The Old Windmill Digital Reconstruction

Brisbane Open House Oct 2018 Architectural History Workshop

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Summary:

The Old Windmill tower on Wickham Terrace in Brisbane is the oldest surviving building in Queensland. Constructed in 1828 by convict labour, it functioned as a windmill until 1845 when it ceased operation and fell into disrepair. It was substantially renovated and converted to a signal station in 1861. The building is well-maintained thanks to significant conservation work carried out in 1988 and 2009, yet it is generally inaccessible to the public. Thanks to a philanthropic donation to the University of Queensland, this research project is being carried out with the aim of constructing a digital model that captures the experience of visiting the Old Windmill, and communicates its history, to be shared with the public.

Two versions of the Windmill have been modelled: the existing Windmill tower in 2017, and a reconstruction of the Windmill in 1840, its era with treadmill, millstones and sails.

What has been developed through this research project is a methodology for constructing a digital cultural heritage model of a place, grounded in a base reference framework with a high degree of confidence, while allowing for flexible manipulation and interpretation of the scan data, increasing detail and complexity, being easily visualised and shared with others.

The Old Windmill has been scanned using a zeb1 handheld mobile scanner, which uses SLAM (simultaneous localisation and mapping) to construct a 'fuzzy' but complete recording as the scanner moves through space. The tower was then scanned using a Leica P16 ScanStation TLS (terrestrial laser scanning) tripod scanner, which captures a dense, accurate coloured point cloud. These two sets of scan data were integrated using the zeb1 data as a 'fuzzy' background structure. A detailed digital 3D model of the Old Windmill was then constructed and assembled in a video game environment, where the model can be readily experienced by users without any specialised knowledge or software.

The historical reconstruction is based on the existing physical evidence as much as possible. The digital reconstruction of the state of the windmill in 1840 is based on dimensionally accurate knowledge of the existing conditions, and the interpretation of historical sources. Ray Whitmore's "industrial reconstruction" of the Old Windmill (Whitmore, 1989) has been used as a methodological precedent and a major source, along with the research of Janet Hogan for the National Trust (Hogan, 1978) and the other resources listed on the next page.

This document has been prepared for the Brisbane Open House 2018 Architectural History Workshop and documents the research, sources and reasoning behind the 3D models of the existing and reconstruction of the Old Windmill that have been constructed.

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Architectural Drawings and other resources:

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Proposed dwarf stone wall to frontage of observatory reserve - Preliminary sketch. A. H. Foster, Brisbane City Architect. 1926. (Plan and elevation of stone wall along Wickham Terrace)

BCC heritage unit flag pole tower mill Wickham Tce foundation details. James Pierce & Associates Consulting Engineers. 1996. (Construction details for the flagpole reconstruction)

Windmill. Geoffrey Pie Architects Planners Pty Ltd. (Plans, sections and elevations of existing tower)

Por. No. 367 and 408, SI.7151. Brisbane City Council. (Survey title plan)

Brisbane LGA 2014 LIDAR LAS Tiles. Queensland Government: Department of Natural Resources & Mines. (LIDAR data tiles covering the Brisbane CBD and the Old Windmill)

Plan of Brisbane Town, Moreton Bay 1839, drawn to accompany Report of Major Barney, C.E.

Town of Brisbane 1840, Compiled from early maps from the office of the Surveyor General Queensland, traced by Ailsa Taylor, March 1948.

The Department of the
Colonial Architect
To John Petrie

Repairs &c to old Windmill

		£	s	d
	To taking down old Machinery & top time of Men and tackling	26	–	–
73. 13. 4	Repairing Stone work 221 feet ashlar including Cutting out old Stone work	80	–	–
	Building up openings in wall ground floor and sleeper walls under joists 5 perches	7	10	–
32. 11. 3	Furnishing 1600 bricks. Build do on top of wall and making good to inside Brickwork	26	–	–
	Painting Stopping & making good on walls	8	–	–
58. 2. 9	Taking out old materials and renewing four floors 11½ Sqs	92	–	–
	3¾ Squares double floor on Top including framing			
56. 2. 6	Caulking chimney and painting 5 Coats @ £14	52	–	–
7. 4. –	18 Cantilevers 8/	7	4	–
	108 feet Lining facia & soffit 3/	16	4	
27. 6. –	168 Cedar framing to House & top 4/	33	12	–
8. 4. 7	50 feet Superficial Boards & Zinc roof 4/	10	–	–
3. 7	615 feet 6lb Lead tacks &c	1	10	–
	5 pair Casements & fastenings & Stone sills	35	–	–
59. 11. 2	Cedar Stair, 62 Steps Cedar newell & pine Casing £1	62	–	
22. –	Flag Staff 44 ft run & painting do	22	–	
	Front Door and pr Lock complete &c.	8	–	
15. –	60 feet & Gutter & 50 feet Down pipe @ 3/ £25/1/ Head & 20/	26	1	–
54. 15. –	1095 lb Iron railing & fixing do @ 1/	54	15	
5. –	56 " Iron Arms on flag Staff vane & Gilding do	5	–	–
3. 11	Lightning Conductor and fixing do	3	11	–
1. 1. –	Two straps and Bolts for mast	1	8	–
	Painting Exterior 4 Coats 366 yards @ 3/6	64	1	–
	Do Roundhouse 25 yards @ 3/.	4	4	–
	22 feet Cedar Seat & shelf in round house	1	13	–
	2 Brass Locks		10	
	Carried over	648	3	

The Department of the

Colonial Architect

_ John Petrie

	Repairs _ to old Windmill			
	*_ taking down old machinery. T_*			
	time of Men and tackling.		*26 - -*	
13. 13. 4	*Repairing H__ w__ 221 feet a__ included*		*80 - -*	
	Cutting out old H__ w__			
	Building up openings in wall ground floor			
	and sleeper walls under joists 5 perches		*7 10 -*	
	_______ 1600 bricks. Build / do on top of			
32. 11 3	*wall and making good to inside Brick___*			*26 - -*
	Painting Hopp__ + making good on walls		*8 - -*	
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		11/ ____		
	3 / 4 Squares double floor on top including framing			
56. 2. 9	*Caulking _____ painting 5 coats ____*		*52*	
7. 4 -	*18 Cantilevers*	*8 / .*	*__ 4 -*	
	100 feet ___ faces & soffit	*3 / .*	*16 4 .*	
27. 6. -	*160 Cedar framing to House + top .*	*4 / .*	*33 19 -*	
8. 4. 7	*50 feet _____ ___ + ___ roof*	*4 / .*	*10 - -*	
3. 7.	*15 feet. 6 __ Lead . tacks __*		*1 10 -*	
	5 pair casements + fastenings + Stone sills			*35 - -*
		_ _ / -		
59. 11. 2	*Cedar stairs. 62 Steps Cedar newel_ + pine ___*		*69*	
22 . -	*Flag Staff 44 __ + painting __*		*29*	
	Front Door and __ Lock complete rep.		*8 - -*	
15 . .	*__ feet _ Gutter + 50 feet down pipe _______*		*26 1 -*	

54. 15	*1095 lb Iron railing + fixing __*	*54 15 –*
5. - . -	*56 Iron ___ on flag staff vane + ______*	*5 - -*
3. 11.	*Lightning Conductor and fixing ____*	*3 11 –*
1. 1. - __	*___ Straps and Bolts for Mast*	*1 8 –*
	Painting Exterior 4 coats 366 ____ 3/6	*64 1 –*
	Do Round____ __ yards ___	*4 4 –*
	22 feet Cedar Seal ___ on ___ house	*1 13 -*
	2 ____ locks	*10*
	________ over	*648 3*

(Transcript of the 1861 renovations submitted to arbitrations. QSA Col A/20, 61/2416)

The Old Windmill Existing 2017 information:

Ground level concrete floor:

Here on the ground floor of the tower windmill, the ground wheat and maize meal from the millstones would have been collected: the ground meal would have travelled down chutes from the stone floor (level one) above, and collected in sacks, to be taken down to the town. At some point after the 1862 renovations, a concrete floor slab of unknown thickness was poured over the ground level, replacing a timber floor dating from 1862 (QSA Col A). It is possible that the current floor level is higher than the original ground floor of the mill, evidenced by the bottom sandstone blocks at the doorway being only partially visible, sitting mostly below the level of the concrete floor. Only the surface of the concrete floor has been modelled according to the point cloud scan data.

