

**BRINGING THE CONSTRUCTIONARIUM
EXPERIENCE TO SCHOOLS:
THREE APPROACHES**

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think up

Overview

For almost ten years, the Constructionarium has been at the forefront of giving undergraduate civil engineers practical and inspirational on-site construction experience. Think Up was commissioned by Constructionarium Ltd to explore how a similar learning model can be used to inspire and give practical experience to pre-university students at sites around the UK.

We have used the Construction syllabus for the new University Technical Colleges as the basis of three approaches for delivering the Constructionarium experience to 16-19-year-olds. In this document we outline these three approaches.

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INTRODUCTION

The Constructionarium was originally conceived to give practical construction experience to undergraduate civil engineers. The underlying model is to challenge teams of students to build a scale model of a real engineering project using real construction materials and processes. Participants are provided with a set of drawings and a pile of components and given a week to complete the job. The experience is a mixture of problem solving, planning, practical work and teamwork, and has the added benefit of inspiring students to stay on in the profession. Constructionarium Ltd now wishes to use a similar approach with younger students already enrolled in construction-based learning, giving them experience of practical working and, at the same time, inspiring those people to stay on in the industry.

In developing these proposals we envisage that participants would be students aged between 16 and 19-years-old enrolled in a construction-based course at a school or college, such as the construction diploma that will be available at the soon-to-be-launched University Technical Colleges (UTCs). In 2012, ConstructionSkills issued guidance on the course requirements for construction courses at UTCs. We have developed the three approaches outlined in this document so that they would support the delivery of the practical components of these construction courses.

OVERVIEW OF THE THREE APPROACHES

Mini Constructionarium

In this approach, we have identified three existing Constructionarium projects and looked at how these could be delivered at sites around the UK requiring minimal site preparation works. We have then looked at how these three projects, together with a new project, can be structured and delivered for a younger audience. The emphasis of the mini Constructionarium approach is civil engineering construction, and practical experience of building using concrete, steel and timber.

Eco House

In this approach teams of students build a two-storey eco house. While the design of the simple steel structure is fixed, students are tasked with designing and building each of the building's walls from a different material. Students have a range of different materials to choose from including concrete, rammed earth, hempcrete, masonry and timber - students must decide according to the orientation of the wall and the role it plays in the building. This project combines practical experience of working with different materials with the opportunity to learn why certain materials may be preferred in particular circumstances. The emphasis of the eco-house approach is on building construction, and low-carbon construction in particular.

Machine for Living

The venue for this approach is the Big Rig, a three-storey scaffolding frame in which students can assemble different construction materials. Here students are encouraged to think of a building as a set of interacting systems: structural, energy, water etc. Their task is to create a series of rooms and to provide these rooms with water, electricity and warmth using low-carbon building technologies. This approach gives students the opportunity to design and build practical solutions to specific problems. The emphasis of this approach is on learning about low-carbon building technologies, and finding out how these are used in practice.

LEARNING OUTCOMES IN COMMON

Common to all of the above approaches is a set of core learning outcomes, detailed below. Learning outcomes specific to individual approaches are described later in this document.

Understanding on-site techniques

Students will have the opportunity to select and use a range of tools, materials and personal protective equipment to perform construction activities. Associated activities include:

- Placing concrete, steel and timber
- Ordering, measuring and cutting materials

Understanding buildability

Through planning and executing a series of construction processes, students will be encouraged to think about what factors make designs easy and safe to build. Associated activities will include understanding:

- how to fit construction activities into a construction sequence
- how to write method statements for safe construction
- how to reduce wastage during construction
- how tools and construction plant can be used to make construction easier and safer
- how pre-fabrication of construction elements can aid safe and high-quality construction.

Understanding safe working

Students will have the opportunity to identify hazards and risks on site and understand how to deal with them. They will also be expected to display appropriate behaviour on site.

Associated activities will include:

- Writing risks assessments for construction activity
- Experience of working at height

Team working

Students will work in teams of between fifteen to twenty people. Each team will be broken down into groups tasked with completing certain parts of the job. They will get the experience of having to organise themselves in order to get a job of work done, and acting as a responsible and reliable team member.

Time planning

The teams of students are supported in developing time plans for their work. They are encouraged to regularly review these plans as the activities unfold and they are presented with new information.

Common approach to supervision and briefing

In all the approaches described in this document, the students are given a more structured set of activities than would be expected at the undergraduate Constructionarium. While students are still expected to problem solve, they will do so in a more structured environment. The student briefing information will define a series of activities that students must work through in order to complete their projects on time. In all of the approaches, the majority of the first day is spent on briefing students, providing basic health and safety training, and helping students plan their time for the rest of the week. As well as carrying out practical on-site work, students will be required to keep a diary in which they log their experiences on site and what they are learning.

Each team of students will be overseen by a supervisor whose role it is to provide initial briefing and to support students working through these structured activities. Assigned to each team of students will be an apprentice-level student who can provide practical support to the team, an approach which worked well at the undergraduate Constructionarium.



Students complete construction of the 'East Reef Pier' at the Constructionarium site in Bircham Newton

APPROACH 1

MINI-CONSTRUCTIONARIUM

Introduction

The first of our three approaches is to take four Constructionarium projects (three existing; one new) and deploy them on a smaller scale and in a way that would be suitable for younger learners. The basic principles remain the same: groups of 15 to 20 students are given a set of drawings and a pile of construction components and are given five days to complete the construction of their structures. The four projects are:

- **Barcelona Tower** - a communications tower with a concrete core and a steel external structure. The construction involves building the steel structure at ground level and jacking it up the concrete core to its final location.
- **Kingsgate Bridge** - a footbridge with a pre-fabricated concrete deck sections and steel legs. The construction involves building the two halves of the bridge on either side of the 'gorge' and rotating the two bridge sections to meet in the middle.
- **Millennium Galleries** - a reinforced concrete building with a barrel-vaulted roof and a timber-clad wall. The construction involves the pre-fabrication of the roof and walls and the craning into position of these three elements.
- **Masonry Arch Bridge** - a masonry arch footbridge spanning between two concrete abutments. The construction involves the creation of a timber former on which the arch is built, after which the timber former can be removed.

