicon moulds.

On the north–south axis of the gallery of student designs was centred the reconstructed Pholiota, its walls and chimney built to full height. On axis from the house's west and east living room windows, giant vinyl reproductions of the external and only surviving original images of Pholiota gave visitors within a reflective view of their own real-time experience in the reconstructed house. Two cane chairs at the centre of the cruciform living space allowed exhibition

Inside out
outside in

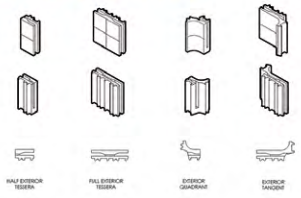


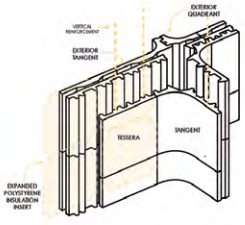
GRIFFIN'S ORIGINAL TILE

Griffin's original system is composed of 16 unique tiles. This project explores how a simple change to the extrusion of the tile can reduce the number of tiles down to 8 and adapting to 21st century need whilst still maintaining its intended aesthetic .

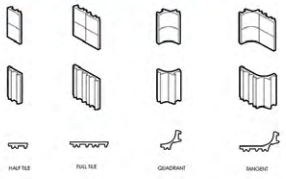
NEW KNITLOCK TILE

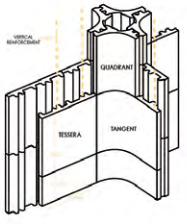
NEW EXTERIOR KNITLOCK TILES



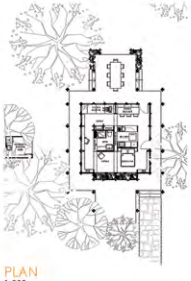


NEW INTERIOR KNIT LOCK TILES

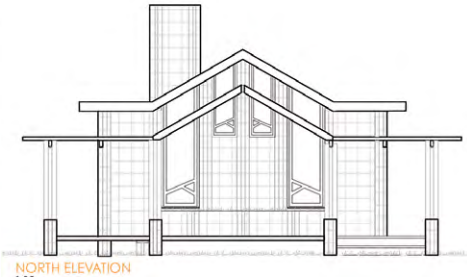




Pholiota
reimagined

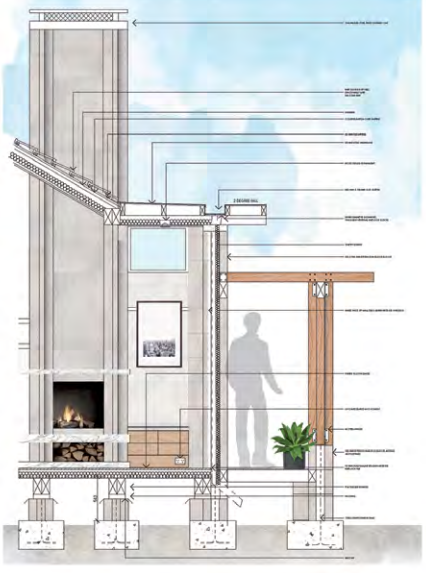


PLAN
1:200



NORTH ELEVATION
1:50

3 BED - EAST ELEVATION
1:50



Pholiota being reconstructed by Master of Architecture students in the Dulux Gallery, Melbourne School of Design building, University of Melbourne, October 2016.

visitors to be Walter and Marion at home. To add a further layer of complexity, the site-specific virtual reality experience developed by Travis Cox for 'A New Pholiota' overlaid the virtual with the physical, to reveal Mengyan Wang's new design for Pholiota. Using specially supplied virtual reality goggles, exhibition visitors could stand at various locations in the reconstructed Pholiota and peer into an alternative (student-designed) reality.

Conclusion

When *Pholiota UNLOCKED* opened on 6 October 2016, it was as if the students had completed a real building. They had undertaken historical research, reconstructed an historical object through drawing, inspected archaeological artefacts on site, critiqued two architects' bold visions for alternative patterns of minimal living in residential and subdivision design, rethought the fabrication process of a building element, participated and collaborated in the making and construction of a building, and proposed their visions for a future. They also—like the public—were able to experience in reality the scale and ambition of the Griffins' ideas, and judge for themselves the veracity and continuing relevance of those ideas.

