ROAD TO NET ZERO 2030

UNDERSTANDING SUSTAINABLE MATERIALS AT THE BARTLETT SCHOOL OF ARCHITECTURE

Research Summary Report & Proposals for Change

July 2022

The Bartlett Faculty of the Built Environment, UCL

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For
Bartlett Climate Action: Journey to Net Zero 2030

Funded by
The Bartlett Climate Action Fund

Acknowledgements
Thanks to all at the Bartlett School of Architecture and Faculty, students and staff, who contributed to this process, especially all those in B-made who gave their time, thoughts and suggestions, and everyone who completed the anonymous questionnaire (98) sharing their knowledge, experience, opinions and proposals on BSA materials teaching and learning, as well as use in B-made workshops and through studio practice and research.

Questionnaire: Understanding Sustainable Materials at the Bartlett School of Architecture
The anonymous questionnaire was a useful tool, to collate thoughts from students and staff on what the BSA does well in teaching, learning and use of materials, where it could improve, suggestions for improvement and questions to put to BSA leadership and decision-makers about the direction for a sustainable BSA materials culture aligned with The Bartlett's and UCL's commitments, and people's desire and need across the world for a healthy, sustainable, equitable future for all.

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0.0 EXECUTIVE SUMMARY

0.0 Executive Summary

The purpose of this research

The need for a shift in materials culture is not an isolated requirement. This report sits within the context of existing commitments made by UCL and The Bartlett, and a change in materials use is fundamental to achieving commitments made.

Strategic direction and leadership is important for change. This report sets out opportunities identified for change by BSA staff and students, leadership and at every level, and which areas could be responsible for championing and driving change.

The need and support in the BSA for change towards a sustainable, equitable future for all is evidenced by:

- Existing sustainability commitments and strategies: Build a Better Future, Journey to Net Zero 2030, Bartlett Ethics Commission etc.
- Calls by students for change (including Architecture Education Declares, June 2019)
- Responses by the school to those calls: BSA Declares a Climate and Ecological Emergency, October 2019 https://www.ucl.ac.uk/bartlett/architecture/news/2019/oct/bartlett-school-architecture-declares-climate-and-ecological-emergency
- Formation of the BSAS the Bartlett School of Architecture Departmental Society and within that B!CAN the Bartlett Student Climate Action Network

Research process and key findings

However, despite real desire and willingness to move towards a sustainable, equitable future for all, change itself appears slow and hard to perceive across the school. Some taught programmes do place value on sustainable materials exploration and research, although not widely recognised, nor rewarded through any assessment criteria. Other programmes appear to see sustainable materials exploration more than as a tick box exercise, whether in materials teaching and learning, or through practical making and materials use.

The research team formed three groups to explore and understand BSA materials teaching and learning, and use in B-made workshops and shops, in relation to Net Zero 2030 and wider sustainability criteria.

Group 1 **Behaviours, Norms and Rituals (Chapter 2)** explored the existing BSA Materials culture, how it is created, what and who drives it, from BSA Senior Leadership team to taught programmes Directors/Leaders, Module Leaders

and Tutors, students' opportunities for full intellectual learning, exploration and informed decision-making, proposals for change.

Group 2 **Usage, Consumption, Trade and Creation (Chapter 3)** explored materials practice and making culture in the school, as well as related teaching and other forms of knowledge exchange; it explores how B-made operates, processes and practices in workshops and shops and proposals for change.

Group 3 **Impact Assessment Methodologies and Criteria (Chapter 4)** explored arrange of assessment methodologies that could help the BSA understand at all levels the impacts of materials selection, both in terms of embodied energy and carbon, whole life cycle analysis and social-life cycle analysis, and proposals for change

A Questionnaire (Chapter 5) was also created by Group 2 to share the research process across the school and give all students and staff the opportunity to participate and contribute their opinions, and proposals for change, asking participants to comment on:

- Materials teaching and learning, and use, including on taught programmes and in B-made workshops and shops
- What they thought the BSA currently does well
- Where it could improve
- Proposals for change and
- Questions to put to leadership

The findings of these three groups and proposals for change have been synthesised and are set out in this report to present proposals for actions needed in each area of responsibility across the BSA.

Proposals recognise that change needs action top-down as well as bottom-up, and that students and staff both have opportunities to take action at every level. It is also important to recognise that each level has opportunity to act within its remit, so that changes requiring more strategic direction are harder to make at say a delivery level. Not to say that people at delivery level cannot advocate for strategic change.

This research group believes these actions have the potential to unlock real leading change and enable the Bartlett School of Architecture to

- create an inspirational materials culture and
- lead on action on sustainable materials teaching, learning and use
- share this leadership with other schools, institutions and organisations in the UK and globally

It is really inspiring to remember that when students and staff work in concert, great leaps in understanding, relevance and application can be achieved.

Potential to develop a BSA Sustainable Materials Strategy and culture

There is a need to address actions at each level if a transition to a more sustainable, equitable teaching and learning materials culture in the BSA is desired. This will require a process in its own right to develop this and is not the focus of this report.

However it seems helpful to try to set out the process by which key strategic decisions appear to be made, although this can be a little opaque. Even those involved in such key strategic decisions are not always clearly identifiable, either by staff or students. Engaging therefore in change-making is not easy.

B-made have made great progress developing the BSA's materials culture, as have many other staff in the school. But there is a limit to what B-made workshops/shops and staff can implement without strategic school direction and leadership. It could be useful therefore to instigate the next stage of research, at the following levels.

Actions by Senior BSA Leadership

How can BSA leadership – student and staff leaders – develop open and transparent processes to develop actions for teaching, learning, research and practice to explore a sustainable, equitable materials culture?

Including how to engage and increase Student Voice, transparency of decision-making, transparency of strategic BSA sustainable teaching and learning process and development, support for the delivery of the BSA Declaration of a Climate and Ecological Emergency and for the development of the B!CAN Bartlett Climate Action Network, engaging with alumni and external organisations such as A!CAN the Architects Climate Action Network, LETI Low Energy Transformation Initiative, AECB, ASBP, Passivhaus Trust and so on.

Engagement with staff and students on decisions in each of the areas of school activity:

- **Taught Programmes:** asking for example, how can we, staff and students, analyse existing teaching and learning and propose changes or development, to explore key questions around materials and sustainable, equitable futures?
- **Research Programmes:** asking for example, how can we, staff and students, develop materials research programmes that address key sustainable, equitable materials culture questions?

And actions by staff and students across all other areas of the school too, such as:

- Within B-made and supporting B-made
- Student Voice
- BSA Shows
- Communications, Events, Publications
- HR
- Finance
- Professional services

Who and what drive decisions in the school on materials and our materials culture?

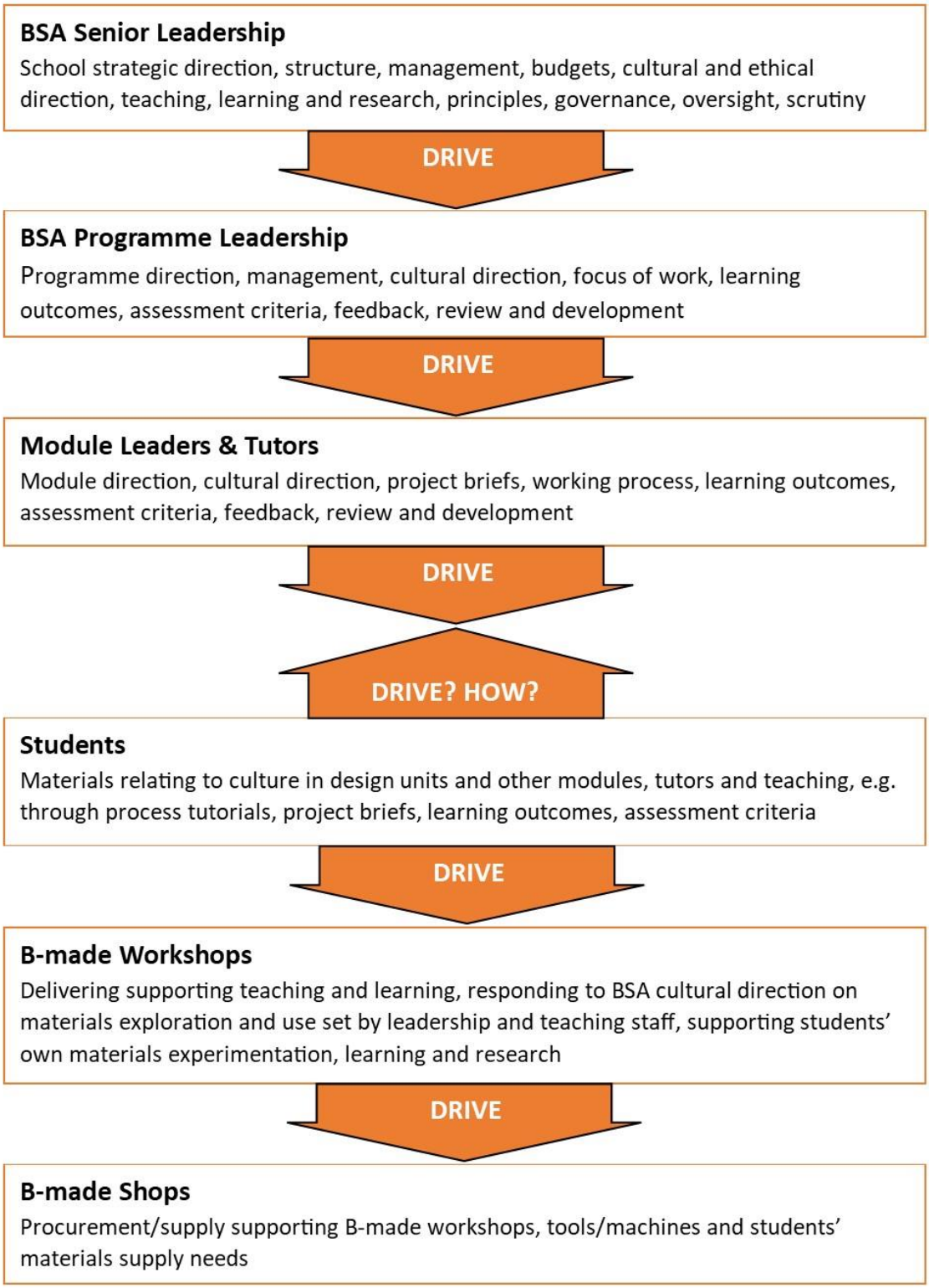


Fig. 1: Diagram of how BSA hierarchy appears currently to drive materials culture, decision-making and thus procurement, supply and use and, ultimately, reuse, recycling and waste.

The (imperfect) diagram above attempts to set out the apparent hierarchy of strategic decision-making driving BSA's materials culture (within a context of wider ARB/RIBA and UCL strategy, direction, reporting and so on). It could be useful to develop a more accurate diagram and understanding of how decisions are made in the school, for greater transparency and participation. It also tries to represent how fundamental B-made is to BSA materials culture, but how hard it might be for B-made staff to drive strategic changes.

This research group believes the actions recommended below have the potential to unlock real change and enable the Bartlett School of Architecture to:

- create an inspirational materials culture and
- lead on action on sustainable materials teaching, learning, research and use
- share this leadership with other schools, institutions and organisations globally

Through the following steps:

1) Instigate a process for positive, inclusive, collaborative, interdisciplinary school-wide discussions on materials and BSA materials culture generally – what do people think about materials relating to teaching, learning and research? The commitments made by UCL, The Bartlett Faculty and the school itself to implement change? What actions could be implemented?

2) Integrate students and staff at all levels into this strategic development process, which should also include timing on implementing any changes recommended

3) As part of Bartlett Net Zero 2030 and drawing on existing standardised processes, and to enable comparison and proportionate responses without limiting educational and research potential, develop a process to monitor, analyse and act on:

    a. data on energy consumption by use, in 22 Gordon Street and Here East, including operational energy (heating, cooling, lighting etc) as well as activities such as in B-made workshops by machine

    b. energy and carbon impact of procurement, services, travel, and other activities by the BSA

    c. assessment of materials generally, their embodied energy, ecological footprint and any other relevant sustainability criteria, drawing from existing data and research, especially those materials commonly used in the built environment - globally not just in western/industrialised cultures and contexts, so including materials such as earth-based, timber, straw etc.

    d. assessment using the same criteria of materials used within the BSA, either through B-made workshops and shops, or otherwise

    e. develop from this a 'traffic lights' information and communication process on a wide range of materials – whether in teaching and learning, research or use

– to enable students and staff to make informed decisions around materials in design, research, use and in other ways

4) Based on this, develop and publish a clear, simple, deliverable BSA Sustainable Materials Strategy enabling BSA, Bartlett and UCL existing commitments and any additional agreed steps to be put into action

5) Open up opportunities for existing staff with skills and knowledge to deliver and expand sustainable materials teaching, learning and research, including training of trainers

6) Offer training and development as appropriate to teaching and technical staff to increase confidence, knowledge, skills, practical experience and expertise within the school

1.0 INTRODUCTION

1.0 Introduction

1.1 BSA Net Zero 2030, Bartlett and UCL Climate Goals and Commitments

The need for a shift in Materials culture is not an isolated requirement. This report sits within the context of existing commitments made by UCL and The Bartlett, and a change in materials use is fundamental to achieving commitments made.

UCL states on its website:

"As London's Global University with a diverse community, we have an opportunity to inspire sustainability action on an international scale."

As a key department within UCL, The Bartlett School of Architecture (BSA) has significant potential to positively influence efforts towards a sustainable, equitable future. As a constituent of the wider UCL institution, we also share in a collective responsibility to carry out the commitments set by the institution as a whole regarding climate action.

In 2019, UCL launched its Environmental Strategy, *"Change Possible: The Strategy for a Sustainable UCL 2019-2024."*

"There are three founding principles behind our vision for a Sustainable UCL 2019-2024.

1. *First, because UCL students will go on to be the leaders of tomorrow, we commit to empower every student to champion sustainability during their time here at UCL, and beyond.*
2. *Second, we want to lead by example. We want to make operating in a sustainable and socially responsible way the new normal by fully integrating sustainability into our planning, processes and culture.*
3. *Third, UCL must shape the debate. As world leaders in research, we want to spark debate and co-create sustainability solutions with the wider world."*

In 2019, after a petition from more than three hundred students and staff, the Bartlett School of Architecture declared a climate and ecological emergency:

"Our planet is being driven towards catastrophic climate breakdown, biodiversity loss, and profound suffering or extinction of future generations of living species.

Seeking partnership with Faculty, UCL, professional, and industry experts, as well as other schools around the world, staff and students of The Bartlett School of Architecture are declaring a climate and ecological emergency.

Ecologically and ethically conscious design, delivery, and management of the built environment has a constructive impact on the life of our planet and its inhabitants. Committed to making an essential and vital contribution towards building an ***ethical,***

***equitable, healthy, biodiverse, fair and globally prosperous future**, we will implement actions in our academic, operational and management practices, beginning with three key steps*.

1. *Form a Citizen's Assembly – a working group of staff and students to explore how architectural education and research could be further developed and harnessed to avert catastrophic climate change and irreversible biodiversity loss*

2. *Establish a voluntary Register of Intent for each of the school's teaching, research and administrative streams to record their actions and strategies in response to the declaration.*

3. *Document the academic, operational and social changes we are delivering as a school, define and publish our direction for the coming years, and demonstrate these changes openly.*

For a world-leading architectural teaching and research academy, this staff and student declaration will aim to pool and concentrate our talents, expertise, networks, and abilities on developing transformational knowledge and actions in our field, as well as occupying an influential and collaborative role with all related built environment disciplines.

Our students are co-leading the inter-architecture school call for change – Architectural Education Declares, which the Bartlett School of Architecture supports unequivocally."

https://www.ucl.ac.uk/bartlett/architecture/news/2019/oct/bartlett-school-architecture-declares-climate-and-ecological-emergency

The Bartlett Faculty joined the UCL-wide pledge committing to become a Net Zero institution by 2030. Concurrent with this, it set out a series of objectives for achieving this including *"define and publish our direction for the coming years and demonstrate these changes openly."* – Bartlett Manifesto: Building a Better Future

This report forms part of that commitment by The Bartlett to define and disseminate its climate change and ecological crisis strategy.

An estimated two thirds (66%) of carbon emissions associated with UCL relate to what is being procured. At the Bartlett School of Architecture specifically, this relates to the consumption and reuse or disposal of materials, as well as energy, water, travel and other activities.

This research was commissioned:

- to understand BSA materials culture, teaching, learning, research and use in B-made workshops and shops in relation to Bartlett Net Zero 2030 and other sustainability criteria
- to explore existing contexts, and the potential for change
- to draw out drivers and barriers to change needed and possible

- to make proposals for actions that could deliver that change

This report represents a first step in reflecting critically on the materials culture of the Bartlett School of Architecture.

Research commissioning statement:

"The Bartlett has pledged to become a net-zero carbon faculty by the year 2030. This aligns with UCL's overall commitment to becoming a net-zero institution by the same year. In order to achieve this target, we are examining in turn each of the sources of emissions that contribute to our greenhouse gas footprint: emissions from the energy we use in buildings; emissions from the materials and products we consume; emissions from our travel; emissions from construction. We will also examine issues concerning offsetting, or "negative emissions"; and consider finance and sponsorship relationships with carbon-intensive businesses and institutions.

This report contributes to our analysis within the topic of emissions from the materials and products we consume. Different university faculties and departments will have different emissions profiles relating to their materials and products, depending on their activities. The Bartlett's use of materials in its workshops within the School of Architecture is a particularly distinctive element of The Bartlett's activity. There is therefore a strong need for original research to understand the particular materials used within The Bartlett School of Architecture, and how different choices in respect of these materials can contribute to reducing our overall emissions."

- Dr Nick Hughes, UCL Institute of Sustainable Resources and Bartlett Climate Action Lead

1.2 Materials culture and the BSA

What is the existing materials culture at The Bartlett School of Architecture? What might its future sustainable materials culture be? Most crucially, how can we get there by 2030?

Our strength as an institution lies in the diverse approaches to the question and the discursive engagement with the subject. So fundamentally, how can we channel and capitalise on this diversity of knowledge? How can we increase discussion and accelerate collaboration? How can we define shared goals and work together whilst maintaining diversity of opinion?

If we hope to change the materials culture at the Bartlett School of Architecture, how do we want to develop our teaching, learning and making practices, and expand our knowledge and understanding within the school and in the wider world of the built environment, with all its impacts and challenges? Which materials do we wish to explore and understand? How can we define a sustainable material?

Throughout this report, the following working definition is used: Within the context of the BSA, and more specifically B-made, the term 'sustainable material' can be understood through multiple lenses. Ecologically sustainable considerations, (such as carbon footprint, and carbon life cycle) are important as well as other factors such as affordability to workshop users and students.

A definition local to B-made will also consider factors such as Health and Safety (based on existing regulations and laws that considers fumes and other potential hazards), off-gassing, COSHH (Control of Substances Hazardous to Health) and the operation of machines in B-made workshops at 22 Gordon Street and Here East.

Fundamentally, a 'sustainable' material must perform well when assessed across its life cycle. However, this is only part of the story. The material must, through its qualities and through how it is used, encourage sustainable making habits, norms and behaviours. The existing cultural and social behaviours in the school also influence how we define sustainable materials, and what drives material choices. For example, we must consider aspects such as the existing value system that defines 'success' and 'failure' in students' design projects.

This scoping report gathers evidence that will help us understand the existing materials culture at the Bartlett School of Architecture. Through mapping what exists, we will be able to challenge existing behaviours and materials systems in a targeted way. Ultimately, we hope to accelerate action towards achieving an alternative.

Beyond The Bartlett, there needs to be a radical shift in material use generally within the field of architecture. As an architecture school with global recognition, The Bartlett should be leading this material transformation.

Materials culture can be defined as:

> *'The aspect of social reality grounded in the objects and architecture that surround people. It includes the usage, consumption, creation, and trade of objects as well as the behaviours, norms, and rituals that the objects create or take part in.'*[1]

Within the context of the Bartlett School of Architecture, we may understand the school's Materials culture as including:

> *'The usage, consumption, creation, and trade of [materials] as well as the behaviours, norms, rituals, [design decisions and assessment criteria] the materials take part in.'*

This definition suggests there are three key areas which require analysis, reflected in this report's structure:

1) Behaviours, Norms and Rituals: This section explores materials teaching and learning, materials selection, use and making, and assessment criteria in the context of the Bartlett School of Architecture. Which 'behaviours' and 'norms' exist within students, staff, and

[1] https://african-studies.uonbi.ac.ke/thematic-areas/material-culture-section

directors? Crucially, if materials play a role in creating behaviours, norms and rituals, what changes in behaviours might more sustainable materials thinking encourage?

2) Usage, Consumption, Trade and Creation: This section explores the usage and consumption of materials by B-made and students, as well as the trade of materials (including the procurement/purchasing of materials for the school by B-made and the purchasing of materials within the school by students), and the creation of objects and models as part of their learning and research, using these materials.

3) Impact assessment methodologies and criteria: This section explores how we can begin to define a sustainable material through rigorous assessment methodologies. This is a step in reviewing the materials we use. Furthermore, through observing B-made and the BSA through the lens of a life cycle assessment framework, it will be clear which areas must be targeted in the future.

We also conducted questionnaires with BSA students and staff to understand their perspectives about materials teaching and learning, and demand, supply and impact of material use in B-made workshops and across BSA, as well as suggestions for improvement and questions to put to BSA leadership and decision-makers.

This report was put together by three groups of students from a variety of programmes at the BSA. The first group explored the existing context, the second group researched impact assessment methodologies, and the third group evaluated the questionnaire responses by students and staff.

The general findings and proposals from each chapter are summarised as follows:

Framing of findings and proposals

Our proposals for change are formed through combining the following:

- The experiences of others understood through a questionnaire
- Data-based information provided by staff
- Scientific analysis
- Our own lived experiences as students at the BSA, The Bartlett, UCL

Key findings and proposals are listed below.

Behaviours, Norms, and Rituals

<u>Findings & Proposals</u>

- It would be beneficial to create a plan for increased collaboration between management, tutors/staff, students and B-made.
- To accelerate the process of collaboration, the school could provide platforms as part of the curriculum that encourage knowledge sharing and up-skilling between different experts, staff, programmes, modules and students within the school.

- Alternatively, there could be a core working group that contains representatives from each stakeholder group at the BSA.
- There must be a tracking system set by the BSA and core working groups which are tasked to analyse progress towards Net Zero. How is progress mapped and made transparent?
- Students and staff require a basic level of education on sustainable materials, and this should be part of the curriculum. This should address all aspects of sustainable material choices, from embodied carbon to ecological, economic, social and cultural factors.

Usage, Consumption, Trade and Creation

Findings

- The energy use of the workshop equipment is not being measured or monitored.

- Although the existing strategies and systems for sustainability at UCL ensure some level of accountability from suppliers, the protocol is still not enough to monitor whether the suppliers are meeting their sustainability goals, nor UCL's.

- B-made is sometimes caught between balancing competing needs and directives of the school and its various programmes. For this reason, B-made responds to what is required of the workshop, which is itself driven by the wider existing Materials culture of the school.

- B-made has already made an effort to improve Materials culture by working on the development of a sustainable strategy, teaching and training of the staff, workshops framework, power monitoring and climate energy.

Proposals

- The BSA should use its position as a large-scale buyer of goods to encourage suppliers to increase transparency over material sources and to develop sustainability processes. Similarly, BSA and UCL should aim to better understand the impacts of suppliers through improving existing schemes or introducing alternative ones.

- B-made or BSA Facilities Managers should be enabled to monitor the energy usage of workshop equipment and implement QR codes attached to all materials sold explaining its environmental impacts or credentials.

- B-made should add materials culture in the workshop induction and expand the material library to include materials across the spectrum – with origin for example categorised as animal, mineral and vegetable.

- B-made should create a more transparent system on suppliers and the material selection process. Also, more detailed records of sales to students and orders from suppliers are extremely useful and should be kept, analysed and impacts understood.

Impact Assessment Methodologies and Criteria

Findings

- To date, due to huge gaps in data, it is hard to understand the real, full impacts of material use at the BSA. Without reviews of material suppliers (A1), transportation (A2), manufacturing (A3), making processes (A5), de-construction (C1), waste-processing (C3) and opportunities for recovery and re-use (D), it will be hard to understand how to make targeted and meaningful improvements to support the school's journey to Net Zero 2030.

Proposals

- Taking a Life Cycle Assessment and embodied carbon approach, the BSA to require a review of material suppliers (A1), transportation (A2), manufacturing (A3), making processes (A5), de-construction (C1), waste-processing (C3) and opportunities for recovery and re-use (D), so that steps forward can target key areas based on meaningful relevant data. A review into each of these is likely to produce interesting results and provide an opportunity for creative steps forward.
- For example, a review of C1 might produce the following proposals:
    - A plan to encourage the disassembly of models into reusable blocks of material, before disposal.
    - This requires discouraging the use of chemical bonding between different materials, looking at alternative, less extreme bonding methods.
    - This might also lead to a 'second-hand shop' for students, where materials can be bought for a fraction of the original price (see case study example).
- Demand greater transparency from suppliers over the source of materials; students and staff should have freedom of access to information regarding the original geographic location of a material's source.
- More rigorous assessment of suppliers from both social and environmental perspectives prior to procurement or creating a contract.
- Enhance communication between different parts of the school to promote 'sharing' of resources – thus also reducing external supply in the first place.
- Currently only direct suppliers are asked to set up a Net Positive sustainability plan. This could be expanded to also incorporate indirect suppliers, to give a better overview of material chains of custody.
- Simple embodied carbon and GHGs equivalent number along with each material price in the shop.
- Create a small group or community of staff/tutors and students that specialize or would like to specialize on LCA, and maybe even provide LCA services to other institutions, programmes or individuals.

- Communication of impact assessment – how can this be framed and communicated simply, in a way that is easily understandable and allows students to compare the impacts of different materials, when considering which materials to use?
- Although embodied carbon might be a more universal approach to quantify the environmental impact of products or buildings, especially in the construction industry, for B-made materials, information on embodied energy might be more relevant, available and reliable. Since half of the materials are not common building materials to be registered in the ICE or other carbon factor databases.
- More research could therefore usefully be done to understand the scope of assessing the embodied energy and understand how it could be used in visible spaces to inform students and tutors the environmental impact of the specific material, as is taken place for example with food (embodied CO2e, water, land, food miles etc).

2.0 BEHAVIOURS, NORMS AND RITUALS

2.0 Behaviours, Norms and Rituals

To understand the 'norms' of current BSA material use, we must understand the structures of teaching and learning within the school. These structures will result in behaviours, some of which will need to be challenged.

It can be understood that the formation of 'norms' and 'behaviours' are the result of shifting dynamics between 5 key stakeholders within the BSA materials culture:

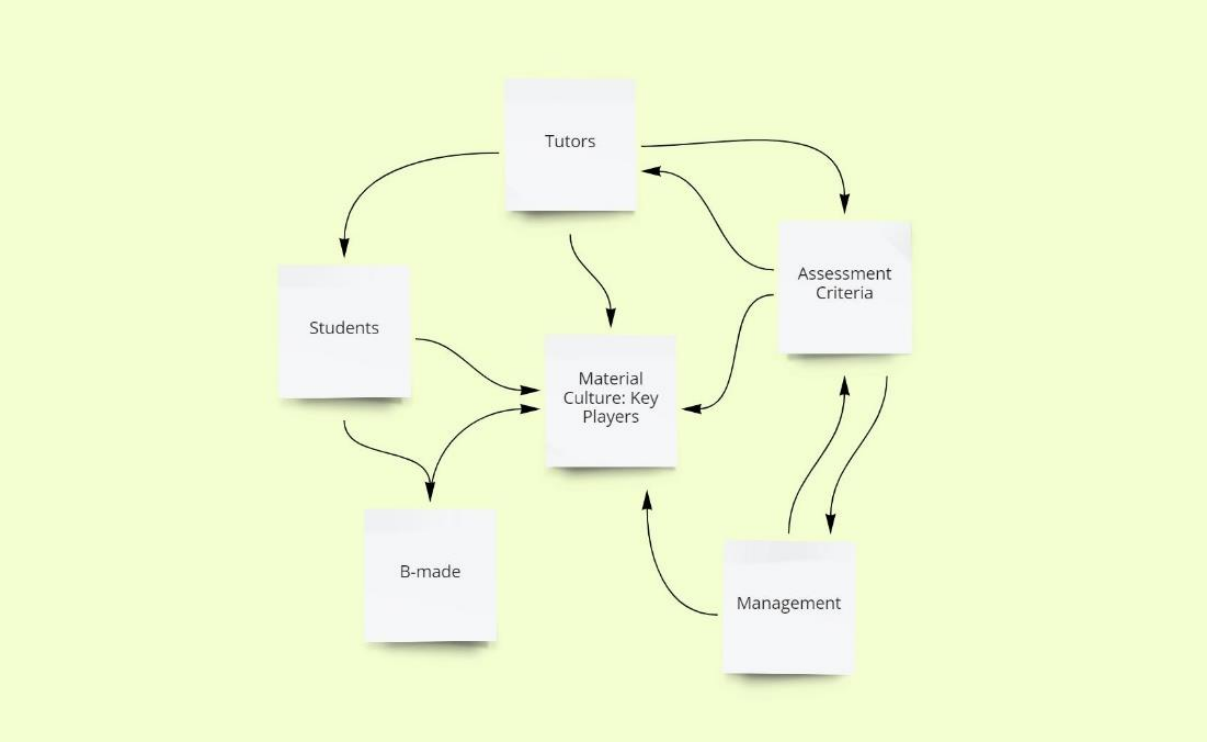


Fig. 2: The five key stakeholders within BSA materials culture (as they appeared to the research team)

There are multiple forces at play within the BSA learning environment which result in material choices, such as:

- Discussions, priorities and strategies set by BSA senior leadership/management
- Priorities reflected in and written into the assessment criteria
- Decisions made in tutorials
- Specific design briefs
- Specific making processes available within the workshop
- Specific materials stocked in the B-made shops, to support (drive?) these processes

Each has influence therefore each must play a role in working towards cultural transformation. Similarly, each shows evidence of material habits, which need review.

There needs to be a collaborative effort between management, tutors, students and B-made. It is important that each of these key players can influence the wider culture, with each using their own knowledge and skills to enable transformation.

Each part of this Materials culture must have political influence within the BSA. Each must have the opportunity to make a case for change and have this suggestion discussed. If we are to meet our 2030 goals, the rate of change will have to be fast. A fast rate of change requires a deliberate and bold scaling-up of collaboration, which will include forming new dynamics across the school structure.

This will especially require vision, commitment, support and active championing at BSA Senior Leadership level and by leadership throughout the school.

The desire to change behaviour and material habits is an opportunity to learn. It is an opportunity for staff and students to learn together. Each stakeholder, from management to tutor, and from tutor to student and B-made, will play a unique and fundamental role in transformations.

2.1 Existing BSA Staff and Student Leadership, Structure and Management

At the time of writing in July 2022, the Bartlett School of Architecture has approximately 1,743 students. These include **622 undergraduates, 1027 Postgraduates taught, and 94 Doctoral or other.**

It also employs **around 330 staff on a range of employment contracts from full-time to fractional (part-time) roles**, covering:

- BSA chair, direction and senior leadership
- Delivery of teaching and learning programmes and modules (which includes some B-made staff)
- Delivering research and continuing professional development programmes and modules (including Year Out, Part 3 and CPD)
- Professional Services including key administrators supporting the delivery of all programmes, research management, B-made shops and workshops, etc
- The departmental and personal tutoring system, supporting student welfare, rights and experience
- Exhibitions and Shows
- Communications, Publications and Events
- Human Resources, representation and development – including employment rights and representation for all staff
- Finance strategies, budgets and payments

- Facilities management, health and safety
- Other activities including Summer Schools, widening participation and outreach

There are also other permanent, part-time or casual roles within the BSA including

- **security, cleaning and catering staff** currently out-sourced but still a key part of supporting and delivering the BSA's aims and objectives

BSA Student Leadership and Representation

Systems of representing the BSA student body, which as mentioned is currently at 1,743 students, whose fees vary depending on which Programmes they are on, include:

- BSA Student Representation system within the school, activated by termly Student Staff Consultative Committees chaired by a member of staff
- BSA Student Representation to The Bartlett Faculty
- Bartlett Faculty Representative on UCL Academic Board (BSc AIS Alexia Koch held this position in 2019-2020)

A key channel for BSA student voice was also added to the school in 2020, in response to the need for a stronger representation and strategic involvement in decision making and direction, including relating to sustainable, equitable futures, teaching and learning:

- **The Bartlett School of Architecture Society, BSAS or BSASoc:** The is the BSA's Departmental Society registered with UCL Students Union, with the aim to increase student representation in the BSA and contribute to the social, environmental and cultural development of the school

BSASoc elected officers include President, Treasurer and Welfare Officer, as well as a range of other Committee Officers working on a range of activities and thinking, including B!CAN (Bartlett Climate Action Network), Media, Communications and Events. https://studentsunionucl.org/clubs-societies/bartlett-school-of-architecture-society

UCL Students Union is also an incredibly useful source of information and support for students, although formal links between the BSA and the Students Union have only very recently begun to be developed. UCL's is one of the best Students Unions in the country with one of the largest offerings of activities and opportunities for personal development. It has a range of Officers and activities relevant to this discussion, including Academic Support and Student Welfare as well as Sustainability Officers and programmes, often linked with Sustainable UCL. Find out about UCL's Students Union here: https://studentsunionucl.org/

All student representation methods are key to help support the delivery of proposals for change within this report.