In general, the execution of these projects differs from the undergraduate Constructionarium as follows:

- The duration is five days and may be non-residential. All activities including briefing sessions are intended to take place during the five day period to enable the event to be more easily included in the school or college calendar.
- The projects have fewer construction steps (in some cases the final structure is smaller) to allow construction in the compressed timetable. For example, all projects will be already set out and in some cases the foundations will already be in situ.
- While students will be asked to develop their own construction sequence at the start of the event, they be ultimately guided through a pre-determined and timetabled construction sequence
- Daily 'Spotlight' discussion sessions will provide students with useful but non-essential background information during the course of the event. This will enable some of the key learning outcomes to be more explicitly drawn out.
- Each project team will be assigned a supervisor to guide and oversee student activity.

While each of the Mini-Constructionarium projects will have a different construction sequence, the overall structure of the event will be as described below.

Indicative timetable

Day 1 - Introduction and health and safety briefing. Exploring the brief and construction planning exercises. Toolbox training and rebar fixing training.

Day 2 - Small groups work on rebar fixing for early-pour items (formwork already produced). Break teams into working groups each assigned to carry out particular construction tasks. Students work from pre-prepared method statements for the first elements they work on. Spotlight discussion on writing method statements.

Day 3 - Construction continues in working groups. Spotlight discussion on temporary propping.

Day 4 - Construction continues in working groups (most prefab element construction should be finished by now). Spotlight discussion on working with construction plant.

Day 5 - Last stage of construction (typically lifting in pre-fabricated components and making good). Spotlight discussion on the structural engineering of each project. Final presentation and debrief.

Learning outcomes

In addition to the learning outcomes common to all three approaches described at the start of this document, this approach specifically offers a number of specific learning outcomes as described below.

- Of all the approaches, the Mini-Constructionarium event will provide students with the greatest amount of practical experience of working with real construction materials.
- This approach has a particular emphasis on reading and understanding construction drawings.
- Students will have to think carefully about producing method statements and working to construction sequences.

Over the following pages we have provided more information about each of these proposed Mini-Constructionarium projects.

Facilitation and supervision

Supervision will be more intense version of existing Constructionarium. The event will require a site supervisor and support operatives. In addition, each team will have a dedicated supervisor. Some of the planning activities may take place in more of a classroom format, for example writing method statements. Apprentices at the host institution could be brought in to support students. Over all the event could be supervised by a mixture of college staff and contractors.

Logistics

Of all the approaches this one requires the greatest range of plant - telehandler, excavator, dumper and water bowser. In addition students will require access to hand tools. A local supply of concrete will need to be sourced.

Support materials

Briefing information needs to be accompanied by structured activities that allow students to develop their construction sequences. Students may benefit from using models of the structures that they are building to help them work out the correct construction sequence.

Extension or preparation activities

Schools could prepare their students for working on these projects by showing them online virtual models of the construction site, so they can start to think about their on-site activities. Any of the themes that feature in the Spotlight discussions could also be expanded to form a preparation activity. Alternatively, students could study the original projects on which their structures are based.

Short-term and long-term

In the short-term this approach could be piloted at Bircham Newton with one of the projects that doesn't require significant redesign. In the longer term, these projects could be repeated several times at a particular college before moving on to a new location. The masonry bridge project could be developed for the undergraduate Constructionarium.

All of the projects featured in this approach could also be developed for deployment from shipping containers, as per the Tructionarium document that Think Up produced in May 2012.

Barcelona Tower

The construction sequence for this telecommunications tower involves pouring a concrete core, building the steel superstructure at ground level and then jacking it into position. The existing Barcelona Tower project can be deployed in much the same format as at the existing Constructionarium. The principal differences, listed below, allow for a more compressed construction time:

- we propose reducing the overall scale of the project so that the height of the tower reduces to six metres, allowing the construction of the core to only need two pours rather than three.
- the foundation for the core is already in place when the students come on site
- the anchor foundations are already marked out, although students may be required to verify their location.

The intended construction timetable would be:

Day 1 - Briefing, toolbox training and rebar fixing training; possibly verification of setting out

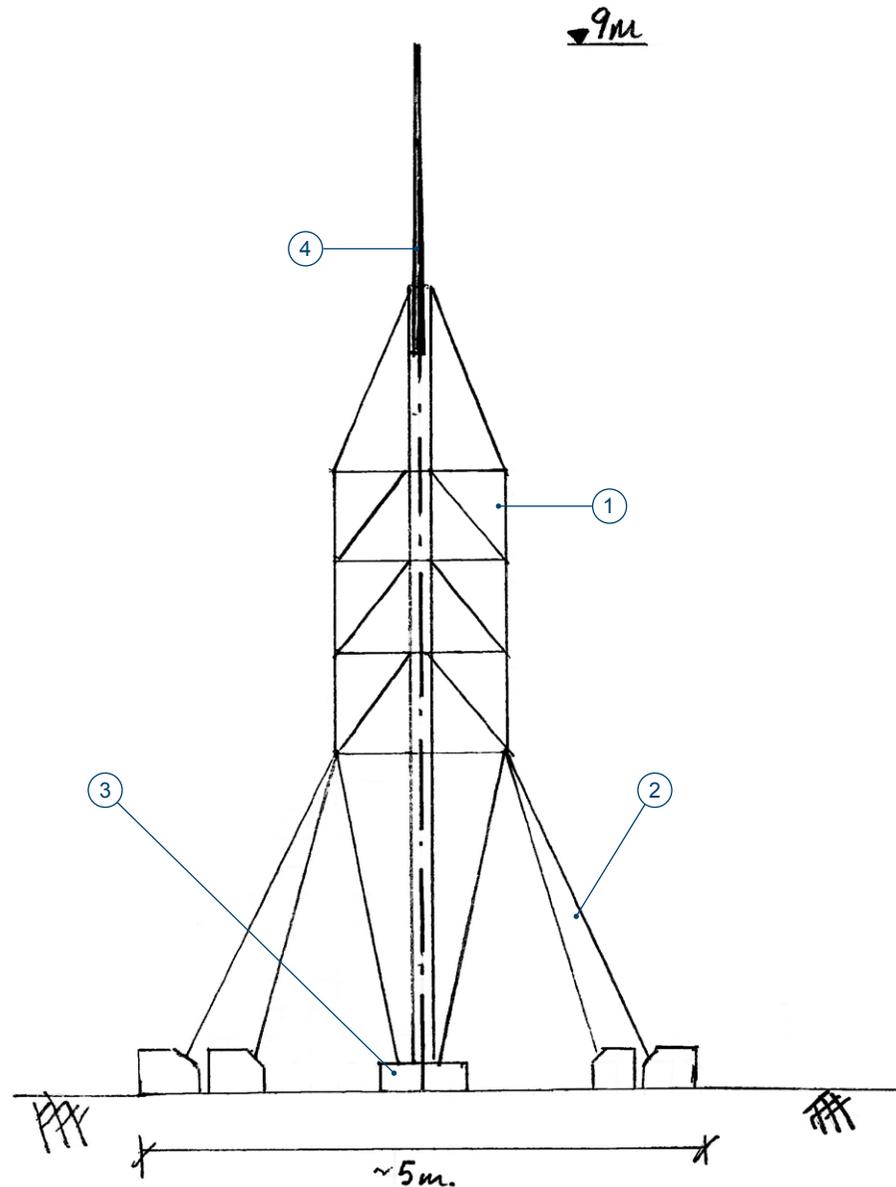
Day 2 - Assemble shutter for first core lift and pour. Build formwork and fix rebar for anchor points; excavate anchor points.