Thus *Pholiota UNLOCKED* aligns with current thinking in architectural pedagogy, in which, as University College London's Brent Carnell describes, students 'participate in research and enquiry throughout their education' and make connections 'horizontally across disciplinary divides, as well as beyond the university setting'. This is part of what is becoming increasingly described as a 'connected curriculum'.[29]

A project like *Pholiota UNLOCKED* does not happen overnight. It also presented some difficulties. Time and budget did not extend to putting a roof on the new Pholiota. This was a pity, as even a skeletal timber frame would have solved structural problems for the slender Knitlock block mullions on three sides of the house. As it was, health and safety considerations came into play as alternatives were sought to ensure the stability of the mullions. Yet this was also a useful learning experience for the students—to solve real problems in a construction workplace and also realise the extraordinary clarity, structural integrity and wholeness of the Griffin design. The pyramid roof of Pholiota, the cap to the 'mushroom', was the final seal in locking the composition in place as a complete structural whole.

As a lesson in pedagogy, *Pholiota UNLOCKED* was a rare opportunity to use the medium of the exhibition as the long goal in an extended program of teaching and research, where supervisor and students could collaborate, plan and work together in discovering something fresh from historical material, and also present their findings to the broader community. And all from the diminutive object of Griffin's elegantly conceived Knitlock block. After all the media attention and public interest, perhaps the most gratifying compliment was that the Architecture Library at the University of Melbourne requested a complete set of Knitlock blocks, moulds and master shells as an addition to its permanent collection of rare materials. On the centenary of Griffin's invention, this was a fitting tribute.

This article has been independently peer-reviewed.

Professor Philip Goad of the Melbourne School of Design, University of Melbourne, is an authority on modern Australian architecture. He has worked extensively as an architect, conservation consultant, curator, writer and editor. With Julie Willis he edited the *Encyclopedia of Australian architecture* (Cambridge University Press, 2012).

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Knitlock walls and Pholiota complete in the Dulux Gallery, Melbourne School of Design building, University of Melbourne, October 2016. Photograph by Alex Goad.

