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Author	La Rosa, Andrea Grech;Simpson, Peter;Peach, Thomas
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Piloting Circular Economy Initiatives in an Educational Maker Space

Grech La Rosa. Andrea[1], Simpson. Peter[1] and Peach. Thomas[1]

[1]Departmnet of Mechanical Engineering, University College London, United Kingdom

a.grechlarosa@ucl.ac.uk

Abstract

The UCL MechSpace is a versatile workshop and creative space located at University College London (UCL). It is designed to support hands-on learning, innovation, and collaboration among students, researchers, and staff. The MechSpace is equipped with a variety of tools and equipment, including 3D printers, laser cutters, CNC's and other fabrication tools, to facilitate the creation and prototyping of projects. The workspace supports numerous taught and research driven modules as well as student-led initiatives focused on engineering competitions such as Formula student, hydrogen vehicles, Mars Rover, drones, and rockets.

Noting the global drive to be more sustainable, an opportunity was identified to utilise the UCL MechSpace as a test bed for circular economy initiatives. The aim was to make the UCL MechSpace more sustainable, influence students' thinking through example, and evaluate whether similar initiatives can be implemented across the University. This allowed for practical experimentation with sustainable practices that will be discussed in this paper. After considering the use case of the UCL MechSpace, three pilot projects were identified and trialled. These were a free repair shop, a waste to resource system and finally a library of things. Wherever possible, the products of this work was for the benefit of students, staff and the local community.

These circular economy initiatives at the UCL MechSpace have been academically led but primarily student-driven. While the degree of implementation varies across each of these projects, the impact on students has already been noted. Those who participated directly gained hands-on experience in sustainable practices, enhancing their skills in repair and resource management. Students supported the running of repair shops, transforming waste into resources for various projects, and promoted sustainable practices in the workspace. Their active involvement not only provided valuable project management experience but also fostered a sense of ownership and responsibility towards environmental sustainability which has led to some students deciding to dedicate their individual and/or group project to.

1 Introduction

A maker space in an educational environment plays a crucial role in fostering creativity, innovation, and hands-on learning among student. These spaces are designed to provide students with access to a variety of tools, materials, and technologies that enable them to engage in creative projects and practical problem-solving activities(Saorín et al., 2017). They also promote collaboration and communication as students often work in teams, sharing ideas and resources to accomplish their projects.

The UCL MechSpace, for example, is a workshop and creative space located at University College London (UCL) dedicated to UCL Mechanical Engineering Students. It facilitates hands-on learning, innovation, and collaboration among students, researchers, staff and industry(Mugwagwa, 2020; UCL Mechanical Engineering, n.d.). It supports numerous taught modules as well as student-led initiatives focused on engineering competitions like Formula Student, Human Powered Submarine and Mars Rover. The workshop is operated by academic and technical staff, along with student mentors who assist in the daily running of the site.

The facility is fitted with equipment including 3D printers, laser cutters, CNC machines, precision instruments, woodworking tools, soldering stations and other fabrication tools. Dedicated academic and technical staff help students design, build and test their prototypes to ensure that safe practices are maintained and resources are used fairly.

Such a maker space bridges the gap between theoretical knowledge and practical application, providing students with the opportunity to explore their interests, develop new skills, and prepare for real-world challenges.

2 Pilot Projects

The initiative to leverage maker space as a workspace to expose students to real-world challenges has identified an opportunity to utilise it as a test bed for circular economy initiatives. With the department increasing its focus on sustainability within its modules, the maker space decided to operate as a live experiment trailing three projects that would champion circular economy principles.

These pilot projects were designed to improve the learning experience, to support students and the local community and to offer students insight into what it means to operate in a circular way. The projects selected were the UCL Repair Shop, a Waste to Resource Hub and the library of things. These projects were implemented with a staggered approach, noting student feedback throughout.

While running the projects, staff and student reflections and observations were recorded to determine whether each project was having the intended outcomes. Where possible, taught lectures pointed back to these observations to help facilitate a discussion. Each pilot project together with some observations and learnings will be described below.