Central stairwell

This hexagonal timber stairwell dates from the 1862 conversion of the old windmill into a signal tower by John Petrie. It consists of 62 steps, with cedar used for the treads, risers and central axis pole (QSA Col A). It is likely that much of the original cedar timber is still present, though later additions have been made. During the 1988 conservation works strengthening plates and thin hardwood protective tread overlays were added (Marquis-Kyle, 1991). The works from 1988 and 2009 respectively can be identified by stamps on each timber element showing the year. The stairwell has been precisely modelled according to the point cloud scan data.

Ground level interior walls

The ground level interior walls are constructed from whitewashed Brisbane Tuff quarried at the Kangaroo Point cliffs. The foundations are likewise constructed from Brisbane Tuff, and continue down to the bedrock approximately one metre beneath the exterior ground level. The cavity between the interior and exterior stone walls is likely packed with rubble (BCC Heritage, 1996). The irregular interior surface of the ground level walls has been generated from point cloud scan data.

Filled openings in the ground level walls.

Two square filled openings are visible in the ground level walls: located approximately 600mm above the ground floor slab and measuring approximately 650mm square. Above the openings the whitewashed outlines of lintels are visible. The digital model confirms that these openings are parallel to an axis line drawn out from the centre of the tower to a point directly between the two openings. The line of this axis matches with the treadmill alignment determined by Janet Hogan (Hogan 1971) and also matches with the rectangular outline of the treadmill visible on the 1940 Dixon map of Brisbane town (Dixon, 1840).

Ground level existing timber lintels

The existing decayed timber lintels resting on the concrete ground level floor were removed from above the ground level entry door and window in 2009 (BCC Heritage). These lintels were replaced with steel because their structural integrity had been compromised by termite damage.

Ground level window

The ground level window opening dates from the original construction of the windmill, though the casement has likely been replaced at least once. The window opening has a sandstone lintel and sill externally, beneath the protective render. The internal timber lintel was recently replaced with a new steel lintel due to termite damage.

Level one timber floor

The level one timber floor in its existing configuration dates from the 1862 conversion of the old windmill into a signal tower by John Petrie, who renewed all four timber floors of the tower, from ground level to level three (QSA Col A). The level one floor sits on a rebate at the top of the ground level walls, suggesting it is at the same level as the original “stone” floor of the windmill, which housed the two millstones (Whitmore, 1989). This floor has been modelled by tracing the point cloud scan data.

Level one windows

The level one windows were probably once doors giving access to the reefing stage platform around the tower, evidenced by the brick infill beneath the window sills visible on the photos of when the exterior render was removed in 1988 (Allom Lovell Marquis-Kyle, 1988). The openings certainly date from the original construction of the windmill, evidenced by the original timber lintels visible internally above the openings. The casements have been replaced at least once.

Level two timber floor

The level two timber floor in its existing configuration dates from the 1862 conversion of the old windmill into a signal tower by John Petrie, who renewed all four timber floors of the tower, from ground level to level three (QSA Col A). The level two floor sits on a rebate in the brickwork, suggesting it is at the same level as the original "bin" floor of the windmill, from which the wheat and grain was fed down a chute to the millstones below (Whitmore 1989). This floor has been modelled by tracing the point cloud scan data.

Level two windows

The level two window openings date from the original construction of the windmill, with stone sills and lintels externally, and timber lintels internally. The casement windows have been replaced at least once.

Pencil graffiti on the stairwell walls

On the interior walls of the timber stairwell, pencil graffiti dating back to the early 1900s can be read, written by visitors to the Observatory, as it was then, with many leaving their name and date of visitation.

Level three timber floor

The level three timber floor in its existing configuration dates from the 1862 conversion of the old windmill into a signal tower by John Petrie, who renewed all four timber floors of the tower, from ground level to level three (QSA Col A). The level three floor does not sit on a rebate in the brickwork: the height of the tower was likely increased as an afterthought, in order to add a "dust" floor at this level. The existing level three floor has likely been constructed using the same joist pockets of the original "dust" floor (Whitmore, 1989). This floor has been modelled by tracing the point cloud scan data.

Level three windows

The level three window openings are unlike the other windows: they are much smaller, not glazed, and formed by the gaps between the exterior sandstone blocks of the topmost cylindrical section of wall above the tapering brick walls (Allom Lovell Marquis-Kyle, 1988). These window openings have timber lintels internally, some of which are covered with pencil graffiti.

Cylindrical top section of the tower (level three walls)

The Old Windmill possesses an unusual feature: the tapering brick walls are topped with a cylindrical ring of brickwork, faced externally with sandstone blocks. Ray Whitmore has theorised that this section was added as an afterthought to increase the height of the tower, so that an additional "dust" floor (level three) could be added (Whitmore 1989). This theory is supported by the fact that there is no rebate in the internal brickwork walls to support the level three floor, suggesting it had been completed before it was decided to raise the height of the tower.

"In the Brisbane mill the stone floor (level one) rested on top of the lower stone section (ground level), with doors leading out onto the reefing stage. A rebate in the brickwork 3.2 metres higher up the tower supported what is presumed to have been the bin floor (level two). This would have left a clearance of 4.27 metres to the bottom of the curb if it had been fitted on top of the conical section of the tower. There would have been insufficient headroom for an additional floor… By raising the curb a further 1.25 metres it was possible to add a "dust" floor with 2.13 metres of clearance to the curb while still leaving 3.5 metres of headroom to the bin floor. The advantage of a dust floor is that it prevents dirt, grease and rain falling onto the bin floor, and it can also house the mill hoist – which is an advantage inside the tight confines of the tower. However, if construction had been completed to the original curb level before it was decided to increase the height of the tower there would be no rebate incorporated in the brickwork to support a dust floor. This is indeed the case in the Brisbane mill. The builders also had to provide some lighting to the new floor without seriously weakening the top of the tower and their solution, it is suggested, was to insert the ring of tiny windows in the additional masonry, giving the Brisbane mill tower its unusual, characteristic appearance." (Whitmore, 1989)

Tapering brickwork section of the tower (level one and level two walls)

Most of the height of the Old Windmill is constructed from brick: this tapering brickwork wall section sits on the stone base of the ground level walls, reaching up to the cylindrical top ring of the tower. While the exterior section has been rendered, the convict-made bricks are visible on the interior of the tower on level one and level two beneath the whitewash: the surface of some bricks has crumbled away, revealing the orange and brown colours of the local soils that were used. The irregular surface of the interior walls has been generated from point cloud scan data.

The exterior render

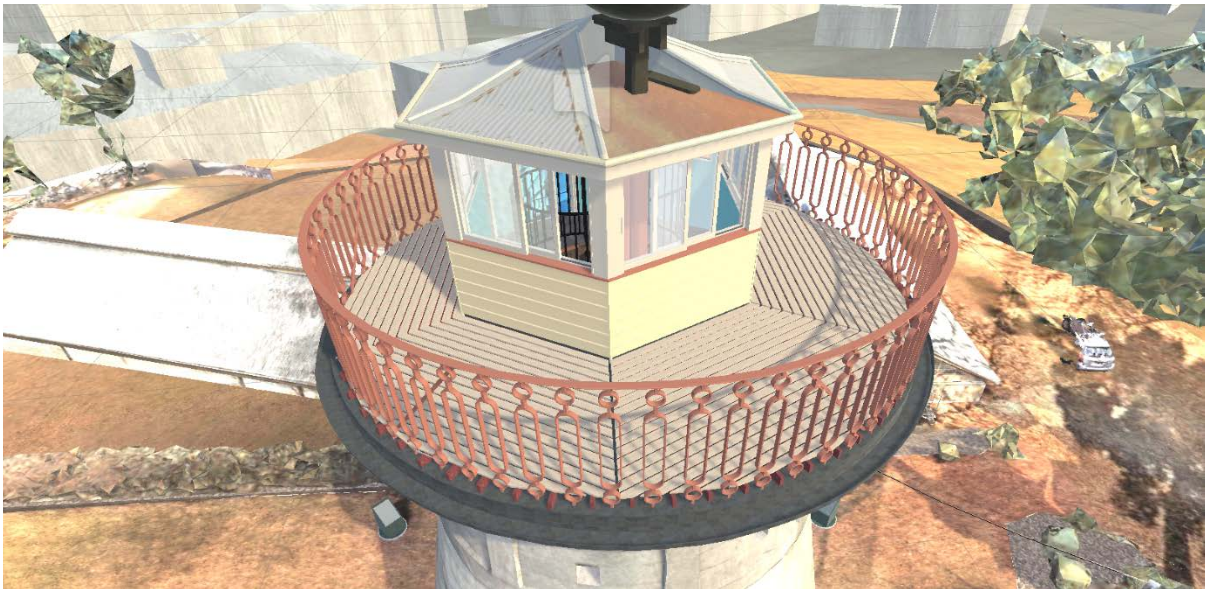
The exterior of the Old Windmill is rendered to protect the sandstone blocks and brickwork from weathering. The conical brickwork section has been rendered in all historical photos of the tower, and by around 1902 the entire exterior had been rendered, including the sandstone sections (BCC Heritage, 1996). In 1950 the old render was removed and the entire exterior was re-rendered as part of controversial renovations (BCC Heritage, 1996). Most recently the render was also completely stripped away and renewed during the 1988 conservation (Allom Lovell Marquis-Kyle, 1988).