See the BSA website and academic manual 2021-2022 for the latest detailed BSA school staff and student leadership, programmes, structure, employees and activities.

BSA Senior Leadership team

The list of the Bartlett School of Architecture's Senior Leadership team below is from the BSA website (https://www.ucl.ac.uk/bartlett/architecture/people/ accessed July 2022).

Professor Jacqueline Glass, Interim Director
Professor Amy Kulper Director, from 1st September 2022
Professor Frédéric Migayrou, Chair
Andy O'Reilly School Manager
Tan Sapsaman Deputy School Manager
Professor CJ Lim Director of Admissions and International
Professor Sean Hanna Director of Research
Professor Yeoryia Manoloupolou Associate Director of Research (Design)
Professor Penelope Haralambidou Director of Communications
Dr Chris Leung Director of Digital Skills
Dr Brent Carnell Director of Education
Elizabeth Dow Director of Student Wellbeing
Julia Backhaus Director of Enterprise
Maxwell Mutanda and Dr Lakshmi Rajendran, Directors of Equality, Diversity and Inclusion
Chee-Kit Lai Director of Exhibitions
Dr Tania Sengupta Director of History and Theory
Felicity Atekpe Director of Professional Studies
Professor Sabine Storp Director of Short Courses
Oliver Wilton Director of Technology
Underneath the list on the webpage is stated:

"Each programme of study within the school also has a Programme Director, sitting within the school's leadership team."

Interestingly, the **Director of B-made** (Peter Scully) is not listed here although B-made is a very distinct and vital activity within the school.

It may be because Peter Scully is also a Programme Leader (Design for Manufacture MSc) and Programme Leaders are not listed here (although are also members of the BSA Senior Leadership team).

There is also no mention of Student Leadership on this page, despite the BSA's commitment to increase student voice as a priority and involve students in strategic decision-making.

This research group proposes adding the B-made Director, as well as Programme Leaders, and Student Leadership and Representatives to the BSA Senior Leadership list on this webpage – or perhaps finding an alternative way to express strategic leadership and decision-making processes in the school, staff and students.

It is a key communication point for students and staff about BSA leadership, structure and management, and would help to represent and situate both B-made's, Programme Leaders and Student Leadership's key roles and contribution to BSA Senior Leadership.

BSA Programme Directors/Leaders

As BSA Programme Directors are mentioned as members of the Senior Leadership Team, they are listed below (also Programme Leaders as it is not clear whether these are synonymous with each other or not). This list is correct at time of writing, taken from the BSA website accessed July 2022, https://www.ucl.ac.uk/bartlett/architecture/programmes.

Undergraduate Programmes

- Architecture BSc (ARB/RIBA Part 1): Ana Monrabal-Cook and Luke Pearson
- Architectural & Interdisciplinary Studies BSc: Elizabeth Dow

Recent Programmes combining Undergraduate with Postgraduate qualifications

- Architecture MSci (ARB Part 1 & 2): Sara Shafiei
- Engineering & Architectural Design MEng: Luke Olsen

Postgraduate Programmes

- Architecture MArch (ARB/RIBA Part2): Marjan Coletti and Kostas Grogoriadis
- Architectural History MA: Professor Peg Rawes
- Architecture & Historic Urban Environments MA: Professor Edward Denison
- Advanced Architectural Research PG Cert: Professor Nat Chard
- Landscape Architecture MA/MLA: Laura Allen and Mark Smout
- Space Syntax: Architecture & Cities MRes/MSc: Kayvan Karimi (MRes) and Kerstin Sailer (MSc)

15 / Fifteen Month Postgraduate Programmes:

- Design for Manufacture MArch: Peter Scully
- Design for Performance & Interaction MArch: Ruairi Glynn
- Situated Practice MA: James O'Leary

B-PRO Postgraduate Programmes
B-PRO Director Professor Frédéric Migayrou and Deputy Director Andrew Porter

- Architectural Computation MSc/MRes: Mañuel Jimenez Garcia
- Architectural Design MArch: Gilles Retsin
- Architecture & Digital Theory MRes: Mario Carpo and Ava Fatah gen. Schieck
- Bio-Integrated Design MArch/MSc: Marcos Cruz and Brenda Parker
- Urban Design MArch: Roberto Bottazzi

Doctoral Programmes

- Architectural Design MPhil/PhD: Professor Jonathan Hill
- Architectural and Urban History and Theory MPhil/PhD: Professor Sophia Psarra
- Architectural Space & Computation MPhil/PhD: Ava Fatah gen. Schieck
- Architectural & Digital Theory MPhil/PhD: Mario Carpo
- Architectural Practice MPhil/PhD: Professor Murray Fraser

Professional Studies Programmes

Professional Studies Programme Leader: Felicity Atekpe (who is also listed on the Senior Leadership team list)

- Part 3 Architecture (ARB/RIBA)
- Professional Studies in Architecture (Lectures Only Course)
- Stage 1 – Year Out
- Stage 2 – Professional Experience and Development Record Monitoring
- ARB Exam Guidance and Continuing Professional Development

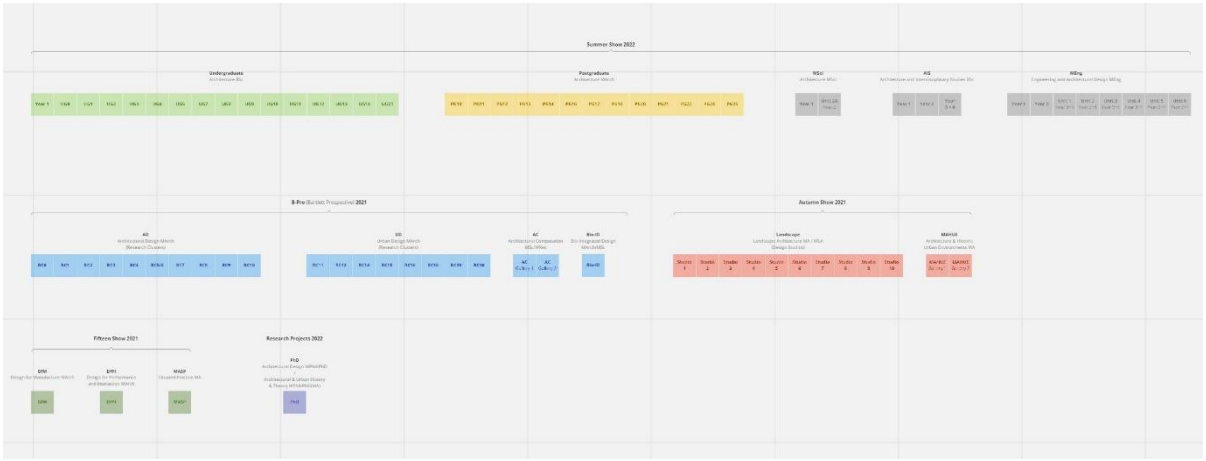


Fig. 3: Representation of taught programmes in BSA Shows 2021-2022 (compiled from BSA Shows website)

Drivers of BSA materials culture in relation to taught programmes

Some programmes do not use materials as much physically in teaching, learning and research as others, and some do not use materials physically at all (except for stationery, printing etc. which this report does not cover).

However, the way materials are discussed and framed, their uses, sources and impacts on people and planet, as part of the architectural education in these programmes – as all programmes – is still very relevant in considering drivers of a BSA Materials culture.

However, many of the Architecture programmes, such as Architecture BSc and MArch programmes, Architectural & Interdisciplinary Studies BSc, Architecture MSci, MEng E&AD, Design for Manufacture MSc etc, do also have a very direct relationship to physical material use in the school, as well as the wider framing of materials teaching and learning in relation to the built environment and a sustainable, equitable future.

Many of these programmes are structured through a Unit system, led by Unit Tutors. For example, the postgraduate Architecture MArch (ARB/RIBA Part 2) programme consists of 13 different Design Units, with two to three tutors per unit, plus a Technical Advisor attached to each Unit. Each Unit has approximately 15 to 17 students each year.

So a considerable number of people within the school just within that programme have a considerable influence on materials culture, teaching, learning and use.

The hierarchical system that drives BSA materials culture in the school, not only programmes that study or use materials more frequently or practically, could be simplified as below. This diagram helps show how BSA materials culture is driven.

It is easier to understand and empathise with the difficulty to change BSA materials culture in B-made workshops or shops, when decisions about materials are largely driven by BSA Senior Leadership, down through Programme Leaders, Module Leaders and Tutors, and on to students and B-made.

It also helps to explain issues when students arrive in B-made workshops to make something with B-made support but with very little if any lead-in time, which can cause frustration and stress because desired materials may not be available – or even suitable, depending on the level of understanding of how materials behave and perform.

Sustainability criteria or environmental or social impact of materials is seldom being considered by this stage, as materials selection is made further up the decision-making hierarchy.

It shows how important the role of BSA Senior Leadership is in setting BSA strategies and cultural direction on materials – and how vital any change process is not just supported but **actively championed, set within strategic direction, understood and championed across the school and passed on down through the hierarchy of culture and decision-making**.

And change nonetheless still needs championing all the way down through the hierarchy too. Programme and Module Leaders and Tutors still need to actively encourage, support and enable students to explore and research materials beyond the limited range common in developed economies, while excluding many more that are used widely in buildings and the built environment throughout the world.

Further up-skilling and training is needed to support changes to BSA materials culture, both at Senior Leadership level and throughout the BSA, if the school is to meet the commitments of its own declaration of a climate and ecological emergency, The Bartlett's and UCL's

commitments to Net Zero 2030 and other UCL sustainability and environmental strategies, as well as the desire by people around the world for a sustainable, equitable, future for all.

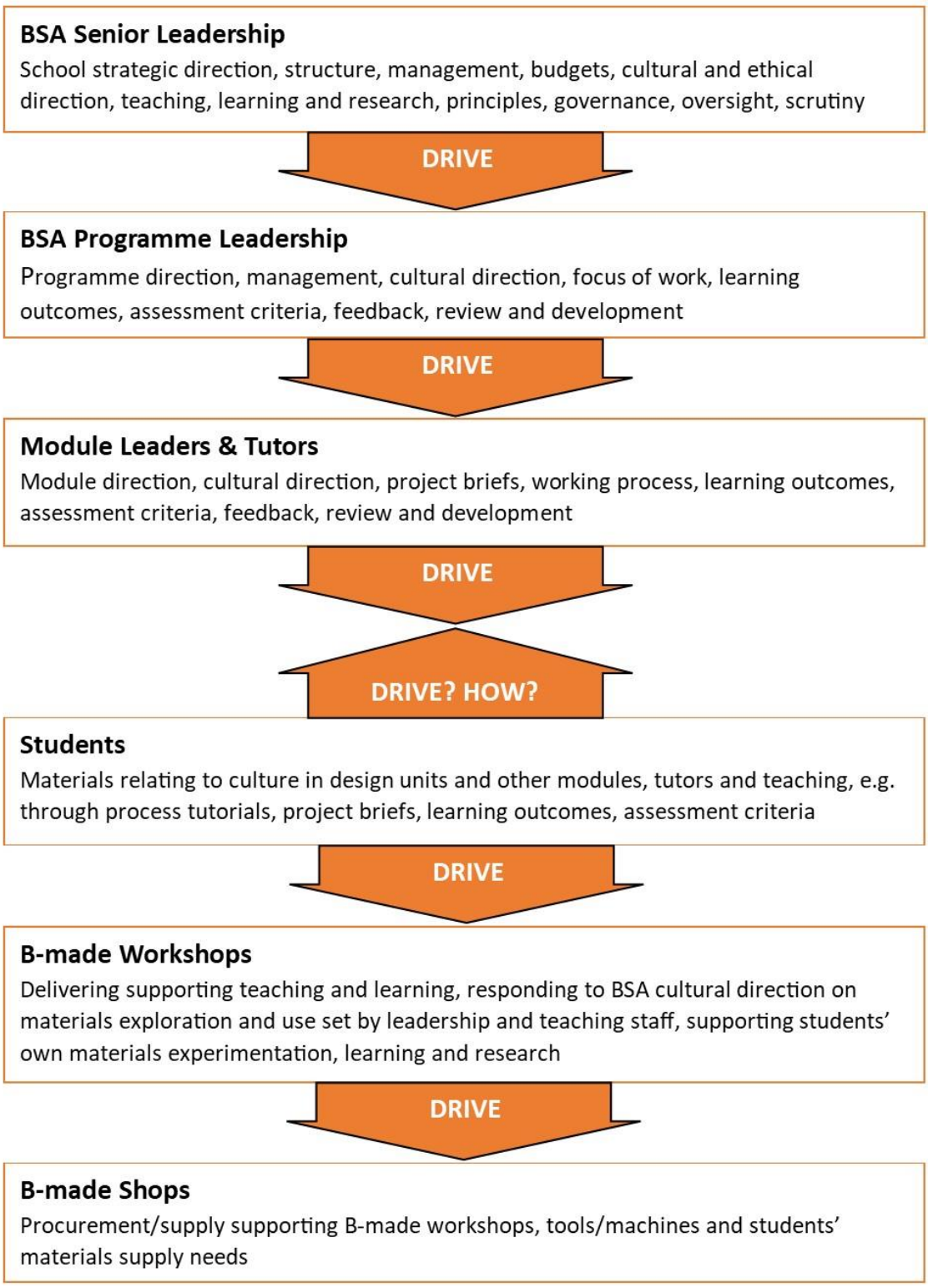


Fig. 4: Diagram of how BSA hierarchy appears currently to drive materials culture, decision-making and thus procurement, supply and use.

Questions that could help to frame a developing BSA materials culture

- How might this structure of drivers above be altered to allow more extensive, less hierarchical inter-level collaboration?
- Which new teams or groups of individuals might need to be involved?
- How could a collaborative effort between management, tutors and other staff, students and B-made be achieved?
- Do we need to establish a core working group which contains representatives from each stakeholder?
- How might collaborations and conversations grow and be fuelled?
- Do we need a Materials Culture conference?
- What goals do we need to set, and how can we track progress?

2.2 Assessment Criteria and the Role of Tutors

What role do assessment criteria play in influencing material behaviour?

- Can you mark someone down for using concrete?
- Can you mark someone up for using straw?

There is of course the argument that it is oversimplified to assume that every project at the BSA must be designed using 'sustainable materials'.

Students and tutors should, of course, be able to explore all ideas – and all materials – in unconfined ways and to question assumptions from first principles.

What if practical exploration and research into unsustainable materials gave rise to unexpected sustainable possibilities, for example through comparative understanding?

Within the short three-term annual teaching process, students may wish to dedicate time to other aspects of architectural design, with material choice and sustainability taking a back seat. Whether this then contradicts UCL's and The Bartlett Faculty's sustainability statements, commitments and Net Zero 2030 strategy is another question – should the embodied energy of materials and their use be a limiting factor on procurement and provision in B-made shops and workshops?

However, to offer a level playing field of exploration to students, are all materials taught and learnt about and explored equally? Or is precedence currently giving to certain materials – for example, concrete, steel, glass, some types of timber construction – while others are largely excluded or ignored within the 'animal, mineral, vegetable' categories – for example straw for structural or insulating purposes, thatch etc? Clay, lime and other mineral-based renders, plasters, mortars, slips? Earth-based materials generally? Fibres, reeds and grasses such as hemp and bamboo? What about animal by-products like sheep's wool, horse hair or human/animal urine used as a binder?

Whose materials culture are we teaching and learning about? Is it a mainstream global north construction culture, carbon-intensive, based on untrammelled extraction of natural resources and permanent growth? Or is it a more holistic global picture, comparing materials cultures around the world to discover the healthiest and most locally-appropriate approaches for the most life-supporting designs, that respond to bioclimatic and other contexts, drawing on millennia of knowledge and practice, to best support and host human and other life sustainably into the future?

And what happens to the materials, models and architectural objects created during these carbon intensive architectural projects? Are they wasted eventually? How can the school reach Net Zero if staff and students accept this approach?

How can we protect and even develop full intellectual freedom whilst placing value on sustainable thinking?

We already place value on many aspects of design on the taught programmes, without worrying whether these hinder intellectual freedom. These values are reflected in the assessment criteria as well as through the wider BSA materials culture at Senior Leadership level, Programme Directors/Leaders, Module Leaders and Tutors and in processes such as design process tutorials.

In the same way, sustainability can be included within assessment criteria without fear of limiting intellectual freedom either. In fact there is a case to say that it could increase it, as it would reward students for exploring, analysing and comparing materials against each for their sourcing and performance, and relationship to environment, society and culture.

Arguably, a relevant curriculum should teach each student how to make sustainable materials choices, and students should be aware of the impacts of their materials choices – and the wide range of other materials available, their sourcing, manufacture, performance, benefits, impacts and potential for deconstruction and reuse too – so that material selections are calculated and considered.

If a carbon-intensive material is still selected, then at least the student has explored and understood its impacts and the basis of their use of it in this case, and can argue why this and not another material was selected, empowering the student and informing them and others in the process.

Introducing these considerations as a vital part of design does not restrict intellectual potential or place limits and bans on modes of thinking, quite the opposite. Putting value on sustainable thinking, assessing the negative and positive impacts as part of the educational process is very beneficial to creativity as well as real-world thinking, and preparedness for real-world decisions generally.

There are examples of assessment criteria which focus on sustainable materials. It is understood in masters programmes such as Landscape Architecture, Bio-Integrated Design and Design for Manufacture, that sustainability is valued as a key design concept and subject area.

We believe that this is not the case for all programmes at the BSA. For example, in the Design Realisation module on the Architecture MArch, there is a focus on materiality in general, yet investigations into material choices and consideration of their impact on the environment, people, nature and health is optional and not compulsory. This means not all students will have the opportunity to learn and skill-up on this subject as part of their programme.

A proposal to change this, is to introduce these considerations as a consistent element of assessment criteria across all programmes.

This in turn provides opportunities for module directors, and staff to skill-up on this matter further too.

Therefore, to implement that into practice, we ask:

How can we:

- Enable students to integrate proper whole life cycle impact assessments into design decision-making?
- Develop staff capacity to support students in this?
- Examine and develop concepts and vocabulary that enable proper meaningful discussion about the impacts of architecture and design as a starting point for all courses?
- Get students excited about the opportunities and possibilities of sustainable design and avoid it being a tick-box exercise in modules.

To start the process of change and implementation of ideas into practice in the most realistic and authentic ways is to learn from other existing structures.

For example, as extracted from a response to the questionnaire it appears that, at some universities, there is an option to take Passivhaus and carbon-accounting training to ground the material decisions of students' projects in real building-science. This has proved to be a very helpful guide when it comes to material decisions for the student, and '*a great learning opportunity that provides stronger background knowledge'* (see Questionnaire responses, Appendix A).

It also could offer the opportunity for better understanding and exploration of how materials choices relate to building energy performance, bioclimatic response and health.

As well as understanding the role of existing assessment criteria in forming the BSA's Materials culture, it is crucial to challenge and explore the role of tutors and the briefs they set. Therefore, in the next part we ask:

What role do tutors play in influencing materials culture and behaviour?

The design briefs that are set by tutors in each unit most often prescribe the initial thinking of students' design projects. This means each year, students choose their unit based on the

brief and develop their project according to that brief. For the past four years, and after BSA declared a climate and ecological emergency, it is evident that most of the units' briefs are moving towards a more ecologically conscious architectural focus. This shift has been visible in this year's summer show – as expressed in the questionnaire – with a unifying interest in ecology, and particularly plants, which indicates a push by tutors to integrate climate and biodiversity-conscious thinking into the unit briefs.

However, even though there have been some changes to the units' briefs and the general consciousness of the school to move towards a more sustainable practice, it is important to acknowledge that there are still some obstacles blocking the school fully implementing this shift into practice. These obstacles most often are as a result of the existing 'cultural behaviour' and 'norms' within the school and system of management.

The first barrier that can be identified is the existing hierarchy between programme directors, module leaders, and unit tutors, and the centralised system of programme management. This hierarchical power structure places autonomy before knowledge and expertise. And in the process of decision-making and setting assessment criteria, most often the conversation around sustainability lacks real and authentic knowledge and implementation in practice.

This is well illustrated in responses to the questionnaire, as a body of staff have identified that at undergraduate level, the architecture programme encourages an awareness of sustainability issues only, as mapped against ARB's learning outcomes for Part 1 Accreditation.

This is also similar in Year 1 and the MEng programmes, which are now triple accredited. What stand against the full implementation of sustainability issues, '*is the high degree of autonomy in Module leads, which can result in shortfalls in knowledge and reaching delivery where a Module Lead lacks knowledge and experience and the will or opportunity to learn'*.

The second barrier is the lack of on-going conversation and collaboration between different programme directors, module leaders and tutors, design unit tutors and departments within BSA and wider UCL. Encouraging collaboration and conversation between programme directors, module leaders and others would mean that the gaps in existing knowledge and expertise within the school could be easily identified and therefore be addressed.

For example, if a student wants to explore a project that is concerned with bio-based materials, and the tutor does not have the expertise, the student can easily be referred to an expert within the school and thereby be able to develop their project. Currently, it is evident from the questionnaire that students are limited to the existing knowledge within their unit. Collaboration can widen the horizon and provide opportunities to learn and expand knowledge in ways that are inclusive, accessible and non-hierarchical.

The third barrier is the existing framework with tight deadlines and intensive programme structures meaning that students fall short in time and mental energy to skill-up and learn more about sustainable materials and methods of making. This is twinned with the fear of

failure, that most often drives design decisions and choices of materials in BSA. This is especially true for courses at undergraduate level where the level of risk taking is low.

This idea is well illustrated with a response in the questionnaire that identifies the concept of 'Black Box thinking', '*which can cause students and staff to jeopardise learning if they think it risks them looking anything less than perfect*'. Instead, the mindset needs to shift to a be more '*resilient in the approach to design and practice, that welcomes risk taking at every level, even when the outcome is 'identified' as failure'*.

We recognise that issues around advocating for sustainable materials and practice that lie within the assessment criteria and the role of tutors are multi-faceted and go beyond the list above and are not limited to it. However, if we put collaboration and on-going conversation at the heart of our practice in shifting to a more climate and ecologically conscious education, wider opportunities can be opened for students and staff.

To include all voices expressed through the questionnaire responses, we would like to include further notes related to this chapter, synthesised from questionnaire responses:

- Can the consideration of the whole life cycle of materials be an important future theme at the BSA (including design tools)?
- Can we be more student-led in the way we approach design and history & theory?
- Why is sustainability and life cycle analysis not a required aspect of the brief in design modules?
- Can we integrate material research more into the design modules and what support at UCL would there be for this?
- What is being done to ensure sustainability becomes as central to design as form and function? Indeed, is not a very clear part of function, as well as influencing form?
- Should there be a change in emphasis of architectural education to the reuse of buildings rather than only new build?
- Please provide a materials library where things can be seen in different formats and sizes, tested and manipulated by students.
- How can we... 1) enable students to integrate proper impact assessments into design decision-making 2) develop staff capacity to support students to do this 3) examine and develop concepts and vocabulary that enable proper, meaningful discussion about the impact of architecture and design as a starting point for all courses.
- Why is proven technical knowledge not a prerequisite for leading a design unit on the BSc Programme?
- Why is routine training - on core subjects such as social justice and climate science, as well as sustainable materials - not written into the Job Description of staff, and provided as mandatory for all teaching staff?
- When and how are these materials going to become part of the design teaching?

2.3 B-made

This section explores what role B-made plays in influencing BSA materials culture and behaviour.

The decision by B-made to ban MDF recently is a good example of the existing dynamics at work within the school, and a good case study in support of the argument for increased collaboration and the need for a coordinated approach between all stakeholders. It must involve all levels of the school to be successful and meaningful.

The decision to ban MDF was made on the basis that MDF is unhealthy for people and for the machines that use it, as well as for staff exposed over longer periods to it (when MDF is cut, sanded or shaped, it releases formaldehyde-coated or urea-formaldehyde-coated dust).

However, the process of implementing this ban did not allow space for learning. The opportunity that was missed was the possibility for students to learn about material selection, material properties, their impacts on human health and the environment. This gap in knowledge between staff and students meant that B-made were then put in the position of enforcing the ban on students who sometimes didn't understand the ban.

Sometimes MDF was bought outside the school and brought in, or simply used elsewhere. Also, a breakdown in communication between B-made and tutors meant that tutors were not surprised to see MDF models, and even at times encouraged students to use more of it.

The school will undoubtedly need to reduce the use of particular materials, for health and other reasons, and introduce the use of healthier, more sustainable materials. But how can this be done in an effective way? What could those materials be replaced with? And how can we ensure this doesn't create further problems?

Through teaching students about material selection from a sustainable perspective, they will be better equipped to make educated judgements in practice. Teaching students to behave differently with regard to materials is therefore arguably more impactful than imposing material change through banning materials.

This point does not belittle the need for change, or placing certain materials beyond use or making them a 'material of last resort'. But it does make a case for a transformative, educational process which will involve actions by all people involved in the teaching and learning structure.

Arguably, materials, when used within specific making processes, teach different skills and values. For example, when comparing the construction process of concrete and cob, it is clear that each construction process encourages specific making skills and approaches to design, whilst also educating about overall values:

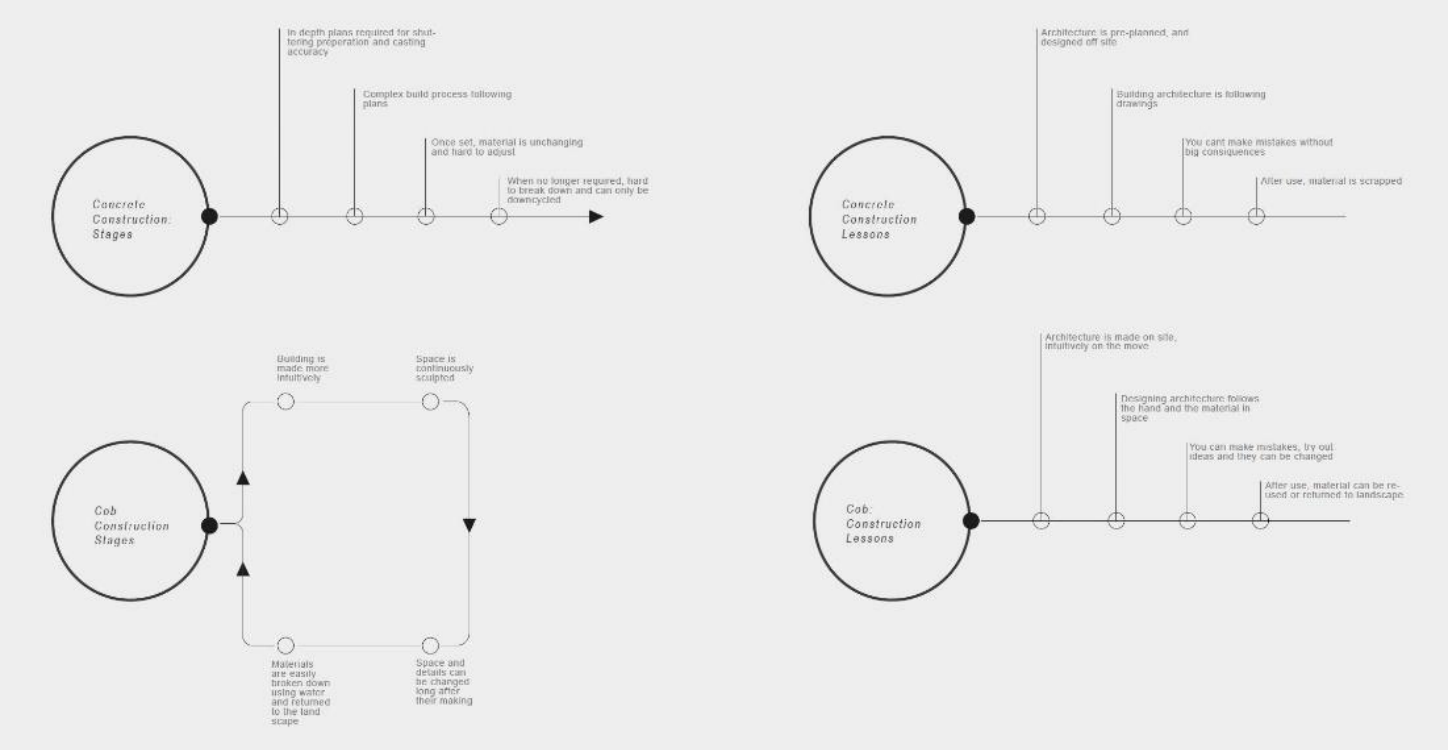


Fig. 5: A simple comparison of concrete and cob construction stages and lessons

In this example, contrasting values can be noted. Regarding sustainability, cob can be re-used, and returns easily to reintegrate with the earth's natural cycles and processing systems. This process inherently encourages more sustainable thinking and behaviour.

Regarding education, it also encourages a different design process that allows mistakes and adaptability, because of its ease of reuse, retesting and reuse, within an iterative process of exploration.

In this way, we can learn to ask:

- What do specific materials teach us? About life and the wider world, about ourselves, about our past? Present and future?
- Which specific processes should we advocate? Inclusive teaching and learning? Comparisons, analysis? Questioning assumptions and unconscious bias regarding materials?
- How can we create values through materials understanding? How do the questions we ask and the materials we select reflect our values and value systems?
- Do we need to review existing processes through this lens, and understand their impact on our wider culture, behaviour and values?

2.4 Students

On an individual level, existing material use at the Bartlett is largely reflective of our cultural approach to material use more widely. It is currently normal to design an architectural fragment or model which ends up in landfill. There are varied timelines, depending on the owner. A model might be kept and stored, where it remains, preserved, until it is eventually

scrapped at some point. Or it may be photographed and then discarded quickly. If left in the studio over the summer it is binned, or it is binned by the student who is unable to store it.

This behaviour is similar to how architects operate in practice. Buildings are built, 'finished' and photographed for practice websites. In a variable amount of time, the building is usually demolished and its construction materials downcycled and/or sent to landfill.

We know these 'norms' and 'behaviours' are unsustainable. We know we need to think about the whole life cycle of materials and impacts at each stage, including during their time before as well as after their use in buildings.

We know that this is a design challenge. How can we encourage the consideration of longer processes, and the understanding that throughout material lifespans, their use in buildings is only temporary, and often short-lived? How can we understand that materials used at the Bartlett are the same – their use in education being short-lived?

How can we make thoughtful change?

- What if we don't consume materials, we merely use them temporarily?
- What if we use materials which can be reused and reshaped?
- What if students never 'own' materials, but rent them?
- What if the return of materials was a specific educational event?
- What if a student returns with a concrete model base? What do we do with it?
- What opportunities for discovery and learning do these new approaches create?
- What if it was normal to not throw anything away?
- What if it was normal to pass on your materials to the next year?
- What if breaking down models was an opportunity to learn about breaking down buildings?
- What if we brought small scale waste management and recycling on-site? Seeing it as an opportunity for innovation, education and thorough analysis?
- How can we encourage these new 'norms' within architectural education?
- How can students make differently, in a way that reflects the challenges they face in future practice?
- How can the BSA lead behavioural change, by making bold moves itself?
- How do we change habits?

Selecting which material to use

The diagram below proposes some questions for students to consider when selecting a material. This is a simplified version of a complex process, intended to offer suggestions and raise questions, rather than provide clearcut solutions. Proposal: Share this mind map formally either through B-made or accessible online tool/checklist of "things to watch out for/things to consider" for students approaching making.