1 Robin Boyd, foreword (June 1963) to James Birrell, *Walter Burley Griffin*, Brisbane: University of Queensland Press, 1964, p. ii.
2 Jeffrey John Turnbull and Peter Navaretti (eds), *The Griffins in Australia and India: The complete works and projects of Walter Burley Griffin and Marion Mahony*, Melbourne: Miegunyah Press, 1998; Jeffrey John Turnbull, *Walter Burley Griffin: The architecture of Newman College, 1915–18, part 1: Specifics*, e-book, 2014, https://issuu.com/walterburleygriffinnewman/docs/walter_burley_griffin_-_the_archite/1.
3 Students participating in studioKNITLOCK in Semester 1 of 2016 were Sheena Bagley, Sam Bertram, Sam Brak, Ali Eslamzadeh, Kelvin Karel, Aaron Lougoon, Manjit Patil, Anne-Marie Randall, Sean Taaffe, Justin Ting, Mengyan Wang, Stanley Yeoh and Aisyah Zakiah. Studio leader was Professor Philip Goad.
4 Patent 1917004171, 'Improvements in and relating to structural components', lodged with the Commonwealth of Australia, Department of Patents, 31 May 1917.
5 See Mati Maldre and Paul Kruty, *Walter Burley Griffin in America*, Urbana: University of Illinois Press, 1996; Paul Kruty, *Walter Burley Griffin: Architectural models and demolished buildings*, Champaign: School of Architecture, University of Illinois at Urbana Champaign, 2003; and Paul Sprague, 'Marion Mahony as originator of Griffin's mature style: Fact or myth?' and Anna Rubbo, 'Marion Mahony: A larger than life presence', in Anne Watson (ed.), *Beyond architecture: Marion Mahony and Walter Burley Griffin: America, Australia and India*, Sydney: Powerhouse Publishing, 1998, pp. 26–39 and 40–55.
6 Walter Burley Griffin, 'Segmental architecture: A system to simplify and cheapen building construction', *Australian Home Beautiful*, 1 September 1927, pp. 13–15, 62.
7 James Weirick, 'Griffin and Knitlock', *Content*, no. 1, 1994, p. 104.
8 Meredith Walker, Adrienne Kabos and James Weirick, *Building for nature: Walter Burley Griffin and Castlecrag*, Castlecrag: Walter Burley Griffin Society, 1994, p. 9.
9 Patent 1918006690, 'Improvements in and relating to roof tiles and like structural elements', lodged with the Commonwealth of Australia, Department of Patents, 2 March 1918.
10 Walter Burley Griffin (attr.), 'Knitlock construction: Revolution in house building: Foundations, walls, floors, roofs, windows, doors and fittings', *Australian Home Builder*, no. 1, August 1922, p. 73.
11 A Knitlock block-making machine and a Knitlock roof tile-making machine are held in the W. Herbert and C. Peters Collection, National Museum of Australia, Canberra.
12 E.F. Spreadborough, 'Moore, Malcolm Stewart (1888–1969)', *Australian dictionary of biography*, National Centre of Biography, Australian National University, http://adb.anu.edu.au/biography/moore-malcolm-stewart-11154/text19869, published first in hard copy 2000, viewed 25 September 2016.
13 Weirick, 'Griffin and Knitlock', p. 104. Weirick incorrectly cites this as the foundry of Robinson Bros (founded 1854, over the ensuing decades expanded into general engineering, boiler-making, and brass, iron and steel foundry work, to become Melbourne's most important engineering firm).
14 Advertisement for the Shepparton Knitlock Syndicate, *Goulburn Valley Stock and Property Journal*, 27 April 1921, p. 3.
15 Turnbull and Navaretti (eds), *The Griffins in Australia and India*, pp. 162–3.
16 Auction notice, The old 'Kendenup' homestead, *Albany Advertiser*, 21 June 1934, p. 8.
17 See Richard Neutra, *Wie baut Amerika?*, Stuttgart: Julius Hoffman, 1927, pp. 56–9.
18 Miles Lewis, 'Section 7.07 Knitlock', in *Australian building: A cultural investigation*, p.7.07.1, www.mileslewis.net/australian-building.
19 Gerardo Cázares, 'This self-build concrete block system reduces construction time by 50%', *ArchDaily*, 21 September 2016, www.archdaily.com/795653/this-self-build-system-reduces-construction-time-by-50-percent. I am grateful to Tobias Horrocks and Alan Pert for drawing my attention to this Mexican invention by Juan Manuel Reyes of Armados Omega and architect Jorge Capistrán.
20 Turnbull and Navaretti (eds), *The Griffins in Australia and India*, pp. 168–9.
21 Marion Mahony Griffin, *The magic of America* (electronic edition), Art Institute of Chicago and New York Historical Society, August 2007, www.artic.edu/magicofamerica/index.html.
22 Exactly the same doors can be found at the Vaughan Griffin House in Heidelberg.
23 Robin Boyd, *Victorian modern*, Melbourne: Victorian Architectural Students Society, 1947, p. 11.
24 Turnbull, *Walter Burley Griffin: The architecture of Newman College*, pp. 316–17.
25 Peter Navaretti, information to the author, September 2016.
26 For further information on the Griffins' design for the Capitol building, see Christopher Vernon, 'Australia's lost capitol', *Journal of Architectural Education*, vol. 70, no. 2, 2016, pp. 284–99. Vernon however makes no reference to Pholiota or the other ziggurat-shaped internal volumes that make frequent appearance in Griffin/Mahony commissions.
27 Marion Mahony, quoted in 'An ideal one-room home', *The Sun*, 1 August 1926.
28 Courtesy Eric Milton Nicholls Collection, National Library of Australia.
29 Brent Carnell, 'Towards a connected curriculum in architectural education: Research-based education in practice', in *Curiosity, production, risk, participation: AAE2016*, vol. 2, conference on research-based education, hosted by the Bartlett School of Architecture, University College London, 7–9 April 2016, pp. 416–26.