APAF Breezeblock Bookends

SLQ Wiki Fabrication Lab 2026/06/13 13:27

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Developed by Steve Curran, 2023

Acknowledgement

We acknowledge Aboriginal and Torres Strait Islander peoples and their continuing connection to land and as custodians of stories for millennia. We respectfully acknowledge the land on which we all meet today, and pay our respects to elders past, present and emerging.

Summary

- Build community interest in the State Library's image collection
- Encourage creativity in the design of architectural details
- Activate community use of the 3D printers and laser cutters in our Open Lab
- Confirm the effectiveness of 3D-printing 1-piece reusable rigid plastic moulds for use in casting multiple plaster objects that don't feature undercuts
- Introduce participants to the capabilities of typical industry-standard CAD program
- Encourage participants ongoing engagement with the Open Lab and its capabilities

Skills Introduced

- Intro to using the SLQ collection
- Design process
- Fabricating with plaster

Tools and Materials

- Computer running vector drawing program
- Computer running Solidworks parametric CAD program
- Computer running PrusaSlicer
- Thumb drive for file transfers
- Prusa MK3s+ printer fitted with 0.4mm nozzle
- 0.5kg PETG filament
- 0.1kg PLA filament
- Laser cutter
- 3mm clear acrylic
- 7mm interior grade Hoop Pine plywood
- Acrylic sanding blocks
- Double-sided tape
- Wet & dry silicon carbide sandpaper
- Petroleum jelly (Vaseline)
- Plasticine clay
- 3.8 litre rubber bucket
- Ultracal 30 (up to 3kg)
- Clean water for mixing Ultracal (room temperature)
- Nitrile gauntlets
- P2 dust mask
- Safety glasses or face shield
- Coveralls
- Vibrating table
- Hand trowels
- Stanley Surform 65mm shaver tool
- Putty knife
- Small stiff-bristle brush
- 2 x water-filled plastic tubs (for rinsing tools and gloves)
- Bin (for disposal of set plaster waste)

Workshop Walk through

Session 1

Workshop participants will meet up in the Edge Digital Media Lab (DML). Participants will be introduced to historical images of Southeast Queensland homes contained in the SLQ Corley Collection that feature breezeblocks via Corley Explorer (slq.qld.gov.au). A set of 6 3D-printed moulds for casting plaster bookends inspired by breezeblocks documented in the Corley Collection will be available for participant examination. These moulds will also be available for use in casting during Session 2.

The facilitator will lead participants step-by-step through modelling one of these moulds and its extraction aids in Solidworks CAD software. Participants will also be shown the procedure for saving a native CAD model as an STL file, importing this file into a slicing program, and generating a g-code file for use in 3D printing. The Facilitator will also initiate a 3D print and export some DXF files for use in cutting parts on a laser.

Attendees wishing to design their own breezeblock-inspired bookends can sketch their designs on paper. Those with software skills can access a vector drawing program (e.g., CorelDraw, Inkscape, Illustrator). Breezeblock designs must all conform to the dimensions set out under the 2D Design section below. The facilitator will assist participants in use of the various tools in the drawing programs.

At the end of this session each participant will have decided on one of the following options for their return in Session 2:

- Cast their plaster bookends using one or more of the 6 ready-made moulds on offer
- Provide the Facilitator with a hand-drawn sketch for development into a mould for 3D printing and casting
- Provide the Facilitator with a digital file for conversion and import into the CAD program and development into a mould for 3D printing and casting

Homework

In the week between the 2 workshop sessions, the Facilitator will take any hand or digital sketches for custom breezeblock/bookend designs provided by workshop participants and model moulds in CAD for casting these designs in plaster. During the week, as many moulds as possible will be 3D printed in PETG filament on one of the Open Lab's Prusa MK3s+ FDM printers (a single mould sliced for printing with a 0.4mm diameter nozzle and a 0.2mm layer height will take approximately 38 hours to print on the Prusa machines). Any moulds not completed during the week will be printed ASAP.

Associated aids for use in extracting casts from the mould will be 3D printed in PLA or laser cut in acrylic/plywood as appropriate.