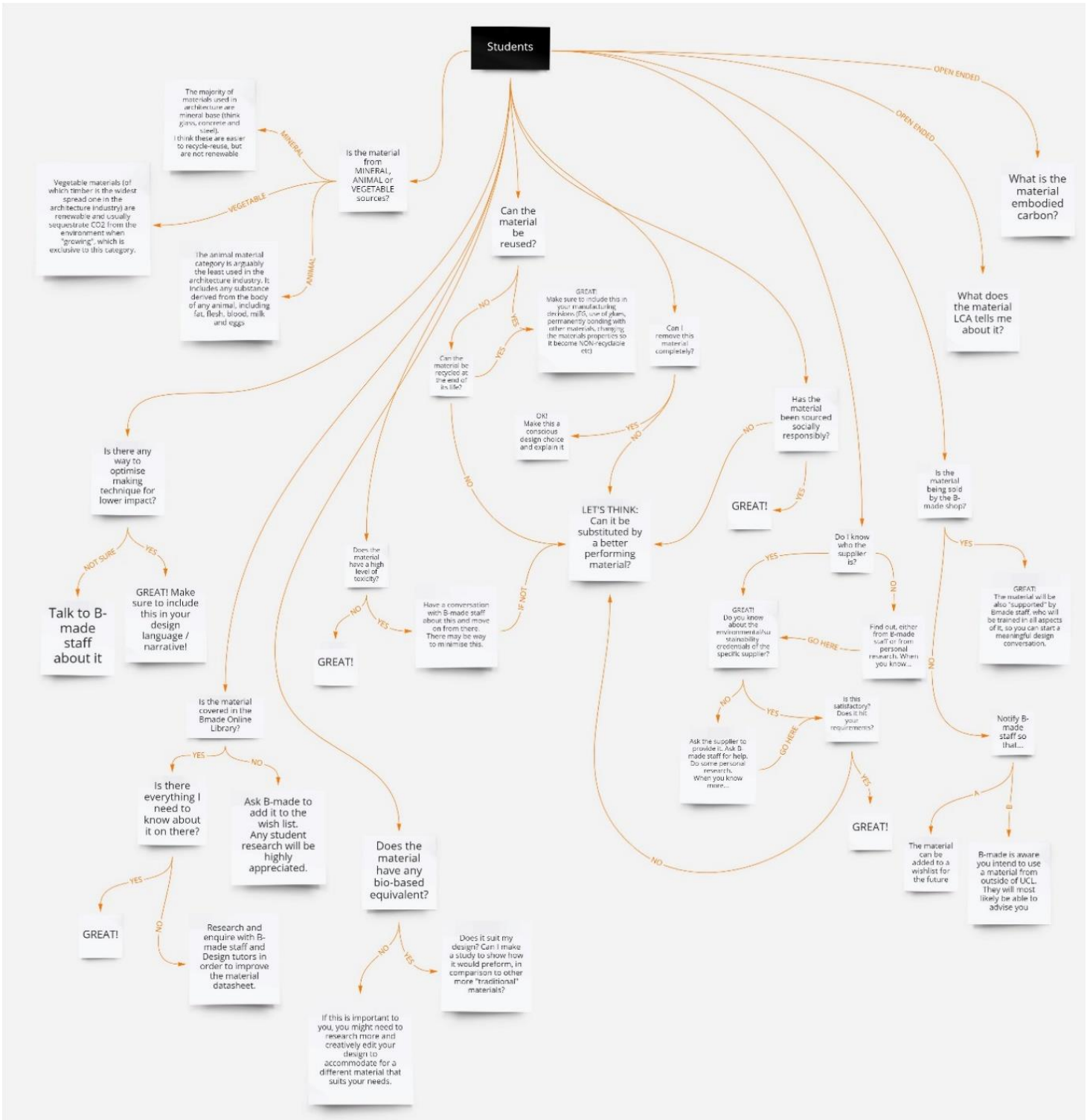


Fig. 6: Mind-map of student selecting a material to use (zoom in for more detail)

2.5 Proposals for Change

- Encourage collaboration and on-going conversations between BSA senior leadership, programme directors, modules leaders and tutors, design unit tutors and students, to allow a more fluid system of knowledge sharing to skill-up and learn from each other's expertise.

- Encourage a shift towards a more resilient and risk-taking mindset that does not shy away from testing, and exploration into different materials and making methods due to fear of failure.

- UCL and BSA to provide time in the curriculum and teaching year for a platform such as collaborative workshops and events for students and staff to skill-up and learn new skills and methods of making together, outside of the structure of units, modules and programmes.

- BSA to identify gaps in knowledge and expertise in sustainable materials and methods of making, and to address those gaps by hiring experts, from within or outside of the architectural field, to share their practical knowledge and application.

- To create a non-hierarchical system for decision-making and setting assessment criteria that places value on sustainable thinking and processes and is inclusive and transparent.

- Possibility for student and staff to participate in courses or workshops related to UCL such as this on life cycle assessment: https://www.ucl.ac.uk/short-courses/search-courses/conducting-life-cycle-assessment-lca-theory-practical-application

- Production of a comprehensive glossary of terms that is widely available and easily accessible by both students and staff so that these conversations can become more meaningful and happen more often. This research team has produced an initial list of terms (presented in this report's appendix) and strongly encourages this to be built on through further funded research. The glossary could exist on Moodle, the B-made website and/or as downloadable PDF for personal reference, updated on an ongoing basis by students and staff.

- Expand the digital material library to include a fuller and more globally representative range of materials, including earth-based and bio-based materials.

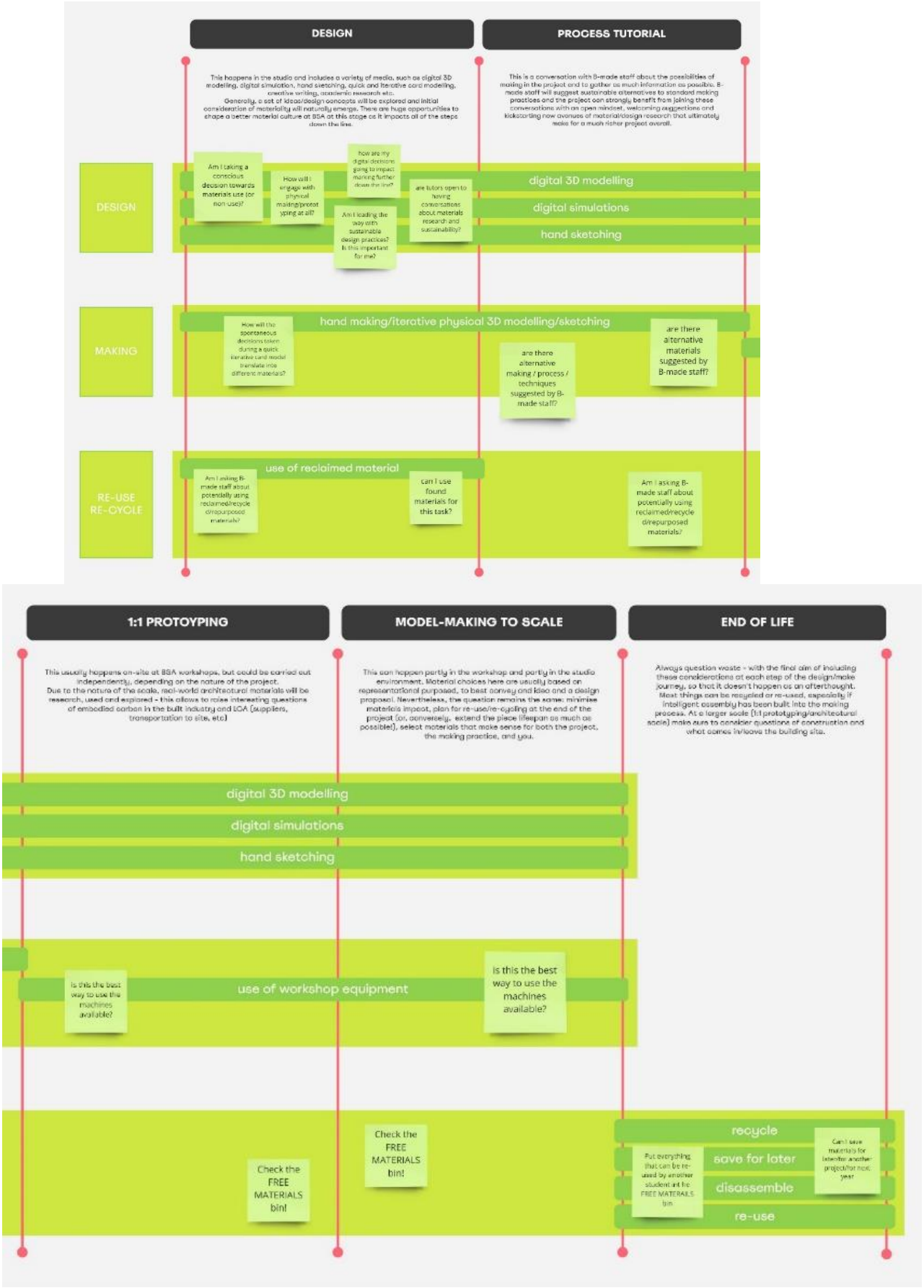


Fig. 7: Example of the educational timeline of a design student at the BSA and opportunities for change when selecting materials

3.0 USAGE, CONSUMPTION, TRADE AND CREATION

3.0 Usage, Consumption, Trade and Creation

3.1 Existing Making and Material Processes

There are a range of machines and tools offered at the B-made workshops that support woodworking, metalworking, numerical manufacturing, and other analogue processes. The available equipment is shown in the diagram below. Currently, the energy use produced from the workshop equipment is not being measured, monitored or analysed. The energy use around UCL can be tracked by building at an hour-by-hour interval, but more detailed data is not readily available.

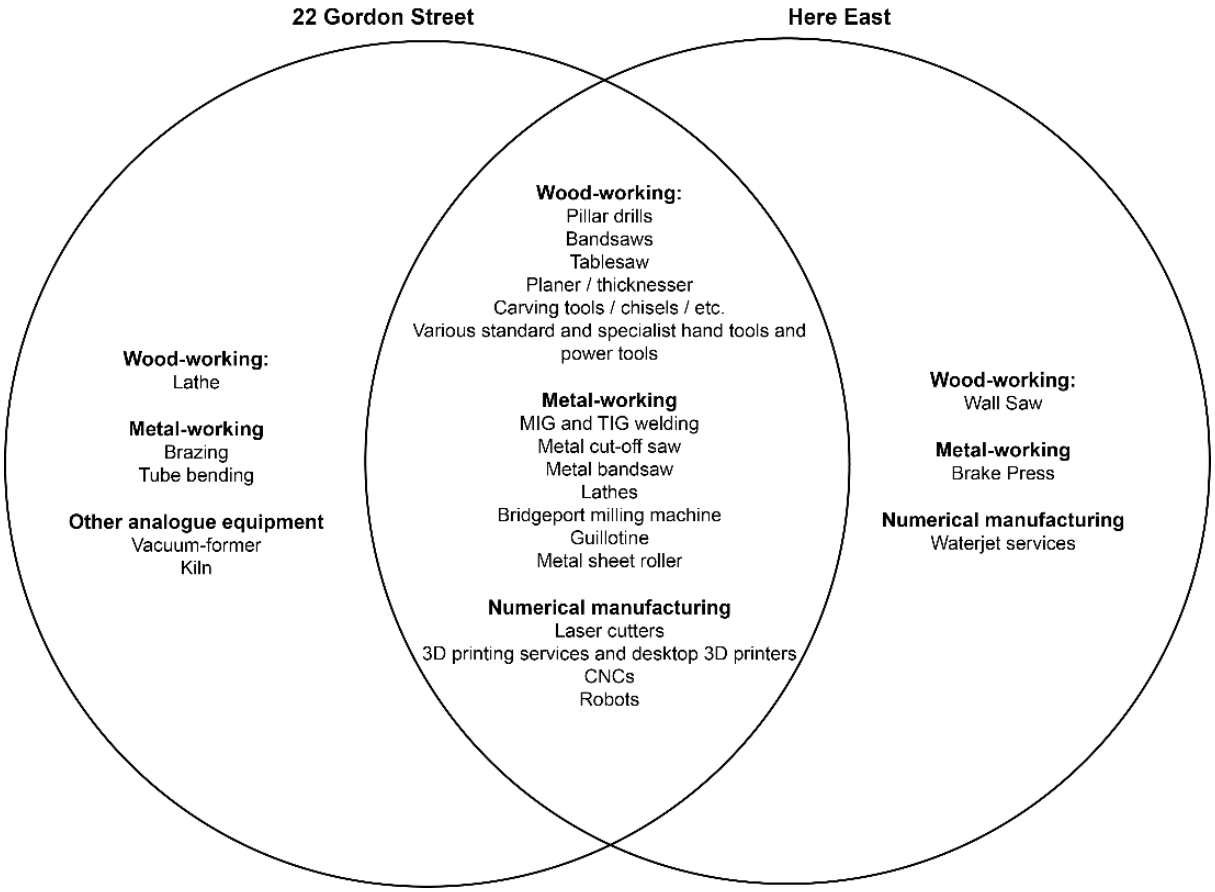


Fig. 8: Equipment currently available at B-made workshops at 22 Gordon Street and at Here East

3.2 B-made Materials Procurement

The B-made shop was established to allow students to have easier access to materials that work well with the equipment in the workshop. Much of the decision-making around which materials are stocked comes from what materials can be used on the machines that are present in the workshop. For example, plywood is supplied because there is a table saw, non-galvanised metal is supplied because there are welders, poplar ply has a non-formaldehyde gluing/bonding layer that is engineered for laser cutting. This reasoning aims to maximise efficiency for students, staff and machinery.

The shop supplies materials that aim to support students to make their design and fit within the teaching framework and brief set out by tutors. While some alternative materials are supplied such as recycled acrylic and PLA 3D print filament, there tend to be blocks to changing suppliers. The research group was informed that UCL often questions why there is a request to change suppliers if there is already one doing the job? Additionally, there is a question of how to have the support of the students and staff when bringing in an alternative material or banning a certain material. If a material is taken away, there needs to be a shared understanding of why this is happening and a suitable alternative that does a similar job if still required, or there is the risk that students will bring in the same material but from an outside source.

In order to change the materials that students access and want to use, there needs to be a change in teaching, learning, and workshop facilities. Providing and banning certain materials is not enough to make intended change occur. There should be education explaining why certain changes are made and tutors must lead and encourage students also to successfully create a culture of sustainable materials practice at the BSA.

Change at all levels, especially leadership and teaching level, is needed for success in this area. B-made staff (teaching or professional services) can only respond as allowed within hierarchical decision-making framework and depend therefore on leadership in the school, as discussed above, to support any changes in B-made.

So this also raises the question, How can BSA and UCL in general find a balance between top-down and bottom-up decision-making and change?

3.2.1 Responsible Procurement

Procurement of materials and services is one of UCL's most impactful operations, both environmentally and socially, accounting for as much as two thirds of UCL's total carbon emissions (https://www.ucl.ac.uk/sustainable/staff/loop-resources/procurement).

The need for responsible strategies for the procurement of materials by B-made is therefore needed, if the goal of Net Zero is to be reached successfully by 2030. UCL's total expenditure currently exceeds £600 million annually across 300,000 suppliers, each having their own impact on the environment. B-made accounts for a considerable proportion of this purchasing power, making repeat orders from around 25 suppliers, a fact that should not be

ignored as this indicates the opportunity for a level of influence over supplier's ethical and environmental impacts and conduct.

Indeed, the BSA should aim to use its position as a large-scale buyer of goods to encourage suppliers to increase transparency over material sources (direct and indirect) and enhance sustainability processes, such as goods extraction, manufacture and transportation processes.

Fig. 9: Map of B-made primary (direct) and some secondary (indirect) suppliers.

A number of schemes and guidelines are in place ensuring that UCL and the BSA contract with suppliers with existing sustainability plans and who source materials responsibly.

For all its acquisition operations, UCL stresses that it endeavours to satisfy the criteria of responsible procurement, by defining this as "*the process whereby environmental, social and financial impacts of all of UCL's procurement processes are taken into account, making sure to reduce negative impacts and enhance positive impacts*." This is part of UCL's 20-year plan to 2034 which *"identifies the need for a focus on Sustainable Procurement as a financial enabling objective".*

As one of its sustainability-related schemes, UCL's Net Positive program allows companies to quickly create bespoke sustainability strategies based on the company characteristics (e.g. size, industry) and existing sustainability credentials. UCL requests new suppliers (as well as suppliers which are being reactivated) to go through this process, as a means of determining the aims of suppliers with relation to their environmental impact. However, exceptions are made if companies have existing plans or no need for one, so are not required to sign up.

Although UCL's Net Positive scheme does ensure some level of accountability from suppliers, there are some potential flaws that may mean the service is not as effective as it aims to be. While the process of creating an 'action plan' is designed to be straightforward for suppliers to complete, the downside of this is that the process lacks nuance and companies may be less eager to follow the suggestions of UCL's Net Positive plan. For example, businesses can state whether their goods are required to travel which could drastically impact on carbon footprint and therefore the sustainability strategy.

Additionally, there is ostensibly no defined protocol in place for the university to monitor whether suppliers are in fact meeting their stated sustainability goals. UCL should therefore aim to better understand the impacts of their suppliers, be this through improving the existing Net Positive scheme or through introducing alternative schemes, for real-time carbon reporting.

In addition to UCL's procurement strategies, B-made also applies further actions to procure and supply materials in a more sustainable way. For this purpose, B-made have sourced recycled PLA plastic for the 3D Printers and worked with the suppliers to remove extra packaging, sourced water-based spray paints, and found a hard wood supplier that sources wood hyper-locally from felled trees.

In addition, B-made uses due diligence practices to source ethical large Spruce (for construction) and Birch (for quality/finish) ply sheets that have a provable provenance. However, it is understood that B-made at times falls short to keep the balance between competing needs and directives of the school and its various programmes and at the end of the day is tasked to respond to what is being required of the workshops by students and staff, which in turn is driven by the existing Materials culture of the school.

3.3 Existing Material Demand

Currently, the highest quantity of materials procured by B-made shops are card and paper products, timber and wood products, and acrylics (see graphs below). As discussed, B-made shops were set up to support the operation of the workshops as well as give students easier access to materials useable in the workshops, so the materials supplied in the shops are directly correlated to which materials are most purchased by students.

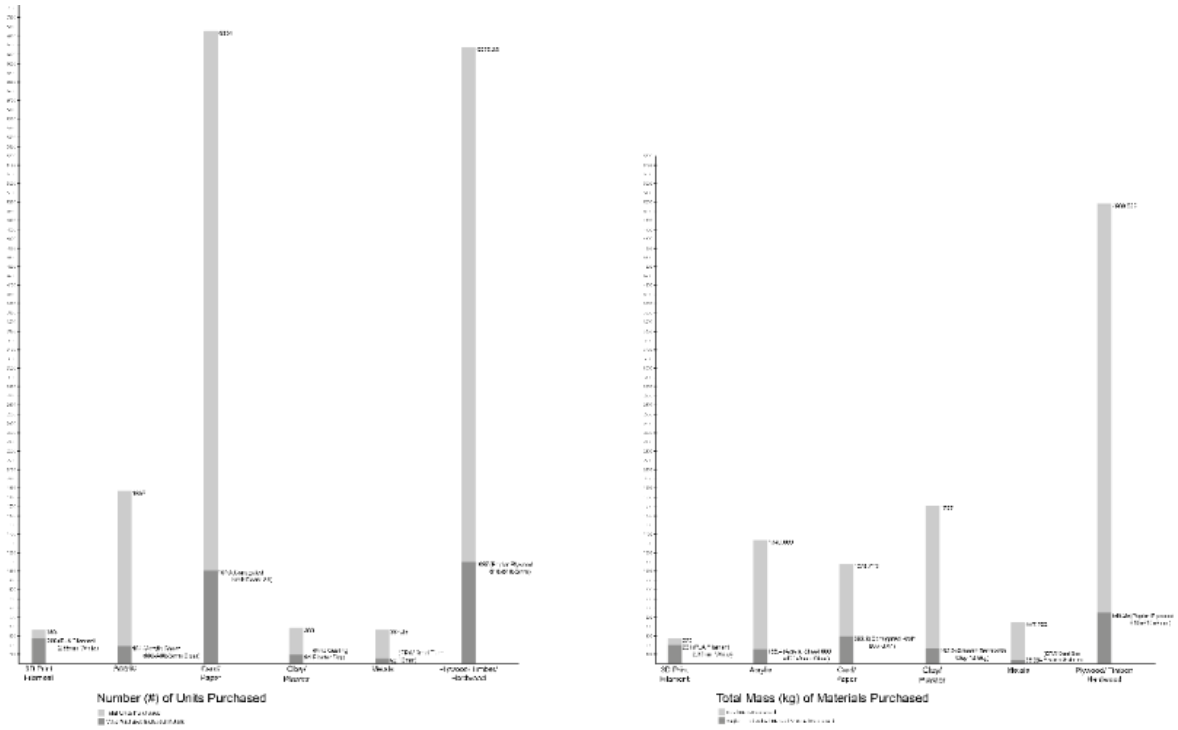


Fig. 10: Number of units of various materials purchased and total mass (kg)

When considering banning or swapping out one material for a more sustainable option, questions about what and why there is a desire and use of a certain material must be considered. Is it possible to ban or switch a material and still provide an alternative option that provides a similar function to the material that is being changed? If something is banned, will students source a material from outside of the B-made shops? How can it be determined if there is an educational need or design unit brief requirement for a certain (or new) material? And how are educational and Net Zero 2030 needs compared? Are we talking about unhealthy materials or energy-intensive ones?

And how much of the overall BSA energy, carbon and ecological footprint is materials use, when compared with say artificial lighting, heating and cooling, printing or other operational energy uses? As mentioned above, this requires more monitoring, research and understanding of the full BSA impact, in order to understand where to focus Net Zero action.

As well as looking at embodied energy or CO2e, action may be needed on materials that are unhealthy or unsustainable in other ways, such as high embodied water or ecological footprint; pollution of water, land and air; environmentally or socially unjust extraction, processing, transportation, use and reuse; adverse impacts on people, biodiversity, habitats and ecosystems, in turn damaging processes essential for all life on Earth.

How can waste from materials be minimized? Methods such as laser cutting, and other techniques often leave relatively large pieces of material unused or wasted. How can the BSA encourage a more efficient use of materials?

Below are two graphs, representing materials procured and supplied through B-made shops, the first showing the number of units, and the second analysing total mass by weight (kg):

In short, how can the BSA apply its declaration in 2019 of a climate and ecological emergency to its teaching, learning use and reuse of materials and the culture surrounding that? Further analysis of materials supplied in B-made shops is needed, to gain a fuller picture of impacts and potential solutions.

3.4 Considerations from B-made to date

Considerations of improved Materials culture in B-made are not a new topic of conversation and the research team acknowledges that B-made staff have been discussing these ideas for a number of years. Below are some of the ideas, discussions, and actions B-made have already given thought to.

Development of a Sustainability Strategy

- Develop a B-made Workshops Sustainability Framework with help from Martin Farley, Sustainability Labs Adviser at UCL (https://www.ucl.ac.uk/sustainable/about-us), to identify and troubleshoot areas that could use better practices in the workshops and thereby help influence change in B-made shops.
- Share and involve students and staff across the BSA in this process as a great learning opportunity, as well as helping people understand and be part of the sustainable change process.
- Complete review of energy suppliers and waste contractors.
- Introduction of an Embodied Carbon Strategy into B-made Hub as well as B-made procurement
- A wider BSA Departmental Sustainable Operations Strategy to manage work and ensure B-made goals, efforts, and visibility align with the wider school and are supported and championed at a strategic leadership level.
- More efforts in teaching sustainable materials including strategies for energy, pollution/toxicity, and personal and planetary health in general.
- Including a staff guide, B-made presentations through a UCL wide lecture series on sustainability-focused projects, research of topics from the Architects Climate Action

Network (ACAN) Education Toolkit to influence and value B-made and BSA sustainability teaching, exploration processes and output.

Ecofye Analysis

- Work with Ecofye, a business that helps analyse and suggest actions for change for companies to achieve sustainability goals such as Carbon Net Zero by 2030. A 360^{o} assessment of the BSA, grading the department's circular economy, emissions, and social impact must be completed.
- With the information from the assessment, Ecofye will advise the department on impacts around material choices, waste/water management, how to implement emissions reduction and other circular processes and actions.

Areas for Development

- **Operations:** LEAF and Sustainable Frameworks, teaching and research opportunities linking with BSA and UCL buildings operations, maintenance, adaptation and improvement of performance of internal environments, energy and health.
- **Teaching:** training, and upskilling staff to pass on knowledge to students, alignment through the school, B-made branch for supporting sustainable making skills for staff, alumni, and professionals (for example at Flimwell and other educational centres that BSA may choose to procure services and use of facilities from).
- **Staff Training:** update staff skills, training and priorities, update lectures and other module content, update staff awareness of wider sustainability considerations, not just embodied energy/CO2e but the interrelationship of whole Life Cycle Analysis including S-LCA (S=Social)

B-made Workshops Framework

- **Waste:** update and streamline systems for dismantling and disassembly, reuse, repair, (and as a last resort recycling), monitoring of energy and water consumption and opportunities for more efficiency; waste stream management; access to advice on disassembly and reuse for students and staff.
- **People:** Integration of sustainability into B-made workshops inductions, discussions with programme directors, module leaders and unit tutors on implementing a whole lifecycle plan into design, as well as built or made projects, define and appoint sustainability officers and teams that are easily visible and accessible to students and staff.
- **Materials:** Creation of more signage and guidance for material selection and processes based on sustainability, health and safety, practicality, toxicity, durability, ease of disassembly and reuse, etc.
- **Equipment:** Training on shutting down machinery over night / outside of periods of highest use, and the most economical use of power. Potential for a master kill switch

for all machinery power. Encouragement of students and B-made staff to ensure ventilation extraction is off when no one is on the machinery.
- **Procurement:** checklist for suppliers before procurement, carbon cost analysis, sustainability review of stocked products and alternatives, application of UCL Net Positive and other strategies for sustainable procurement.

B-made operational energy monitoring (Gordon Street or Here East, whichever is easiest to implement first but ideally both)

- Monitoring BSA operational energy use, separate B-made monitoring from other BSA operational energy use, and within that, monitoring separate channels such as machinery, artificial lighting, air-conditioning and ventilation, specific machinery extraction etc.
- Monitoring individual machines to give students and staff an idea of the carbon cost over time (CO2e kg/hour?) on the machine. Potential to collaborate with the UCL Energy Institute, UCL Institute of Making on monitoring, sharing best practice etc.
- Transparency on energy use provides a great opportunity for educating users as well as assessing and improving the workshops' environmental efficiency and contribution to BSA Net Zero 2030.

Proposals for training courses at Flimwell and other educational centres and individuals

- Training courses for students and staff (CPD) on sustainable construction and teaching of sustainable making skills, in collaboration with leading practitioners. Showcase how sustainable practice can fit into more contemporary circular building design, construction, use, maintenance and repair, disassembly and reuse, carbon negative materials, etc.
- Education on techniques and materials such as earth building, strawbale, timber frame, clay and lime plasters, mortars, renders and slips, as well as understanding how to minimise or put beyond use high-embodied energy/carbon materials (reflecting their fossil fuel use over their life cycle).
- Each course to be captured to create a body of information such as video content, crib sheets, podcasts, interviews, that could then be uploaded for access on B-made's connected learning portal, BSA website and YouTube channel etc.

B-made staff responses to the BSA's declaration of a climate and ecological emergency:

- Audit B-made's culture, workflow, and workshops to establish our achievements, and where to improve.
- Secure funding for a year for specialist teaching, training, machinery and technologies that focus on sustainable building and manufacturing practices (LCA and S-LCA, embodied carbon/CO2e, environmental and health impacts/benefits etc).

- Collaborate with UCL Estates in relation to waste management and consumables, ensuring we are practicing the leading thinking on these topics, not merely meeting the 'bottom line'.
- Acknowledge that responding to the climate and ecological emergency poses many challenges and mistakes will be made. Transparent analysis and reviews will be carried out and published, to drive pedagogical change and learning opportunities, to accompany changes in strategy and direction at leadership level, championing sustainable changes to teaching and learning, as well as in B-made.
- Encourage collaboration with other faculties across UCL and further afield.
- Establish links with industry to create new research opportunities and student engagement with industrial processes.
- Continue to develop and review the production of all shows internal and external and their potential for improvement in terms of embodied carbon and other sustainability criteria.

3.5 Proposals for change

- Monitoring of energy produced by workshop equipment. Currently this information is unknown and will be vital to decision-making processes about materials and machines used in B-made.
- Addition of a new section in the workshops induction on materials culture: using information gathered in this report and elsewhere, could B-made introduce the concept of sustainable materials practice in the workshop induction to get students thinking about their material choices from the time they start using the workshop? B-made sees and trains up to 65 students per day during inductions. This is an opportunity to provide baseline information to a wide range of students on materials culture across the BSA.
- Implementation of QR codes attached to all materials sold so that one can learn more and compare between all materials and their environmental credentials. Additionally, a more general information sheet would be useful in the shops and on Moodle pages, explaining Materials culture, and how BSA is developing its own Materials culture in the light of the climate and ecological emergency, as well as for health and other sustainability considerations.
- Expansion of the materials library to include equitable representations of materials used around the world in the creation of the built environment – materials could be categorised as 'animal, mineral, vegetable' – and composites thereof?
- Creating a transparent system on suppliers and materials selection and procurement processes – this might mean answering questions such as: On what basis has this material been chosen for procurement over another? Why is this material priced as it is in B-made shops, when it can be found cheaper elsewhere? What are the supplier's credentials? How can B-made monitor to ensure those credentials are practiced as well as preached?
- More detailed recording of sales to students, as well as orders made from suppliers. This will allow trends to be identified and might promote more informed decision-

making regarding choice of supplier or switching to a new supplier. For example, if B-made can demonstrate that a certain number of orders of a certain product will be made in a given time period, then suppliers may be more ready and able to provide that product.

B-made staff's questions and suggestions on material choices/improvements

The diagram below shows some key areas where this research group could see potential for improvement in regard to B-made practices, after discussions with B-made staff. They are:

1. **One-to-one knowledge exchange.** This might happen during design process tutorials, or physically while in the workshops.
2. **Procurement.** This must include considerations on how materials are selected for use in B-made shops and generally around the workshops/BSA.
3. **Digital knowledge exchange.** This presents an opportunity to create a digital library of material and shared sustainable making practices, easily accessible by all students and staff, whether on Moodle, the B-made web area or elsewhere.
4. **Environmental Product declarations (EPDs).** These often include only Modules A1–A3, so take care if you are combining EPD data with other sources that may include additional modules (e.g. A–C), as you will need to fill in the gaps (or at least note the limitations of quick calculations). If you wish to use A4 and A5 data from an EPD, always check that the assumptions within these calculations align with the project-specific circumstances and/or the advice contained within Section 2.3 of this guidance.
5. **EPD validity.** EPDs are normally valid for five years, and their validity date will be displayed on the EPD. Make sure the data you are using is valid.
6. **Best sustainable practices in workshop management.** This can be further divided into three areas:
    - **Making** – what are the ways to optimise materials use with the machines available?
    - **Showing** – can an "inclusive" sustainable material physical library spark a wider conversation?
    - **Selling** – can the shop provide a more varied range of materials for purchase, moving away from solely mineral materials, into vegetable and potentially animal materials? What are the limitations? Alternatives? And again on what basis are decisions a) currently made b) could be made in future, if change were championed at strategic BSA leadership level, and supported and driven in BSA teaching and learning?

The two diagrams below summarise these areas for further investigation and could also be helpful in discussion or questions to explore with BSA leadership.