Day 3 - Pour anchors; commence erection of steelwork

Day 4 - Complete erection of steelwork, and prepare for lifting of superstructure

Day 5 - Jack up superstructure, and fit antenna.

Students will be asked to pay particular attention to developing method statements for pouring the concrete lifts and for assembling the structural steel work. Students will be provided with a scale model of the structure that they can assemble themselves to help them to understand the construction sequence for their method statements.



1. The steel superstructure is built at ground level and then jacked up the core
2. Cables attached to the superstructure are anchored into the ground to give the structure stability
3. The central foundation is already in place when students start on site.
4. The spire is lifted on as the final stage in construction.

Kingsgate Bridge

The key feature of this footbridge project is that the two halves of the bridge are built on either side of the river and then swung into place to meet in the middle. This project is an ideal size for a Mini-Constructionarium project, the principal differences with the existing Constructionarium project being how to create the permanent works:

- we create an artificial river by spreading plastic sheeting between a pair of inflatable plastic tubes, all aligned on a slight incline. Water will flow from one end to the other, and then be pumped back round. The 'river' should be of sufficient length that it poses a logistical barrier to the students.
- Piled foundations for the bridge (or piles of alternative design if appropriate) should be pre-installed
- Scaffolding staircases should be used for the approaches rather than a reinforced earth embankment.

The intended construction timetable would be:

Day 1 - Briefing, toolbox training and rebar fixing training, training on working near/over water

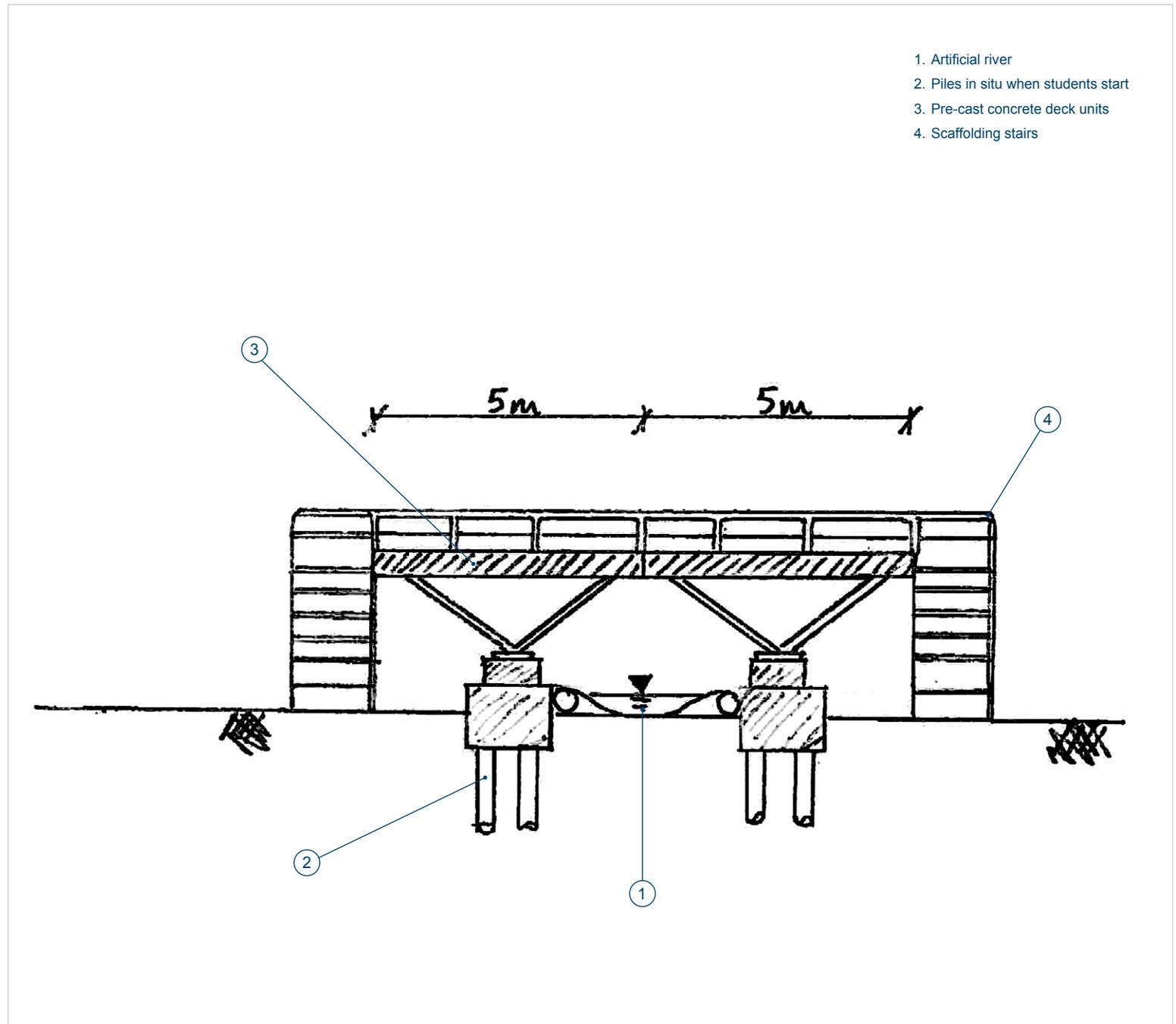
Day 2 - Build pile cap formwork and assemble reinforcing steel

Day 3 - Pour concrete for pile caps. Build formwork and rebar for deck units

Day 4 - Install bearing plates, check position and grout. Pour concrete deck units. Construct scaffolding steps.

Day 5 - Install legs. Fit handrails to deck. Lift in deck units. Rotate bridge into position.