The top level observatory room

This hexagonal observatory room dates from the 1862 conversion of the Old Windmill into a signal station by John Petrie. Most of it appears to be original fabric from 1862, such as the timber floor and internal linings, though the roof sheeting was replaced in 1982 (BCC Heritage. 1996). The original casement windows were replaced with louvered windows during the controversial 1950 renovations (BCC Heritage, 1996), but re-instated during the 1988 conservation (Allom Lovell Marquis-Kyle, 1988).

The top level balcony platform

This circular balcony platform dates from the 1862 conversion of the Old Windmill into a signal tower. It consists of a timber duck-boarding walkway, over copper sheeting falling to the perimeter gutter. The floor joists underneath the copper sheeting sit directly on the existing timber cap frame on top of the walls. The wrought iron railing around the balcony platform, and the timber cantilever supports on the underside of the platform are original fabric from 1862. Strengthening additions were made to the floor substructure in 1988 when the gutter was added (Allom Lovell Marquis-Kyle, 1988). The duck-boarding walkway was replaced in 1982 (BCC Heritage, 1996). The platform and substructure has been modelled according to point cloud scan data and site investigations.



The existing curb and cap frame

These timbers that form the top section of the internal level three walls are actually the remains of the original curb and cap frame of the windmill: the bottom layer is the curb support, the middle layer the curb itself (the levelled top of the tower mill) and the top layer was the rotating cap frame, which was supported by rollers sitting on the curb surface. Wear marks from the truckles (rollers) can be seen on the visible face of the curb. The faces of these timbers are etched with roman numerals to mark the order in which they were to be assembled (Whitmore, 1989). These timbers are local hardwoods, which suggests that this windmill machinery was constructed with significant skill here in Brisbane (BCC Heritage, 1996). It appears that during the 1862 conversion of the windmill into a signal tower, the cap frame was simply cemented into place on top of the curb.

The mortise where the sprattle beam (which supported the vertical shaft) was removed is clearly visible. Site investigations suggest that the corners of the rectangular cap frame, including the shear beams (which supported the fantail) were cut away. Any surviving physical evidence of the toothed rack which would have run around the outside of the curb is impossible to examine because the exterior brickwork is laid closely against the outside face of the curb.

The time ball mechanism

The mechanism on the ground level stairwell was used to operate the copper time ball on the mast above the roof of the windmill tower, which was dropped at 1pm every day to enable people to set their watches. (Hogan, 1971).

The time ball

This copper time ball was raised to the top of the mast, and dropped at 1pm every day to enable people to set their watches (Hogan, 1971). The time ball was installed during the 1862 conversion of the windmill into a signal tower. Use of the time ball was discontinued in 1866 and replaced with a time gun (cannon) adjacent to the tower (Hogan, 1971). The copper time ball was removed, cleaned and eventually re-assembled and reinstalled in 1982 (BCC Heritage, 1996). The time ball and mast have been modelled according to point cloud scan data.

The flagstaff

The original flagstaff from the era of the tower as a signal station after 1862 was dismantled in 1950 (BCC Heritage, 1996). This current flagstaff is a reconstruction dating from 1988 (Allom Lovell Marquis-Kyle, 1988). The flagstaff was used to signal ships on the Brisbane River (Hogan, 1978).

The reservoirs

The heritage-listed Spring Hill reservoirs functioned as a crucial part of the city's water supply infrastructure. They were constructed in 1871 and 1882, with the roofing material dating from 1904 and 1905 (BCC Heritage, 1996). The reservoirs have been roughly modelled according to point cloud scan data.

The stone wall along Wickham Terrace

This stone wall along Wickham Terrace dates from 1926, designed by the city architect A H Foster, as part of "beautification" works around the tower (BCC Heritage, 1996). The wall is constructed from Brisbane Tuff and wrought iron. The irregular shape of the wall has been generated from point cloud scan data.

The Old Windmill Reconstruction 1840s information:

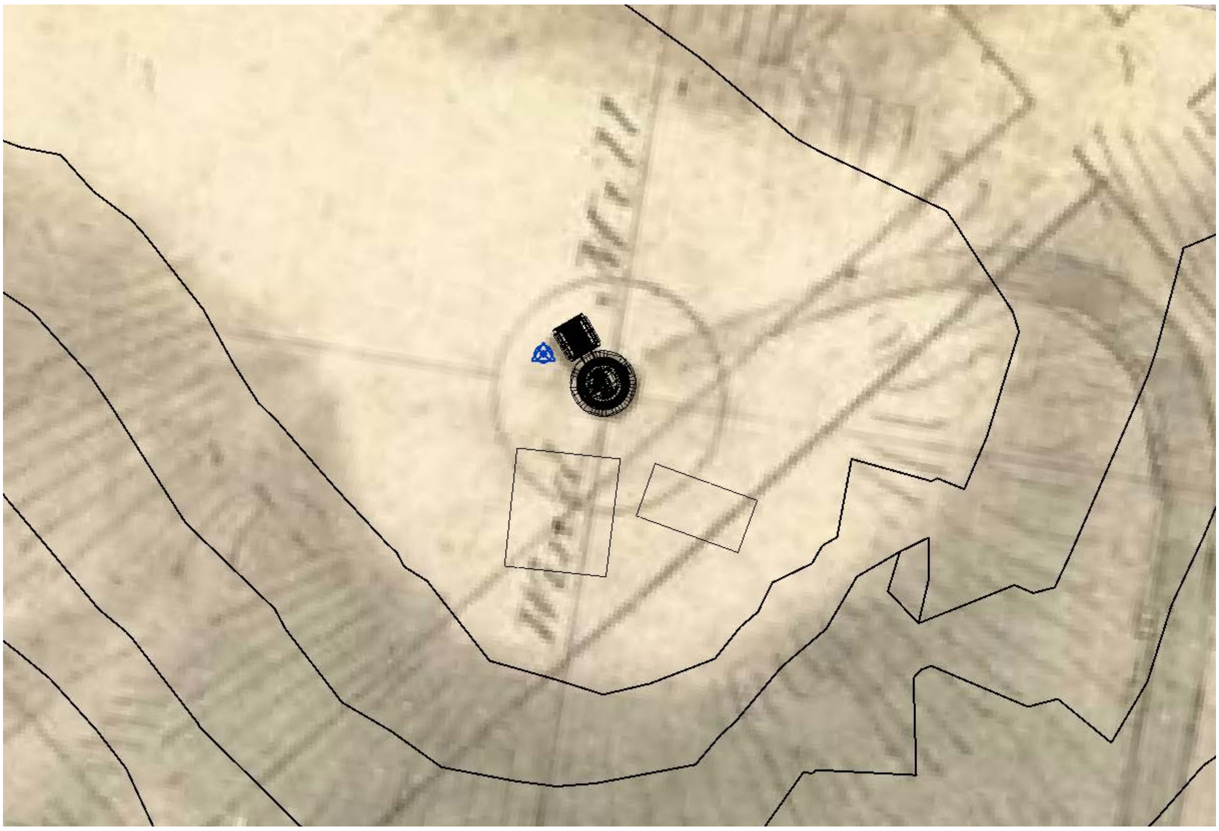
The treadmill

The convict treadmill supplied the rotation power to turn one of the two millstones in the tower mill. The treadmill was not a later addition to the tower to compensate for insufficient wind speeds: it was always intended that one millstone would be turned by convict labour (Whitmore, 1989).

The existence of the convict treadmill is well documented, though the historical accounts attesting to its configuration and operation are often conflicting (Steele, 1975) (House Histories, 2017). The consensus is that the treadmill was usually powered by a gang of twenty-five men, with sixteen convicts at work on the wheel at a time (Whitmore, 1989).

The shed housing the treadmill is visible on contemporary maps of Brisbane Town as a rectangular outline directly adjacent to the Old Windmill (Dixon, 1840).