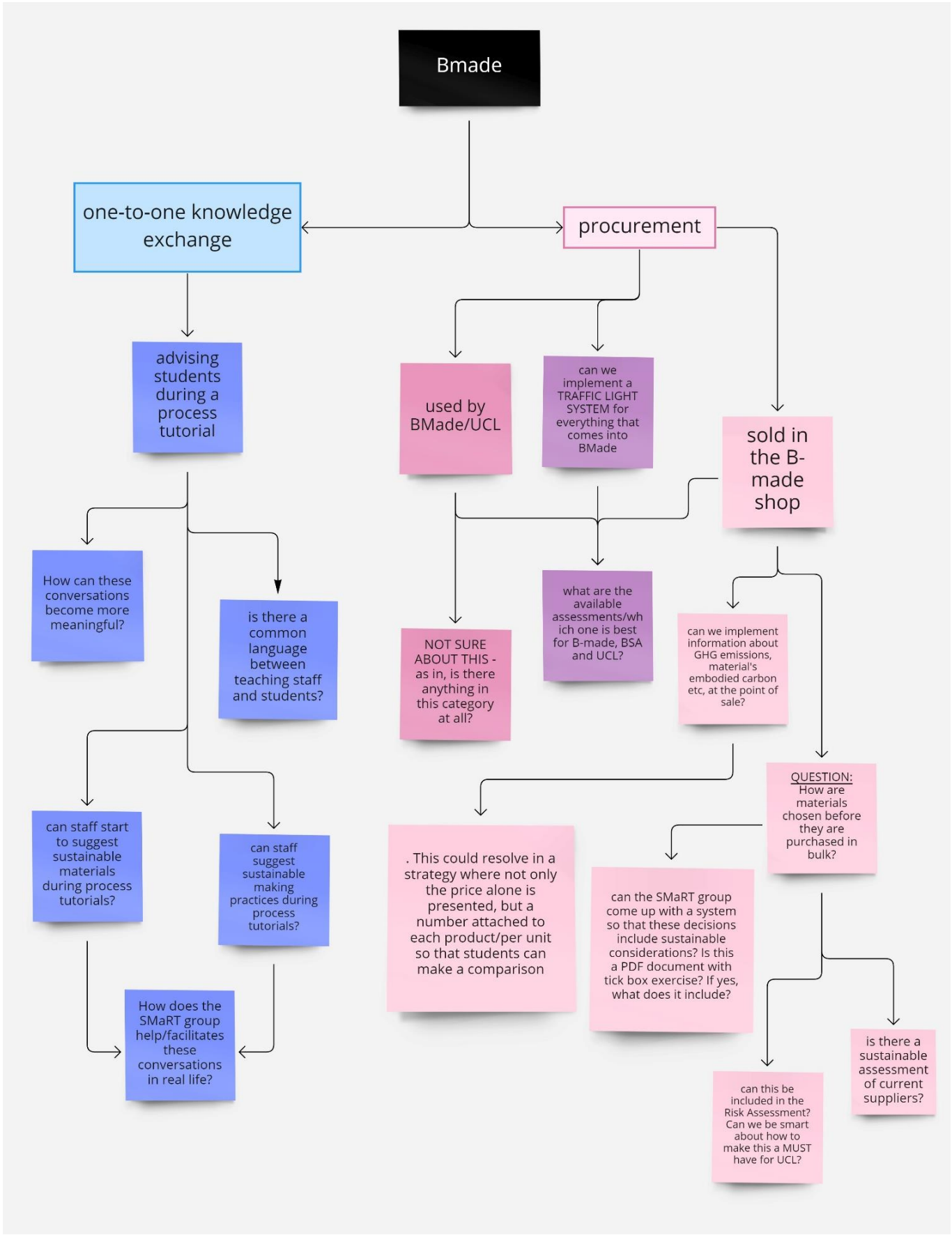


Fig. 11: Key areas where this research group could see potential for development of B-made practices (zoom in for more detail)

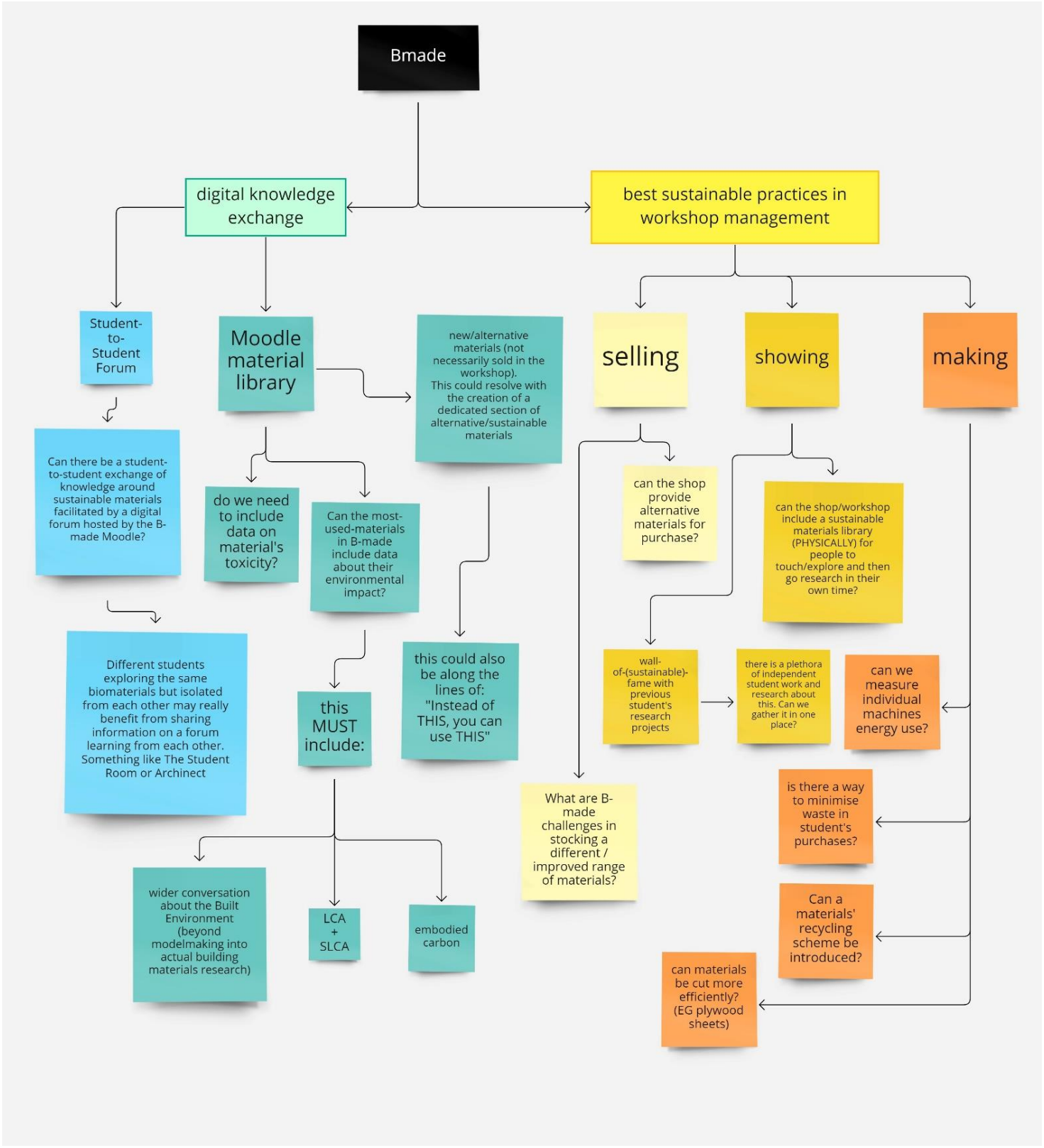


Fig. 12: Further key areas where this research group could see potential for development of B-made practices (zoom in for more detail)

Case Study

Student-led Materials Reuse Process at Universitas Indonesia

By Frista Puspita Marchamedya, Sustainable Materials Research Team member, Architecture and Historic Urban Environments MA, July 2022

In 2017, the Architecture Students Society at the Universitas Indonesia began developing a financially-driven programme that initiated a step closer towards a circular economy.

Essentially, this circularity came from 2 major programs:

- **Donars** a materials donation platform
- **Brangkars** a materials give-back platform

The initial idea came from concerns raised amongst students about how expensive new materials are, and significant numbers students cannot sustainably afford these purchases each term, while simultaneously, many students are also fortunate enough to be able to buy and also discard these items, used or even sometimes unused.

Fig. 13: Brangkars promotional picture, July 2022 (Source: https://www.instagram.com/ima_ftui/)

Fig. 14: Donars promotional picture, July 2022 (Source: https://www.instagram.com/ima_ftui/)

Donars (Material Donation)

Donars is a materials donation event held and organized by the Architecture Students Society at the end of every term to give an opportunity for students who have any leftover materials or off-cuts, or even reusable/recyclable models to donate, and potentially give it another life in the next term and help another student with economic difficulties who cannot afford new materials. This is based on goodwill and care amongst fellow architecture students, hence there is no exchange of money for the material given. Students were given full information on the benefits of participating in this event and how it will help others. The event is particularly popular for senior or final year students who no longer needed their physical models, so it also gave them chance to free up space in their room/studio, while also doing good for others.

Workflow

- **Online Registration** Students with materials to donate complete an online registration form asking about how they're going to donate it – collection, delivery themselves – and list of materials that they are donating

- **Collection** Student society sets up time, date and drop-off locations, usually the last week of term somewhere in the building/campus.

- **Continuation to Brangkars Event** After collection, materials are kept and categorized by another team and given back for free in an event called *Brangkars*

- **Brangkars (Material Give Back)** After all the materials are collected from *Donars,* they are sorted and divided into categories. Brangkars Materials give back is targeted for students that have financial difficulties affording new materials. The school keeps records of these students and to which the student welfare division of the Student Society has confidential access.

If by the end of the Give Back event there are still materials left, these are then promoted to the rest of the students.

Workflow: Sorting from Donars, Material categorization, Online registration, Collection

- **Sorting** Materials collected from *Donars* is sorted out and given treatment as necessary; for off-cuts, they make sure there are no sharp edges, and angles are cut perpendicular where possible so they are easier to use afterwards.

- **Categorization** After sorting and treatment, materials will be put into categories based on what it is and its condition, for example:
  Balsa wood (size and type): New/Offcut
  Bamboo (size): New/Offcut
  White board (size): New/Offcut/Folded
  Cardboard (size): New/Offcut/Folded/Stained
  Metal (Type): New/Offcut
  Stationery: New/Stained

- **Online Registration** All available materials including their condition are then listed in an online form and the link distributed to targeted students. All is based on a first-come first-served basis, but materials available always exceed demand, which also has other benefits.

- **Collection** After registering their interests, all materials are then packed and prepared for collection by targeted students, and on the same day any leftover materials are advertised to other students to get for free. All materials are usually sold out on the same day. But if there are still leftovers, they are kept for another round of *Donars* and *Brangkars* next term.

4.0 IMPACT ASSESSMENT METHODOLOGIES AND CRITERIA

4.0 Impact Assessment Methodologies and Criteria

4.1 Current methodologies

For every material that is procured and used at the BSA, there are 3 stages where this research shows efforts could and must be made in minimising impact. This is for multiple benefits, not just meeting Net Zero 2030 commitments. They are production, use and waste.

Production

Generally, considerations of a material's production will include an understanding of the extraction or growing processes, selection of suppliers, raw materials input and energy and resources use in manufacturing, processing and transportation.

Important questions of social sustainability also need to be addressed here, with respect to human rights such as safe labour and freedom from slavery, fair retribution or payment, fair trade that supports local social, environmental and ecological sustainability, and so on.

Use

Regarding use of materials, it is important to acknowledge the impact of design decisions, especially if they happen digitally, or in a medium that does not directly translate into the physical world.

Sustainable making and assembling practices can be optimised to save materials, improve performance and solve creative challenges.

Waste

Lastly, waste is an important part of the conversation and needs to be included in design considerations from the start, rather than coming in as an add-on or even an afterthought.

Striving for a truly circular system means eradicating the concept of waste completely (in its contemporary understanding), therefore the need to introduce ideas of refusal to use, reduction of use, re-use, repair, retrofit and (potentially as a last resort) recycling.

Each of these steps contributes to a material's overall impact on people and the planet. In order to quantify the impact, a few assessment methodologies have emerged. The research team focussed on presenting the most relevant methodologies in the context of B-made and Materials culture and choices at the BSA.

These can briefly be summarised as follows:

- **LIFE CYCLE ASSESSMENT (LCA)** A cradle-to-gate or cradle-to-cradle approach, with the possibility to expand this into **SOCIAL LIFE CYCLE ASSESSMENT (S-LCA)** due to the high interest in these themes from both student body and staff, as well as relevance to real-world issues and emerging strategies for design response.

- **WHOLE LIFE CARBON** Whole Life Carbon emissions are the sum of all a material's related GHG emissions and removals, both operational and embodied, over the life cycle of an asset including its disposal (Modules: A1- A5 Upfront; B1-B7 In Use; C1-C4 End of Life). Overall Whole Life Carbon asset performance includes separately reporting the potential impacts/benefit of future energy recovery, reuse, and recycling (Module D). It is the output in a carbon format, after life cycle assessment.

- **EMBODIED CARBON** calculation, which gives an estimate of CO2e emissions in producing materials and may be more relevant for the construction industry and building materials.

- **EMBODIED ENERGY** calculation, similarly, to embodied carbon, this looks at the quantity of energy used in the sourcing, production and manufacture of a material.

During this research, the team found that the different methods for calculation, while similar in their processes, address different challenges.

For the BSA specifically, it is of interest to explore what impact assessment, or combination of assessments, could be best suited in the move towards more sustainable practices.

These kinds of impact assessments are useful in creating a hierarchy of materials, yet they only tell part of the story.

- What other impact assessments could BSA introduce?
- Can we produce our own assessment criteria in relation to the BSA context?

4.1.1 Embodied carbon

Embodied carbon is estimated by measuring energy used to extract and transport raw materials as well as emissions from manufacturing processes.

Some definitions:

kgCO2e: Carbon dioxide equivalent emissions, often referred to as 'carbon' for short. This measure considers other greenhouse gas emissions (GHGs) in addition to carbon dioxide (CO2), expressing them in terms of CO2 normalised by their global warming potential (GWP).

Whole life carbon (kgCO2e): The sum total of all asset-related GHG emissions and removals, both operational and embodied over the life cycle of an asset including its disposal (Modules

A1–A5, B1–B7 ((plus B8 and B9 for infrastructure only)) and C1–C4). Overall whole life carbon asset performance includes separately reporting the potential benefit from future energy recovery, reuse, and recycling (Module D).

Net zero whole life carbon: Where the sum total of all asset-related GHG emissions, both operational and embodied, over its life cycle (Modules A1–A5, B1–B7, C1–C4) plus offsets equals zero. Minimising emissions should always be prioritised over offsetting.

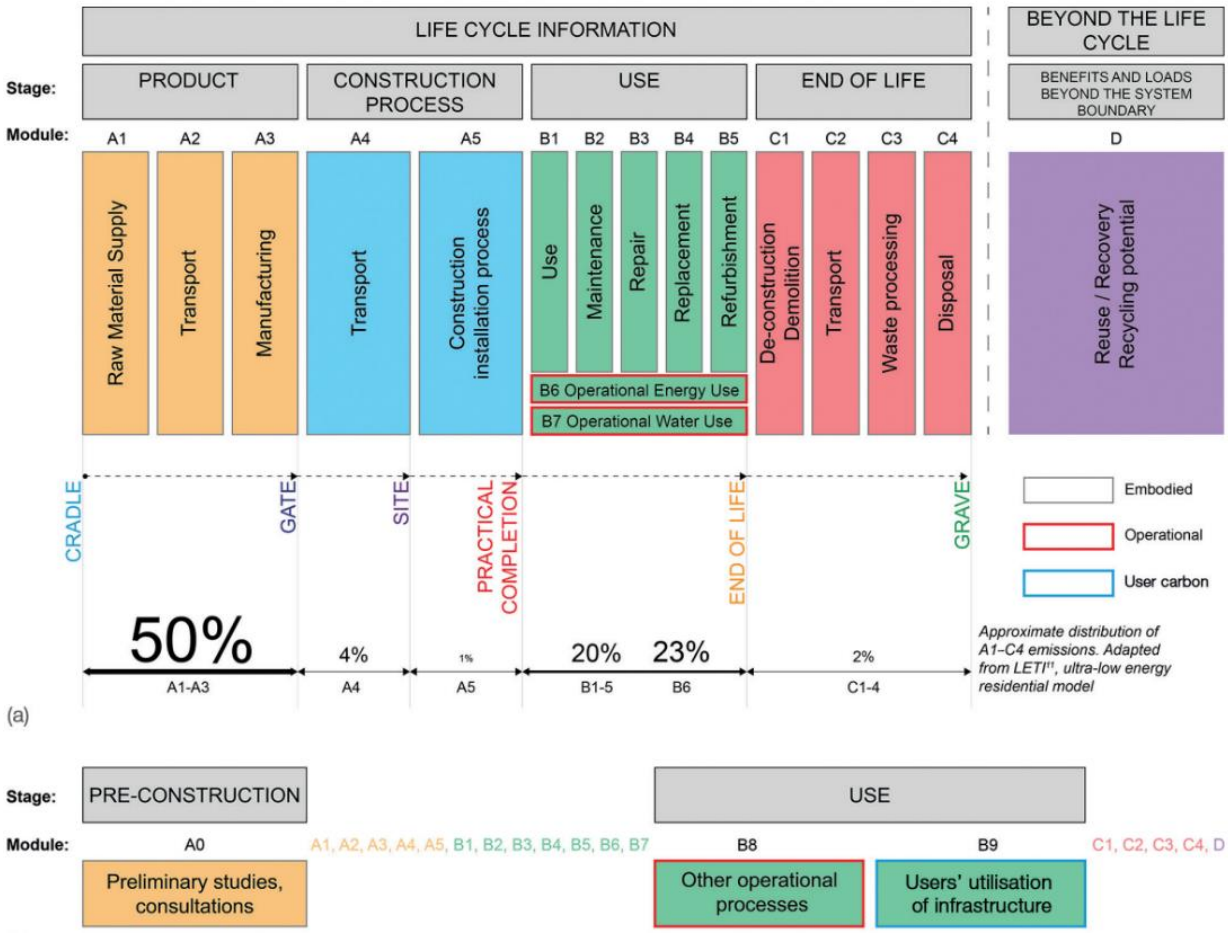


Fig. 15: Standardised Embodied Carbon assessment overview

How to calculate Embodied Carbon:

Inputs	**ECF** Embodied Carbon Factor of Material Type ($kgCO_2e/kg$) QUANTITY (kg)
Formula	ECF x QUANTITY = **EMBODIED CARBON**
Embodied carbon factors	The kgCO2e per unit of product, often with units of kgCO2e/kg or $kgCO2e/m^3$

Carbon sequestration

Biogenic carbon emissions relate to the natural carbon cycle and there is significant interest in quantifying how plants capture CO2 in the process of photosynthesis, how it is lost in respiration or evapotranspiration, and stored in biomass (both living and dead), and finally biologically sequestered into long-term biological stores in the soil. This biogenic terrestrial carbon cycle offers significant potential for greenhouse gas emissions (GHG) reductions.

Biogenic carbon is not considered in the same way as fossil carbon.

While fossil carbon is typically what is emitted during the production/construction of a timber structure, biogenic carbon is instead the carbon transferred into the structure during production/construction. At the structure's end of life, the biogenic carbon is then either transferred out of the structure (e.g. sending the timber for reuse), emitted into the atmosphere (e.g. incineration for energy), or both (e.g. sent to landfill).

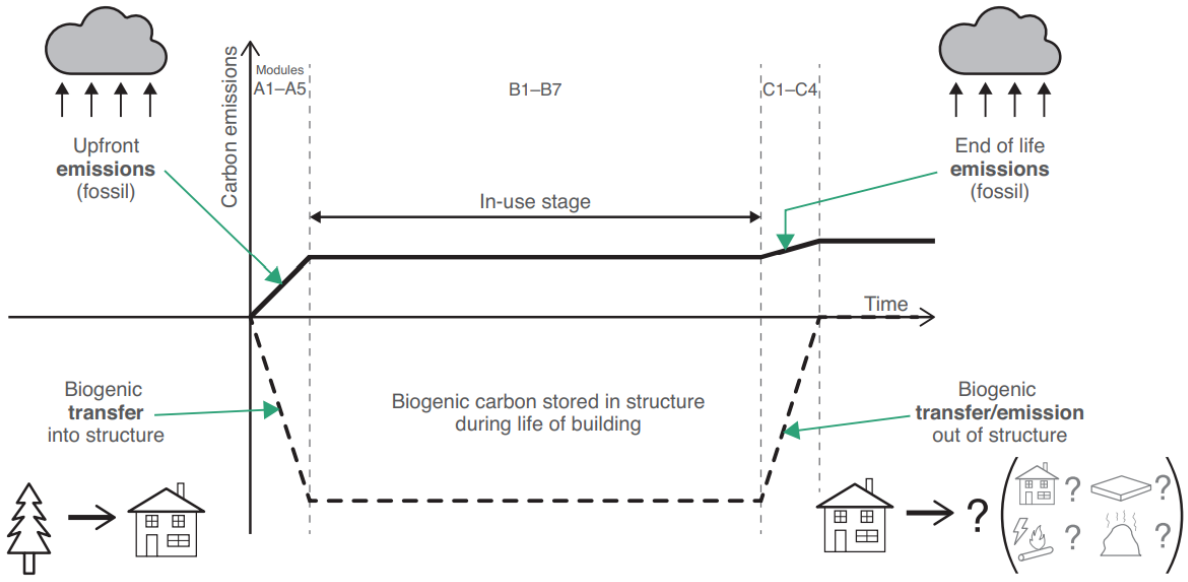


Fig. 16: Biogenic Carbon – Capture and Sequestration (Biogenic Carbon—Capture and Sequestration - ScienceDirect)

Calculation Stages

Embodied Carbon calculations include 4 different stages:

1. Product stage (also known as 'cradle to gate'), **Modules A1–A3**

kgCO2e released during extraction, processing, manufacture (including prefabrication of components or elements) and transportation of materials between these processes, until the product leaves the factory gates to be taken to site. Note that recycled content of a product affects the kgCO2e released in Modules A1–A3. Whether it is recycled after its end of life or not, the A1–A3 impact of the project being considered is not affected — this is considered in Module D.

The A1–A3 carbon factor depends on:

- Location where the project will be constructed (when using consumption or production average values for a region or country)
- Location where the products/components are to be manufactured (when supply chain is better understood, and component origin is known)
- The material specification

2. Construction process stage, Modules A4 and A5

kgCO2e released during transport of materials/products to site, energy usage due to activities on site (site huts, machinery use etc.) and the kgCO2e associated with the production, transportation, and end of life processing of materials wasted on site.

3. Use stage, Modules B1–B7

kgCO2e released due to use, maintenance, repair, replacement, refurbishment and operational energy and water while the building is in use. Module B4 (replacement) is often the focus of the use stage when embodied carbon is being considered.

4. End of life stage, Modules C1–C4

kgCO2e released during decommissioning, stripping out, demolition, deconstruction, transportation of materials away from the site, waste processing and disposal of materials

Research data supporting 'How to Calculate Embodied Carbon' (cam.ac.uk)

Scoping an embodied calculation approach applied to B-made

- What does this mean for B-made and the BSA in general?
- How can this framework be applied to B-made, and understood across the BSA?

Required actions

A1-A3 Product stage. A review of raw materials, transport, and manufacturing of purchased materials. This information should be available in the shops, to inform students and staff.

A4-A5 Construction process stage. A review of workshops' energy used by each making process and machine. Monitoring and analysis of energy use, related to specific materials and machinery. Monitoring of waste generated and opportunities for reduction/elimination, opportunities for waste produced during postproduction to be reused (see student-led case study above).

B1-B5 Use stage. Not so applicable to B-made, but greater knowledge and application of this stage is needed in teaching across the BSA.

C1-C4 End of life stage. A review of the de-construction of objects made in the workshops. Where are these materials taken? How are they then processed? Where does this waste go?

D Beyond the Cycle. Explore, how can B-made support the recovery and re-use of materials in workshops and across the BSA more generally?

To date, due to large data gaps, it is hard to understand the full impact of material use at the BSA. Without reviews of material suppliers (A1), transportation (A2), manufacturing (A3), making processes (A5), de-construction (C1), waste processing (C3) and opportunities for recovery and re-use (D), it will be hard to understand how to make targeted and meaningful improvements.

A review of each of these areas would produce interesting results and also provide an opportunity for creative steps forward and better teaching and learning across the school.

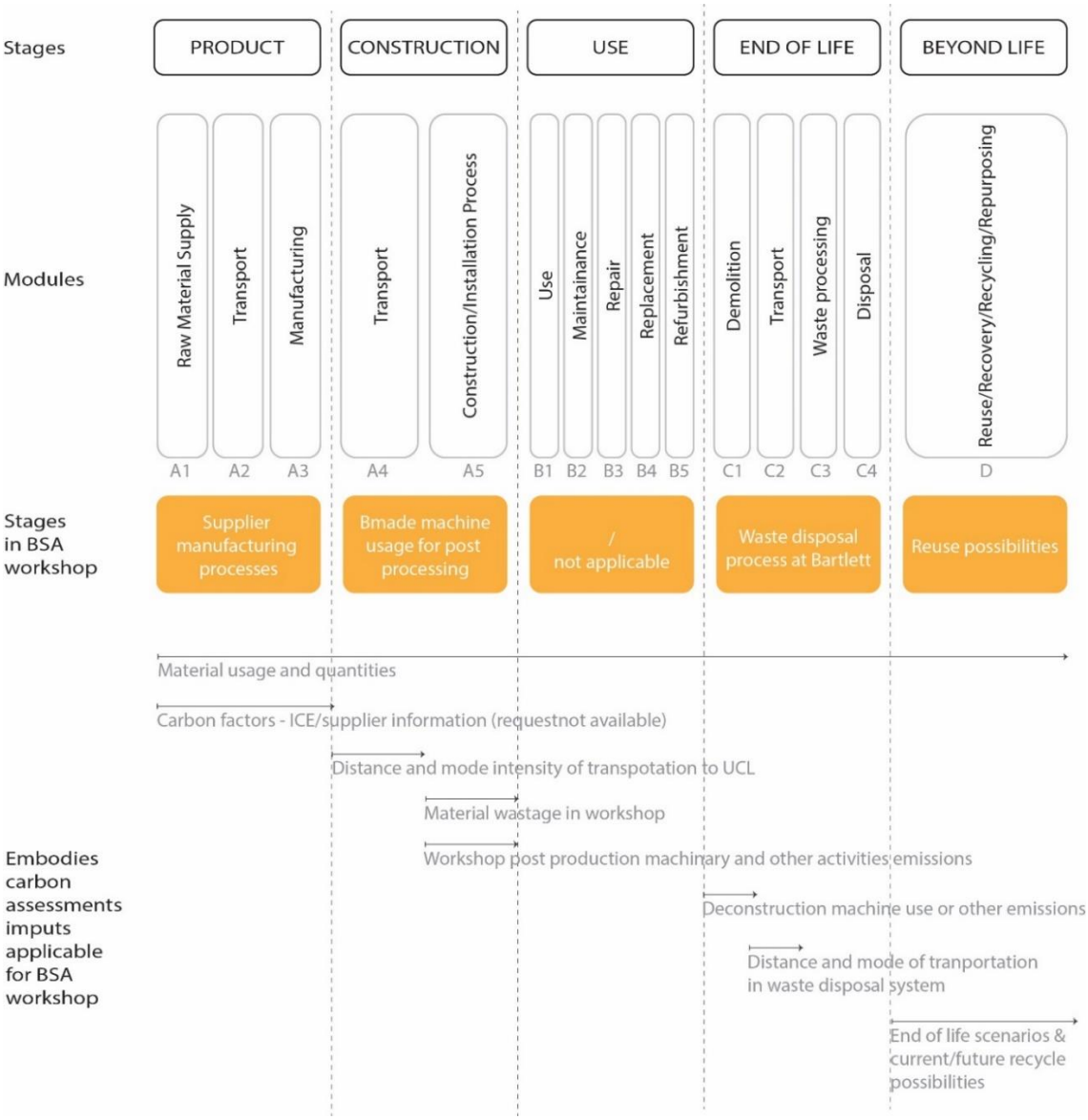


Fig. 17: Diagram of embodied carbon calculation stages and required inputs in B-made context.

4.1.2 Life Cycle Assessment (LCA)

LCA assesses the environmental effects of a product or service; the evaluation is based on a specific function and considers all life cycle stages. It assists in the design of new goods and identifies areas of a product's life cycle where environmental improvements might be achieved. This tool is primarily used to compare distinct goods, systems, or processes, as well as the various stages of a product's life cycle.

An LCA can be:

- **Cradle to grave:** A product's life cycle from primary resource extraction to production, transportation, consumption, and disposal - 'Take-Make-Waste'.
- **Cradle to gate:** A product's life cycle that includes just primary resource extraction to fabrication (ending at the factory's gate).
- **Cradle to Cradle:** (C2C) is a method to sustainable product and system design that is founded on the notion of mimicking nature. Creating a loop from material extraction to disposal.

An LCA, according to the International Organization for Standardization (ISO) guidelines and the Society of Environmental Toxicology and Chemistry (SETAC), comprises of goal and scope definition, inventory analysis, impact assessment, and result interpretation.

These four stages are described as follows:

1. Goal and scope *definition*, objectives and scope of the investigation specified. At this step, critical aspects are determined: the system's function, the functional unit on which the emissions and extractions will be based, and the system boundaries. The base situation and the options are well discussed.

2. The ***inventory study*** quantifies damaging emissions to air, water, and soil, as well as the extraction of renewable and non-renewable raw materials.

3. The ***Impact assessment*** evaluates environmental consequences of inventoried emissions.

4. The ***Interpretation*** stage is when the results gathered thus far are interpreted and the uncertainties are appraised. The essential parameters and improvement alternatives may be found through sensitivity studies and uncertainty propagation, and a critical analysis examines the effect of the chosen limits and hypotheses. Finally, environmental consequences might be contrasted to economic or social implications.

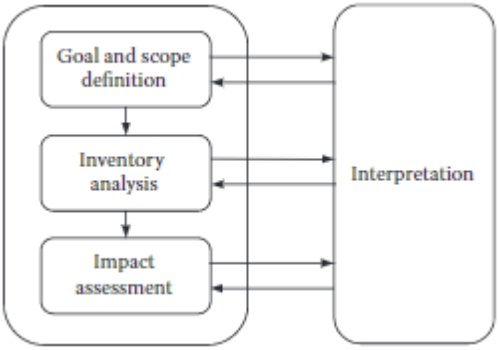


Fig. 18: Stages of Life Cycle Assessment (Olivier Jolliet, Myriam Saade-Sbeih, Shanna Shaked, Alexandre Jolliet, Pierre Crettaz. Environmental Life Cycle Assessment)

An LCA's declared objective is to determine the environmental implications of a product, service, or material, often in order to make a choice in the development of such object or in the creation of some policy. It is possible that several methods of making a product or providing a service are being evaluated to discover which has the lowest environmental effect.

Without measuring all inputs and outputs, as is done in an LCA, it is exceedingly challenging for people to determine the true environmental implications of a good or service. Thus, LCAs enable us to measure environmental consequences and make more informed environmental choices. Stakeholders may understand what modifications to make at the various phases to enhance environmental outcomes overall by measuring the environmental consequences at various stages of manufacturing the good or service.

Fig.19: 'Take-Make-Waste' linear materials process (still commonly employed)

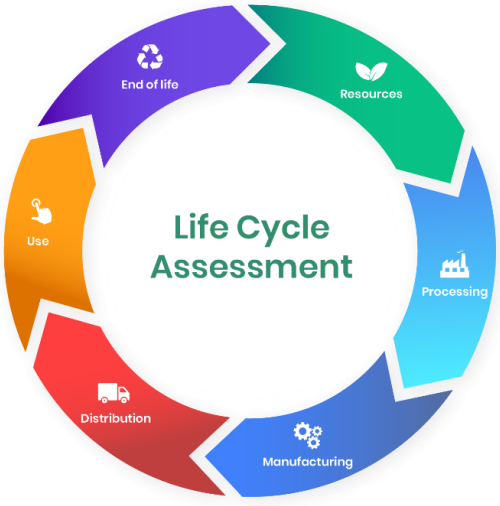


Fig. 20: Life Cycle Assessment explained: an introduction to building LCA
https://www.oneclicklca.com/life-cycle-assessment-explained/

A focus on re-use: Moving from *Cradle to Grave,* to *Cradle to Cradle* or *Circularity*

On the idea of changing from a *Cradle-to-Grave* to a *Cradle-to-Cradle* loop, the conversation needs to shift from asking 'where do we find new suppliers/more materials?' to 'How can we

move to becoming truly circular?', questioning the assumptions of the existing conversation from first principles, and aiming to exclude waste completely.

The life cycle of materials still remains a largely linear process, from material extraction to manufacture, use and disposal – a Take-Make-Waste approach, both in B-Made and across the BSA.

But we can start to change this and try to approach a loop, circularity where disposal can become raw material again and replenish the cycle.

Ultimately, someone discarding something should become someone else's supplier.

How can we implement these systems in B-made and the wider BSA? Some proposals below:

- Championing at BSA Senior Leadership level
- Education and training on life cycle assessment and integrating in BSA materials culture, teaching and learning, and supported through B-made
- Better systems for reuse (and potentially recycling, although reuse preferred)
- Second hand shop for students
- Encouraging disassembly of models into re-suable blocks of material before disposal
- Setting up a visible system to receive materials for re-use, and supply in the second-hand shop
- Discouraging the use of chemical bonding between different materials that could otherwise be recycled individually

4.1.3 Embodied energy

Embodied energy is the total energy required for the extraction, processing, manufacture and delivery of building materials to the building site. Energy consumption produces CO2e, contributing to greenhouse gas emissions.

So embodied energy is considered an indicator of the overall environmental impact of building materials and systems.

Embodied energy, however, only considers the front-end aspect of the impact of a building material.

Embodied energy is measured as the quantity of non-renewable energy per unit of building material, component, or system. It is expressed in megajoules (MJ) or gigajoules (GJ) per unit weight (kg or tonne) or area (m2).

4.2 Case studies

Two case studies are presented below, looking at **acrylic or PMMA** and **softwood plywood**, two of the materials most commonly used in B-made.

The research team acknowledges the complications behind material choices and doesn't intend to present complete solutions, rather to raise awareness and test the effectiveness of impact assessment methodologies in the context of BSA.

Each material is analysed through the lens of the LCA and Embodied Carbon calculation, in an attempt to scope what methodologies should be implemented, in order to optimise results for the school and the workshops.

4.2.1 Acrylic

Acrylic, known as Poly-methyl methacrylate (PMMA), is a colourless, transparent thermoplastic polymer. It is a pigment-wetting binder for coatings that improves hardness, weather durability, and chemical resistance.

PMMA has a remarkable optical clarity due to the structure of the polymer solid. It is frequently available in sheet or bead form, is easily produced, and may be tinted as needed (Syrrakou, E. & Papaefthimiou, Spiros & Yianoulis, Panayiotis, 2005).

Data sheet available at:

https://amariplastics.com/wp-content/uploads/2022/03/Green_Cast_Data_Sheet.pdf

LCA of Acrylic or PMMA

1. *Material Extraction*

The most frequent raw resources used to make plastics are oil and natural gas. To obtain the necessary plastic, several chemical steps must be performed. Certain monomers are frequently joined into polymers to form chains, which result in a wide range of plastics.

Materials containing Methyl Methacrylate ($C_5H_8O_2$): Although oil and natural gas are frequent components utilised in plastics, other, more fundamental constituents may also be included. Many polymers include oxygen, chlorine, fluorine, and nitrogen in their chemical structure.