Session 2

Workshop participants will meet up in the Edge Innovation/Open Lab to collect their moulds for casting. Attendees who have opted not to design their own custom breezeblock/bookend will cast a pair of bookends using available ready-made moulds. Bookends will be cast in a high-strength, low-expansion plaster called Ultracal. Moulds may need light sanding to remove any anomalies that threaten to key into the plaster casting and interfere with extraction. A mould release must then be applied. Corners will require sealing with a small amount of plasticine clay. Participants will relocate to â€˜The Pitâ€™â€”a sheltered outdoor area located on Level 0 between the Edge and SLQ buildingsâ€”to undertake the actual casting procedure.

2D Design

Breezeblock designs will need to be prepared as vector art. The Edge has a few vector drawing programs available for your use. Adobe Illustrator and Inkscape are installed on desktop computers in the Digital Media Lab (DML). CorelDraw and Inkscape are available on laptops in the Innovation Lab. If you prefer to work with another, more familiar vector drawing program (e.g., AutoCad) you are welcome to bring your own laptop to the workshop, or sketch by hand during the workshop and prepare your vector drawing when you return home.

The capacity of the Prusa 3D printer build platform limits the size of the moulds that can be printed; therefore, all breezeblock designs will need to adhere to the following constraints:

- Overall dimensions must be 180mm high x 180mm wide x 68mm deep
- Block detail must be suited to open face casting in a single-piece mould
- Block detail must be robust enough for successful extraction from mould

The facilitator will provide guidance and feedback as to what level of detail can be successfully cast. A good rule of thumb is that all elements should be a minimum of 20mm wide to ensure they are robust enough to survive extraction from the mould without cracking. Your finished designs will need to be exported in DXF format and provided to the Facilitator on a thumb drive (or emailed to steven.curran@slq.qld.gov.au, if you intend to finish your drawing at home). Thumb drives will be provided.

CAD Modelling

Unfortunately, there is insufficient time available in this workshop to train participants in the use of a parametric CAD program. To provide participants with some understanding of how an effective mould can be constructed in 3D, your Facilitator will step you through the process of modelling a mould and casting extraction aids in a parametric CAD program called Solidworks. Solidworks documents the creation of a 3D model using a “design tree” on the left side of the computer screen called the FeatureManager. The FeatureManager and the graphics area displaying the model under construction are dynamically linked. This allows a completed model to be rolled back to the initial sketch and rebuilt on-screen step-by-step. In this way, participants can see how the final mould takes shape. Your facilitator will import your DXF file into Solidworks as a base sketch for constructing a 3D model of an open cast mould. Once complete, a copy of the native Solidworks model will be saved as an STL, OBJ, or STEP format file for import into PrusaSlicer. This slicer program will process the model geometry into ‘g-code’—a set of instructions that the printers will interpret when building the mould layer upon layer on a steel build plate. Note that all block penetrations—the internal voids that extend from the front face through the entire depth of the breezeblock—will require a 2° draft angle to ensure the casting can be successfully extracted from the mould. This feature will be applied to all moulds in the CAD program.

3D Printing

PrusaSlicer is available on all laptops in the Open Lab, and on all PCs in the DML. Your Facilitator will prepare your mould models for printing; however, it is worth knowing a few things about the process.

- We will print your moulds using PETG filament. The Open Lab offers 3D printing using either PLA or PETG filament. These polymers have different properties including different melting temperatures. PETG is better able to withstand the heat generated by plaster as it sets.
- We will print using a standard 0.4mm nozzle. While this results in long print times, we have tested printing a mould using a 0.8mm nozzle, and the result is too rough for our purpose.
- We will print at a layer height of 0.2mm. Finer layer heights can be problematic with PETG, and also result in much longer print times. 0.2mm is satisfactory for our requirements.
- We will print on a textured spring steel build plate. PETG adheres too aggressively to a smooth build plate. Using a textured plate is essential.
- It will take an estimated 38.5 hours to print each mould. Printing all participant's moulds equates to a significant amount of printing to be completed in the week between workshop sessions. Note that print failures are always a possibility. Any moulds which aren't ready in time for Session 2 will be printed ASAP during the following week. We will arrange a mutually convenient time for those participants to return and cast their breezeblock bookends. During Session 2, participants whose moulds aren't yet printed can acquire casting experience using other moulds available on the day.

Laser Cutting

To aid in the extraction of plaster castings from the printed PETG moulds, a handful of additional components must be made. Some of these components will need to be cut on our lasers from 3mm acrylic and 7mm plywood sheet. The vector art necessary for cutting these components will be exported from the native CAD model as DXF files. Your facilitator will prepare all of these components prior to Session 2.