2.1 Repair Shop

The first pilot project implemented was the UCL Repair Shop that was managed by staff but run by students. This project extended the maker spaces offering at the termly Repair Café and offered staff, students and the local community the opportunity to get their damaged items repaired (Sustainable UCL, 2024). A dedicated platform was created to allow users to submit a request for an item to be repaired. Once approved by staff and the item delivered to site, Mechanical engineering students would then start to repair the item using the skills and resources available. Some examples of items that have been repaired can be seen in Figure 1 to Figure 3

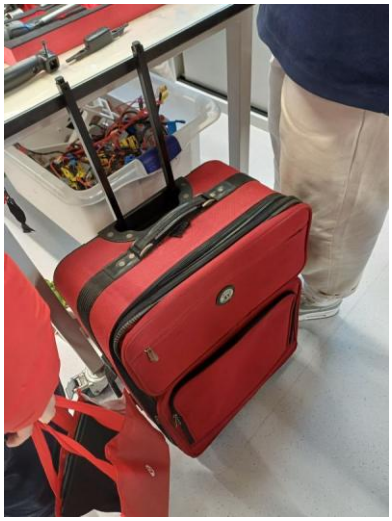

Figure 1 - Luggage with damaged handle

Figure 2 - Laptop with damaged port

Figure 3 - Damaged clothes rail mount

In nearly all repair attempts, students recognised the challenges associated with repairing items. Whether due to inaccessible screws, lack of information, fear of causing further damage, or uncertainty regarding the time commitment required for the repair, students were aware of these difficulties, which in turn affected their confidence. Whenever possible, students were asked to reflect on the design of the damaged item and asked whether any changes could have been implemented at the design stage to make this process easier and therefore increase the lifespan of the product. Additional considerations relating to the single point of failure caused by the damaged component, which rendered the entire product unusable where also discussed. These reflections were shared in a design focused module and discussed more widely when covering topics such as setting requirements, design for repair, assembly/disassembly and sustainability.

As well as the design based knowledge, these repairs gave students more exposure to different tools and processes that they may not have covered in their taught modules. This system addressed a range of technical topics that are not necessarily covered in modules, including the role and application of adhesives, the suitability of utilising a 3D printer, waterjet cutting techniques and the extensive array of hardware options available.

Running the UCL Repair shop has highlighted several pros and cons, as shown in Table 1. These points should be considered when starting a similar service. In particular, while most students who have participated in the UCL Repair shop felt that it improved their learning experience, the added workload on staff and risks of damaging an item further should not be overlooked.

Table 1: The pros and cons of running an in-house repair shop.

Pros	**Cons**
An enhanced learning experience	Increased staff workload

A means of adding value to student and community experience	Risks of further damage or delayed failure
A proven system of reducing waste	Potential of poor quality repair
A means to help reduce the cost of living	Potentially seen as a means of undercutting local repair shops

Running the UCL repair shop presented a number of operational challenges. The most notable challenge was sustaining student motivation throughout the year, particularly as the taught workload increased and when students faced difficulties in properly repairing parts. The voluntary nature of the repair shop allows students to participate at their discretion. Introducing a competitive element or reward system may help maintain that motivation. Additional challenges involved managing liability in cases of repair failure or item loss, as well as addressing the logistical complexities associated with dropping off or picking up items.

2.2 Waste to Resource

The nature of a maker space within an educational environment necessitates the provision of materials for students to construct their designs. Despite the implementation of measures to mitigate waste, this can still lead to considerable material consumption. Where feasible and appropriate, the maker space enables students to learn through failure, which occasionally results in the use of additional resources. A typical example of this is a component being 3d printed with incorrect settings leading to a print failure.