Methyl Methacrylate ($C_5H_8O_2$): Methyl Methacrylate is one of the most prevalent monomers that make up plastic, and it may be obtained in a variety of methods. Acetone Cyanohydrin can be obtained by reacting Acetone with Sodium Cyanide. This is then reacted with methyl alcohol to form the end product, methyl methacrylate. This Methyl Methacrylate may then be joined together to produce other polymers.

2. *Manufacture*

Highly hazardous compounds are used in the production of acrylic polymers, which need cautious storage, management, and disposal. If the polymerization process is not strictly controlled, it might result in an explosion. It also emits harmful gases. Recent regulation demands that the polymerization process take place in a safe and controlled environment and that the fumes be filtered, collected, or otherwise neutralised before they are discharged into the atmosphere.

Acrylic plastics are created and produced in three forms: flat sheets, long tubes and rods, and moulding powder. Suspension polymerization is used to create moulding powders. A reaction occurs between components of the monomer suspended in a solution of water and catalyst in this procedure. This produces polymer grains with finely regulated molecular weights that are appropriate for moulding or extrusion.

Acrylic plastic sheets are created by a process known as bulk polymerization. The monomer is put into a mould together with a catalyst, where a reaction takes place. The reaction results in the formation of a plastic in the shape of the mould. The continuous process is more efficient and requires less effort. It is used to create sheets with thinner walls and narrower widths.

Acrylic polymers are moulded and sculpted before being allowed to cool. For packaging they are layered and coated in a thin layer of plastic after cooling to minimise scratching and blurring.

3. *Transportation*

All materials are ready to ship and transport once they have been transformed into plastic and packed. Sheets of acrylic plastic are frequently piled and put onto cargo ships to be exported all over the world. Acrylic plastic is not created in a single area since it is simple to make and replicate, thus it is produced all over the world.

4. *Use*

Acrylic plastics are widely utilised in everyday life. Polymethyl methacrylate (PMMA) is the most popular acrylic plastic, and it is offered under the trade names Plexiglas, Lucite, Perspex, and Crystallite. This material is both strong and translucent (clearer than glass).

Because of these features, it is very useful for a variety of applications such as aeroplane windshields, skylights, automotive taillights, and outdoor signage. Plastics may also be found in the way we package products.

5. *Disposal*

Acrylic plastics may be repurposed after they have been used for the first time. This can take the form of reusing, recycling, or direct dumping as waste into landfill. Many acrylic polymers are neither biodegradable nor combustible and must be handled with considerable caution to be disposed of properly.

6. *Reuse*

Large chunks of plastic may be bent and moulded (for example by adding heat energy) into various useful products that can then be reused. However, as with the original manufacture process, great care in a highly controlled environment must be taken to ensure the health and safety of those involved and to limit pollution of the wider environment, due to the toxicity and other hazards associated with the processes involved.

SUPPLY CHAIN

B-made uses two main suppliers for sourcing acrylic materials. Tilgear provide the majority of acrylic-based materials, though B-made has also begun stocking products from Amari Plastics comprised of a recycled PMMA (R-PMMA) known as Green Cast.

Figure A below outlines the current supply chain for the R-PMMA material and Figure B proposes how B-made might alter its practice to move towards a more circular model, with a focus on this chosen material.

Madreperla, the primary supplier of this material, claim the production process to be carbon neutral and also have a scheme which allows unused material to be returned and manufactured into new material. B-made might also aim to phase out the use of non-recycled PMMA in favour of R-PMMA as a more sustainable alternative. However, Amari currently only stock acrylic sheets of thicknesses 3mm, 5mm and 10mm, while Tilgear also provide thicknesses of 1.5mm and 2mm, as well as a number of different colour options. Acrylic sheets are used frequently by students; therefore, instead of switching entirely from Tilgear to Amari Plastics as a supplier, which may impact student work, there may be an opportunity for B-made to use its position as a frequent bulk buyer to encourage Amari Plastics to widen its range of products, in return for procurement from them as a preferred supplier.

However, it appears that cost is the main factor driving decision making right now in relation to procurement. In this case, a piece of acrylic from Tilgear is considerably cheaper than a comparable piece from Amari Plastics. Increasing costs for students is also undesirable as it might create an environment where some students are more limited in terms of production by excessive material costs. This raises several questions:

a) Would the BSA be prepared to subsidise materials which have a better LCA/environmental impact, to allow students the continued freedom to choose a material with lower embodied energy or less polluting manufacture, for the same price?

b) Or does the BSA need to develop a more strategic Materials culture and related teaching, learning and making approaches, including upskilling staff and knowledge exchange processes between students, staff and where relevant experts elsewhere across UCL and beyond?

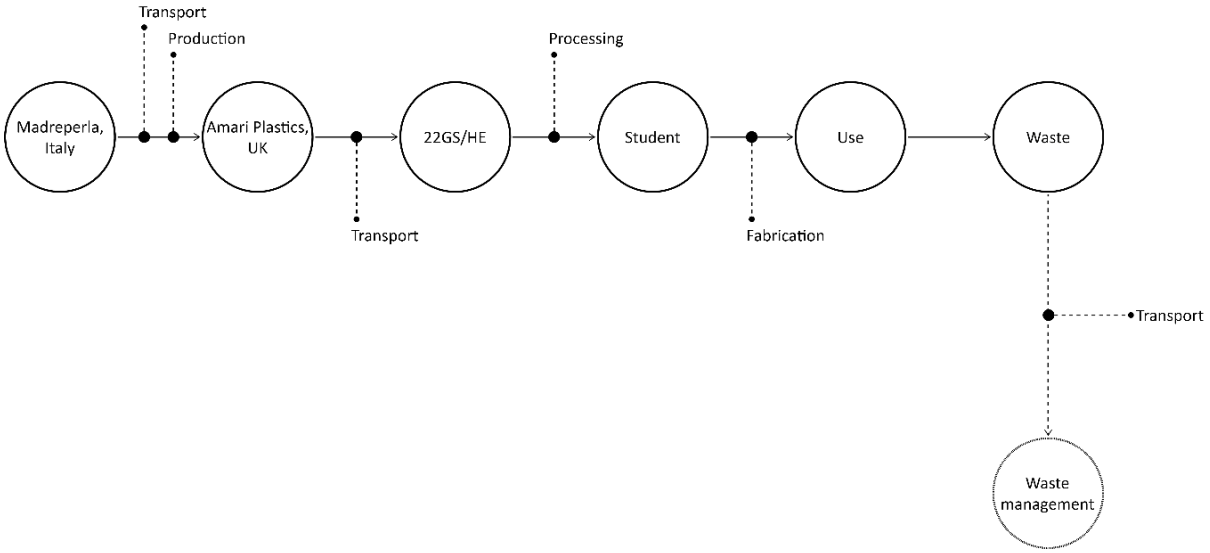


Fig. 21: Current supply chain for Green Cast acrylic. Potential sources of carbon emissions are identified with the dashed lines.

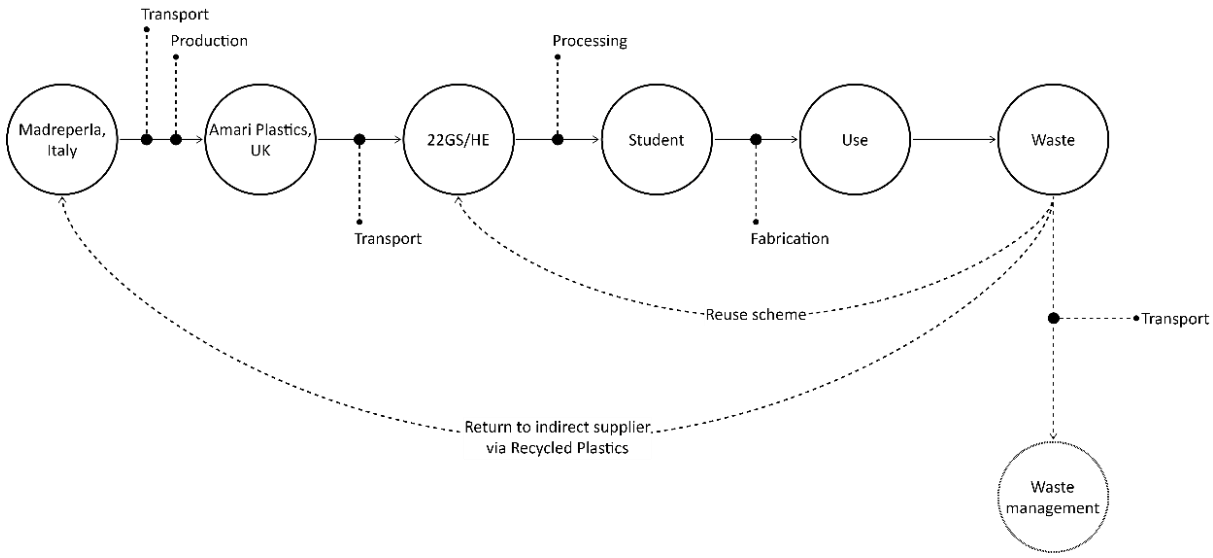


Fig. 22: Proposed supply chain for Green Cast acrylic which could aid the transition towards a more circular economy materials model at B-made.

EMBODIED CARBON

There is no available information on the embodied carbon factor of acrylics in resource, or any EPD of this material. Calculation is made by using the general embodied carbon factor for plastic.

Example:

Quantity Total Mass (without recycled content): **1095.171kg**

Embodied carbon = Quantity × Embodied Carbon Factor

Embodied carbon factor (general plastic, ICE) = **3.31 kgCO2e/kg**

So **Embodied Carbon** = 1095.17 kg × 3.31 kgCO2e/kg = **3625.13 kgCO2e**

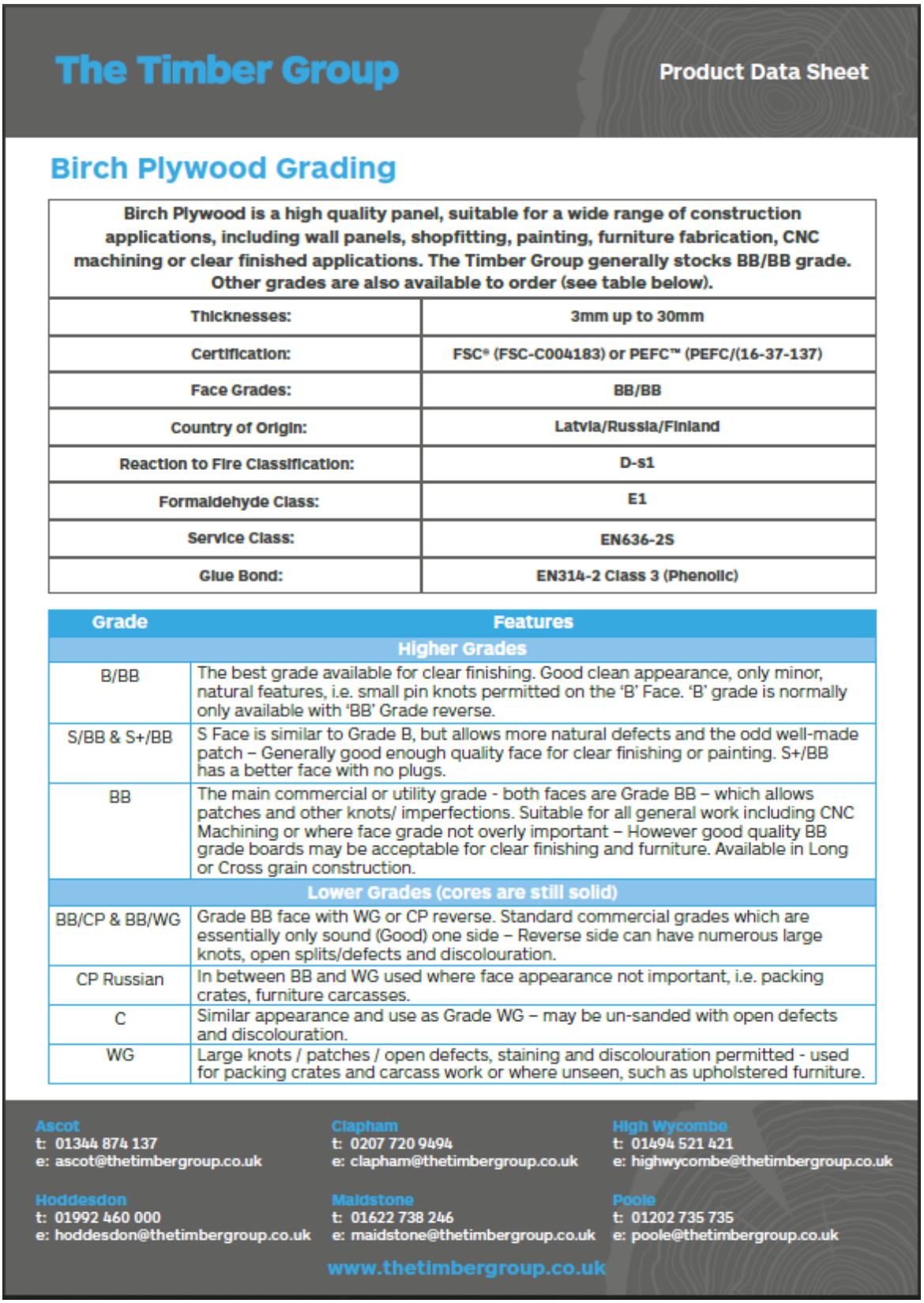
The research team found that embodied carbon is generally a more universal approach to quantify the environmental impact of products or buildings (which is particularly relevant in the construction industry). In the case of materials provided, sold and used in B-made, providing information on embodied energy might be more readily available, relevant, and reliable. About half of these materials have been identified as common building materials (to be registered in the ICE or other carbon factor databases) but the rest fall outside of this category.

4.2.2 Plywood

Plywood is a panel product made entirely or largely of veneer sheets known as plies. Softwood plywood is made by peeling logs into veneer sheets, drying the veneer, adding glue (for example phenol-formaldehyde), and stacking the sheets together, often with alternate grain orientation. The veneer stacks are then placed in a hot press, which uses pressure and heat to establish contact and curing, and the cured panel is then removed and sawn to standard sizes. Softwood plywood has a relatively long history of use as a structural building material in both commercial and residential construction. Plywood is utilised in house building as structural sheathing for roofs, walls, and floors, as well as subflooring uses and in furniture[2].

B-made stocks both birch and poplar plywood, supplied by Timberite and Timber Group Ltd. As the most purchased wood-based material within B-made (ref. previous section), 18mm birch plywood procured from Timber Group Ltd. is used as an example to study and understand the supply chain and associated LCA and embodied carbon of the material.

[2] Milota, M., & Puettmann, M. E., Life-cycle assessment for the cradle-to-gate production of softwood lumber in the pacific northwest and southeast regions. Published 2017 in Forest Products Journal, 67(5-6), 331–342. https://doi.org/10.13073/FPJ-D-16-00062



The Timber Group

Product Data Sheet

Birch Plywood Grading

Birch Plywood is a high quality panel, suitable for a wide range of construction applications, including wall panels, shopfitting, painting, furniture fabrication, CNC machining or clear finished applications. The Timber Group generally stocks BB/BB grade. Other grades are also available to order (see table below).	
Thicknesses:	**3mm up to 30mm**
Certification:	**FSC® (FSC-C004183) or PEFC™ (PEFC/(16-37-137)**
Face Grades:	**BB/BB**
Country of Origin:	**Latvia/Russia/Finland**
Reaction to Fire Classification:	**D-s1**
Formaldehyde Class:	**E1**
Service Class:	**EN636-2S**
Glue Bond:	**EN314-2 Class 3 (Phenolic)**

Grade	Features
Higher Grades	
B/BB	The best grade available for clear finishing. Good clean appearance, only minor, natural features, i.e. small pin knots permitted on the 'B' Face. 'B' grade is normally only available with 'BB' Grade reverse.
S/BB & S+/BB	S Face is similar to Grade B, but allows more natural defects and the odd well-made patch – Generally good enough quality face for clear finishing or painting. S+/BB has a better face with no plugs.
BB	The main commercial or utility grade - both faces are Grade BB – which allows patches and other knots/ imperfections. Suitable for all general work including CNC Machining or where face grade not overly important – However good quality BB grade boards may be acceptable for clear finishing and furniture. Available in Long or Cross grain construction.
Lower Grades (cores are still solid)	
BB/CP & BB/WG	Grade BB face with WG or CP reverse. Standard commercial grades which are essentially only sound (Good) one side – Reverse side can have numerous large knots, open splits/defects and discolouration.
CP Russian	In between BB and WG used where face appearance not important, i.e. packing crates, furniture carcasses.
C	Similar appearance and use as Grade WG – may be un-sanded with open defects and discolouration.
WG	Large knots / patches / open defects, staining and discolouration permitted - used for packing crates and carcass work or where unseen, such as upholstered furniture.

Ascot
t: 01344 874 137
e: ascot@thetimbergroup.co.uk

Clapham
t: 0207 720 9494
e: clapham@thetimbergroup.co.uk

High Wycombe
t: 01494 521 421
e: highwycombe@thetimbergroup.co.uk

Hoddesdon
t: 01992 460 000
e: hoddesdon@thetimbergroup.co.uk

Maidstone
t: 01622 738 246
e: maidstone@thetimbergroup.co.uk

Poole
t: 01202 735 735
e: poole@thetimbergroup.co.uk

www.thetimbergroup.co.uk

Fig. 23: Product Data Sheet for plywood, The Timber Group Ltd. (https://www.thetimbergroup.co.uk/assets/link/1/03phs08500_33390_t.pdf)

LCA of Softwood Plywood

For Softwood Plywood LCA, the specified unit for plywood is one cubic metre ($1.0m^3$).

1. *Material Extraction*
   Wood is extracted from forest facilities where, as well as energy, materials such as water and soil are required for the planting and logging operations.

2. *Transportation*
   Logs are loaded onto a truck and then moved to the location for the processing stage. Once manufactured, Plywood is also mainly transported by road (haulage trucks) to point of sale.

3. *Manufacture*
   Logs first go through bucking and debarking, then clipping and peeling to create veneers. Veneers are dried, stacked and hot-pressed, bonded with resin, then trimmed into standard sizes and prepared for shipping. These machine-based processes all require energy, either directly from fossil fuels or indirectly from electricity (still mostly fossil-fuel based).

4. *Use*
   Plywood is commonly used on the furniture and construction industry, and most of the time it is still trimmed or bent using special tools or equipment that require electricity or fuels. And it is also sometimes mixed with adhesives

5. *Reuse and Disposal*
   For the construction and furniture industry, plywood is considered to decay in situ. Resins could be reduced in processing to make it more reusable, but eventually it still requires disposal to landfill, due to the resins and chemical bonding agents it contains.

SUPPLY CHAIN

Sheets of birch plywood of 18mm thickness are supplied to B-made from Maidstone, Kent. This material has 70% (Forest Stewardship Council) FSC certification, meaning that at least 70% of the wood used to create the material is FSC-certified, while the remaining content comes from sources which are controlled and have previously undergone some level of assessment to ensure environmental standards meet FSC requirements.

The precise location that the wood is sourced from is not given and the supplier was unable to provide this information on request from one of the authors of this report. Furthermore, the full chain of custody of the material is unclear.

Gaining access to this information would go a long way towards B-made being able to assess the full environmental impact of its material library. In addition, there is not such an obvious means for recycling or reuse of plywood materials, though B-made does encourage the use of recycling bins which students can put any material they have finished using in, creating a more circular system. A comparison of existing and potential suppliers based on embodied

carbon as well as other sustainability criteria (embodied water, toxicity, etc) would be useful, as well as cost, in line with UCL's, The Bartlett's and the BSA's strategies and commitments.

The figure below from Wisa Plywood illustrates how some suppliers communicate their carbon and other sustainability credentials, in this case through the lens of responsibility. Perhaps the BSA could develop a clear graphic language to communicate its materials culture?

Fig. 24: WISA Plywood communication of its sustainability values, "leading our industry in the area of responsibility" https://www.wisaplywood.com/responsibilitymadeeasy/

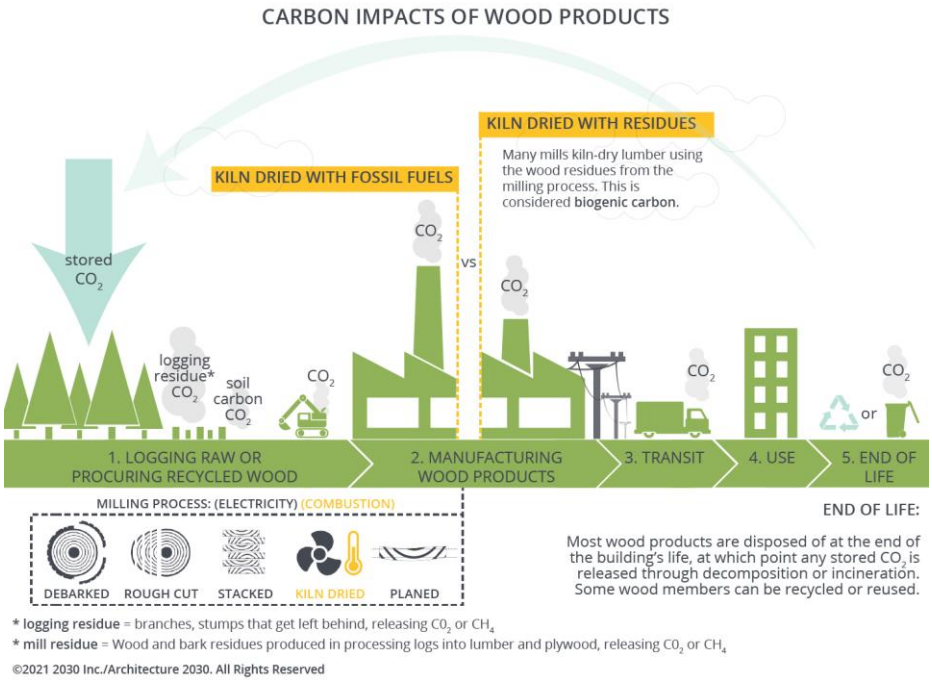


Fig. 25: Carbon impact of Wood Products, Carbon Smart Materials Palette: https://materialspalette.org/wood/

EMBODIED CARBON

Total plywood: 5080.2 kg

	Carbon factor with carbon storage ($kgCO^2e/kg$)	Of which carbon storage ($kgCO^2e/kg$)	Carbon factor without carbon storage ($kgCO^2e/kg$)	
Timber, Plywood	-0.93	-1.61	0.681	ICE 2019

Embodied Carbon with carbon storage =5080.2*-0.93 = **-2724.586 $kgCO_2e$**

Embodied Carbon without carbon storage =5080.2*.681 = **3459.616 $kgCO_2e$**

4.3 Comparison and conclusions

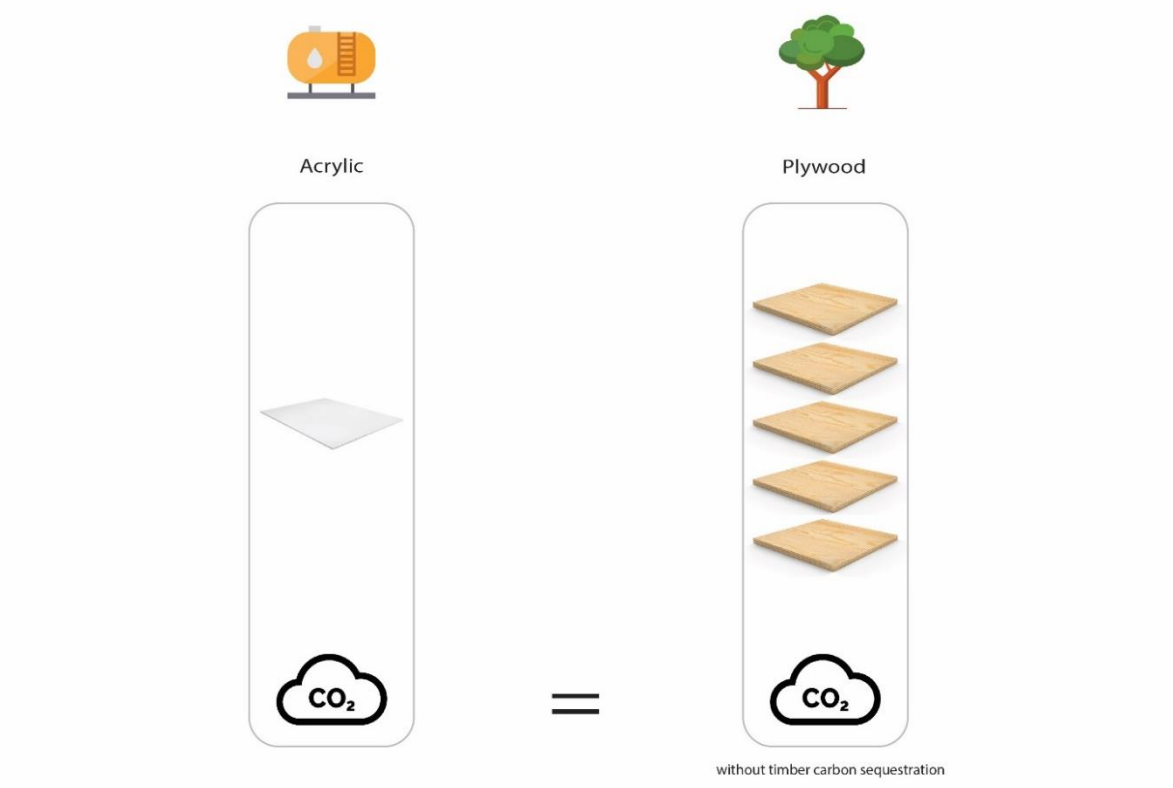


Fig. 26: Diagram comparing embodied carbon intensity of acrylic/PMMA and softwood plywood

4.4 Proposals for change

This research team has compiled a list of ideas, proposals and further questions and research opportunities, which is presented below. This is to summarise the findings in a way that directly addresses students' and staff concerns at the BSA and to spark conversations in order to continue to move forward.

Procurement and supply chain proposals

- Demand greater transparency from suppliers over the source of materials; students and staff should have freedom of access to information regarding where materials have come from and their impacts.
- More rigorous assessment of suppliers from both social and environmental perspectives, prior to creating a contract.
- Enhance communication between different parts of the school to promote 'sharing' of resources – this will reduce the need for suppliers or procurement in the first place and save costs too.
- Currently only direct suppliers are asked to set up a Net Positive sustainability plan. This could be expanded to also incorporate indirect suppliers to give a better overview of material chains of custody.

Impact Assessment proposals

- Communicate simple embodied carbon and GHGs equivalent number with each material price in B-made shops.
- Better recycling and waste bins throughout the workshops (and the school in general) and improved labelling and education on what goes in which bin (B-made staff to be trained on this to best support students who might not know.
- Create a small group or community of staff/tutors and students that specialize or would like to specialize on LCA, and maybe even provide LCA services to other institutions or individuals.
- Communication of impact assessment – how can we frame this in a way that is easily understandable and allows students to compare potential impact of individual materials?
- Although **embodied carbon** might be a more universal approach to quantify the environmental impact of products or buildings especially in the construction industry, for B-made materials, information on **embodied energy** might be more relevant, available and reliable, since half of the materials are not common building materials to be registered in the ICE or other carbon factor databases.
- More research needs to be done to understand the scope of assessing embodied energy and understand it could be used in visible spaces to inform students and tutors the environmental impact of the specific material.

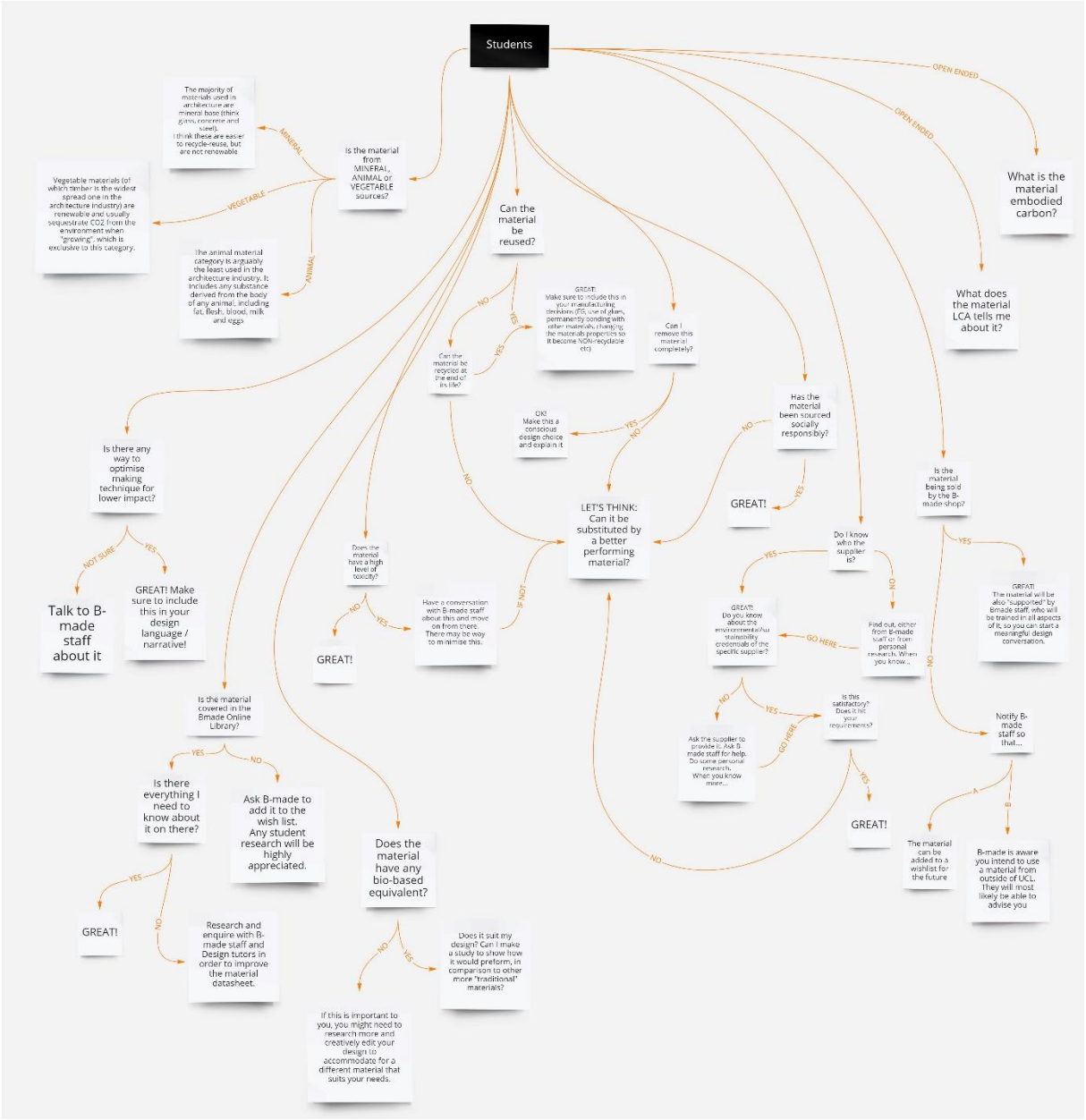


Fig. 27: Mind-map for students when selecting a material to use (zoom in for more detail)

Selecting which material to use

The diagram above proposes some questions for students to consider when selecting a material. The team acknowledges that this is a simplified version of a complex process. It is intended to offer suggestions and raise questions, rather than provide clearcut solutions.

It could be interesting to see this introduced formally either by B-made or making it accessible as an online tool/checklist of “things to watch out for/things to consider” for students approaching making.

4.5 Tools and Databases for Assessment Methodologies

Assessment tools in the construction industry

The Structural Carbon Tool is an open-source Excel-based carbon estimator. The tool includes stages A1-4, C2, C3, C4, D. The material catalogue is based on ICE database, and there is option to add data for custom materials. There could be possible application of this tool to B-made tracking, as input of materials quantity is not by building or extracted from modelling, are simply based on kg or volume. The schemes comparison page can also easily model the elimination in certain material and the overall change of the annual carbon data of B-made.

The Structural Carbon Tool Version 2 - The Institution of Structural Engineers (istructe.org)

- FCBS CARBON is distributed as a beta version to provide guidance at early stages of building design. It is intended to provide a consistent methodology to understand the magnitude of design decisions, enabling whole life carbon to be compared between different options. The tool is provided as a macro enabled spreadsheet; please ensure you enable the macros to experience the full functionality of FCBS CARBON.

  The tool has been developed by FCBStudios Ltd using carbon factors derived from the Inventory of Carbon and Energy (ICE) database and Environmental Product Declarations (EPDs). FCBSCarbon (fcbstudios.com)

- H\B:ERT is an easy-to-use open-source Revit-based tool that enables design teams to quickly analyse and clearly visualise the embodied carbon emissions of different building components and construction material options at any time during the design process.

  H\B:ERT works by measuring the volume of all materials tagged in the Revit model. It then applies embodied carbon data to that material, broken down into life cycle stages (product, construction, use stage and end of life) in line with BS EN 15978:2011.