No physical remains of the treadmill have been discovered to date. The only known physical evidence for its existence is the two square filled openings are visible on the ground level walls. These openings are located approximately 600mm above the ground floor slab and measuring approximately 650mm square. Above the openings the whitewashed outlines of lintels are visible. The digital model confirms that these openings are parallel to an axis line drawn out from the centre of the tower to a point directly between the two openings. The line of this axis matches with the treadmill alignment determined by Janet Hogan based on contemporary maps (Hogan, 1971).



The treadmill was reconstructed based on Ray Whitmore's description (Whitmore, 1989) and the physical evidence of two openings, which suggests two parallel shafts entering the windmill from two treadmill wheels of eight places each. For confirmation, the contemporary Dixon map (Dixon, 1840) which shows the treadmill as a rectangular outline, was overlaid in the digital model, using the only two buildings on the map that still exist, the Old Windmill and the Commissariat Store beside the river, to accurately scale the map. The resulting overlay matches remarkably closely to the reconstructed treadmill.

Ray Whitmore argued that the contemporary maps, which show a rectangle of approximately 6m by 5m, support the conclusion that the treadmill was built in two sections with six places each, rather than a single long wheel (Whitmore, 1989). This is supported by Knight's account of two treadmills being built (Steele, 1975). Moreover, Whitmore argues that this would have made it easier to divide the workforce into three groups of eight, of which two groups would have been working at any one time (Whitmore, 1989).

Ray Whitmore argues that the treadmill wheel and machinery was likely assembled from a modular system of prefabricated cast-iron components which had been adopted at that time (Whitmore, 1989). This argument is supported by the fact that the treadmill which had been despatched to the colony intended for Dunwich on Stradbroke Island, was requested by Captain Logan in 1827 to be diverted to Brisbane Town instead (Steele, 1975). It is therefore likely that the central shafts of the treadmill wheels were cast-iron, which were notoriously prone to failure (House Histories, 2017). This suggests that the treadmill wheels would have been arranged in parallel rather than in sequence to reduce the mechanical torsion stresses upon the central shaft.

The standard construction for the treadmill wheel would have been twenty-four timber steps (House Histories, 2017) around a central shaft, looking something like a “chaff cutter” likely with a guard screen of timber boards, and a handrail to hold on to (Whitmore, 1989). According to one account, “five steps” were climbed onto the treadmill, which suggests there were no floorboards alongside the length of the treadmill wheel (House Histories, 2017). This means that any convicts losing their feet would have merely fallen to the ground, instead of regularly having their feet mauled between the floorboards and the descending wheels. There is actually only one recorded instance of an exhausted convict meeting his death upon the treadmill, and this was likely due to being unluckily dragged underneath the wheel.

It is certainly possible that there exists physical evidence of the foundations that were dug and constructed for the treadmill, buried partially beneath Wickham Terrace. Future archaeology may be able to confirm the location and arrangement of the treadmill by searching for the physical evidence of the foundations on the bedrock.

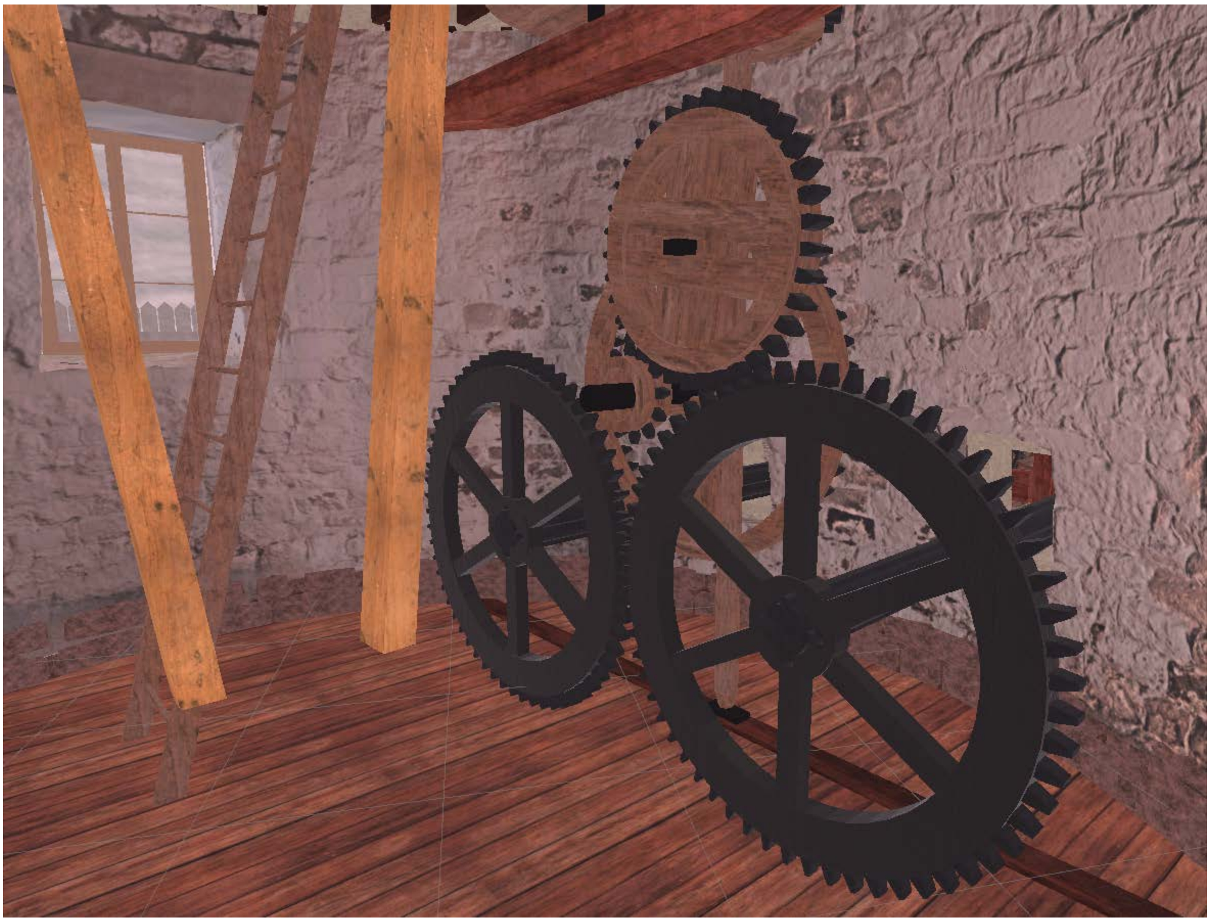
The tower wall foundations

The circular stone footings of the tower are constructed from Brisbane Tuff, and have been modelled according to the site investigations carried out by the BCC Heritage unit in 1993 (BCC Heritage, 1996). The foundation walls are wider at the base than the ground level walls. The foundations sit on the bedrock approximately 1000mm – 1050mm beneath the ground (BCC Heritage, 1996).

The ground floor

It is possible that the original level of the ground floor was lower than it is today, assuming that a timber floor was laid directly on top of the stone foundations of the tower. Around the exterior, the foundations are wider than the base of the walls (BCC Heritage, 1996) and so if the same is true on the interior, then this would have formed a convenient rebate upon which to construct the ground level floor. The ground floor would have housed the machinery connecting to the treadmill, as well as the chutes leading from the millstones above, through which the ground meal was fed into sacks ready to be taken down to the town below (Whitmore, 1989).

The cast-iron machinery of the treadmill and the gears that transferred its rotation to drive the millstone from underneath has been modelled indicatively based on Whitmore's sketch of a standard arrangement (Whitmore, 1989) with the arrangement and sizing according to the locations of the two filled-in openings in the ground level wall.



The stone floor (level one)

The stone floor of the windmill (level one) housed the two millstones, with the great spur wheel above. This floor also gave access to the exterior reefing stage platform around the tower through the two doorway openings. The reconstruction assumes that the structure of the timber floor was supported on the rebate at the top of the ground level walls, at the height where the brickwork walls begin, at the same level as the current level one floor.

The upright shaft

The central rotating upright shaft ran the height of the windmill. It was powered by the windmill sails via the wallower at the top, which meshed with the brake wheel which was turned by the windshaft (the wallower was a toothed wheel fixed to the central upright shaft, which took the rotation from the brake wheel and transferred it to the upright shaft). On level one the upright shaft drives the great spur wheel, which in turn drives the millstone via the stone nut.