Mould Preperation

- Sanding. With luck, few (if any) printed moulds will have protrusions on surfaces against which the plaster will be cast. If high points are evident, they must be removed by sanding to ensure they don’t key into the casting and interfere with extraction from the mould. Wet & dry sandpaper affixed with double-sided tape to acrylic plates will be provided for this purpose.
- Mould release. Once internal mould surfaces are assessed as acceptable, a thin film of petroleum jelly should be applied to the entire PETG mould (inside and out) and laser-cut acrylic plates. This film will assist extraction of the casting from the mould, and also make mould clean-up easier. Note that, if moulds are cleaned with soapy water after use, they will need a reapplication of release before another casting is attempted. Even if cleaned with plain water, an additional application of release between casts is recommended as a precaution.
- Joint sealing. If you intend to measure the volume of the mould with water, the extraction pin holes on the underside of the mould will need sealing with plasticine clay. This should be done with the laser-cut 3mm clear acrylic insert plate fitted at the bottom of the mould cavity. Take care that you don’t push the plate away from the mould base with the plasticine. There are also vertical gaps at the 4 external corners of all moulds where the outside walls meet. These gaps will need sealing with a small amount of plasticine clay prior to filling the moulds with plaster.
- Assembly. Ensure the laser-cut 3mm clear acrylic insert plate is pressed firmly and evenly into the bottom of the mould cavity. Also fit the acrylic plate that will prevent the sides of the mould from spreading under the weight of the wet plaster.

Casting

Finished mould assemblies will include the following components:

- 1 x printed PETG mould
- 1 x laser-cut 3mm-thick clear acrylic base insert plate
- 1 x laser-cut 3mm-thick clear acrylic retaining ring to keep mould walls from spreading
- 1 x laser-cut 7mm plywood plate with holes for fitting ejector pins
- Printed PLA ejector pins (quantity to suit mould hole count)
- 1 x laser-cut double-layer plywood push plate for pushing mould down over ejector pins

Breezeblocks will be cast in Ultracal 30—a high-strength, low-expansion plaster. Mixing and casting will take place in 'The Pit'—a sheltered outdoor area located on Level 0 between the Edge and SLQ buildings. All necessary materials, tools, and equipment should be at hand before commencing to mix plaster, as once mixing commences the window for completing a pour is very brief. A vibrating table will be provided to reduce the occurrence of voids in the castings. Note that Ultracal is composed of calcium sulfate hemihydrate, Portland cement, and crystalline silica—substances that all present health hazards if not handled correctly. A safety data sheet (SDS) for Ultracal 30 can be found here. When working with Ultracal in powder form, a P2 respirator, safety glasses, and protective gloves should be worn. Once the plaster is a wet mixture, a respirator is no longer necessary. Protective clothing is recommended, but certainly don't wear your nice clothes while working with plaster.

Mixing the Plaster

To avoid mixing too little plaster, you will prepare more than you need. Commercial manufacturers control the plaster to water ratio using scales, but most artists use the following, simpler method:

1. Ensure you have all necessary materials, tools, and equipment at hand before progressing to Step 2!
2. Measure your water, either by:

* Filling your mould to the top with clean, room temperature water, and then transferring this water into a flexible rubber mixing bowl.

- Measuring the quantity of water required based on the CAD model calculation using a graduated vessel, then transferring this water to a flexible rubber mixing bowl.

1. Place your mould on the vibrating table. Have an offsider standing by, ready to switch the table on.
2. While wearing protective gloves, a P2 face mask, safety glasses, and keeping airborne dust to a minimum, sift handfuls of plaster through your fingers evenly across the top of the water in the mixing bowl, discarding any lumps. Everyone working in the immediate vicinity should also be wearing a P2 face mask while plaster is being sifted. Do not touch the water. Continue to do this until a small island of plaster forms above the water level.
3. Keep sprinkling small amounts of plaster around the island, until most of the loose water on the top is absorbed, so that just a thin film about 2 mm is left. Do not push the plaster below the surface.
4. Let the plaster and water stand still for up to two minutes. This process wherein plaster absorbs

available water is called â€˜slakingâ€™. You can gently tap the sides of the bowl to help release any air bubbles in the bowl.