  H\B:ERT V1 (V2.1.5) aligns with the RICS and RIBA guidance and currently uses the Circular Ecology ICE database, but can use alternative data where available. Hawkins\Brown: Emission Reduction Tool (hawkinsbrown.com)

- The Inventory of Carbon and Energy commonly known as 'ICE', is an open-source material carbon factor database. It contains UK-specific data as well as European and global averages, based on EPDs. https://carbon.tips/ice3

- Built Environement Carbon Database (product-level database) www.becd.co.uk

- BRE Verified BS EN 15804 EPD https://carbon.tips/breEPD

- BRE IMPACT https://carbon.tips/umx

Proposal: Make available EPD library information for shop or students' reference

- Environdec: https://www.environdec.com
- Institut Bauen und Umwelt: https://ibu-epd.com/en/published-epds/
- EPD Ireland: https://www.igbc.ie/epd-search/ • BRE Green Book Live: http://www.greenbooklive.com/
- Carbon Leadership Forum: http://www.carbonleadershipforum.org/resources/
- ECO Platform: https://www.eco-platform.org/list-of-all-eco-epd.html
- Transparency Catalog: https://www.transparencycatalog.com/
- Climate Earth: https://www.climateearth.com

5.0 QUESTIONNAIRE AIMS, STRUCTURE, PROCESS AND RESPONSES

5.0 Questionnaire Aims, Structure, Process and Responses

5.1 Aims of the Questionnaire

In our first research team workshop, a questionnaire was chosen as one of the key methods to bring out creative ideas from students and staff of all kinds across the BSA.

A sub-group was formed to create, conduct and analyse the research Questionnaire:

Understanding Sustainable Materials at the Bartlett School of Architecture

The aims of the Questionnaire reflect the research group's aims:

- Understand existing sustainable Materials culture at the BSA, in teaching, learning and in B-made workshops and shops
- What do people think the BSA does well?
- What could be improved?
- Proposals for change?
- What questions would people like to put to BSA leadership?

5.2 Questionnaire Structure

The anonymous Questionnaire was kept as short as possible to encourage as many people as possible to participate and draw out as wide a variety of responses as possible, with no identifying personal details.

The Questionnaire was divided in two parts, students and staff.

- Student participants entered which programme they were on and which year.
- Staff participants shared which programme/s they are involved with.

All participants then answered four questions about BSA's Materials culture including materials teaching, learning and B-made facilities.

Question 1: How would you define the term 'sustainable materials', what does it mean for you? Feel free to give as broad an answer as you like.

Question 2: What do you think the BSA does well in terms of a sustainable materials approach, including teaching and learning (any programme) and/or B-made shops and workshops? Please list as many aspects as you like.

Question 3: What changes or improvements would you like to see in materials teaching and learning, supply and use across the BSA and/or B-made shops and workshops? Please make as many proposals as you like.

Question 4: What questions would you like to ask BSA decision makers about sustainable materials teaching, learning and use? Again, please list as many questions as you would like.

5.3 Questionnaire Process

For all programmes, and all staff, the Questionnaire was structured to be inclusive, so that all staff (teaching, research, professional services, leadership and management) and all students from any programme could participate, and contribute their thoughts, opinions, proposals for improvement, and questions to put to leadership and decision-makers.

The group prepared a low-risk ethics application and information sheet for the UCL Ethics Committee, which was approved.

The Questionnaire was emailed individually to every member of BSA staff to ensure all staff had the chance to participate (staff emails accessed via the BSA website, People > Leadership, Academics, Professional Services, with a request to pass it on to students and other staff).

The following week, permission was also given by the school to share the Questionnaire with students through programme administrators, so that it was then shared more formally with the BSA student body.

Participants' answers to each question were analysed, classified and shared in this report, in relevant sections and summarised below.

5.4 Questionnaire Responses

The questionnaire elicited direct original data. In total, **42 students and 52 staff** completed the questionnaire.

The full results (anonymised) are in the Appendix.

Participants were first asked to state whether they were staff or student, and which programmes/modules they were involved with.

Q Staff: What program are you involved in the BSA? If more than one, please list all of them. (E.g. Bio-Integrated Design MArch, Architectural History MA)

Q Students: What program are you studying and in which year? Please do not abbreviate. (E.g. Bio-Integrated Design MArch/Year 2)

Then **4 open-ended questions** were asked on the BSA's materials culture, teaching, learning and use, to bring out thoughts and ideas, proposals for improvement, and questions to put to senior leadership.

Below are responses unanalysed to each question. These responses were analysed and integrated into relevant chapters and findings in the report, given here for reference.

Question 1: How would you define the term 'sustainable materials', what does it mean for you? Feel free to give as broad an answer as you like.

Q1 Staff responses

Lifecycle

- Able to not pose additional damage to environment throughout its life cycle (from extraction, processing, forming, manipulation, deployment, etc.) from cradle to cradle.
- Able to return as raw material
- Able to be disconnected or adapted within its lifecycle.
- Have resilience and regenerative qualities.

Carbon

- Low/zero/negative carbon impact

Energy

- Have natural energy flows
- Have passive energy design principles

Ethical Responsibility

- Ethically sourced with known origin
- Contribute to the sustenance of people's life
- Economically sustainable

Ecological Impact

- Its extraction is not damaging to the ecology
- Able to be reciprocated.
- Minimal or zero impact to environment.

Recyclability/reusability

- Able to be recycle, reuse, repurpose, infinitely with minimum additional energy consumption.
- Can be use as part of a circular economy

Bio/Natural

- Can co-exist with nature

- Can be regrown
- Came from replenishable/renewable sources
- Non fossil fuel based sources
- produced by processes that actively regenerate the biosphere and able to break down and return to the biosphere at the end of the their useful life.

Non-toxic/no VOCs
- Minimum impact on health.
- Safe as static material as well as when machined.
- VOC free

Waste
- Able to biodegrade

Other
- Incorporate holistic and intersectional approaches

Q1 Student responses

Lifecycle
- Have a long life cycle or circular life cycle.
- Able to return as raw material
- Regenerative

Carbon
- Low/zero/negative carbon impact

Energy
- Have low embodied energy

Ethical Responsibility
- Ethically sourced with known origin
- Does not displace and disrupt local and/or indigenous communities and non-human inhabitants

Ecological Impact
- Its extraction is not damaging to the ecology
- Able to be reciprocated.
- Minimal or zero impact to environment.

Recyclability/reusability
- Able to be recycle, reuse, repurpose, on a human time scale.

Bio/Natural
- Made from biodegradable and organic substances
- Came from replenishable/renewable sources

Non-toxic/no VOCs

- Non-toxic and non-polluting
- Able to contribute to a healthy ecosystem if it decays.

Waste

- Minimum waste.
- Can be composted/degradable.

Other

- Affordable/cost efficient
- Part of a circular economy
- Do not cause damage ecologically, socially, economically.
- Its rate of consumption does not exceed its rate of regeneration

Question 2: What do you think the BSA does well in terms of a sustainable materials approach, including teaching and learning (any programme) and/or B-made shops and workshops? Please list as many aspects as you like.

The responses to Question 2 were used to develop the content in Chapter 2.

Question 3: What changes or improvements would you like to see in materials teaching and learning, supply and use across the BSA and/or B-made shops and workshops? Please make as many proposals as you like.

Q3 Staff responses

General

- Present sustainability as a core part of the school.
- New environmental/sustainable leadership.
- More technical training for staff (not just design tutors).
- Acknowledge limitations and shortcomings from existing frameworks, including space.
- Interaction between facilities (Gordon St, Here East, and Filmwell Park)
- Teaching and Learning

Compulsory / Embedded In Each Course

- Incorporation of efficiency of material use in the learning process.
- Mindfulness in the use of materials for model making and printing.
- Shift towards environmental design approaches.
- Addressing climate emergency in examination and course criteria.
- Realistic design approach on sustainability instead of idealistic and opportunistic greenwash projects.
- Less overseas travel

- Incorporation of life cycle in design learning process.
- Incorporation of embodied carbon and energy in design learning process.
- Unified approach between theory, history and technology.
- Modules focusing on material innovation/sustainable materials.
- Early introduction of the subject to undergraduate students.
- Encouragement towards the use of environmentally friendly and recyclable materials.
- Encourage model-making with compostable materials such as (food-based alternative) to allow for valuable processes of iteration and test that can then be disposed.
- UCL to recruit and fund additional external world-leading expertise through fair recruitment processes to help teach the modules relating to sustainability.
- BSA to provide students with practical and critical education, enabling them to respond to real, authentic and urgent climate issues.
- Engage in “real architecture” and “real materials” rather than staying in an abstract concept.
- Teaching materials that is transferrable to practice in real world.

Additional

- Induction
- Campaign
- Workshops
- Online Teaching and Learning Resource
- Lecture Series
- Exhibitions/Summer Show
- Incorporating lifecycle of the physical prototypes of the projects presented
- Reusable walls
- Support and communication from exhibitions and fabrication team

B-made Practices:

Making and Material Processes

- Testing facilities
- Encourage conversations on searching for better practices rather than giving a set of restrictions.

Material Procurement

- Provide options to alternative “sustainable” material
- Cataloguing materials based on its “sustainability”
- Incorporation in material libraries
- Procurement allocated for climate emergency based purchases
- Source local materials
- Source certified supplier
- Labelling to indicate energy/carbon use.
- Labelling to indicate ethical labour sources.
- Establish materials bank to borrow rather than buy

Waste

- Raising awareness of waste (storage, labor, and ecological impact)
- Pay more attention to end of term studio clearance
- Acknowledging that 'novel' materials are often a blend of materials that become inseparable and therefore impossible to recycle.

Circular Economy / Reuse / Recycle

- Publicly and loudly say the aim is to achieve 100% recycling of materials
- Paying close attention to demolition of buildings and harvesting materials to enable efficient reuse.
- Removal of non-recyclable materials
- Publish how recycling is currently done.
- Accountability to staff and student that doesn't comply.

Sustainability Assessment

- Full environmental impact assessment undertaken by independent group (I.e., URGE)
- Publication of annual impact assessments in BSA.

Materials – Specific:

Cement/Concrete

- Acknowledgement that there is a high level of ingrained bias based on industry share/power.

Acrylic

- Bring back acrylic in a sustainable way.

Balsa Wood

- Potentially supplied from waste stream from other industry (I.e. Surfboard manufacture).

Others

- Encourage diversity within the school
- Hiring experts in environmental design on a full-time basis
- Integration of technical knowledge from people with industry knowledge/skills.

Q3 Student responses

General

- Open campaign

Teaching and Learning:

Compulsory / Embedded In Each Course

- Mindfulness in the use of materials for model making and printing.

- Incorporation of life cycle in design learning process.
- Modules focusing of material innovation/sustainable materials.
- Encouragement towards the use of environmentally friendly and recyclable materials.
- Encouragement towards sustainable fabrication throughout design process.
- Incorporation of sustainability as part of design thinking.
- Have environment lectures integrated into the module.
- Acknowledge limitations and challenges of sustainable materials.

Additional

- Induction
- Campaign
- Workshops
- Online Teaching and Learning Resource/Open Class
- Lecture Series
- Summer Show
- Formatting to certain extend so some parts are reusable (I.e frames, mounting, etc.).
- Open discussions with other programs
- Notice board or forum

B-made Practices:

Making and Material Processes

- Testing facilities
- Provide organic and bio-based materials and growing facilities
- B-made should encourage the understanding of carbon footprint related to specific techniques and making processes.
- Time, labor and accessibility must play a part in choosing any material and making processes.
- Improvement in advocating for sustainable material that is well integrated into practice.

Material Procurement

- Catalog of existing materials with their benefits / limits
- Cataloguing materials based on its “sustainability”
- Provide options to alternative “sustainable” material
- Publish statistics and data on all B-made materials
- Labelling to indicate energy/carbon use.
- Subsidised budget for materials so it’s affordable
- Decline the supply of unsustainable material.
- Consultation with the student body in regards to stock.
- Publish where materials are coming from.

Circular Economy / Reuse / Recycle

- Provide access to scraps/half used/off cuts collected from the building or donated.
- Provide access to recycled materials.

- Provide methods of recycling materials, using scraps, and using less materials.
- Guidance on how to recycle.
- Provide program or a platform to share items between students.
- Provide knowledge about secondhand materials
- Provide space for students to keep materials over the summer
- Encourage the reuse of scraps/half used/off cuts to buying new ones.

Materials – Specific:

Wood
- Expand on options for larger pieces

Acrylic
- Be careful on banning certain materials, it may set a restrictive precedent.

Others
- Display different materials or techniques in common areas
- Invest in B-made teaching staff

Question 4: What questions would you like to ask BSA decision makers about sustainable materials teaching, learning and use? Again, please list as many questions as you would like.

Q4 Staff responses

General
- How to develop staff capacity to support this subject?
- Can this subject be the core and written into staff job description?
- are the right people being brought into develop the BSA's policy in this subject?

Teaching and Learning
- Can we have open discussion of the subject within each course?
- Can we have more student-led in the way to approach this subject?
- Can we integrate the subject in modules brief?
- Can we make the subject central to design as form and function?
- Should we put emphasis in architectural education to the reuse of buildings rather than new build?

B-made Practices:

Making and Material Processes
- How do we reconcile with our spending on capital equipment that has no engagement with sustainability?

Material Procurement

- Can sustainable materials be subsidized so it's cheaper than less sustainable one?
- Is it so much about providing sustainable materials or a sustainable cycle of materials?

Sustainability Assessment

- How can we reach an accurate Sustainability Audit?

Materials – Specific:

Cement/Concrete

- What is done so far to find alternatives to concrete?

Q4 Student responses

General

- What prevents you from implementing sustainable materials practice?
- Why aren't sustainable building materials the standard yet?
- What strategies does the school currently have in place to reach its net zero target?
- What are Bartlett goals in terms of sustainability?

Teaching and Learning

- How can encouragement of the use of sustainable material be useful in learning process?
- How to incorporate the subject into existing modules?
- Can we have separate modules focusing on the subject?
- How to balance consideration in sustainability and creative freedoms in learning process?
- How to change the model making approach to be more sustainable?
- Can we learn about software/computational tools to help measure the subject the environmental impact of materials?

B-made Practices:

Material Procurement

- Why are we provided with the materials that we have now?
- Is there any way to reduce the price of material?
- Are the more sustainable alternatives have similar cost-efficiency to less sustainable one?

Waste

- What happens to the non-recyclable materials that are dumped after every course ends?
- What is done with leftover materials?
- What can be done to the models and materials discarded after the end of each year/the summer show?

Sustainability Assessment

- Can we be more transparent about BSA consumption of materials?

Materials – Specific:

Wood

- Since it considered safe option, will it still be sustainable if everyone use wood?

Plywood

- Can plywood be made with nontoxic glue?

6.0 CONCLUSIONS AND NEXT STEPS: PROPOSALS FOR CHANGE

6.0 Conclusions and Next Steps: Proposals for Change

The findings of the three research sub-groups are set out in this report to present proposals for actions needed across the BSA, for a sustainable materials culture as part of the Bartlett Journey to Net Zero 2030.

There are many things that students and staff think the BSA does well around sustainable materials culture, teaching, learning and research. However, research shows there are also gaps in teaching, learning and opportunities on materials generally that would help the BSA and The Bartlett Faculty develop a sustainable materials culture as part of its Net Zero 2030 commitments.

It also seems clear from this research that the desire and support for a sustainable BSA materials culture exists across the school.

It is also clear that the mandate for this change exists – in global scientific consensus, commitments from BSA senior leadership and support at all levels of Bartlett School of Architecture staff and students, strategies and commitments in The Bartlett Faculty and across UCL, as well as from ARB, RIBA, Landscape Institute and all chartered institutions, and governments at UK, European and international level.

Proposals recognise that change is difficult and needs action top-down as well as bottom-up. It is important to recognise opportunities and limits at each level to take action. It is very hard for a delivery level such as B-made to set strategic direction, if not impossible.

Strategic change needs strategic direction and leadership, to give other levels a mandate and scope for action. All students, B-made and other staff can play a significant role doing what they can, while advocating for change. But key leadership staff have greater power to set direction and mandate those changes, giving a framework to support action and delivery.

It is really inspiring to remember though that when students and staff work together, great leaps in understanding, relevance and application can be achieved. Ultimately, what direction the school takes lies with school leadership, as well as all staff and students in a collaborative and interdisciplinary approach, to take the school into a more sustainable future.

This research group believes the actions recommended below have the potential to unlock real change and enable the Bartlett School of Architecture to

- create an inspirational materials culture and
- lead on action on sustainable materials teaching, learning, research and use
- share this leadership with other schools, institutions and organisations globally

Through the following steps:

1) Instigate a process for positive, inclusive, collaborative, interdisciplinary school-wide discussions on materials and BSA materials culture generally – what do people think about materials relating to teaching, learning and research? The commitments made by UCL, The Bartlett Faculty and the school itself to implement change? What actions could be implemented?

2) Integrate students and staff at all levels into this strategic development process, which should also include timing on implementing any changes recommended

3) As part of Bartlett Net Zero 2030 and drawing on existing standardised processes, and to enable comparison and proportionate responses without limiting educational and research potential, develop a process to monitor, analyse and act on:

    a. data on energy consumption by use, in 22 Gordon Street and Here East, including operational energy (heating, cooling, lighting etc) as well as activities such as in B-made workshops by machine

    b. energy and carbon impact of procurement, services, travel, and other activities by the BSA

    c. assessment of materials generally, their embodied energy, ecological footprint and any other relevant sustainability criteria, drawing from existing data and research, especially those materials commonly used in the built environment - globally not just in western/industrialised cultures and contexts, so including materials such as earth-based, timber, straw etc.

    d. assessment using the same criteria of materials used within the BSA, either through B-made workshops and shops, or otherwise

    e. develop from this a 'traffic lights' information and communication process on a wide range of materials – whether in teaching and learning, research or use – to enable students and staff t make informed decisions around materials in design, research, use and in other ways

4) Based on this, develop and publish a clear, simple, deliverable BSA Sustainable Materials Strategy enabling BSA, Bartlett and UCL existing commitments and any additional agreed steps to be put into action

5) Open up opportunities for existing staff with skills and knowledge to deliver and expand sustainable materials teaching, learning and research, including training of trainers

6) Offer training and development as appropriate to teaching and technical staff to increase confidence, knowledge, skills, practical experience and expertise within the school

Recap of some of the other specific proposals

These are some proposals previously mentioned, drawn from questionnaire responses:

- Can the consideration of the life cycle of materials be an important future theme at the Bartlett (including design tools)?
- Can we be more student-led in the way we approach design and history & theory?
- Why is it not a compulsory part of brief writing in design modules? Can we integrate material research more into the design modules and what support at UCL would there be for this?
- What is being done to ensure sustainability becomes as central to design as form and function?
- Should there be a change in emphasis of architectural education to the reuse of buildings rather than new build?
- Please provide a materials library where things can be seen in different formats and sizes, tested and manipulated by students.
- How can we... 1) enable students to integrate proper impact assessments into design decision-making 2) develop staff capacity to support students to do this 3) examine and develop concepts and vocabulary that enable proper, meaningful discussion about the impact of architecture and design as a starting point for all courses.
- Why is proven technical knowledge not a prerequisite for leading a design unit on the BSc Programme? - Why is routine training - on core subjects such as social justice and climate science, as well as sustainable materials - not written into the Job Description of staff, and provided as mandatory for all teaching staff?
- When and how are these materials going to become part of the design teaching.
- Encourage collaboration and on-going conversations between program leaders, modules coordinators, unit tutors and students, to allow a more fluid system of knowledge sharing to skill up and learn from each other's expertise.
- Encourage a shift towards a more resilient and risk-taking mindset that does not shy away from testing, and exploration into different materials and making methods dure to fear of failure.
- UCL and BSA to provide time and platform for students and staff to skill up and learn new skills and methods of making outside of the structure of units, modules and programs.
- BSA to identify gaps in knowledge and expertise when it comes down to sustainable methods of making, and therefore to address that by hiring experts outside of architectural field to share their knowledge.
- To create a non-hierarchical system for decision making and setting out assessment criteria that is inclusive, and transparent.
- Possibility for student and staff to participate in courses or workshops related to UCL such as this: https://www.ucl.ac.uk/short-courses/search-courses/conducting-life-cycle-assessment-lca-theory-practical-application
- Production of a comprehensive glossary of terms that is widely available and easily accessible by both student and staff so that these conversations can become more meaningful and happen more often. The group has produced and initial list of terms (presented in the report appendix) and strongly encourages this to be built on

through further funding and research. The glossary could exist on Moodle, the B-made website and/or as downloadable PDF for personal reference.
- Expanded digital material library to include bio-based materials etc.
- Monitoring of energy produced by workshop equipment. Currently this information is unknown and could be useful in future decision-making processes about materials and machines used in B-made.
- Addition of a new materials culture section in the workshop induction: using information gathered in this report and elsewhere, could B-made introduce the concept of sustainable materials practice in the workshop induction to get students thinking about their material choices from the time they start using the workshop? B-made has the potential of seeing up to 65 students being inducted per day a. This is an opportunity to provide baseline information to a wide range of students on materials culture within the Bartlett.
- Implementation of QR codes attached to all materials sold so that one can learn more and compare between all materials and their environmental credentials. Additionally, a more general information sheet explaining materials culture could be useful in the shop.
- Expansion of the material library to include equal representations of animal, vegetable, and mineral materials.
- Making a system that provides more transparency on supplier and materials selection process – this might mean answering questions such as: why has this material been selected over another? Why is this material being priced as it is in the B- Made shop, while it can be found elsewhere at a more competitive price? What are the supplier's credentials?
- More detailed recording of sales to students, as well as orders made from suppliers. This will allow trends to be identified and might promote more informed decision making to be made regarding choice of supplier or when switching to a new supplier. For example, if B-made can demonstrate that a certain number of orders of a certain product will be made in a given time period, then suppliers may be more ready to provide that product.

The research team hopes this report provides some information and evidence to support the framing, to help deliver these suggestions for change.

This research shows there is huge support for this strategic direction across the school.

More work is needed and is beyond the scope and time for this research and report. This could include restarting the school's commitments in 2019 contained in its declaration of a climate and ecological emergency, of all-school collaborative conversations and workshops, exploring opportunities for development and change together.

Ultimately, changes need direction and support at leadership level – staff and student leaders – as well as delivery levels such as B-made workshops and shops, programmes and modules. For a BSA sustainable materials strategy as part of the journey to Net Zero 2030, an all-school collaborative, interdisciplinary process with staff and students would help bring the school together for a more sustainable future.

7.0 GLOSSARY

7.0 Glossary

Methodologies and systems

LIFE CYCLE ASSESSMENT (LCA) (istructe.org) A method to quantify the carbon emissions and other environmental impacts (such as acidification and air pollution) of assets or products over their whole lifecycle (Building on LETI (2020) Climate Emergency Design Guide [Online] Available at: www.leti.london/cedg)

ENVIRONMENTAL PRODUCT DECLARATION (EPD) (istructe.org) A third-party verified, standardised document that provides the environmental impact of a product, based on the data from an LCA.

CIRCULAR ECONOMY (istructe.org) A circular economy is based on the principles of designing out waste and pollution and keeping products and materials in use, e.g. refurbishment, reuse, design for adaptability/deconstruction (REF https://www.istructe.org/ Adapted from Ellen MacArthur Foundation (2017) What is the circular economy? [Online] Available at: www.ellenmacarthurfoundation.org/circular-economy/what-is-the-circular-economy)

CHAIN OF CUSTODY The FSC chain of custody (CoC) is the path taken by products from the forest, or in the case of recycled materials from the moment when the material is reclaimed, to the point where the product is sold with an FSC claim and/or it is finished and FSC labelled. The CoC includes each stage of sourcing, processing, trading, and distribution where progress to the next stage of the supply chain involves a change of product ownership. (FSC Chain of Custody Certification FSC-STD-40-004 V3-1 EN)

GREENHOUSE GAS (GHG) EMISSIONS/ CARBON EMISSIONS (istructe.org) Emissions of gasses including carbon dioxide, methane and water vapour that trap heat in the atmosphere. The global warming potential (GWP) of these gasses is measured in CO2 e (carbon dioxide equivalent).

EMBODIED CARBON (EC) (istructe.org) The GHG emissions associated with materials and construction processes throughout the whole lifecycle of an asset (Modules A1–A5, B1–B5 and C1–C4).

OPERATIONAL CARBON (OC) (istructe.org) The GHG emissions arising from all energy and water consumed by an asset in use, over its lifecycle (Modules B6 and B7)

UPFRONT CARBON (istructe.org) GHG emissions up to practical completion, excluding sequestration (Modules A1–A5)

WHOLE-LIFE CARBON (WLC) (istructe.org) The removal and long-term storage of CO2 from the atmosphere in biomaterials such as timber. The carbon stored in these materials is known as biogenic carbon.

CARBON CAPTURE AND STORAGE (CCS) (istructe.org) Process to capture the CO2 arising from fossil fuel combustion or industrial processes, transporting it to a storage site and storing it where it will not enter the atmosphere.

Materials

BIOGENIC MATERIAL A subsection of natural materials. For example, both stone and timber are natural materials, but differ in the way that they can absorb carbon as they 'grow'.

NATURAL MATERIAL A material that doesn't involve man-made processes in its inception but can still undergo manufacturing/manipulation to suit construction needs. [TBC]

REUSABLE MATERIAL (ISTRUCTE.ORG) To use a product again while largely maintaining its original form. Unlike recycling, reuse requires minimal reprocessing.

RECYCLED CONTENT (RC) (ISTRUCTE.ORG) A measure of how much material within a product is from a non-virgin source.

RECYCLING RATE (RR) (ISTRUCTE.ORG) Indicates how much of a product is collected and returned to the manufacturing process. A high recycling rate reflects that the product is technically recyclable and that the market infrastructure exists for it to be reclaimed.

Targets

NET ZERO (istructe.org) A net-zero-carbon asset is one where the sum total of all asset-related GHG emissions, both operational and embodied, over its lifecycle including disposal (Modules A1–A5, B1–B7, C1–C4), plus offsets, equals zero. Minimising emissions should always be prioritised over offsetting

ZERO CARBON (istructe.org) An asset, product or service that produces no carbon emissions and therefore no offsetting is required. Also known as carbon zero, absolute zero, or gross zero.

CLIMATE POSITIVE (istructe.org) An activity that goes beyond net zero by achieving an overall reduction in GHGs in the atmosphere. Also referred to as carbon negative.

CARBON OFFSETTING (istructe.org) The use of GHG emission reductions or removals to compensate for CO2 emissions.

APPENDIX A

UNDERSTANDING SUSTAINABLE MATERIALS AT THE BARTLETT SCHOOL OF ARCHITECTURE: QUESTIONNAIRE RESPONSES JULY 2022

Appendix A: Questionnaire responses in full

Understanding Sustainable Materials at the Bartlett School of Architecture

All responses are given here exactly as entered in the questionnaire.

Programmes

STAFF: What program are you involved in the BSA? If more than one, please list all of them. (E.g. Bio-Integrated Design MArch, Architectural History MA)

DFPI, MArch AD, MEng EAD, MSci
Design for Manufacture
B-made so all programs
B-made
MArch PG Unit tutor, PhD architectural Design
B-made
Making cities, PhD supervision
Urban Design MArch (B-Pro)
U/G tech lectures, MArch studio, PhD, PGCAAR etc.
Design for Performance and Interaction , Design for Manufacture, MArch Architecture
MArch Architecture/ Landscape Architecture
MArch
Mahue
B-Pro
All programmes (B-made staff)
MA Architectural History and PhD
Bsc Architecture, Bsc AIS, MArch AH, MAHUE, Bio Id, Space Syntax.
AIS
MSc/MRes Space Syntax Architecture and Cities; MSc/MRes Architecture
BSc Architecture (ARB/RIBA Part 1), MArch Architecture (ARB/RIBA Part 2), MA Architectural History
All programmes
MArch Meng
Architecture Bsc, Architecture Msci
MA Situated Practice
MSc
BSc Architecture & MEng Programmes
MArch / Part 2, Architectural Design MArch, Bio-Integrated Design MArch
Architecture BSc (Design Technology), Architecture MSci
Dfm, BioID, Bmade Robotics
Bio-Integrated Design
Bio-Integrated Design MArch/MSc, BPro Architectural Design MArch

BSc, MArch, MA Architectural History, MA ASrchitecture and Historic Urban Environments, PhD
NA
Bmade
MArch (Architecture), MPhil/PhD
MArch, MA/MLA
MArch Architectural Design
All BSA PhD programmes, MA Architectural History, MA Architecture and Historic Urban Environments, MSc/MRes Space Syntax: Architecture and Cities.
MArch
NA
School of Architecture
BSc AIS, PhD AD and H&T
MArch, MASP, MAAH
BSc Architecture
MEng Masters of Architecture and Engineering, MArch (ARB / RIBA II), BSc (ARB/RIBA I)
B-made
Architecture undergraduate
Design for Manufacture, Meng, BMade
Bio-Integrated Design MArch and MSc
BSc Architecture, BSc Architectural and Interdisciplinary Studies, MA Situated Practice, MArch Architecture
BSc
BSc Architecture, MEng Engineering and Architectural Design, MArch Architecture

STUDENTS: What program are you studying and in which year? Please do not abbreviate. (E.g. Bio-Integrated Design MArch/Year 2)

MA Architecture and historic urban environments
MA Architecture and Historic Urban Environments, Year 1
Architecture and Historic Urban Environments MA/Year 1
Master in Architecture and Historic Urban Environments
MASP/Year 1
MASP/Year 2
Situated Practice MA Year1
Architecture MArch/Year 4
MArch/Year 2
MAHUE
MAHUE 1 yr
Ma Architecture and Historic Urban Environments
MA Architecture and Historic Urban Environments / 1 year
Design MArch/Year 2
Bio-Integrated Design year 2
MArch Architecture/Year 5 (just finished)

Architecture MArch, Year 5
Design for Manufacture/Year 1
Design for Manufacture MArch/Year 1
Bio-Integrated Design MSc/Year 1
Bio-Integrated Design MArch/Year 1
Bio integrated design march year 1
Bio-Integrated Design MArch/Year 1
Architectural and Interdisciplinary Studies/ Year 3
Architecture BSc/Year 3
Architecture MArch/Year 4
Bsc AIS
Architecture BSc/Year 3
Architectural and Interdisciplinary Studies
Bsc Architecture/Year 3
Bsc Architecture - Year 3
Architecture BSc/Year 3 (Graduate)
Architecture BArch Year 1
BSc Architecture/Y2
Architecture BSc/Year 2
MArch Architecture/Year 4
BSc Architecture/Year 1
BSC Architecture
Design for Performance and Interaction MArch/Year1
MSci Architecture/Year 1
MArch Architecture Part 2 (Year 4)

Q1 How would you define the term 'sustainable materials', what does it mean for you? Feel free to give as broad an answer as you like.

STAFF:

Materials that can be quickly returned to the lifecycle as new raw materials, as well these materials are quite responsive to the environment with as, i.e. a lower CO2 footprint.

low carbon, bio - responsive, bio degradable, natural

I would have a cradle to cradle approach THE HANNOVER PRINCIPLES:

- Insist on the right of humanity and nature to co-exist in a healthy, supportive, diverse and sustainable condition.
- Recognize interdependence. The elements of human design interact with and depend upon the natural world, with broad and diverse implications at every scale. Expand design considerations to recognize even distant effects.

- Respect relationships between spirit and matter. Consider all aspects of human settlement, including community, dwelling, industry and trade, in terms of existing and evolving connections between spiritual and material consciousness.
- Accept responsibility for the consequences of design decisions upon human well-being, the viability of natural systems and their right to co-exist.
- Create safe objects of long-term value. Do not burden future generations with requirements for maintenance or vigilant administration of potential dangers due to the careless creation of products, processes or standards.
- Eliminate the concept of waste. Evaluate and optimize the full life cycle of products and processes to approach the state of natural systems, in which there is no waste.
- Rely on natural energy flows. Human designs should, like the living world, derive their creative force from perpetual solar income. Incorporate this energy efficiently and safely for responsible use.
- Understand the limitations of design. No human creation lasts forever, and design does not solve all problems. Those who create and plan should practice humility in the face of nature. Treat nature as a model and mentor, not as an inconvenience to be evaded or controlled.
- Seek constant improvement by the sharing of knowledge. Encourage direct and open communication between colleagues, patrons, manufacturers and users to link long-term sustainable considerations with ethical responsibility and to reestablish the integral relationship between natural processes and human activity.

The Hannover Principles should be seen as a living document committed to transformation and growth in the understanding of our interdependence with nature so that they may be adapted as our knowledge of the world evolves.

https://mcdonough.com/writings/principles-practices-sustainable-design

A sustainable material is one that has been selected for use not because it is 'green' or 'in vogue'. A sustainable material is one that has been chosen through careful consideration that takes into account the following: it has a total continuous lifecycle CO2 impact that is either negative (locks up more CO2 than it emits) or net zero (this would include extraction, manufacturing, transport, building life and recycling/renewal), ideally has low embodied energy in its manufacturing and in its upkeep, is an ethically sourced material (minimal environmental/ecological damage and is non-exploitative of the workers/community it comes from i.e. a fair price is paid financially and culturally [non-discriminatory]), and a sustainable material should be healthy for it's makers and users i.e. non-toxic/no VOCs etc.