Students will be asked to pay particular attention to developing method statements for working safely over water, and for dealing with the logistics of working either side of a river. Students will need to be closely supervised for the setting out of the bearings. This task could be simplified by removing one degree of freedom.



Masonry Arch Bridge

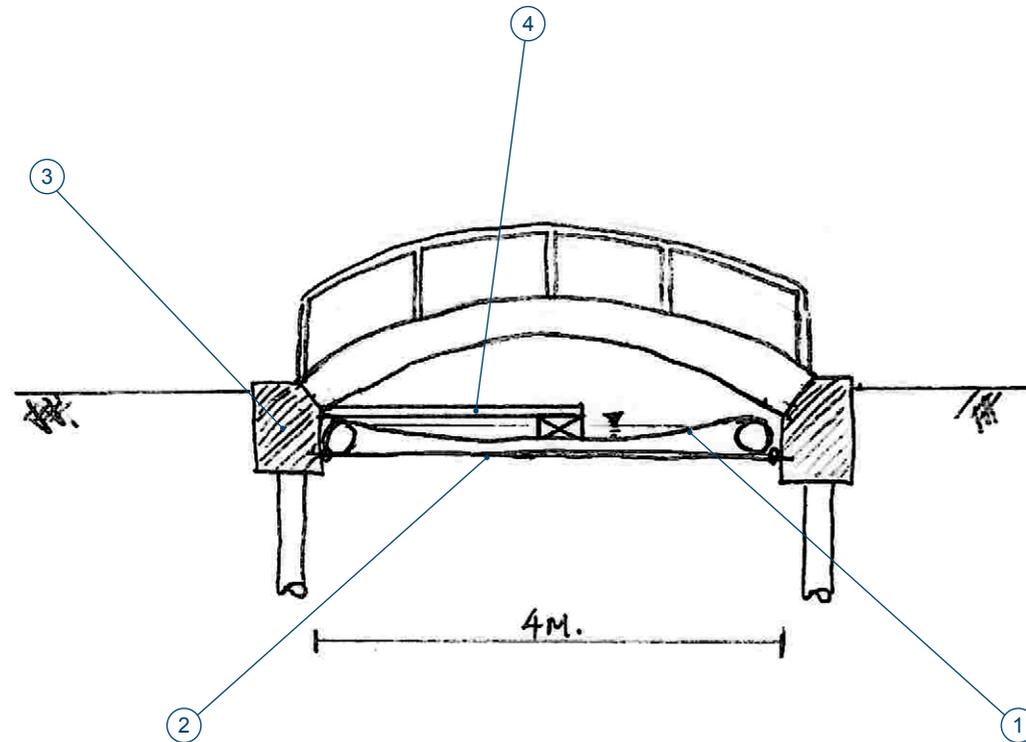
This project involves the creation of timber temporary formwork to allow the construction of a masonry arch over water. While this project is another bridge project, the main difference is that students must plan their own temporary works sequence. This is a new project. The main features of the permanent works are:

- the creation of an artificial river, as described for the Kingsgate project.
- construction of the concrete bridge abutments
- depending on the soil type the abutments may be built on piles, with the horizontal thrust of the arch being resisted by cables that pass beneath the 'river'.

The intended construction timetable would be:

- Day 1** - Briefing, toolbox training and rebar fixing training, training on working near/over water
- Day 2** - Build temporary jetty to access centre of river, and install temporary foot for timber former. Start construction of timber former.
- Day 3** - Complete construction of timber former. Lift formwork into place. Start placing brickwork.
- Day 4** - Complete placing brickwork.
- Day 5** - attach handrails and remove formwork. Remove temporary jetty.

NB the proposed timetable is very tight. Time could be saved by giving students semi-preassembled formwork for the arch.



1. Artificial river
2. Steel cables between the bridge abutments resist the lateral thrust of the arch
3. Bridge abutments in place when students start on site
4. Students build jetty in water in order to position arch formwork.

Millennium Galleries

In this project, students build pre-cast wall and roof elements which all come together on the final day. The existing project lends itself well to the Mini-Constructionarium approach, as it demonstrates a range of structural principles and involves the construction of several elements in parallel, meaning that early hold-ups won't necessarily cause major delays. The principal differences from the existing project are:

- foundations should be excavated prior to students arriving on site
- some formwork elements should be pre-constructed, for example one of the walls and one off the arches, so that students can imitate what has been constructed already

The intended construction timetable would be:

Day 1 - Briefing, toolbox training and rebar fixing training

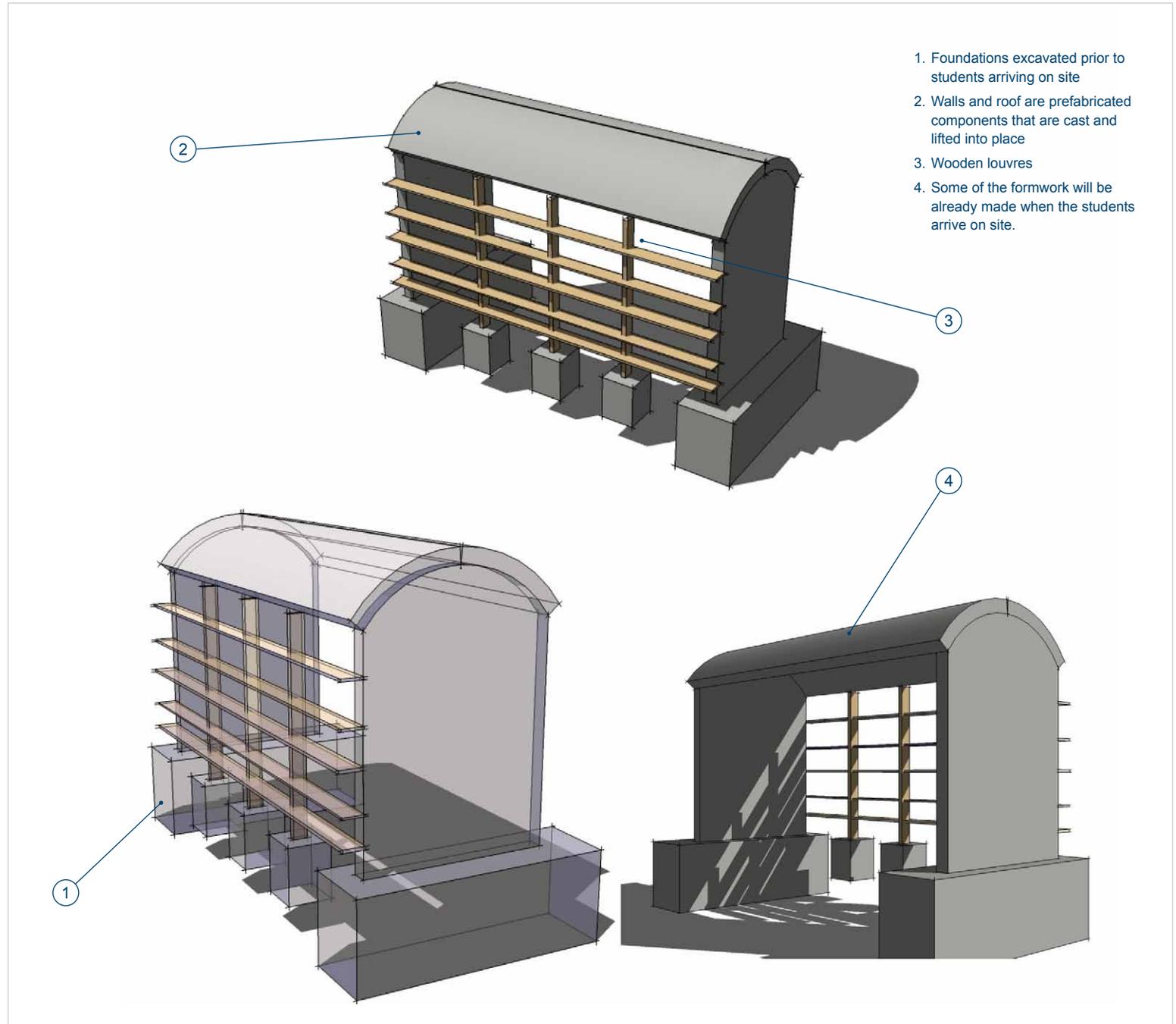
Day 2 - Fix rebar in moulds for first wall and first arch and pour concrete. Set out formwork for foundations.