The millstones

There were two pairs of millstones in the tower, one driven by the windmill sails from above, and the other driven from below by the treadmill (Hogan, 1971) (Whitmore, 1989). The millstones were housed inside timber vats. Each pair consists of two stones working together: the upper revolving “runner” stone and the fixed “bed” stone underneath. The grain was funnelled into the eye of the runner stone, and ground by the passage between the two stones. Mill stones do not grind against each other: there is a small gap between the stones through which the grain passes, and is moved along and ground by sharp furrows cut into the surfaces of the stones. The millstones were imported from France made from a special type of stone called French Burr, which was ideal for millstones (Hogan, 1971).

The fate of the millstones is unknown (Hogan, 1971) but if ever discovered, they can be conclusively identified: they will be the only stones of this special French Burr in Brisbane, or they could be identified by the furrow patterns. Each millstone was approximately 1.2 metres diameter (48 inches) and between 250mm – 300mm thick, furrowed on one side. They would have been very heavy and difficult to transport, and useless at the end of their life, so likely they have ended up somewhere in a close radius around the windmill, perhaps used as construction material.

The grain chutes

The chutes fed grain down from the bins above into a flat hopper, which was agitated by the rotation of the millstone spindle to cause the grains to drop into the eye of the millstones.

The great spur wheel and stone nut

The function of the machinery on this level was to transfer the rotation from the central spinning shaft to the runner millstone. The great spur wheel was fixed to the central rotating upright shaft, with a toothed rack around the outside that meshed with the teeth of the stone nut, which drove the spindle of the runner millstone.

The bin floor of the windmill (level two)

The bin floor (level two) housed the two grain bins, into which corn or grain was poured, to be gravity fed through chutes into the millstones to be ground. The sacks of grain were hoisted up to this level through the trapdoors using the sack hoist on the level above. The reconstruction assumes that the structure of the timber floor was supported on the existing rebate in the brickwork wall, at the same level as the current level two floor.

The grain bins

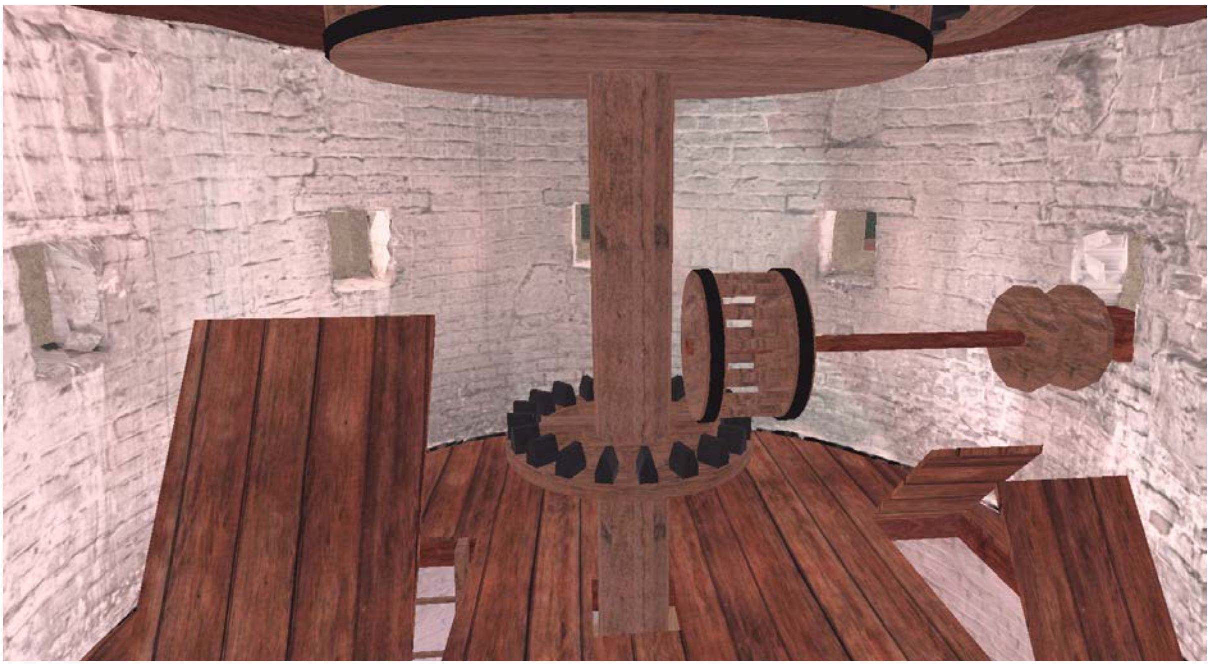
After the maize and wheat grown in the colony was harvested, the kernels of maize and the wheat grains needed to be manually separated from the inedible husks. Sacks of grain and corn kernels were then transported up to the windmill, and hoisted up to the bin level and poured into the grain bins to be fed to the millstones below.

The dust floor (level three)

The dust floor (level three) would have protected the milling mechanisms below from rain and dust blown in through the cap roof of the tower. It is likely that this level also housed the sack hoist machinery for hoisting sacks of grain up to the bin floor on level two. This timber floor does not sit on a rebate in the brickwork: there are joist pockets knocked into the walls instead. This suggests that this level was added as an afterthought, that the decision was made to increase the height of the tower after construction had already progressed past this level (Whitmore, 1989).

The sack hoist machinery

The sack hoist was a useful piece of machinery that allowed sacks of grain to be hoisted up to the bin floor on level two, from the ground floor. The sacks were tied to a rope that was wound up by the rotation of the upright shaft from the sails, gradually lifting the sacks.



The cap frame

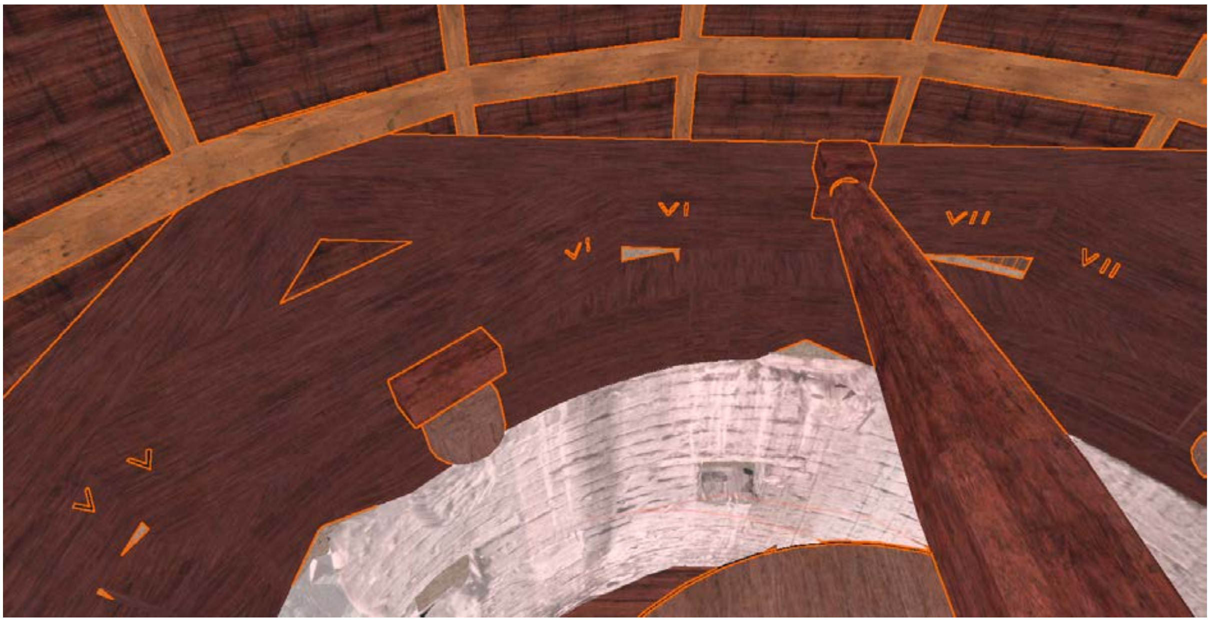
The rectangular cap frame, constructed from heavy timbers, functioned as the frame for the rotating top of the tower mill. The central cross beam (the sprattle beam) held the bearing cap for the central upright shaft. On top of the cap frame was mounted the heavy windshaft, which supported the sails. On the other side, the sails were balanced by the heavy timber supporting the fantail. The cap frame was supported on wheels which sat on the curb below. The cap frame functioned to always rotate the sails to face the wind, turned by the fantail, which slowly rotated the cap frame on a toothed rack, which ran around the outside of the curb below. The remaining timbers of the cap frame can still be seen in the existing tower, as can the cut-out mortises that held the sprattle beam and windshaft sockets.