Long lasting and working well with passive energy design principles

Low Carbon, Lifecycle consideration, Holistic, Design and material Reciprocation

Sustainable = capable of being replaced without a net carbon cost

In context of architectural education to me the use of materials is sustainable if it is necessary for the educational process, or used for essential parts of final presentation.

A meaningless term in itself. It depends on context and ecology of place. What manifests itself as a sustainable material here may be highly problematic there.

Materials that can be regrown (like timber) Materials that last for a very long time and can be recycled(like metal), Materials with high thermal capacity (like stone) Materials that are very good insulators (like cork and expanded hydrocarbons)

Materials produced, distributed and recyclable in a sustainable fashion, that is to say with minimum coat to the environment at the point of manufacture or at end of life

I really have a big problem with the word 'sustainable' - I think it should be substituted with 'less destructive' which I know is a hard sell! Less destructive materials would mean those that are renewable, so timber in the main; or biodegradable, for example vegetable-based plastics, mycelium & bio-rock.

Recyclable

Sustainable for bringing together all aspects related to sustenance: 1. of matter that is reusable / construction that can be disassembled; 2. of an origin that doesn't imply the consumption of further matter; 3. of extraction that is not damaging to the ecology; 4. of extraction that is not unjust on its workers; 5. on extraction that doesn't involve an imbalance of power; 6. that contributes to the sustenance of people's lives

The consumption of any material has an impact on the environment. Through its extraction > transportation from point of origin > processing into a raw material > transport to a reseller > transport from reseller to the end user > processing into a desired form > generation of waste. I don't think there is such a thing as a sustainable material, but its possible to have lower impact material and higher impact materials on the environment. The term sustainable to me means a replenishable source.

I work through an intersectional approach to architecture and sustainability. For me, and the students that I teach, this means:

- social, scientific, technological, cultural, artistic cultures and discipinary approaches that protect, research, prioritise, inculcate, make, support, participate in sustainability.
- an ethical approach that puts sustainability first. Again, this crosses, people, cultures, histories, practices, places, regions, nonhuman environments, disadvantaged communities, planetary resources, renewable energies, alternative technologies.
- I also work with historical, philiosophical, social, feminist, critical race theories -- what can be called 'new materialism' that sees matter as having agency beyond human technological power. This is because certain communities - women/ethic groups - can, and have been historically, associated as closely defined by and through matter (positively and negatively). I address these questions creatively and critically, and encourage my students to contribute to affirmative ways of working with sustainability and matter.

Materials with a minimal impact on health, the planet and building users.

One whose extraction, manufacturing, use, impact etc can be offset, regrown, rebuilt etc sufficiently to have zero or a positive impact on the environment

Materials that can be re-used without recycling and/or easily recycled

I regard the term as meaning either the reuse of recycled existing materials that are already in circulation, or else the use of new materials that come from replenishable, non-polluting, non-fossil-fuel based natural sources.

Materials made from ethically renewable resources that are capable of being used and recycled in a manner that doesn't deplete other resources. I look for evidence of sustainability when purchasing a product much more than I used to because I believe companies now have the duty and, importantly, the capability to be sustainable.

A material that has been considered in terms of where it will be used and where it is sourced, does not deplete a non renewable resource. A material that is considered in terms of energy usage, carbon footprint etc. A material that can be reused, repurposed, remodeled with the least at amount of additional energy being consumed.

Materials that come from renewable sources mostly and therefore they can be replaced easily. Materials that will not damage the environment throughout their life cycle and will allow future generations to use similar products with no damage in

the production, use or recovery chain.

Sustainable is a bit of a misnomer. Regenerative materials is a clearer alternative - materials that be produced by processes that actively regenerate the biosphere, and which break down and return to the biosphere at the end of the their useful life, without causing harm

materials that are produced with negligible negative impact on the environment using legitimate sources of labour

'Sustainable' suggests an absolute condition, ie: that a material labelled 'sustainable' can be extracted, processed, formed, manipulated and deployed, conscience-free, limitlessly, with no detriment to the Earth system. No material can possibly be so in any environment where resources - and energy - are limited. Rather, 'sustainable' can only be used as a term suggesting a conditional attribute imagined on a sliding scale where absolutes are rarely possible, ie: to what degree might a material be sustainable...?

Materials that can biodegrade or that can be recycled infinitely.

Sustainable materials are those that can be sourced in a way that is not harmful to the planet, does not deplete a finite resource, and does not produce large quantities of CO2 in its manufacture or transport. Using materials sustainably also requires consideration of the end of life of that material; how it is connected to other materials and can it be disconnected or adapted in a way that will prolong its usable life. I would also stretch the definition to encompass healthy materials that allow buildings to breathe and that do not emit VOCs.

Reduced carbon footprint

Materials whose production, life-span and end-of-life options are environmentally respectful, with no or minimum damage to ecosystems and species.

For me the is no 'sustainable materials'. It is a misleading term. There are only sustainable USE and REUSE of materials.

Sustainable materials to me are materials that can be used without doing harm to the planet or people in their extraction, processing, production etc.

To be able to defend the choice of material.

materials that are less damaging to the environment/ reusable / recyclable

Materials that do not diminish the Earth's resources and do not have a negative effect on biodiversity and the climate. Of course, it is now not enough just be sustainable. Instead, we need to focus on regenerative potential, when and where possible.

I would define this not merely as sustainable, but also to include the qualities of resilience and regenerativity, as materials are a key part of regenerative design. Also it's important not to look at single factors, such as carbon emissions, but to include the social, ethical, aesthetic, environmental, ecological dimensions. Economic sustainability as it's often defined actually serves usually to obstruct these other categories. Economic sustainability is far from the same thing as "financial viability" on a spreadsheet.

Net-zero, carbon neutral, regenerative

My understanding of Sustainable materials are materials that can be produced without depleting non-renewable resources and have a minimal/neutral impact to the environment and key natural resource systems.

Either a material that comes from sustainable resources or a material that can be recycled or reused in/within a sustainable process.

Materials that can be indefinitely recycled and/or be returned to the ground as waste without harming the environment indirectly and directly

Materials that have low embodied energy, low embodied carbon.

Causing little damage to the environment, during process of being made or when it is used.

Sustainably sourced - materials that are from renewable sources.

Materials that are sustainable in environmental, social, and economic terms. Ideally, the production, use, and disposal of these materials would be of both short term and long term benefit to where they are produced, used (re-used), and, if necessary recycled or disposed.

I would define sustainable materials as those that can be obtained / sourced and used without detrimentally impacting the future supply of world resources, this might be that a material can be used and easily recycled or better reused in another capacity. This should consider both how the final material can be used and the processes required to extract, and create and dispose the material in the first instance.

Sustainable in the context of B-made has a wide definition as it needs to include ecologically sustainable considerations such as carbon footprint, lifecycle, and other essential considerations like affordability to students but because of the specificity of what materials in the B-made shop need supply to keep the workshop operating, the definition also needs to consider things such as Health and Safety (for students and staff) to ensure that not just the static material is safe but that it continues to be safe when machined (does it create dust, if so is that dust safe (there are regulations and laws to consider in this area as well), does it create fumes, or does it off-gas, what COSHH considerations need to be considered in tandem, for example, how is it joined to other materials (glue and what kind of glue/mechanical fastening/welding etc.). Materials need to be considered for their suitability for the machining done in B-made (to avoid excesses waste, breakage or unintended consequences for things such as increased power consumption, or danger to staff with things like increase manual handling etc.). Materials choice should also consider how long it is used for as the end object. A plinth in the summer show has a 2 week life span, so what are the ethical, and environmental impacts of that sort of wasteage? If we were to, for example, replace MDF with plywood as a 'greener' material, we must also recognise that it only makes sense if plywood plinths are friction fit and disassemble-able because we cannot allow ply that has been previous fixed with fasteners to be used in B-made on the tablesaw (it was recycled plywood that cause the fire in the tablesaw at B-made in 2018 because undetected metal fasteners in the wood can spark, ignite the powder fine wood dust coming off of the sawblade as it machines and start a fire that gets sucked into the extraction system and fire is the number one threat to life in large buildings like 22GS. So if we make re-usable plywood plinths, are tutors and students going to accept something that isn't customised to their design each cycle (it will take a collective buy-in to this idea and considerations such as storage...items stored for summer show are driven to a storage facility by truck so there are practical and unintended footprints to all options). There is also the educational value to materials. We can and should certainly do more to source and encourage use of compostable model-making materials (such as food based alternatives) so that those students who are looking to make representational or conceptual models can develop their projects with models allowing for the valuable process of iteration and working with models to test out concepts while then being able to reliably 'dispose' of the materials of their model afterwards. However, there will also be instances where learning about welding for example or materials that are used in construction has a 'loss-leader' value in that the immediate carbon footprint may not be justifiable for a model just for the model's sake, but rather help that future architect or designer understand how to be more economical with materials or better understand making from a maker's perspective to improve their process of preparing real world designs for manufacturing and long-term viability.

Low carbon, VOC free and bio based materials

Materials that can be used as part of a circular economy: easily and fully recyclable or better yet: reusable.

A material that is produced, extracted, transported without causing harm or destruction to nature and people. A material that doesn't deplete our resources. A material that is ideally part of a circular economy

Materials that do not exhaust non-renewable resources, ecosystems, community resources. Sustainability should also account for embodied energy in the overall carbon footprint of a project.

Low, or ideally zero, carbon when considering both the raw material and all associated extraction/production/transport and processing costs (fabrication and finishing processes).

materials that have been produced using renewable resources

Q1 How would you define the term 'sustainable materials', what does it mean for you? Feel free to give as broad an answer as you like.

STUDENTS:

Reusable. Environmental friendly

Materials that can be recycled, reused or repurposed, either in their original form or through alterations and mutations.

materials with low/zero/negative carbon emission, ethically sourced, can be traced with responsible practice of harvest/production.

Materials that are produced with the least amount of negative impact on the environment, ethically and consciously sourced, and/or made of recycled materials.

The use/ reuse of materials to minimise negative ecological impacts. Thinking about materials in the design process to try to reduce waste and minimise carbon emissions etc

Materials that are minimally harmful to the environment and can be recycled

Materials can be reused, and materials in processing or production, do not produce a lot of other waste.

Materials that can either continue to be produced without a lasting effect on the environment or sourced by a means that doesn’t increase the demand of production.

Sustainable materials in the broadest sense are materials that do not cause irepairable damage to the social, economic and environmental fabric of the world. Instead they maintain the current condition.

The materials that contribute to or doesn’t harm the continuity of life - ecologically, socially, economically…

Something that can be used regularly without permanent damage to people or the planet

Materials with low carbon footprint and long life cycle or circular life cycle

Recycled materials, ecological

A 'sustainable material' is one that addresses questions of sourcing, use and disposal to minimise its impact on people and the environment.

Materials that are part of circular economy and does not harm the environment, they are made from biodegradable and organic substances.

Materials that have a low embodied energy and/or are renewable or use by-products/waste from other methods. Basically whether it belongs in a circular economy or has a low carbon footprint, both in processing and transport etc etc

'- materials that are renewable - materials that are sustainably and ethically harvested/sourced - materials that are biodegradable - materials that are used with longevity (as opposed to 'fast-materials' like 'fast-fashion' which have short life-spans and are discarded quickly)

Sustainable materials is that can be reused after a certain amount of processing

Materials that are as low as they can be in embodied carbon, both in producing them and transporting them to the supplier. In addition to this, the machines the materials are being used in combination with should be considered and whether a material with a different machining process that requires less energy could be used.

limited extraction and waste, circular economy (materials resulting from waste streams), safe and limited heavy labour practices & good salary, limited generated emissions overall (production, manufacturing, transport, assembly), non-toxic and non-polluting (ideally can contribute to a healthy ecosystem if it decays/ is demolished and returns to the ground), affordable

Sustainable material could be recycled at a low cost of energy or biodegradable.

Materials that have a low impact on the environment, that cause less harm and can be reused on a human time scale.

Materials that do not have a negative impact on the environment when being sourced, used, or after they are out of use.

Low embodied energy, natural, non toxic

natural materials that generate minimal amount of waste in tranportatation/process. Fully renewable. Degradable. Takes minimal amount of maintenance

'-Materials that are regenerative and does not negatively impact our environment, whether it be during its production process or end of life (for example, managed growing and harvesting and materials that can biodegrade after its intended use). -In my opinion, for materials to sustainable they need to be reused throughout their existing lifetime and so their life cycle management also plays an important role whether a material is sustainable or not (ie does it have proper recycling points and can it be recycled in all cities that it is found in? What will it be reused as after?). -As much as possible, materials grown locally or has a

very low carbon footprint (in production, distribution + end of life processing) -Materials that does not displace and disrupt local and/or indigenous communities and non-human inhabitants but rather, work with them as well as help them thrive. I feel that there are a lot of lessons we can learn from indigenous communities and natives (both human and non-humans) in material growing and harvesting and vice versa.

Materials that have a longer life cycle - from how it was made to how it could be used and reused. And the production process of this material has a low carbon footprint.

A material which fulfills a designers intended functions. A material which is not at risk of exhausting it's own supply. A material whose usage does not cause irreparable damage.

materials with low embodied carbon, low carbon footprint (during production, fabrication and transport), cost-efficient, waste can be reusable/recyclable, non-toxic, release little air/water/soil pollution (during production, fabrication and transport) or the byproducts produced can be reused

Materials that I can afford to use regularly.

Able to be reused, lower embodied energies, no toxins

Materials with a low carbon footprint. Materials which can be replenished as they are harvested to ensure their continued use (as a raw material or composite ingredient within a construction material) does not deplete the natural resources essential to maintaining stability within our ecosystem. e.g. trees which grow fast and can be harvested without destroying habitats for animals.

Using materials that are re-used or can be replenished or regrown with little impact on the environment

can be reused, can be reappropriated, ideally can be composted,

Materials, of which production and existence remains in harmony with the environment

Materials that have little impact on the environment, regenerative materials, or materials which can be reused or have a longer life-span.

Materials that are degenerative and degradable. Low carbon footprint.

Materials that we can continue consuming without the threat of them running out faster than we consume them

Sustainable materials are materials that are reusable and leave no waste or artificial waste.

Any material sourced from a reliable, relatively local, and environmentally conscious distributor. Material should have many recyclable applications.

Typically I would associate the word 'sustainable' with the word 'regenerative'; to mean that the material is replenished over time and therefore is less likely to have a permanent or long term impact on its local ecology. A material can only be sustainable or regenerative if its rate of consumption does not exceed its rate of regeneration. Therefore sustainable materials

must be low carbon for most uses. Overall I believe that the word sustainable is subjective to its context. It certain environments and uses, the use of concrete might be more sustainable than timber!

Q2 What do you think the BSA does well in terms of a sustainable materials approach, including teaching and learning (any programme) and/or B-Made shops and workshops? Please list as many aspects as you like.

STAFF:

Maybe it's about providing materials aligned with this idea of being CO2 neutral as well as providing containers for recycling in different areas of the school

opportunity to experiment and create materials

I find it hard to comment on this as I think the current thinking is very selective in the school more theory than practice. My first year (2018) in the Bartlett my motto was big is not beautiful as I saw students wasting energy, money and material making large complicated components numerous times. My thinking was make a model of your model something in my practice i often did to test ideas in rough un attractive materials such as packaging card. My next motto was :--

I would like to harness the power of learning from mistakes today and address some of our apprehension and the anxiety of staff and students.

Black box thinking –

Self-esteem, in short, is a vastly overvalued psychological trait. It can cause us to jeopardise learning if we think it might risk us looking anything less than perfect. What we really need is resilience: the capacity to face up to failure, and to learn from it. Ultimately, that is what growth is all about.

Syed, Matthew. Black Box Thinking: The Surprising Truth About Success (p. 292). Hodder & Stoughton. Kindle Edition.

We did in B-made start the thinking/talking in 2019 by looking at understanding the schools learning objectives on various courses. Should we be the people banning a material have we got the skill to do this who do we ask ? So we did have some CPD talks. Would knowing the providence of our materials assist in this but do we also know the carbon foot print of techniques/ processes? Time, labour &r accessibility must also play a part.- The Design and Disassembly road map.-

I think that the BSA is very good at talking the talk about sustainability in building (from the perspective of the workshop at least) but when it comes down to on the ground making coupled with tight deadlines, this often goes out of the window and de facto materials are

relied on too much as there is limited time for learning new methods that may be more sustainable.

Certain individual tutors promote this approach.

BSA provides opportunities for Teaching staff to apply for research funding. This could be directed at sustainable research avenues.

The BSA is beginning to consider environmental sustainability in its programmes

Possibility of recycling materials in the workshop.

The strength lies in the diverse approaches to the question and the discursive engagement with the subject

Generally the tech modules in all programmes aim to inform about sustainable materials and B Made is getting really engaged with timber

I have never used the B-Made shop so can not speak to that. Sustainability in terms of construction materials and processes is a key part of DR teaching in year 4 and students are encouraged and supported in their learning to be both imaginative and rigorous in working with materials. In Landscape Architecture sustainability is a key subject area of study this relates to landscape context, biodiversity, material timescales, etc, etc.

From this year's Summer Show, I felt encouraged by the unifying interest in ecology, particularly plants. This indicates a really sustained push by tutors to integrate these approaches into unit briefs. I also like the move to a hybrid format for the Summer Show that places less emphasis on disposable materials.

Exposure to new sustainable materials available

1. ecological thinking that involves discussion on ecological injustice

I've noticed a shift in the last 5 years of material conscious student projects. This may be driven from a more informed / climate aware student body. or through tutors and programme leads narratives (not possible to tell exactly). I've seen large numbers of projects interested in using waste streams as building materials. B-made has always provided a waste collection location for useful offcuts, these are available at no cost and students are encourage to use this supply. B-made has endeavoured to replace the materials it sells for lower impact alternatives. The 3D printing filament swapped from Oil based ABS to plant based PLA in 2017. This was further improved by getting a PLA that is made from a 55% recycled content and its packaging including the spool is made from cardboard. A collection initiative is also being looked into to collect PLA waste / unwanted 3D prints to be ground up and reprocessed into rolls of material again. (Equipment arrived on 19/07/2022). The acrylic sold in the B-made shop has been swapped to 'green cast' this has a recycled content.

There are many very committed and informed colleagues and students across the school. Sometimes we do not connect, or know of each other's work well enough. Generally, my

students and my work does not explicitly work with the workshop colleagues or BMAde, but - as above - I support and enjoy, value the work of these colleagues.

Discussion of materials use in teaching technology and professional practice.

Certian courses such as greening cities are great. Some modules and units integrate it well into their briefs (this should be a standard though not the exception). Workshop supports students to make smart material choices

I'm not sure - most of my students are working on laptops/tablets in traditional classroom situations. I probably don't know enough about what a 'sustainable materials approach' might be applied to this context.

I think there is generally a good awareness of sustainable materials, but it is probably impossible to cover all eventualities and so there is still a good deal of wastage of materials from the models/tests/drawings made by Bartlett students especially in relation to design project work.

I believe the workshop makes every effort to source sustainable materials and tools made in a sustainable way, encourages sustainable design and manufacture in their teaching, and tries hard to dispose of materials in a sustainable way.

The teaching and learning programmes are informing studio design to a greater extent than previous years.

'- Research into materials at the top end - Research into technology applied to materials - Teaching the basics about sustainable materials

I'm impressed that some of my students seem to be so aware of the issue of waste and able to access off cuts and underused materials.

BSA encourages students to consider their responsibility to the planet and society. It was a leader in development of an ethical framework. BSA workshops work to maximise reuse, recycling and minimise waste.

At undergraduate level on the BSc Architecture Programme the BSA encourages an awareness of sustainability issues only, as mapped against ARB's learning outcomes for Part 1 Accreditation. The same can be said for Year 1 of the MEng which is now triple-accredited. Enabling a high degree of autonomy in Module Leads - which the BSA does - can be an asset in the right hands, but can also result in shortfalls in knowledge and teaching delivery where a Module Lead lacks knowledge and experience and also the will or opportunity to learn.

Not quite, there should be a more centralised approach to lectures primarily, on these materials, in order to get the message across staff and students.

The MSci program is framed around analysing building and material life cycle and I think does a very good job of exploring that vast range of impacts that material decisions can have. This is touched on within the tech modules of the BSc program but I have not seen it explored in as much detail. I'm afraid I do not have experience of the materials workshops.

BSA has developed an awareness through multiple initiatives and its teaching activities. Bmade shops offers sustainable and eco friendly materials.

Recent changes in curriculums across the school which encourage rethinking material out of which the architectural models and prototypes are made, reduced and conscious production of such models and use of recycled and/or recyclable materials.

Nothing that I am aware of, besides green-washing. Production per se consumes materials. Rather than talking about which material we use, we might think more about how we use them and if their use is needed at all. For example, we must ask ourselves if an architectural model is needed to prove a concept or a mere illustration of it. Bio-integrated Design and other programmes investigate ALTERNATIVE materials that are not conventionally used in architecture. This does not necessarily make them sustainable.

The Bartlett is very good at using the existing built environment as a driver for new design, by reusing the fabric but also acknowledging the social infrasdtructures.

Show materials

Getting Hard woods from with in the uk and sourced locally, VOCs not being sold in the shop or supported

There is a general awareness within the BSA of the importance of sustainable materials, and their relationship to wider issues of sustainability.

Scaling back materials in the exhibition has been a good move, as well as restricting toxic materials such as resins. Still, much more could be done to teach and explore much more about the full life cycle of materials from extraction to reuse.

BMade recycles materials, students seem to be more aware of being stringent with material use, the idea that portfolios do not need to be 100000 pages is good as well.

I think B-MADDE does make the effort to use appropriate materials, to maximise off cuts and to teach students about the appropriate use of materials. I do believe that much more needs to be done, I am aware that there are staff members that still encourage their students to use resin, something that should not be happening.

Offers a couple of good teaching dedicated to that issue

Materials salvaged and recycled during studio clearances. Some materials banned, some actively discouraged from use. Recycling collected. Teaching

I am not very familiar with all the programmes of the BSA, but I would say that there are well informed lectures on the topic, to start with.

To be honest, I have no idea what the BSA does well on this front.

I am not engaged in the workshop production so sustainability would be something that I discuss with students from a history and theory point of view.

Given the limited space and resources, The Bartlett does reasonably well but could certainly improve. The theoretical teaching about sustainable materials sourcing and use is happening but there's nothing like hands-on exposure to these materials. Even better, not just exposure to these materials, but also the application of these materials through physical processes. This often requires the right amount and type of space to make this type of teaching possible and effective year after year and staff/student group after staff/student group.

Given the limited space and resources, The Bartlett does reasonably well but could certainly improve. The theoretical teaching about sustainable materials sourcing and use is happening but there's nothing like hands-on exposure to these materials. Even better, not just exposure to these materials, but also the application of these materials through physical processes. This often requires the right amount and type of space to make this type of teaching possible and effective year after year and staff/student group after staff/student group.

B-made has worked hard to find suppliers who can work with UCL procurement and reliably supply things like formaldehyde-free poplar laser ply, which is designed to be very efficiently cut by lasercutters; the light interior layer of the ply means it takes less power to cut, the large grain of the poplar and neutral colour and grain mean that significantly less sheets warp with fluctuations of moisture and less are discarded or 'fail'. We have also sourced recycled PLA plastic for the 3D Printers and worked with the supplier to remove extra packaging, sourced water-based spray paints, and found a hard wood supplier that sources wood hyper locally from felled trees (for example we have recently got in wood that was salvaged from felled trees at Euston). We use due diligence to source ethical large spruce (for construction) and birch (for quality / finish) ply sheets that have provenance to ensure we aren't part of the rainforest ply laundering that the UK is complicit with and look for plys that use safe glues etc. That said, there is still lots to be done, and what I can say is there is a wide appetite to change, adapt and lead in the area of sustainable making, but we have struggled to balance the competing needs and directives of the school and its various programmes and end up responding to what is requested of us, so it would be great to find out where we fit into the process of leading on this issue.

B made was open to explore how to help our students with building models and 1:1 pieces. I was hired to teach a unit which focusses on teaching about sustainable materials and construction

Sustainability has had a much greater emphasis in the briefs of both MEng and DfM in the last few years. It's position as a topic has changed from 'something that would be good to consider', to 'the most important issue to address within architecture'.

Biologically integrated materials and systems are core to our teaching in Bio-ID.

BSA has improved significantly in the last few years. Following pioneering BSA Declares, it has been embedded into considerations of care and wellbeing in the school, transformed curricula and lead to dedicated events and actions. However, this is not widespread. There is an enormous amount of work to do to transform the unsustainable practices of many programmes that continue to design and promote unsustainable practices.

Move away from certain materials has been well received. Much better coverage of sustainable principles in teaching in recent years, and much more integration of these with design projects.

I am not particularly aware of BSA's approach to sustainable materials. I teach history and theory.

Q2 What do you think the BSA does well in terms of a sustainable materials approach, including teaching and learning (any programme) and/or B-Made shops and workshops? Please list as many aspects as you like.

STUDENTS:

Recycling bin in the building

Providing separate trash bins; promoting use of recyclable or reusable cups and food containers; providing containers for students to discard the pieces of wood that can be used by others; encouraging the use of scrap materials to build models.

The BSA briefly introduces alternatives to sustainable materials such as bio plastics etc, but the application is not encouraged. Implementation in teaching is still lacking. B-made induction doesn't at all mention any sustainable materials approach as far as I remember.

B-made materials/model making workshops

I think BSA does a good job of supporting students who are interested in sustainable material practices. Some of the newer Masters programmes seem to put effort into thinking about these things such as BioID and DFM. There seems to be a good start in a wider effort towards more sustainable practices at BSA/ UCL (ie Bartlett declares, net zero by 2030, starting to find sustainable material alternatives)

I have no REAL sense of what BSA is actually doing in this area, except for some relevant memories and workshops

Generally, not much thought.

In the past and to my knowledge, Bmade have had arrangements in place with timber yards that either sold or donated their timber off-cuts to the university. These materials normally wasted in the larger construction industry are put to good use using the amazing facilities at Bmade. Material flow and usage at Bmade is already quite organised and efficient.

BMade has an excellent and functional student reuse station. BMade staff are also enthusiastic about helping students use and discover sustainable alternatives.

B-made introduces materials well, re-using materials appears as a common practice, using and showing refillable cups at gather&gather etc reminds that this is an everyday issue not separated from everyday life

Promotes the use of scrap material

Some materials sold at B-made are ecologically sustainable and overall students are encouraged to use bio-materials although in practice this is often not the case.

Institute of making workshops are helpfull. In our programme thats it, we are not very much engaged with other things related to materials

A general understanding of sustainability practices throughout the school and the focus of some tutors/units on environmental problems is good. The staff in the workshop is aware of this and tried to bring this into the conversation/process tutorials. Otherwise, I believe there are many improvements that could be made.

In between - Many students use a lot of acrylic in their projects. They also don't use it efficiently e.g they throw relatively big leftover pieces. I am sure there can be a better system for using acrylic specifically. - There are many leftover items that could be useful for students like acrylic boxes, but there is no clear archive system either online as in a excel sheet or a room for one

B-made generally stocks ‘better’ materials and is good at trying to re-use and collect scraps. Their approach is fairly rigorous, however there are still materials that are used ubiquitously that I question their impact. (aka all the acrylic and 3D printing plastic)

'- the offcut bin in B-made is a positive move - some teaching encourages the use of an ecologically considered approach to not only material usage but design (but only in select units)

I think BSA is not doing a good job with sustainable materials and I think there needs to be more courses on the knowledge and introduction of common building materials, including but not limited to theory classes or workshop practice. At the same time, the lack of knowledge of materials may make the prices of materials in b-made shops seem very unreasonable.

Cultivating a behaviour of reusing materials rather than disposing of them.

waste management in b-made, certain material used at bmade (3D printing fillings, cork..), laboratory and fabrication work at bio-id (would be nice to have more lectures on top of practical work), a lot of bmade staff are thinking about sustainability/waste generated when helping us!

1. In our program, it's the main topic to work with sustainable materials. 2. For the material in Bmade, they stopped supplying acrylic to students and recommended using recycled material which has a good influence on students and staff in BSA. 3. In Here East, we have good waste sorting. 4. Bamde does well at sorting the recyclable material. They put all the wooden waste in the garbage which someone in need can use.

The BSA makes an effort to bring in interesting guest lecturers and speakers to our course. They share fascinating projects that stimulate the imagination. In addition, I would appreciate more systematised education about this area. The majority of the learning that

I've done about sustainable materials has been self lead. It would be wonderful to have a more organized overview of what's out there so that we understand what we're working with. Please put together more coursework. When we have a better understanding of them we can make more innovative and novel proposals.

Use of recycled filament for 3D printing, printing paper. Reuse of materials- one man's trash is another's treasure; with materials like plywood and acrylic. Encouraging us to map the impact of the materials we are planning to 3D print

The scraps boxes that are free and allow off cuts to be reused

It is a huge focus on tech design which is tightly connected with main design course. Lots of lectures on sustainable topics.

B-made shops being conscious of the materials they sell and allow (ie resin being banned), tutors encouraging students to push limits of new and unconventional materials for building use and speculate on them.

1. The workshop has stopped selling materials such as acrylic and mdf - which themselves are low cost materials compared to others - and this could help suggesting student to use less of them. 2. Some programs do have a stronger focus on using sustainable materials, and each ear there will be a few design units exploring topics around that too.

Good access to documents on the subject.

Waste material collection outside b-made for potential re-use

Mediocre, some materials are priced well, others are unnecessarily expensive. It doesn't stock nearly enough materials however.

Free off it pieces.

The year 3 technical dissertaion is an amazing opportunity for students to very carefully consider the finer details of their project and explore the importance of their choice of material. Having dedicated technical tutors for each unit ensures the students are given the resources and professional guidance to think about the sustainability of their designs and is the perfect segue into graduating and working on real projects within a practice.

Rammed earth workshop. Bmade scraps box. In year 1, the environment coursework was linked to our building project

the reuse bins just outside b-made. lots of good material finds

From the beginning, during technology and environmental lectures, we are introduced to as broad as possible range of materials and how they are sourced, how they work within the buildings and examples where they are used.

(1) Reuse of scrap material in the workshop (e.g. making use of offcuts or previously used materials). (2) 3d-print filament material recycling available in the workshop (3) Material recycling bays in studios (4) Celebrates approaches to the built environment (through

projects) that are innovative in terms of their environmental properties or proposed making processes (e.g. through re-use or use of natural materials) - thinking of timber/rammed-earth projects

Mostly in lectures or guided tours, not much seen in practice.

Scrap materials bin in bmade

'- variety of machines - tutors from different disciplines - intersting approaches

The ban of certain materials within the BMade certainly shows progress with material use within an architectural setting. Modules within the syllabus, such as Technology, provide an adequate and standard understanding of each materials impact available within the Bmade.

As a fourth year student who has recently completed the Design Realisation module; I was asked to demonstrate understanding of carbon footprint of material specifications throughout the report. This makes it impossible to not be aware of at least the carbon costs of materials. This is important because it makes it near impossible to justify the use of a completely concrete building when looking at this data which changes the ways we view modernist buildings and makes us do something materially different.

Q3 What changes or improvements would you like to see in materials teaching and learning, supply and use across the BSA and/or B-Made shops and workshops? Please make as many proposals as you like.

STAFF:

A stronger campaign about recycling different materials we are currently using in our studios, including maybe a mandatory induction.

more Bmade workshops - bio composites, maybe a catalogue ' suggestions' for sustainable materials , understanding the use of material in relationship to time and use (ie when is it appropriate to use what materials)

Materials we use a few quick hits. This year I have been asked many times to stock Balsa wood but ? We are currently buying our hard woods from a supplier who sources his wood from inside the M25. This leads on to finding material suppliers, with a difference we only need small pieces so if the Balsa was the waste stream from a surfboard manufacturing in the UK or the rejects. Is banning acrylic wise in B-made when it allows students to think trough design with speed and ease rather than using sheet metal or ply wood and use more energy etc. In the pandemic I looked at food as modelling materials i would like to pursue casting with mash see
https://moodle.ucl.ac.uk/course/view.php?id=21539&section=7#tabs-tree-start

Not turning to concrete/cement as a de factor material choice for larger projects - and only investigating alternatives as a means to support the final choice of concrete/cement. All

materials/processes should be assessed on a level starting point with the understanding that there is a very high level of ingrained bias towards certain materials based on industry share/power (the cement industry for example). Better education about efficiency of material use (i.e. nesting on CAD, accurate measurement and mixing of liquid materials e.g. plaster/concrete etc.). Integration of technical knowledge from people with industry knowledge/skills into teaching - such as through designed, longer duration workshops (e.g. 1 week) and at scale building tests.

More core environmental design teaching across all years in Parts 1, 2. This would need new expertise in environmental design, available on a FT basis, new technical lectures and embedding knowledge of materials in the curriculum.

Ensure the climate emergency is written into all examination and course criteria in a big way. Students treating materials and projects with less disposability, e.g thinking about nesting and material economy. Procurement structure towards the end of the year and can often seem rushed, perhaps there is section of Procurement that is allocated for climate emergency based purchases etc.

For this to be centred as a key component of all courses and rigorously applied. Far less overseas travel

More deliberation on if it is necessary to use materials (specifically printing) throughout the year, or if for those purposes digital presentation would suffice as well. Generally a more focussed approach to model making, keeping it to the essential parts of a project, rather than going for the big, bigger, biggest approach.