Day 3 - Form moulds for second arch and second wall. Fix rebar for second wall, arch and foundations and pour concrete

Day 4 - Construct timber frames and erect first wall

Day 5 - Erect second wall and install timber frame. Lift roof arches into place.

Particular attention can be drawn to the structural system (one fixed and one pinned connection at ground level) using a demonstration model, and also to understanding temporary propping.



APPROACH 2 ECO-HOUSE

Introduction

In the second of our three approaches students are challenged with part-specifying and building the structure for an eco-house in five days. While the design for the steel superstructure of the two-story eco-house is already determined, students must specify and construct each of the in-fill walls from a different construction material. Their choice of material must reflect the orientation of the wall with respect to the external environment and the role it is expected to fulfil in the eco-house. For example, a north-facing wall may be constructed from rammed earth while a south-facing wall may be screened with louvres to provide shading from the direct sun. This approach offers students the chance to work with a range of different construction materials as well as the opportunity to see at first hand why specific materials can be used to meet specific needs.

The basic eco-house structure will be a simple steel frame that features, and therefore demonstrates, both cross-bracing and moment connection lateral stability systems. The pin-joined structure is mounted on simple concrete pad footings. The structure will have bolted connections for ease of assembly by students. The floor of the upper storey will be built from pre-fabricated deck units. The infill wall panels will be restrained by channel sections in each of the corner columns. During the construction, students will need to use temporary propping to insure the stability of the structure.

The infill wall materials could include concrete, masonry, rammed earth, hempcrete, timber and straw bales. As part of their briefing information, students receive guidance information on how to specify a wall in each of these materials (for example, wall thicknesses and rebar spacing). They will be expected to produce simple construction drawings and to write a simple method statement for the construction of the walls, all of which will be signed off by the supervisor prior to construction. Each eco-house structure is intended to be built by a team of 15 to 20 students. Larger groups of students would be broken down into teams building a separate eco-houses, each aligned differently, so that the environmental conditions, and therefore the choice of materials, for each building would be different.

The grand finale for each project would be a BBQ on the upper deck of the eco-house. Student teams could be encouraged to compete with each other to produce the best structure, with the winners announced on the final day.

Indicative timetable

Day 1 - Health and safety briefing. Students visit the site and start to work out what is the best configuration of building materials for the site. Develop construction sequence. Some toolbox training.

Day 2 - Construction of ground-floor structure including: erection of columns (fixed to in-situ holding-down bolts); use of temporary propping; installation of first floor beams; installation of cross-bracing. Specification of ground floor infill walls. Further toolbox training if necessary.

Day 3 - Commence construction of ground floor-infill walls. Installation of first floor deck units. Construct upper story superstructure. Install scaffolding staircase. Specification of upper story infill walls.

Day 4 - Complete ground floor infill walls. Commence upper story infill walls.

Day 5 - Completion of upper story infill walls. Clear up.