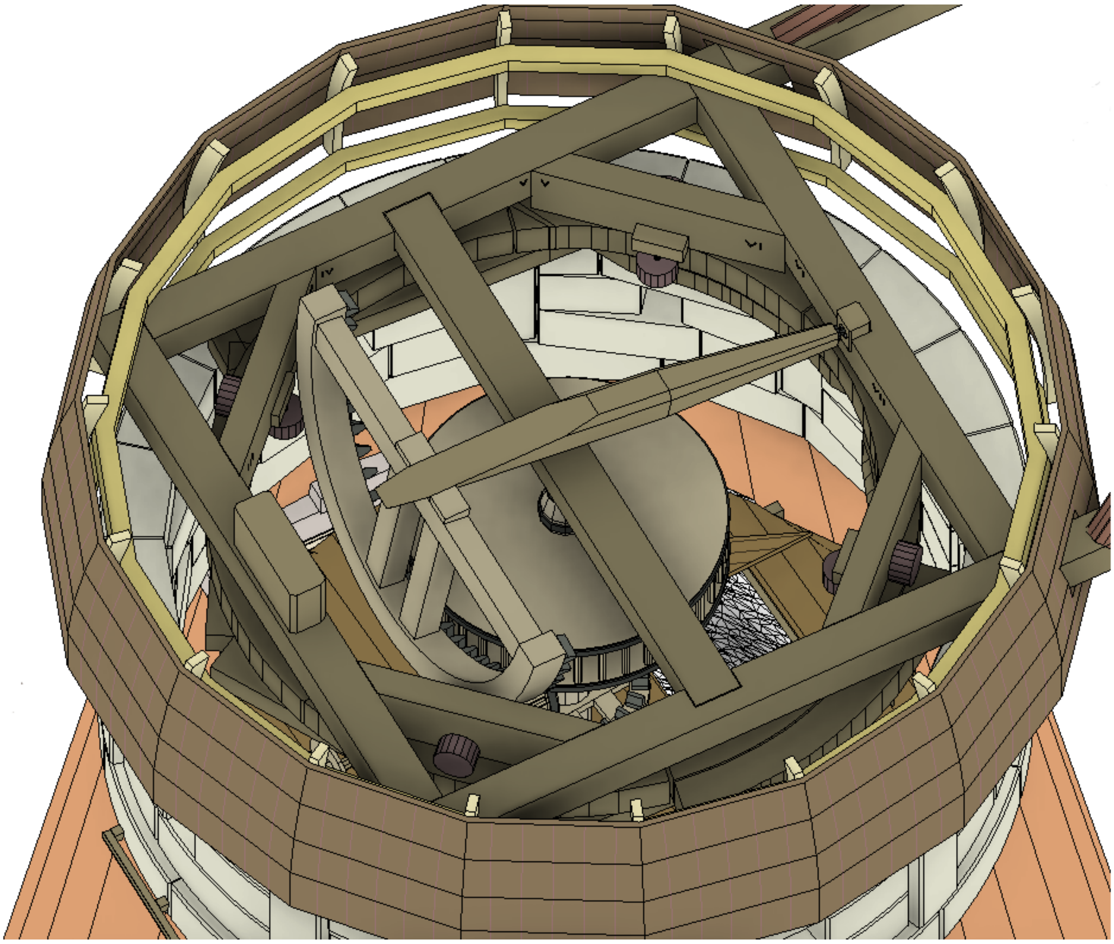
The curb

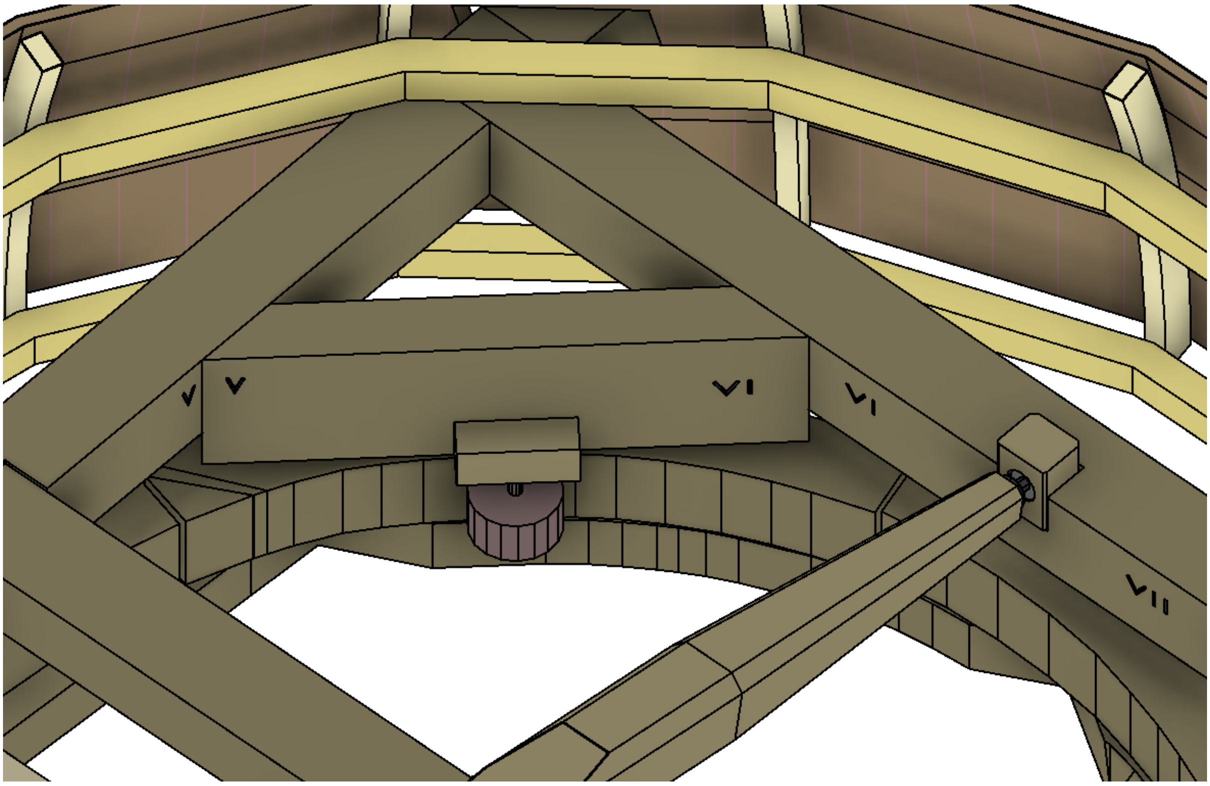
The curb consists of eight solid timbers with a flat top face and circular interior face. The wheels supporting the cap frame ran on the top of the curb, while the cap frame was held in place by four truckle wheels that ran around the inside face of the curb (Whitmore, 1989). The timbers of the curb are still existing, and the scars from the passage of the truckles can also be seen on the inside face. Roman numerals are etched into the faces of the timber to mark the order in which they were to be assembled. These timbers were native local hardwoods, which means they were precisely cut here in the colony, not shipped in from elsewhere (BCC Heritage, 1996). Around the outside face of the curb presumably ran a toothed wheel that geared to the fantail, but no evidence of this has yet been discovered.

The curb support

The eight timbers of the curb support functioned to provide a level base for the curb to sit on. The curb support sits directly on the brickwork walls of the tower. The faces of the timbers are etched with roman numerals showing the order of their construction. Because all timbers are native local hardwoods, this suggests all the framing was manufactured here in the colony with great precision and skill, not shipped from elsewhere (BCC Heritage 1996).