In the workshop the approach follows dubious orthodoxies and could be more critical and open to ways of searching for better practices rather than as a set of restrictions. The impression I get form students is that teaching around the climate crisis is still based on rather narrow sets of problems and solutions (the sort of narrow logics that got us into this trouble) with lots of shopping for equipment rather than understanding the larger ecology that architecture fits into

I think that design programmes need to take on board the reality of sustainability in the built environment . There are too many projects that are built on idealistic or opportunistic greenwash.. These projects do not address the issues that we face and students will leave the BSA with portfolios that will be irrelevant to their future lives as built environment professionals

I have been working with Oliver Wilton to initiate a shared online teaching and learning resource for issues of sustainability and material use in architecture and landscape. This project was supported by Bob and was due to be populated this Autumn. We no longer know what’s happening with it.

Much more attention to life-cycles of design projects, particularly anything that involves computing or robotics. I'd like to see design processes including the tools used to design with (and their embodied energy taken into account). I'd also like to see a more unified approach

to history & theory - with some overarching questions and themes that should be addressed in all teaching.

Potential of local materials

1. awareness of waste, from data waste (data storage, energy consumption by digital technologies), and the relations of labour around waste and ecology (who cleans and maintains, how are they employed...)

The generation of waste is significant across the school. Through poor nesting of parts on the laser cutters, to the items chucked in the skip at the end of the year. There are lots of research clusters who are expected to invent a novel material, then fabricate something with it. These 'novel' materials are often a blend of materials that become inseparable and therefore impossible to recycle.

The projects, dissemination and development of good practice, access to new ideas, and methods for embedding sustainability in the school are there. But we do need to prioritise these as well as we might: new environmental/sustainable leadership -- as shown by many in the public/other disciplines/communities - takes out emphasis on competition, old goals of success/power. I believe we can - and many already do - work to construct sustainability in their work and cultures. But the school doesn't present this as a core part of its leadership/contribution to society. The professional terms of reference often mean we shy away from being bold in commitment and explicit contribution to our external presentation of our educational/citizenship contributions.

All supplies to take sustainability into account. Labelling to indicate carbon use of materials or wider 'green mark'

More sustainable materials actively promoted in the workshop. Perhaps this requires staff training about alternative materials. Material innovation/sustainable materials use to be built into all design modules or made a specific compulsory module

Again, I'm not sure - most of my students are working on laptops or tables in traditional classroom situations. I probably don't know enough about what a 'sustainable materials approach' might be applied to this context.

I think there could probably be a bit more publicity and awareness of the aim to achieve the 100% recycling of materials as part of what is often termed the 'circular economy', as I am note sure that all staff and students have this in mind when making decisions about materials.

Even more consciousness that sustainability is key throughout the whole lifecycle of a product from design through manufacture to recycling/disposal.

An understanding of what are local materials and how they can be used in a contemporary way. Demolition of buildings and harvesting materials to enable efficient reuse, including what is actually the module size the building element could be broken down to be the most

beneficial and economic future building component i.e. does a brick wall have to be broken down to individual bricks or can the entire wall be reused?

'- Materials library - Testing facilities - More experimentation and research available to UG students so they start their architectural journey with a good base.

Full environmental impact assessment of every procured and permitted material, including finishings, screws, glues, etc. Undertaken by an independent group like URGE or if possible within the school, but only if the skills to do rigorous full life assessment really exist. This information should be available to all students and in the workshop, and B-Made should publish annual impact assessments based on the total materials that pass through the workshops.

Embodied energy needs to be formally included in design thinking. Ethical labour sources in construction methods. The school should diversify its student and staff intake - especially among those with disability.

There is not nearly enough technical training for staff on materials to keep knowledge current, and consistent, and understanding and opinions on issues of sustainability vary dramatically between staff so there is no clear and unambiguous message communicated by staff to students. Leadership should come from the Director of Technology, and training should be provided for - and teaching should come from - all tutors, not just Design Technology tutors...this is not an optional or fashionable subject that staff and students can choose to ignore or adopt...like the Climate Crisis itself, it is a part of everything we do, and should be treated as such. MUCH more direct involvement between taught programmes and B-Made should be put into place. The spatial logic of 22GS should be reconsidered - as architects in an architecture school it is beyond belief that it is not openly acknowledged that THE BUILDING is the Elephant in the Room at the BSA, as it causes so many problems that affect teaching and learning...any and all answers relating to improvements at the BSA should include this as a response. Hiding B-Made away in the basement is just one of many. Never having a suitable teaching space available for teaching is another. Now we are being pushed out of the Lecture Hall (G.12). UCL shaped 22GS, and now 22GS is shaping architectural education at the BSA (after Winston Churchill).

More lectures

Material impacts, embodied carbon, natural materials, healthy materials... there is so much to explore in the world of sustainable materials that it feels like it needs more space across the curriculum. Just as embodied carbon analysis is now being done in practice across the collaborative field by architects, structural engineers, mechanical engineers and environmental designers... it shouldn't be left within the teaching arena of "structures and materials" but the key concepts of a sustainable approach to materials could be integrated across technology, design and theory.

The last two years the summer and year shows have been largely virtual. With the return of in-person shows, would be great if they are carefully curated with lifecycle of the physical prototypes of the projects presented.

More environmentally friendly and recyclable materials to encourage their use by students (e.g. 3D printing filaments, so prints can be recycled (externally perhaps), casting materials that could be remelted and reused).

A central supply of materials that are from certified sources would help. UCL should co-fund this since such materials usually come at a higher cost. The students must not bear the weight of this transition. As a teacher, I would appreciate it if I would know that all materials the students are using are safe and ecologically sound. I do not believe, that it is my role as a teacher to check what materials are used at all.

Some teaching about embodied energies, but also the human infrastructures involved in producing the materials that are being used for models, drawings and finally construction.

Bring back acrylic. Promote material diversity through sustainable approaches.

The rest of the BSA needs to catch up with B-Made. lots of courses still using concrete, being wasteful with no accountability. B-Made can adapt to anything so it all really needs to change form the courses down,

Questions of sustainability tend to get reduced to problem-solving. But sustainability is a cultural, social, political, aesthetic and poetic concern and should be discussed as such. A BSA-wide interdisciplinary lecture series on the subject would be exciting, and stimulate debate.

As above! History and theory have much to teach about materials, and bringing history and theory more decisively together with design and tech is hugely important to thinking things all the way through in ways that are necessary not just for sustainability, but for the survival of the habitats that support human and all other life.

Digital portfolios.

There needs to be a complete overhaul of culture, the school needs to embed sustainability into all programmes, sustainability should be an intrinsic part of the ecology of all programmes, indeed, the BSA should, as a preeminent architecture school, be taking the lead globally in such pursuits - reduction in paper cups, reduction in paper use, water recycling etc.

Bring in more teaching about them.

Removal of non-recyclable materials eg. foam board, plastics, chemicals. and large waste producing processes from the BSA. Greater scrutiny/transparency as to how those materials that can be recycled are done so in-house and off-sitE. Greater (re)use of materials discarded by students etc. Greater accountability of those students/units/tutors that don't comply. More knowledge shared as to the processes of recycling, costs involved, how much it costs UCL and where this money might be better spent

Technical studies to effective calculate the embodied carbon and energy materials as well as their thermal performance.

In general, as a history and theory tutor, I would welcome training on the topic of sustainable materials. So I can advise, direct and emphasise to my students accordingly, but also personally understand the different material, social, cultural etc dimensions of this issue. Im aware my definition above is basic. More specifically, in the School's temporary public exhibitions, the amount of waste pre-Covid was unbelievably high. As there is limited wall space in the exhibition space on ground floor, temporary walls / furniture needed to be constructed on an exhibition by exhibition basis to fill the space in the middle of the gallery and showcase much of the work in the exhibition, which led to waste. In future, reusable walls need to be available, and also more support and communication from exhibitions and fabrication team when developing exhibition design to mitigate waste.

I'd like there to be changes in how design is conceived so that architecture is understood as circular and always takes ecological responsibility.

We are seeing the possibility of combining facilities at Gordon Street, Here East, and possibly at Flimwell Park where reasonably real-life teaching could happen. By making use of these places in a joined-up and coordinated way, not only could there be ample space for hands-on work to happen, but there could also be proper thinking space created - especially at Flimwell Park where students could spend time and get access to a variety of sustainable materials. This could even develop into the potential of connecting this type of teaching work with research linked to actual projects that are very difficult to do in London where space is extremely highly pressured.

An improvement in the understanding of how materials are constructed behave and impact design would be hugely beneficial, this should be properly integrated into design studio rather than a side topic taken out of design discourse and relegated to secondary technical modules. There should be a renewed encouragement to explore design through making, testing of ideas at 1:1 and using real materials and processes as an escape from the relentless shift to a purely visual representation of projects.

compostable materials. choice illustrations that diagram how to choose the right material for the job with sustainability being a driving factor. sustainability being a mandatory component across the school's curriculum with opportunities to collaborate with such modules. units planning their making activities with B-made so that sustainability can be considered in advance and bespoke training and materials made for those units.

When presenting my unit's work at crits and marking sessions, i generally felt that it was not very much enjoyed by my superiors, and my students were penalised for making architecture that stands up and could potentially be built. The Bartlett still seems to be extremely afraid of what they call "real architecture" - something that many of my students have confirmed when I asked them about their experience. I have asked the school where we could install a permanent and easy to see material library where students can see and touch samples to get excited about them. Materials are much more scary when they are an absctract concept.

A completely different approach to design and building is required to achieve resource circularity. At the moment the approach to materials within the bMade shop and workshops is largely linear: virgin materials bought, models built, critiqued and then binned. There is an offcuts box, but this could be built upon further. Models should be designed for easy disassembly, so the materials can be reused without problem. Maybe there should be a materials bank, where you borrow rather than buy stuff, and you return the materials when you're done with them. This will also have to be allowed to influence aesthetics. The beauty of a building isn't skin-deep, it's the entire lifecycle in all it's facets that should be considered when assessing the success or failure of a design.

We should introduce more material science awareness in our architectural education so that students are more knowledgeable in what concerns the chemical/geological/biological composition of materials. Students should also be taught ways to understand better the supply chains and LCA of materials/construction. B-Made should focus on selling more sustainably resourced and produced materials. The risk will be cost but thi might have to be analysed/evaluated case by case.

Embed ACAN's education toolkit throughout the school. Demand that programme, module leaders, B-Made staff define how they are addressing this in their teaching, design and practice. Further empower each of BSA Declares' important action points:-A Citizen's Assembly - a working group of staff and students to explore how architectural education and research can avert catastrophic climate change and irreversible biodiversity loss-A voluntary register of intent for each of the school's teaching, research and administrative streams to record their actions and strategies in response to the declaration.-Transparency in the academic, operational and social changes delivered as a school and direction in upcoming years.

Disappointing to see so much MDF used in the show (understand this was a cost issue, in which case Bartlett needs to be more explicit about commitments and hard stops.

I am not particularly aware of BSA's approach to sustainable materials. I teach history and theory

Q3 What changes or improvements would you like to see in materials teaching and learning, supply and use across the BSA and/or B-Made shops and workshops? Please make as many proposals as you like.

STUDENTS:

Nope

A separate collection of scraps collected from the building or donated, so that students who can't afford to buy them can use.

Behavioral change, options to not just sustainable materials but also knowledge on how to deal with it. Experimentation using sustainable materials, broad use in design exploration,

and overall awareness on sustainable material. Also availability and accessibility of the materials to compete with a more conventional one.

More workshops on being more sustainable in model making. Clearer methods of recycling materials, using scraps, and using less materials.

I think this kind of sustainable material thinking could be better implemented into teaching across BSA, there could be a class or even just encouraging students to think like this in their design process from the beginning. Often sustainable materials thinking is forgotten to prioritise design when it could be better integrated. I think the introduction of new more sustainable materials in the BMade shop instead of just alternatives/replacements of what is already there could encourage students to use other materials as well.

There is always a lot of material waste when building things in workshops, and these scraps should be collected for secondary use by those who need them.

No other suggestions for the time being.

In future, I would like to see more consultation directly with the student body in regards to changes in the B-Made shop stock. Removing or banning ‘unsustainable’ or ‘unsafe’ materials from the workshop doesn’t ultimately matter unless a suitable alternative is provided (as students will and have just purchase materials from elsewhere). The responsibility lies with the school to ensure responsibly sourced materials are available to all students. The BSA may well want to achieve its net zero target, however this will not make an environmental difference if it’s carbon footprint is just transferred to adjacent providers. By restricting material usage while withholding alternatives, the result will be an increased advantage to wealthier students and will drive a deeper rift between student opportunities based on financial ability. I believe that investing in bmade teaching staff is the key to making sure that more students are accustomed to processes of making and alternative and more sustainable ways of achieving their goals. Whilst a huge amount of money has been invested in new flashy and seductive facilities, such as 22GS’ new VR room (an example of an underused facility but in no way the most expensive), incredibly valuable bmade staff have been kept on frankly exploitative rolling monthly contracts. How can the school expect to improve its relationship with the materials it uses without investing more in the people with the ability to educate all workshop users?

'- if all materials where labelled with important metrics like embodied carbon students could easily make an informed decision on materials -outwright banning certain materials however sets a dangerous and restrictive precedent - an induction module about environmental issues with materials would be welcomed

Introducing more materials and schemes related to sustainability in the modules or maybe displaying different materials or techniques of using/producing them in common areas.

Supply more knowledge on sustainable material choice alternatives

More sustainable materials available to buy at B-made

Engage with use of recycled materials

Better recycling. Improved material library at BMade shop. Better knowledge from staff on bio-based/sustainable materials. Encouraging re-using practices and a looser approach to what can be explored in terms of new/unconventional materials in the workshop.

More control over leftover materials and general guidance on how to recycle, share un needed items. Maybe a program or a platform to share items between students or just a list of items left in studio for everyone to use.

Sustainable materials are a very low priority particularly in teaching and only come up when convenient rather than driving more of the agenda and being stricter in our approach. The lack of concern resonating in tutors etc trickles down to student behaviours inevitably. Sustainable materials are so much more than the material itself and greater awareness of provenance/processing chains/early-stage intervention in design to minimise material usage are key for the required holistic approach and are not rigorously embedded within student learning compared to other universities.

'- greater resources and lectureres on the topic, as well as more specific/dedicated teaching alongside the primary teaching in design units; this should really be emphasised in the DR module in Y4 which it currently isn't. - a more thorough understanding of materials specified in design projects should be emphasised so students must know their origin/method of production/supply etc. - perhaps a more comprehensive system for material offcuts in B-made, not only timber but smaller pieces of acrylic, metal sheeting etc., or even perhaps a market for 'half-used' materials such as big bags of plaster, half-used sls rolls established through the B-made shop.

Provide additional public or practical lessons on the knowledge of common building materials, such as distinguishing between different types of wood and their advantages. Another point is that there is a great deal of confusion about the price of b-made shop materials, which can be too expensive, and that some kind of subsidised budget for materials may be needed.

'- Offer information on understanding how materials are produced with an emphasis on the energy required. - Have an reuse system for fixing so students can quickly return fixings rather than opting to dispose of them. - Encourage student projects to include actions of sustainable fabrication taken both in the project's design and throughout the research and testing so that they can showcase this and influence other students/researchers. e.g: "we were able to reuse the plywood for our previous failed experiment to produce the next iteration of prototype"

would be nice to have more lectures on LCA & materiality//sustainability (for everyone - as part of the bmade induction for example / or as part of individual programs) and a catalog of existing materials with their benefits / limits

1. Indicate on the price tag whether it is a sustainable material. 2. Decline the supply of unsustainable material. 3. Add the process of learning sustainable material into the BMade Workshop Induction.

Create an entire introduction to sustainable materials module eith descriptions etc. Educate us about sustainable materials and their uses.

Maybe introducing a wider range of sustainable materials to be used for projects

More recycled options in metal and plastics. Recycling of off cuts and scraps. Wood that is sourced from the UK/is native. An option to reuse scaffolding boards/pallets from construction.

more B-made activities show physical testings.

'-More organic and bio-based materials and growing facilities available for students to use, ie mycelium growing spaces and workshops. -It would be nice to see where the materials we are buying form the b-made comes from (ie production, transport, maybe even their CO2 footprint.) -It would also be nice to have more formal settings of sharing ideas and materials research with B Pro students. I reached out to someone from Bio-ID who is exploring the material I was using and it really helped with my project. I would not have known this person if it were not for a friend in my unit. I know as Bartlett students being located under one roof, we are encouraged to connect with students from other courses but most of the time, Architecture students are in their own bubble and feel that we have to use every single day to meet a deadline for tutorials/crits (and I am sure this also goes the same for other students in other courses).

1. In the workshop, there could be more informative / educational notes or posters explaining how sustainable each material is and provide alternatives to some less sustainable ones. 2. At BSA in general - there could be more crossover lectures. / workshops around this topic for students from all. programs to join.

Teaching on the applications and usages of materials, questioning the incessant layering of walls to improve performance of a structure.

We always source, process and build with standardised materials, and discard them just as easily after projects are finished. The scraps, the offcuts, and the junks, are usually presumed to be undesirable for building, mainly due to the lack of knowledge about secondhand materials. The variety of material available is limited to certain materials of higher cost efficiency and greater convenience to obtain. The School should develop a set of guidance for processing and building with secondhand materials, consider the embodied carbon and environmental impact when sourcing materials, and provide a more diverse material palette for learning.

More material variety, subsidised prices, more specialised model making supplies such as scale people, trees, etc etc.

Size of materials in workshop is either always too big or too small, so there is always waste. Maybe more teaching on how to handle older materials so that they can re reused etc.

The administration could be more outspoken about ensuring the materials used across the faculty are sustainable. Amidst the stress of projects, I rarely have the time to diligently read through emails from admin unless they are urgent. It would be helpful if the building was used to more visually encourage sustainability. -A notice board/forum where people pin interesting research into new sustainable materials. -Larger, more eyecatching posters displaying what materials are not recommended and why. -Posters listing of recommended sustainable materials categorised by usage (E.g. 'X' is a fully recyclable material that can be bent and glued for modelling!) -Educating workshop users on how best to plan out their cuts to minimise the amount of wasted material.

Have environmental stats on all bmade materials. Have materials scrap boxes everywhere. Have environment lectures integrated into our design projects. Essential summer reading list

Provide space for students to keep materials over the summer. Had to throw away some laser cut material this year because spaces get cleared out over the summer. Make the reuse bins bigger outside b-made, make the whole reuse infrastructure bigger to make reusing material preferable to buying new ones. There often seems to be a push to use clean, new materials in the making of models in design units. Maybe a greater push for reuse, not as a style of work but just sustainability wise. This seemed much more prevalent during my y1 where we were encouraged to use any material we had at home (given that the year was online), thus essentially putting waste materials to use, and not feeling so bad about having to throw the work away later on.

What I lacked during the first year lectures, as well as later tutorials within my unit, was being provided not only with information about possibilities usage of such materials gives, but also their limitations and challenges they pose: for example it took me a long time to understand that realistically, no developer would choose to build a rammed earth or straw bale building in a city centre as thick walls and low-rise structures limit the surface area of buildings.

(1) Alternative ways of making (both on building project and model making scale) that is more environmentally conscious. This could be within lectures and/or workshop conversations. Especially with new/emerging making technologies/materials. (2) Being made aware of the more sustainable ways of making/material options within conversations about how to approach model-making/prototyping (e.g. when making material decisions in workshop). (3) Ways of making the Summer Show that means that certain elements are reusable for the following years - but in a way that doesn't limit creativity or make all the units speak the same language. These could be small student-designed unit-specific components - such as bespoke holders/frames/wall mountings, with opportunities for future unit students to adapts these to fit that years brief.

More workshops and activities.

'- more workshops and presentations

I believe transparency in regards to the sourcing and origins of materials within the Bmade would help provide students with the information to make an informed decision on their material choices. Further, wood supply should extend further than ply,squares, and dowels, and should also include larger pieces, as stocking them at school would mean a further reduction in individual travel contributing to carbon emissions. A more hands on and involved approach to the scrap bin should be applied in order to fully harness its potential, such as staff being aware of contents in order to redirect students to the scrap bin rather than buying new.

I think student work currently is overwhelmingly dominated by the use of timber materials because in my opinion staff and students feel it is an automatic safe zone to avoid criticism. I think it would be fascinating to see alternative sustainable materials pushed forwards to showcase alternatives. If everyone uses timber to building buildings then would this material still be sustainable? Or does the word sustainable mean by default that a matrix of different materials must be used to strike a balance between consumption and regeneration. I think sustainable materials are much more complex than a carbon cost, and it would be really interesting to learn about the impact on local ecologies who produce these 'sustainable materials'. For example, what is the impact on the Scandinavian natural ecology of the increasing use of CLT globally, with the huge land requirement demanded by managed forests.

Q4 What questions would you like to ask BSA decision makers about sustainable materials teaching, learning and use? Again, please list as many questions as you would like.

STAFF:

Do you think the creation of mandatory inductions about the correct use of materials and how to deal with sustainability is necessary?

understand better what are the resources - materials available

Can we reach an accurate Sustainability Audit taking into account?:

- Material Use
- Carbon foot print of material
- Carbon foot print of process
- No permanent fastening techniques
- Staff time & management of a technique

How can?

When will we open a position for an outstanding FT environmental design engineer and give them the responsibility to ended new knowledge in the school?

Can sustainable materials be subsidised? Can the waste streams be monitored to ensure they are meeting the claims of the contractors?

It would be good to have more open discussions about such issues. There appears to be a significant separation between the ways such issues are discussed in studios and how they are framed in courses

Is there anywhere that the BSA can hire that can house materials for re use in physical design proposals?

1. Is the online resource still going to be supported and can this be formalised, staff are ready to roll? 2. Is the school going to take a measured response to sustainability that might mean that use of paper, wood, wax, etc, etc can still be used in the design process? 3. Can the school find the funding to establish a post for an ecologist to work in the architecture/landscape schools?

Can you tell me whether consideration of the life-cycle of materials will be an important future theme at the Bartlett (including design tools)? Can we be more student-led in the way we approach design and history & theory? It's clear to me that the students want their anxieties about climate change to be addressed.

Is it so much about sustainable materials or providing a sustainable cycle of materials?

Concrete is likely to become a banned substance due to its environmental impacts. what work is being done in collaboration with the construction industry and architecture to find alternatives that can be adopted?

How are supply chains be sustainably managed, and how can we ensure careful selection of materials when making purchasing decisions and maintain the focus long term.

Why is it not a compulsory part of brief writing in design modules? Can we integrate material research more in to the design modules and what support at UCL would there be for this?

Well - I suppose there should a clear policy for good sutainable materials practice: is there one? Any such policy though should be informed by the people (students and teaching staff) for whom sustainable materials issues are most pressing - i.e. not imposed 'top down'. So are the right people being brought into develop the BSA's policy?

Why have we spent so much money in recent years on expensive capital equipment such as industrial robots which are little used and seem to have no engagement with questions of sustainable resources? How do we reconcile this seeming attempt to present ourselves as reliant on high-tech machinery and methods from corporate industry with our claims to be interested in non-polluting, recycled, sustainable materials? This kind of inconsistency stems however from UCL's double-speak on ecology/environmentalism as a whole: how can we ever claim to be aiming at carbon next zero etc when at the same time we are building gas-guzzling, carbon-producing corporate towers which are helping to wreck a park in east

London, rather than environmentally improving our existing building stock? In that sense Here East is part of the same folly as UCL East generally.

What is being done to ensure sustainability becomes as central to design as form and function?

Should there be a change in emphasis of architectural education to the reuse of buildings rather than new build?

'- Please provide a materials library where things can be seen in different formats and sizes, tested and manipulated by students.

How can we... 1) enable students to integrate proper impact assessments into design decision-making 2) develop staff capacity to support students to do this 3) examine and develop concepts and vocabulary that enable proper, meaningful discussion about the impact of architecture and design as a starting point for all courses.

Can UCL allocate a budget to allow students to use materials from sustainable sources in preference to cheaper material from less sustainable sources.

'- Why is proven technical knowledge not a prerequisite for leading a design unit on the BSc Programme? - Why is routine training - on core subjects such as social justice and climate science, as well as sustainable materials - not written into the Job Description of staff, and provided as mandatory for all teaching staff?

When and how are these materials going to become part of the design teaching.

These are some of the questions that both students and school could ask as material decisions are being made:

- Is this material finite or renewable?
- Does it's extraction from the earth have a large impact on the planet?
- If so, what measures and remediation might we campaign for that would make that material's extraction less negative... both in terms of social and ecological impact?
- Does the manufacture of that material rely on an industry that is socially unjust?
- Does the manufacture of that material require large amounts of energy and carbon?
- Is it local sourced?
- How will it break down at end of life?
- Can it be designed/installed in such a way as to be adapted for re-use in future?
- Does it contain a lot of glues and formaldehydes that lead to bad air quality?

I would rather see students and tutors encouraged to ask these questions than create a top down set of strict rules that might seek to demand a specific response: ie, don't just say a material is bad/banned but encourage people to reach that conclusion through developing their own understanding of the key issues.

Could we have sustainability workshops among staff from experts to inform our decisions and impact?

How to find a balance between the necessary model making as integral part of learning in a school of architecture and amount of material resources required for this?

I would appreciate it if the BSA would establish a critical and realistic approach toward sustainable materials. Algae in plastic pipes are not sustainable and so isn't to use a material that costs GBP200 instead of concrete that costs GBP2 for the equivalent amount. We must prepare our students to have enough knowledge about materials to make an impact on the profession. The BSA must not become a fairytale wonderland where 'sustainability' is preached in a way that is not feasible and therefore not transferrable to practice. First of all, for this, all staff should be taught about this too. More CPDs on this topic would be helpful.

Is there enough funding in place to help develop a comprehensive integration of knowledge on sustainable materials and development?

when are you going to do something about it?

How could teaching assessments be done with digital portfolios rather than paper.

What are the steps being taken to embed sustainability into the bedrock of the school? Do you see sustainability as a key element to how we as a school play our part in tackling the climate emergency?

Same questions as the one in this survey

Where items which are currently disposed of in the skip are actually bound? How is the use of skips to landfill part of a sustainable UCL?

about their knowledge on real-life examples

I'd like there to be a connected up thinking/making between the materials B-Made and history and theory.

How can The Bartlett/UCL satisfy its agenda and curricular requirements when it comes to sustainable materials and design in a way that students can understand the impacts of materials decision-making in a world whereby there are colossal pragmatic, economic, and political barriers to the uptake of sustainable materials and construction techniques? How can we inform students and staff of improved alternative materials that are stemming from "traditional" construction materials, such as metals and concrete, that have the chance of becoming positive disruptors that could actually have a far bigger positive impact on the industry than some of the more directly earth or plant-based materials? Innovation is crucial and should be thriving at The Bartlett/UCL. How can we teach students when not to build? How can we import sustainable materials use from rural into urban settings? Can Landscape Architecture serve as a positive influence on Architecture or does LA need its own programme of rethinking about sustainable materials use? How can we inspire students and staff about the thrilling potential of sustainable design and materials use at a time when future social, economic, and environmental prospects are looking so perilous?

How will BSA improve access to materials and making facilities in the school, why does the school consider material understanding, fabrication and construction something that is

taught outside of design studio in dedicated technical modules with different staffing and objectives. Will the school start to define in their learning objectives and outcomes a value placed on use of sustainable materials and low carbon technologies in the design process at a much more in-depth and involved process and less superficial responses.

why isn't sustainability a mandatory, significant component of ALL teaching activities?

how is UCL going to recruit and fund additional external world-leading expertise through fair recruitment processes to help teach the modules it needs to make room for? Is the Bartlett aware of what other International Architecture Schools are teaching in this area? If not, why not...for example when I've asked Tutors at crits why buildings designed to have 'green' components like intensive green roofs with large trees and water features, why the students haven't been taught the basics of landscape principles of grading and drainage, or the difference between an intensive or extensive green roof and that these roofs need proper structural consideration, the response has always been that it doesn't matter, that the Bartlett is 'speculative' and isn't interested in these kinds of things. The BSA report surely calls out this response as insufficient, so what is leadership going to do to provide students with the practical and critical education they need to be able to respond to the real, authentic and urgent climate issues that they will face when working in the field of the built environment.

How can the Bartlett embrace real architecture, making and construction as a positive field of innovation? How can making become more of a celebrated part of Bartlett culture? B-made has wonderful, knowledgeable and friendly staff who deserve more visibility. How can materials and construction become more integrated into the architecture design studio? Currently the separate tech module actively prevents students form showing technical or material considerations in their design portfolio because this would be "plagiarism".

What does true designing for circularity look like, and how would we change the school to bring that closer to the centre?

How can the Bartlett truly set the benchmark, not meet the baseline, for sustainable material teaching, learning and use? This requires difficult, transformative actions to be set in motion and evaluated.

How can we encourage more research collaborations with industry to better contribute to sustainable thinking/prototyping?

Q4 What questions would you like to ask BSA decision makers about sustainable materials teaching, learning and use? Again, please list as many questions as you would like.

STUDENTS:

Is there any open class?

What happens to the non-recyclable materials that are dumped after every course ends?

How do you encourage the use of sustainable materials? How can it be useful in learning process? How can it be a reliable alternative to the conventional one?

What is done with leftover materials, what can students do to make models more sustainably?

What prevents you from implementing sustainable materials practice? Is there anything that would encourage more sustainable teaching requirements at BSA? Is there a way to incorporate sustainability modules into courses at BSA? If not separate modules, how can it be written into existing modules?

Needs to be universal.

How can we maximize the use of sustainable materials?

What strategies does the school currently have in place to reach its net zero target? What percentage of Bmade staff are working on permanent contracts? Has the B-Made been able to track where it's waste in either processed or dumped?

How is the BSA negotiating the complex intersection of education and maternal usage? Ultimately, the most environmental education wouldn't use any materials but obviously this would reduce a students learning potential. How can a balance be struck that doesn't reduce creative freedoms and an appreciation of artistic endeavour.

What easy to use resources are available to help us make more innovative and sustainable material choices?

What are Bartlett goals in terms of sustainability? How can we change the model making approach to make it more sustainable?

None

What changes are in the future of the school towards better recycling and reuse? How can these be made accessible to all, despite of people's background? Will this be included in the formal education pathway of each course?

I have no questions

Can more hours/resources be put into training staff and students into sustainable materials/building science etc? At my previous university, we had the option of undertaking Passivhaus training and in practice I have also been completing carbon-counting training to ground the material decisions of our projects in real building-science. Despite the nuances of sustainability, both of these learning opportunities have provided a stronger background knowledge in which to critically analyse materials. Without this, I would feel a lot less guided with material decisions.

'- how can sustainable materials teaching be more sufficiently integrated into the BSA's curriculum across all its programs? - would it be possible for the BSA to be more transparent

about its consumption of materials through both student projects and general maintenance as a building? - what responsibility do we as a school have in discouraging the over-indulgence of student projects which neglect the role of sustainable materials in favour of concept, narrative, and drawing... (of which I, and many others, are guilty)? - is there a better way to recycle/make use of student models at the end of term instead of binning them? If not, is it perhaps time to encourage a more considered/limited use of model making when only necessary so as to not create so much waste?

There are a number of faculties that offer a range of materials-related specialisms to explore the development of materials and the future of materials. I was wondering if BSA offers a similar programme? If so, is it possible to increase the number of collaborative projects between majors? I think interdisciplinary collaboration is more in line with the overall development of society and personal growth.

'- What key areas of improvement have been identified in B-Made where we can make changes? - What methods can we put in place so students have a relation to materials which considers sustainability rather than?

introduction to material need in construction (how can we reduce the amount of material needed when possible?). how to think through life cycle assessments in our projects. are there any softwares / extensions for grasshopper that help measure the environmental impact of materials?

1. Is there any way to reduce the price of material....?

Can you create ansolid curriculum about sustainable materials that will give us a good base of knowledge to work off of? That would be an effective way to get us started moving along quickly.

None

Where are the materials from? Can plywood be made with nontoxic glue? Can current options be changed for ones with lower embodied energy?

how can physical testing of sustainbale materials be more engaging during Covid?

1. How would you define sustainable materials? 2. What additions and changes at the BSA will you make to ensure that there is a focus on (non-greenwashed) sustainability in student's learning and project outcomes?

Why are we provided with the materials that we have now? Are their more sustainable alternatives with similar cost-efficiency? What can be done to the models and materials discarded after the end of each year/the summer show?

none

A question I asked myself a lot during the first year: why aren't sustainable building materials the standard yet? It eventually was answered during my time at the Bartlett while reading more about materials, and designing my own projects, but I think that it could have been

much easier had it been answered by a lecture or seminar focused on practical aspect of materials.

If timber did not exist, what alternative sustainable materials could we construct buildings with? How does local climate and ecology define what sustainable materials can be used? And therefore do we see a shift in international urbanism defined by modernism to give rise to local vernaculars to meet new sustainability criteria. What are the critical thresholds of sustainable material usage. For instance, at what point does the increasing demand for Scandinavian CLT have detrimental impacts for its local ecology due to the area required for tree growth?

Journey to Net Zero 2030

Understanding Sustainable Materials at the Bartlett School of Architecture