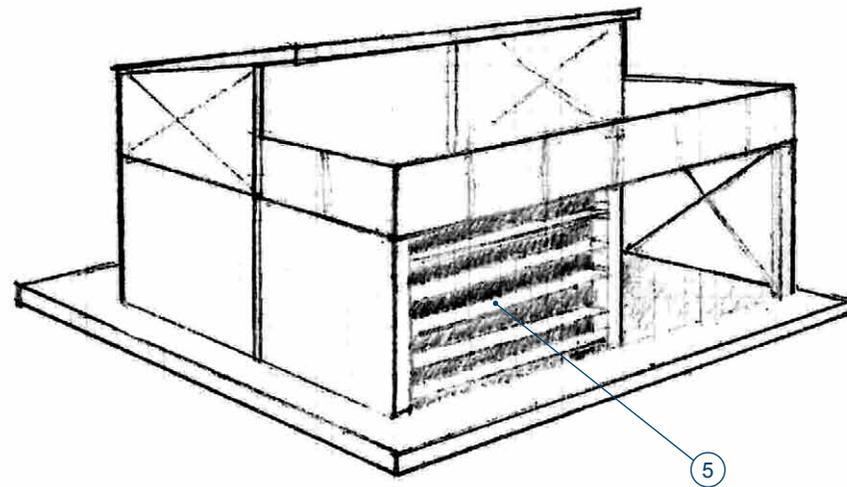
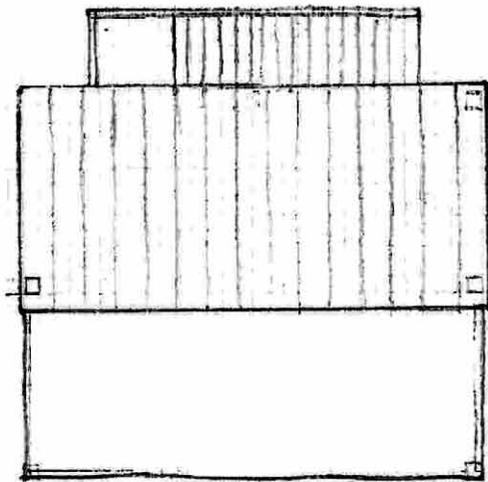
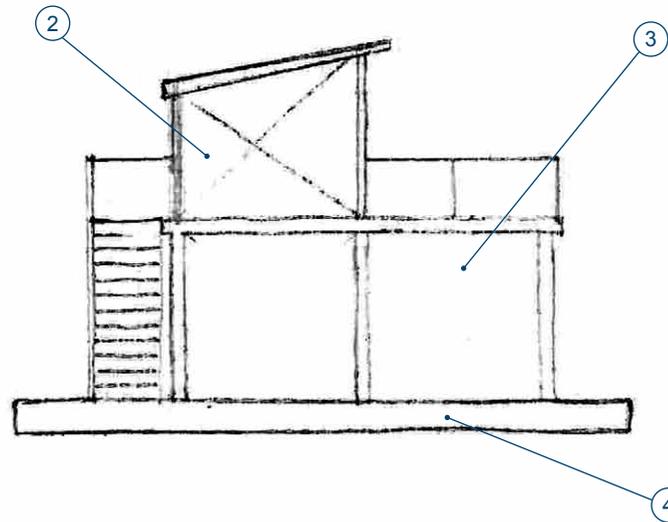
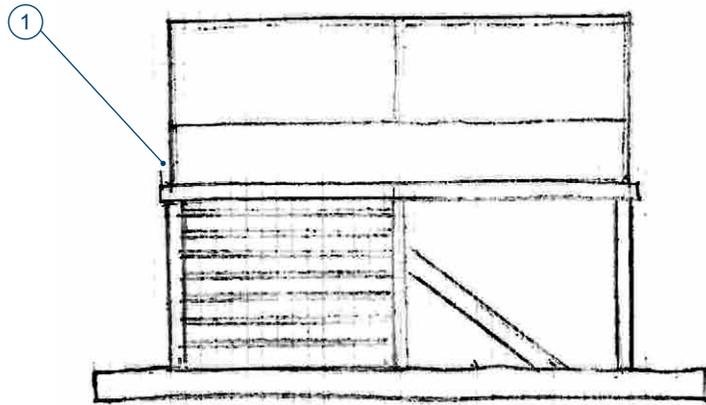
Learning Outcomes

In addition to the learning outcomes common to all three approaches described at the start of this document, this approach specifically offers a number of specific learning outcomes as described below.

- Learning about and working with a wide range of construction materials, including in particular novel 'low-carbon' construction materials. Students could have the opportunity to research these materials in great depth prior to arriving at the event.
- Planning for both the construction and the disposal of a wide range of materials.
- Learning about technical specification, ordering and delivery of materials.
- Reading from construction drawings, and turning designs into construction drawings.
- Use of construction plant to lift and transport materials.
- Understanding why particular materials are suitable for particular uses.

Preparing the site to create the learning environment

The eco-house project includes a mixture of on-site and off-site activities. The ideal venue would be land that can be used for construction within reasonable proximity to classroom facilities so that students can go back and forth with ease during the day. Each eco-house will be built on a concrete base slab that will need to be created in-situ before the students start on site. Holding-down bolts will already be installed on to which the students will fix the steel superstructure. The site requires a perimeter fence to control access.



1. Design of the steel superstructure is pre-determined.
2. Steel frame designed to demonstrate different connection types to students
3. Students specify, design and build the in-fill walls for the structure
4. The structure is founded on an in-situ concrete slab
5. Students will determine the appropriate material for each wall based on its function and its orientation.

Sketches showing the possible layout for a student-built eco-house

Facilitation and supervision

The facilitation model for the eco-house approach is similar to that for the regular Constructionarium events. A site manager, supported by plant operatives, would run the overall site. Each team of students would be assisted by a dedicated supervisor to advise them on construction processes. On site there may also be an architect or structural engineer to advise on choice of materials and design of the walls. It is expected that simple and relatively safe construction activities be carried out by students, but that site operatives, potentially apprentices, would help with the more challenging or dangerous activities.

Logistics

Students would need access to a range of hand tools. In addition, stores of a range of construction materials would need to be on hand to allow students to build the walls of their eco-houses from different materials. This approach requires use of a crane or excavator to lift in the superstructure, and dumper to assist in distributing materials.

Support materials

Students will be provided with a workbook that contains briefing information for the project, and exercises to help students develop their construction sequence, wall designs and method statements. Large-format displays or exhibition panels can be used in the classroom to illustrate particular factors to consider when choosing construction materials. Students will also be encouraged to keep a log of their activities and their learning, either as part of their workbook, or online.

Extension or preparation activities

There are many ways in which this eco-house activity can be integrated into a construction course curriculum. For example, research into the wall materials and the design of these walls could be extended to a much more in-depth activity. Similarly, the theme of eco-houses could be used to explore energy use and design of buildings.

Short-term and long-term

The eco-house project would be relatively straight-forward to test at an appropriate site. Note that some of the wall design activities also feature in the next approach described in this document, which may be easier to pilot. Since the only significant preparatory works are the pouring of the base slabs, it would be relatively straight forward to run events at construction colleges around the country.

In the long-term, the eco-house project could be integrated into the undergraduate Constructionarium. It could also be developed as a project box for the Tructionarium, described in the last section of this document.



The Hempcrete tower is one of the existing Constructionarium projects that introduces students to emerging construction materials. The difficulty with these projects is that they do not give students a great deal of variety of activity. By contrast, the eco-house approach gives students the opportunity to learn about a range of new materials in one project.

APPROACH 3

THE MACHINE FOR LIVING

In the third of our three approaches, students are given four days to design and construct a 'machine for living' - effectively a de-constructed house that contains all the elements of the principal building systems: structure, shelter, heating and cooling, water and electricity. The students assemble their Machine for Living within a Big Rig, a three-storey scaffolding frame ideally suited to learning about how complex systems fit together. This approach takes each of the main functions in a building and separates them, allowing students to get to grips with each component in isolation and to see how each system relates to the whole.