5. After this slaking period, a face mask is no longer required. Begin to stir with your gloved hand or spoon, while trying to avoid the introduction of air into the mix. Once mixing has started, the chemical reaction that culminates in the plaster setting will proceed rapidly. Stirring for 1 minute is usually sufficient, provided the mixing is thorough. Long and rapid stirring will result in the plaster setting before it can be poured into the mould.

Pouring

Try to pour the mixture carefully into the mould in a steady continuous stream in one location, leaving the plaster to flow up the insides of the mould until it crests just above the lip of the mould. This is ideal but may prove difficult. The most important thing is to fill the mould before the plaster begins to set. As you begin pouring, have your assistant switch on the vibrating table.

Screeding

When first poured, the plaster will appear glossy. As it sets, the plaster becomes matte. As it continues to set, the plaster will expand and become warm. While the plaster is still soft, it should be levelled by dragging a hand trowel across the top edges of the mould. This should be done with multiple passes, until the trowel is riding on the mould edges and the top face is smooth. The plaster will eventually be too hard to screed and will begin to cool. As it cools, the plaster will contract somewhat but not back to its original size. Once cool, the casting can be extracted from the mould.

Clean-up

Prior to setting, as much plaster as possible can be scraped from the rubber bowl into the waste bin provided. Remaining residue can then be rinsed off in the water tubs provided. If the plaster has begun to harden, wait until it has set completely before flexing the rubber bowl over the waste bin to release it. Again, remaining residue should be rinsed off in the water tubs.

While the plaster is setting, it is a good opportunity to scrape and brush clean the ledges on the external faces of the mould that will later be used to push the mould off of the casting. If these ledges are not clean, you won’t be able to apply an even force across the entire mould.

All tools with adhered plaster must be completely clean before using them again. Take care not to cut yourself on the sharp edges of the hand trowels.

Running water will be available; however, wet plaster should only be washed from hands and tools using standing water in tubs prepared for that purpose. Plaster should never be rinsed off in a sink that is not equipped with a plaster trap. Plaster will otherwise settle in the pipes and require an expensive plumber call-out to remedy the problem.

Extraction

Each mould has a corresponding set of 7mm-thick laser-cut plywood components to assist with extracting the casting:

1. Remove the acrylic retaining ring.
2. If the 3D-printed PLA extraction pins have not yet been inserted into the plywood ejector plate, do so. The chamfered ends should be inserted into the plate.
3. Place the ejector plate on a flat service with the exposed pins facing up.
4. Place the 3D-printed mould with the plaster casting face up on top of the ejector plate, ensuring that the holes in the underside of the mould fit over the ejector pins. Be sure to clear away any plaster that may have set in the holes on the underside of the mould.
5. Place the plywood press plate on top of the mould, taking care that it drops down to rest flat on all of the mould ledges.
6. Apply light force on the plywood press plate. The mould should move down a few millimetres, coming away from the plaster casting. Confirm this on removing the press plate. The mould can now be inverted, and the plaster casting tipped out. Take care, as the plaster has not yet achieved full strength.
7. At this point, the plaster remains soft enough that a Surform can be used to ease all external arises (if desired). Once the plaster has fully cured, this can only be done by sanding.

Curing

Depending on variables including temperature, humidity, and air circulation, your plaster casting will take time, up to a week or more, to fully cure and dry. After a few days, you can wash the outside of the casting with water and detergent to remove any residual petroleum jelly. Don't soak the plaster but scrub the surface and rinse it thoroughly. The casting will absorb water again, but the release must be completely removed if you intend to apply a sealer or paint to the casting. If you have a set of scales, you can periodically weigh your casting to monitor its drying progress. Once it is no longer losing water weight, you can apply the finish of your choice. Unless sealed, plaster remains hygroscopic and will naturally absorb moisture on humid days. If you wish to ease any edges with sandpaper prior to finishing, be sure to wear a P2 respirator (remembering that airborne crystalline silica content poses a respiratory hazard).

References

- State library Built Heritage collections - https://www.slq.qld.gov.au/collections/queensland/built-heritage
- Corley Explorer - https://explorer.corley.slq.qld.gov.au/
- Previous iteration of our Breeze block workshop - https://wiki.slq.qld.gov.au/doku.php?id=workshops:prototypes:breezeblocks

Downloads

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