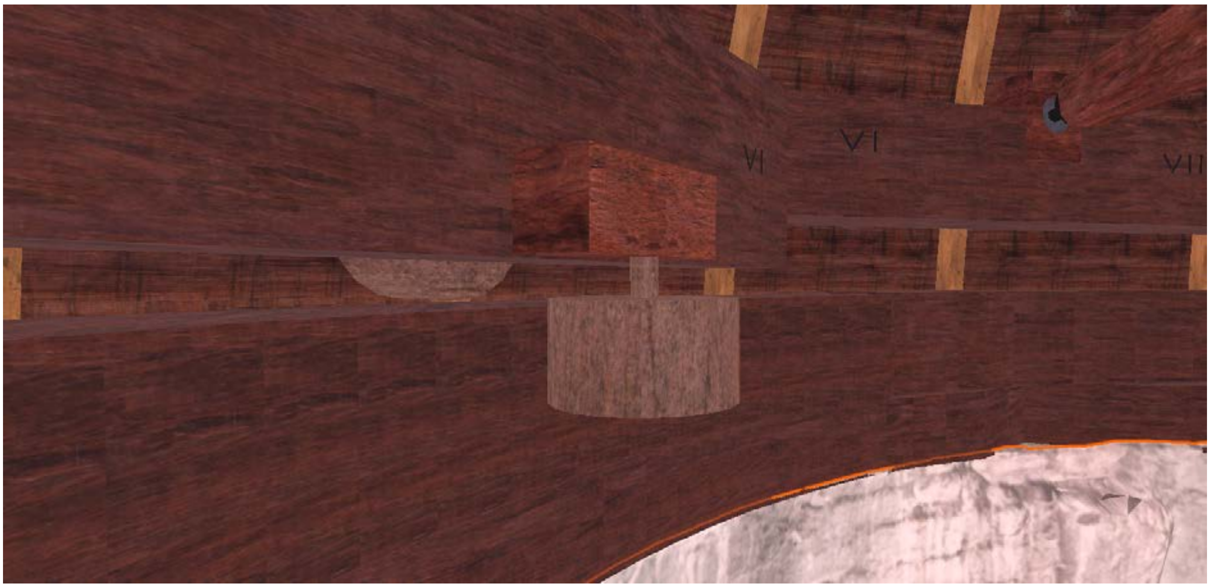





V
V
VI
VI
VII

The truckles

The truckles were four wheels fixed to the cap frame, one at each corner of the cap frame. The truckles ran along the inside of the curb, keeping the cap frame in place as it rotated.



The brake wheel

The brake wheel was fixed to the windshaft, and functioned to transfer the rotation from the windmill sails to the central upright shaft, via the wallower, which was fixed to the upright shaft. It is known as the brake wheel because a strap mechanism allowed the miller to apply friction to slow the rotation of the wheel from below. The sails of the windmill were joined to the heavy windshaft. The windshaft was mounted on the cap frame with socket bearings, allowing it to turn with the rotation of the sails.

The stocks and the sweeps

The stocks were the heavy timbers of the sails that crossed at the windshaft, bolted and fastened together. The sweeps were longer, thinner timbers fixed to the stocks to extend the length of the sails.

The sails

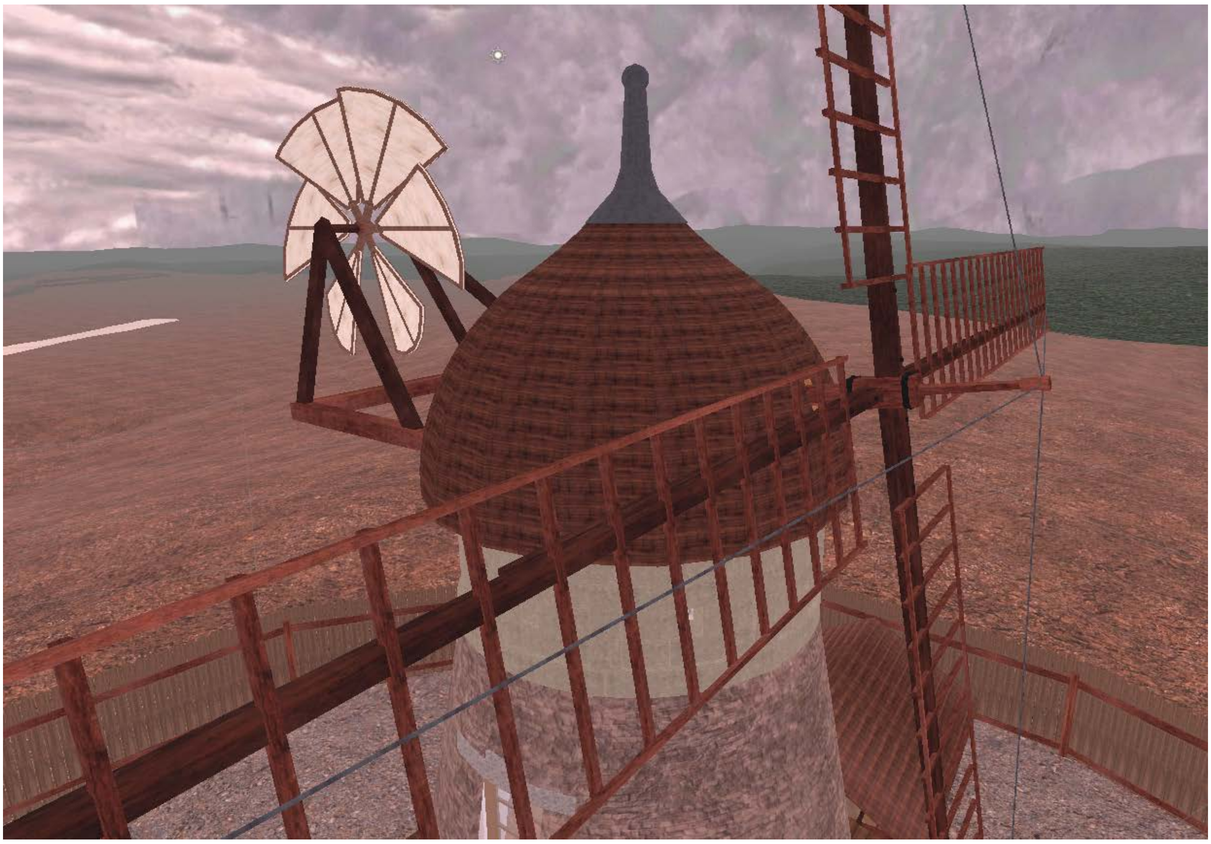
The sails were presumably constructed as a timber frame joined to the sweeps, with canvas fixed over the frame to catch the wind. The sails were trimmed and reefed from the reefing stage at level one.

The fantail

The fantail functioned to always turn the rotating cap of the tower so the sails faced directly into the wind. The wind spinning the fantail rotated the cap frame on a toothed rack along the outside of the curb. The fantail can be seen on early sketches (Bowerman sketch of Brisbane town).

The cap roof

The cap roof can be seen in early sketches of the windmill (Bowerman sketch of Brisbane town) in the distinctive onion shape, known as an ogee cap. This was a similar construction to shipbuilding, warping timbers into a hulled shape. It was likely roofed with shingles like the other buildings in the colony at that time (Steele, 1975). There was a metal spire cap, (visible on the sketches) to waterproof the top.



The exterior sandstone block walls

The exterior sandstone block walls around the ground level of the tower have been reconstructed based on the photographs taken by Richard Stringer during the 1988 conservation works, when the external render was completely stripped away (Marquis-Kyle, 1988). On these photographs, regularly spaced joist pockets around the exterior are visible, which would have housed the joists supporting the external reefing stage platform. Also visible are the external sandstone lintels and sills at the door and window openings.

The tapering brickwork walls

The tapering brick walls make up most of the height of the conical section of the windmill, from the base of level one, to the base of level three. The brick walls sit on the stone walls of the ground floor, and the construction is at least double brick, perhaps with a filled rubble core. The exterior was not initially rendered. The convict-made bricks are visible on the interior, beneath a whitewash. The exterior brickwork has been reconstructed by copying the interior brickwork pattern.

The cylindrical top section of the tower

The tapering brick walls are topped with a cylindrical section of walls, faced externally with sandstone blocks, with brickwork on the interior. The exterior sandstone blocks have been reconstructed based on the photographs taken during the 1988 conservation works, when the external render was completely stripped away (Marquis-Kyle, 1988). Likely this section was added as an afterthought to increase the height of the tower, so that an additional "dust" floor (level three) could be added (Whitmore 1989). This theory is supported by the fact that there is no rebate in the internal brickwork walls to support the level three floor, suggesting it had been completed before it was decided to raise the height of the tower.