Teams of students are given a pile of construction components including: quick-fit scaffolding components, solar PVs and water heaters, timber, concrete, pumps etc. Their brief is to create an off-grid system that incorporates: a winter room; a summer room; a shower room with hot and cold water; a system for harvesting rainwater; a system for heating water; a system for producing electricity; and a way to use grey water.

Their first task is to determine how these components should be arranged in three dimensional space. The systems scaffolding cubes that they are provided with can be arranged in a any number of combinations. They must try to work out the best place to position their winter and summer rooms, the rainwater harvesting system, and the solar panels. They must decide if they want a tall structure so that they can arrange the various elements one on top of the other, or a flat structure. Once they have defined the structural form of their machine, it can be assembled by scaffolders on site.

To create the winter and summer rooms, students must think about how different materials can be used to help naturally control temperature with a room. In the winter room they may choose to create thick walls from materials with a high thermal mass and to create a large perspex window on the south side to maximise solar gain. In the summer rooms they may choose to insulate some walls and to create a louvred screen to the southerly aspect to prevent overheating.

Students must create a rainwater harvesting system to capture water for their Machine for Living. The rainwater will be provided by spraying the structures with water from a bowser (an approach that we have used with dramatic effect at other Big Rig events). Students will create a roof structure from timber and tarpaulin to funnel this rainwater into their system. They will need to figure out how to connect the solar-thermal water heaters to the water system to create hot water. Students working on this task will pre-assemble and test their proposed system on a mini rig before installing their system on the main structure. They will take a similar approach to creating the solar-powered electrical system that will be used to power water pumps and lighting for their rooms.

In each of the above instances, students are required to plan, test, draw and build. This approach is far less prescribed than the Mini Constructionarium and Eco-House approaches, and has a far stronger emphasis on problem solving, choosing the right material or technology for the job, and on planning and testing. There is also a much stronger emphasis on building systems and understanding energy use. This type of event would be run as a competition between teams of students, each creating their own Machines. The winning team will be the one with the warmest water, the warmest winter room and the coolest summer room.

Indicative timetable

Day 1 - Introduction and health and safety training. Briefing about the construction technologies that they can use in their designs, and a description of the process they must go to design and build their system. Students will start to plan the overall layout of their system, and will organise themselves into teams. To students will use models to help with the planning process.

Day 2 - Students will agree the structure for their Machine and will instruct the scaffolders to assemble the structure according to their designs. Fix rebar and pour concrete for winter room floor (optional). Start to develop designs for winter and summer rooms. Design and build rainwater harvesting system. Start to figure out water heating and electrical system.

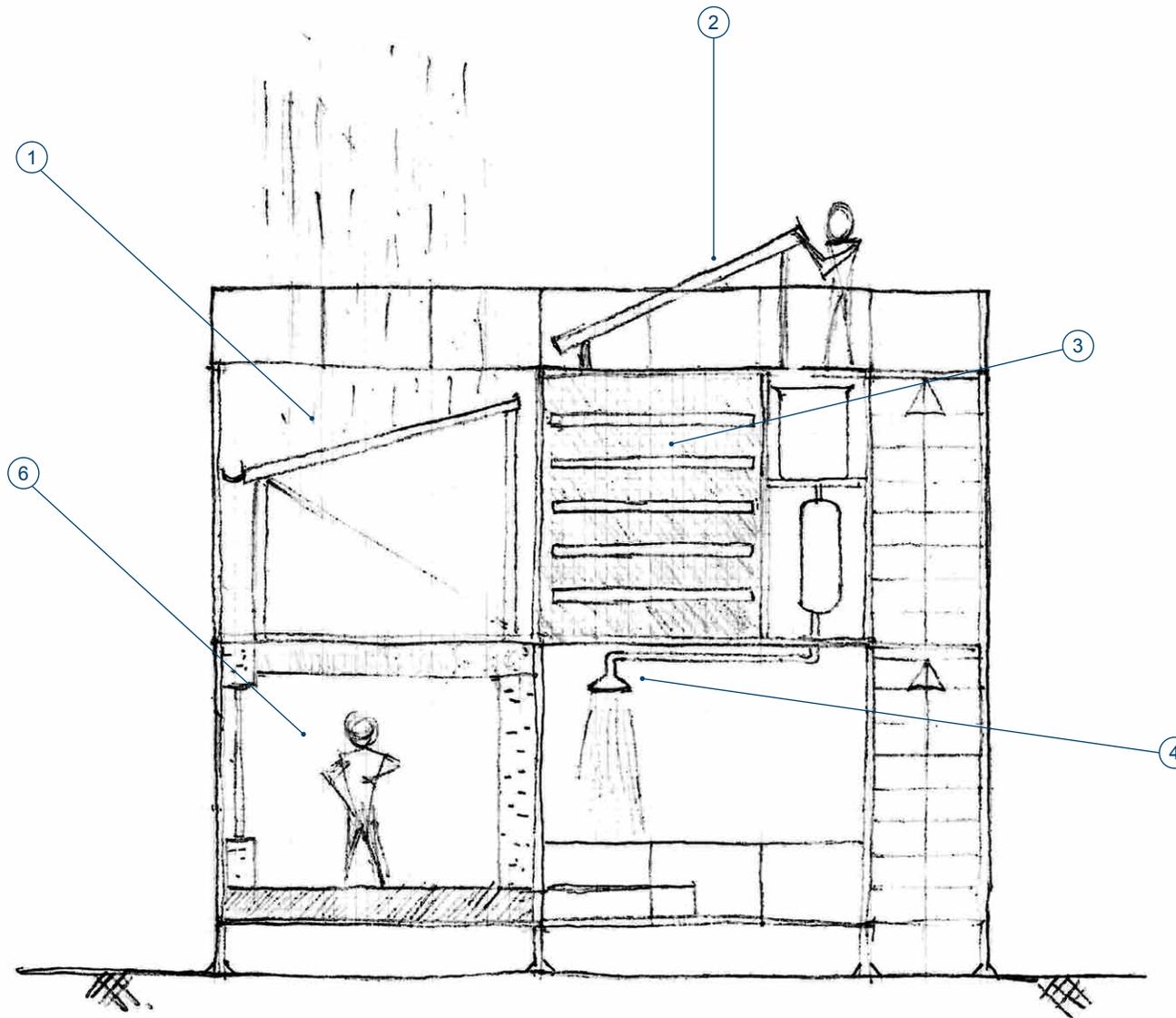
Day 3 - Build winter and summer rooms. Install water heating and electrical systems.