The reefing stage

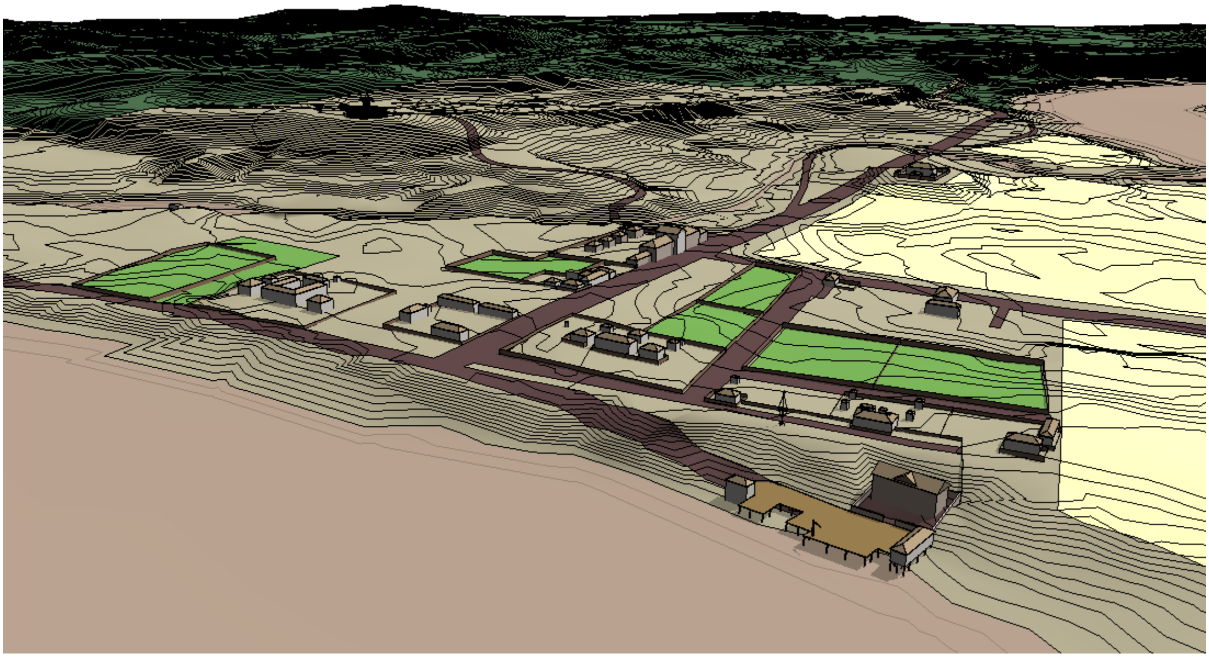
The reefing stage was a timber platform running around the perimeter of the tower, giving access to the sails so they could be trimmed and reefed. The existing level one windows were originally doors giving access to the reefing stage. The joist pockets for the reefing stage supports are visible on the photographs of the exterior sandstone walls taken by Richard Stringer during the 1988 conservation works, when the external render was completely stripped away (Marquis-Kyle, 1988). The reefing stage has been reconstructed based on the spacing of these pockets. Likely the platform was supported by struts (House Histories, 2017), which it would make sense to assume rested on the stone foundations of the tower, which are wider than the base of the walls.

The level one doors giving access to the reefing stage

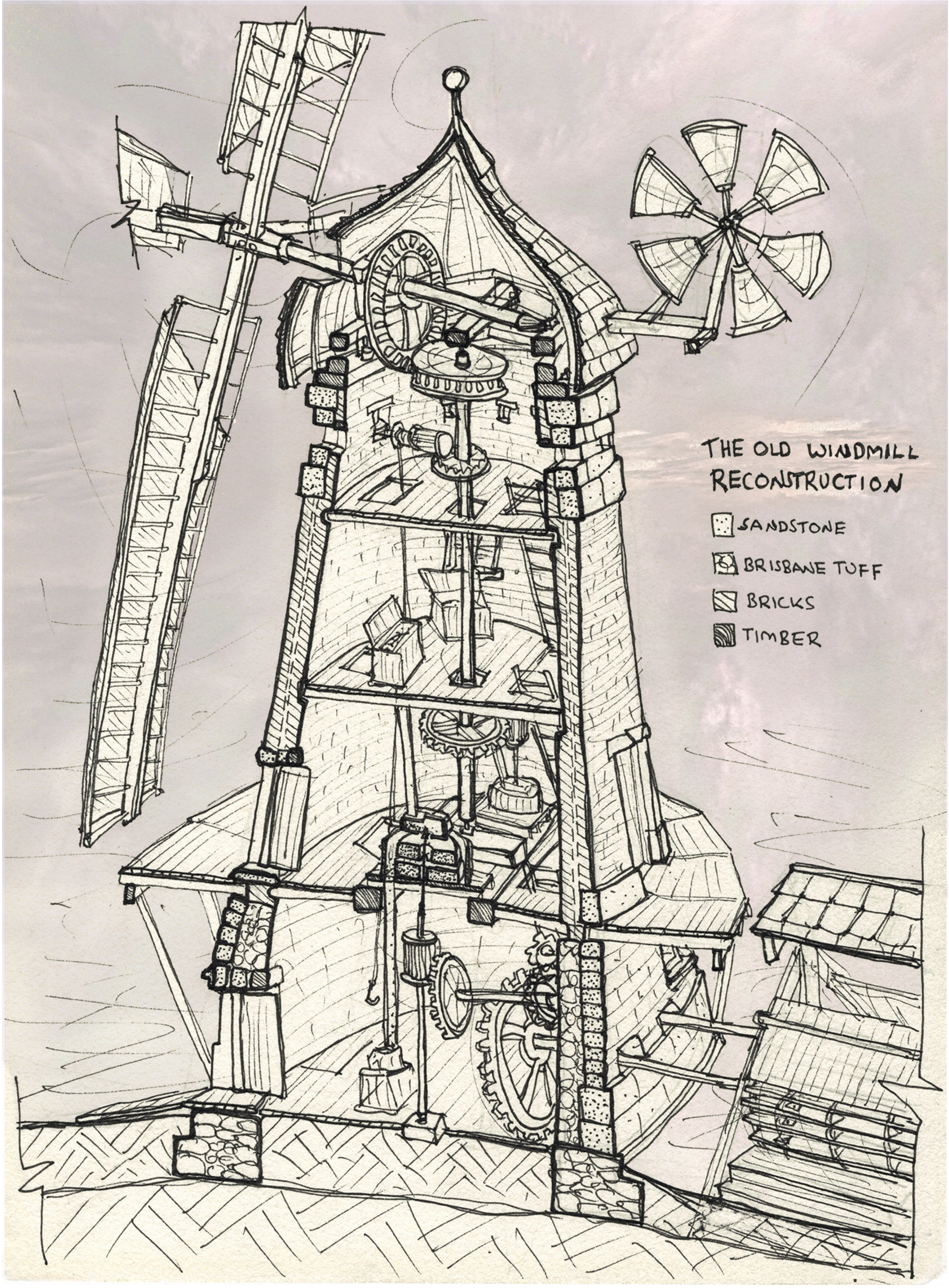
The existing level one window openings were originally doorways giving access to the reefing stage platform. The evidence for this is the infill-brickwork visible on the photographs of the exterior taken by Richard Stringer during the 1988 conservation works, when the external render was stripped away (Marquis-Kyle, 1988).

Brisbane Town

The penal colony of Brisbane Town in 1840 has been reconstructed based on the map drawn by Robert Dixon in 1840 (Dixon, 1840). The brown represents the cleared land around the settlement. The yellow indicates the cultivated fields of wheat, the green indicates cultivated gardens, and the dark green represents the surrounding bush. The path leading up to the windmill is indicated on all contemporary maps, and a fence is also drawn on all maps (of varying diameters) surrounding the windmill.




THE OLD WINDMILL
EXISTING 2017
SANDSTONE
BRISBANE TUFF
BRICKS
TIMBER
CONCRETE
WICKHAM TCE
BEDROCK
TREADMILL REMAINS?


THE OLD WINDMILL
RECONSTRUCTION
SANDSTONE
BRISBANE TUFF
BRICKS
TIMBER

Thanks!

We would like to thank everyone who has been assisting us with this project and in tracking down historical resources, in particular Brisbane City Council and the National Trust Queensland for allowing us to visit the site and view their archive files on the Old Windmill. Many thanks to Magnus Eriksson from House Histories and to Peter Solberg for providing their digital models of the Old Windmill for reference!

We gratefully acknowledge the continuing assistance of the Brisbane City Council in allowing us to access the Old Windmill for 3D scanning and site investigations and for providing us with a reference copy of the 1996 conservation study for the Old Windmill and Reservoirs.

We are most grateful to Dr Huat Seng Lim, for his generous philanthopic donation to the Faculty of Engineering, Architecture and IT, which has enabled this project to be undertaken. Thank you!

The digital model has been constructed in Autodesk Revit using point cloud scan data collected with a Leica P-16 Scan Station and a GeoSLAM Zeb1 handheld scanner.

The following programs have been utilised in the production of the digital model, which has been assembled in Unity: Leica Cyclone, Autodesk Recap and Revit, 3DS Max, Meshlab, Blender, CloudCompare, Adobe Photoshop and Unity.

The Team

Zeb1 scanning: Kelly Greenop

Leica P-16 scanning: Ben Wood and Jay Stocker

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Historical research: Jay Stocker and Kelly Greenop

3D modelling: Jay Stocker

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