Day 4 - Complete construction of rooms and testing of water and electrical systems. Demonstration and announcement of winners. Deconstruction of student-built structures and separation of waste.

Learning outcomes

In addition to the learning outcomes common to all three approaches described at the start of this document, this approach specifically offers a number of specific learning outcomes as described below.

- Learn about how particular properties of materials are made use of in the design and construction of buildings - for example thermal mass and insulating properties.
- Learn about designing, testing and improving.
- Spatial problem solving
- System problem solving (particularly with respect to the water system).
- Planning for both the construction and the disposal of a wide range of materials.
- Learning about technical specification, ordering and delivery of materials.
- Turning design ideas into construction drawings
- Understanding how various low-carbon environment technologies are installed and operated.
- Learning about energy consumption in buildings.



1. Students have opted for a double-height atrium to allow water to pass through to their rainwater harvesting system on the first floor.
2. The solar thermal water heaters and solar panels have been placed on the roof on racks designed and built by the students. They have determined the best position and orientation based on climate data.
3. The students have decided to position the summer room in a shady spot, and have incorporated a wall of louvres to shade the room from the sun.
4. Students design and test their hot and cold water system on the ground before installing. It must heat rainwater captures on their roof and send it to the shower.
5. Students must also find a way of reusing the greywater from the shower.
6. Here the students have located the winter room on the south side of their structure to benefit from solar gain. Their room has a concrete floor and the walls are constructed from various materials of high thermal mass.

Impression of how a student-designed and built Machine for Living may be laid out.

Preparing the site and creating the learning environment

The Living Machine includes mainly on-site activities with some off-site planning activities. The event can be carried out in a car park or an area of hard-standing within reasonable proximity to catering and welfare facilities. The rig structures are designed to be free-standing and so won't require holding-down. Students may be asked to create working spaces for themselves within the structures that they are erecting, thus reducing the need for support classroom space. It is likely that the core of the student's rig structures would already be standing - they would then have to decide what additional elements, floors etc they would like to add.

Facilitation and supervision

The facilitation for the Machine for Living approach would be similar to that at other Big Rig events that Think Up has run with school-aged students. A site manager is responsible for health and safety, and overseeing a number of site operatives providing technical support to the students. A learning facilitator leads the student through the briefing information, and leads the students through the problem solving process. As with the other two approaches, it is expected that simple and relatively safe construction activities be carried out by students, but that site operatives, potentially apprentices, would help with the more challenging or dangerous activities.

Logistics

Many of the materials in the Machine for Living approach are reuseable, and students can be expected to make use of waste material as part of their design, which minimises the need to procure new consumables. It is envisaged that a 6 x 6m three-storey rig would be required for each group of fifteen students.

The main activities on site are on days two, three and four, which means the site staff can get the basic materials in place on day one whilst the students are being briefed. Students will assist with the removal of the materials from the rigs on the fourth day; the clear-up process can be completed on the fifth day when the students have gone.

This event requires use of a telehandler and a bowser.

Support materials

The support materials for this approach would be similar to those for the eco-house approach, though with a greater emphasis on environmental systems. Students would be provided with a workbook that will include exercises that will help through the problem solving process. In addition students will be asked to complete a daily log, either in their work books or online.

Extension and preparation activities

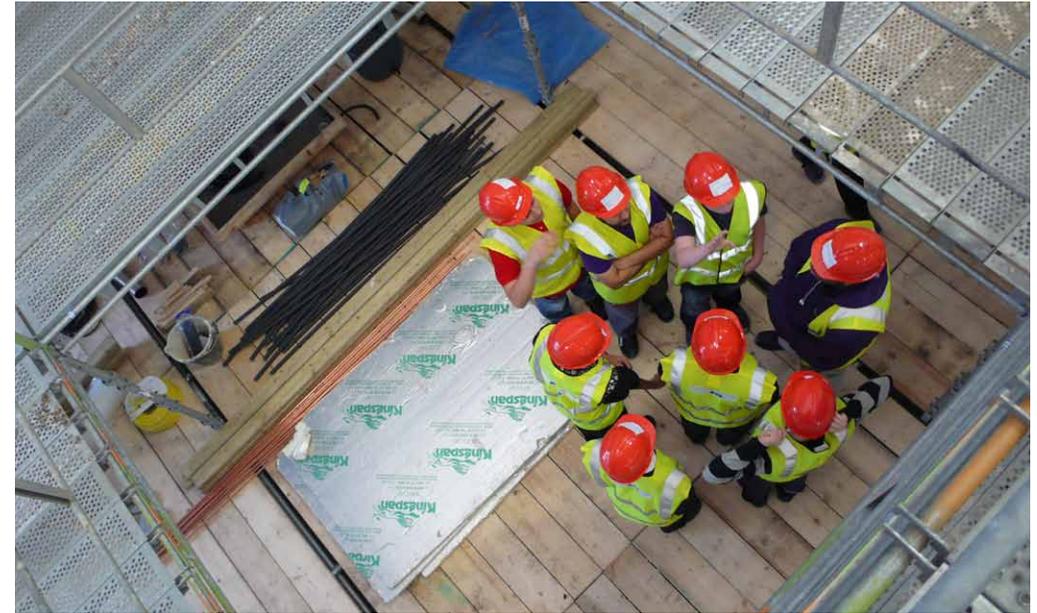
Students could spend time preparing for this event by researching how different vernacular architectures have emerged to help provide a comfortable living environment in different climatic conditions.

Short term and long term

Of all the approaches outlined in this document, this approach would be the most straight-forward to pilot as it is scalable and requires no site preparation. This concept would be easy to run at sites around the country, using locally hired scaffolding and plant, locally sourced materials, and requiring only the transport of the more expensive environmental technologies.



A photograph of the pilot Big Rig event in which participants had two days to build a low-carbon shower. The Machine for Living takes this approach to a higher level of complexity by challenging students to think more carefully about building materials and the role that they play.



We have successfully used on several occasions the Big Rig learning format for events with school aged children, for example at the opening of ConstructionSkills training centre in Waltham Forest.



Designing the water system for their Machine for Living involves a great deal of problem solving. Students will test their system on the ground before installing it in the Rig.



Example of a work book created to support learning in the Big Rig environment

THINK UP

FIRST FLOOR
MORLEY HOUSE
320 REGENT STREET
LONDON W1B 3BB

T +44 (0)20 7307 6520
E INFO@THINKUP.ORG
W WWW.THINKUP.ORG

part of the useful**simple**trust

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