Students were introduced to the concepts of reuse and recycling at various points throughout the course. The maker space allowed students to practise these concepts on a small scale. Waste streams in the maker space were reviewed to identify opportunities for onsite processing and reintegration as resource stream within the maker space. Different options were considered but the key streams considered were:

- 3d printing waste – Inspired by Precious Plastic, the maker space sought to recycle 3d printed parts that are no longer needed (One Army, 2023). The low melting temperature and wide use of PLA in the maker space offered the ideal opportunity to turn a waste stream into a resource stream (Muñoz et al., 2020). Since the plastic was typically clean and free of adhesives, it was shredded down and turned into sheet material, new 3D printer filament and round bar stock. Figure 4 shows an example of 3D printed filament recycled into sheet material for use with the laser cutter. The students who participated in this pilot found this insightful and 1 student even dedicated their third year individual project to investigate this further.

Figure 4 - 3D printer filament recycled into sheet material for the laser cutter

- Obsolete projects – When certain prototypes reach the end of their life, students have been encouraged to disassemble and save hardware, electronics and components that can be used for future projects instead of disposing of them as a whole. Students supporting the dismantling saw how prototypes were made, how they could be improved and how they could have been designed to suite their intended function better. This project not only reduced waste but it enabled students to extend their project budgets further by accessing this free resource. The biggest challenge experienced was the storage and catagorisation of bespoke parts that are less transferrable to other projects.

- Vape batteries – Students and the local community regularly use vapes containing small lithium ion batteries that could be harvested and used for small scale projects (Reid et al., 2023). Owing to the risks associated with this process, some students were specifically trained to harvest, test and catalogue the cells for later use. Figure 5 shows a small selection of vape batteries while being processed. This resource stream proved to be the most contentious due to the risk of fire and injury if improperly handled. After further consultation, this waste stream was temporarily shelved.

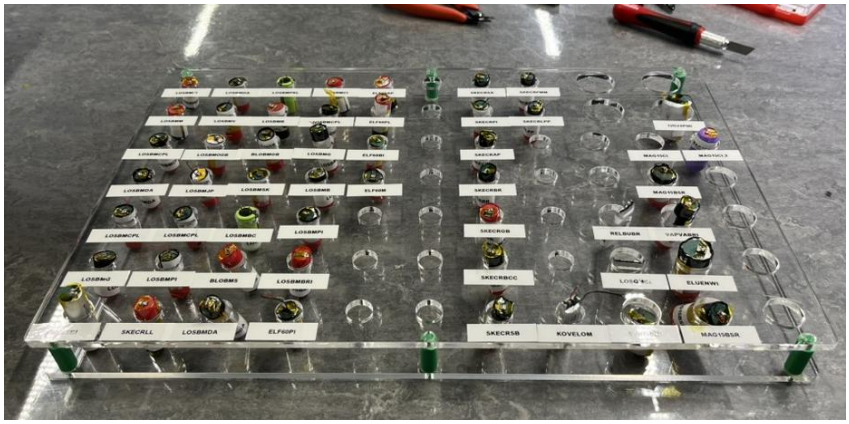

Figure 5 - Harvested vape batteries in a holder awaiting individual testing

The waste to resource pilot project has given students exposure to the different stages of upcycling a material or resource. Similarly to the repair shop, experiences, observations and results of running this system were discussed in different lectures and enabled a more in depth discussion on the topic of recycling. Students who did not participate in the processes directly were invited to visit and see first hand which led to student to student discussions on what should be done going forward. In particular, the technical challenges of implementing such a process at the maker space were widely discussed concluding that should this project be extended further, appropriate resources would be required to sustain and use in the longer term. Another key realisation was the student's suggestion to try and reduce the volume of waste generated as a whole after acknowledging the efforts needed to process it.

2.3 Library of Things

The final pilot project considered was the MechSpace library of things. This complimentary service aims to challenge this stereotype by making "things" available for the benefit of the community in structured manner. This concept also has a positive impact on sustainability by reducing waste and increasing utilisation of assets (Claudelin et al., 2022).

Literature surrounding Library of things is limited but studies show positive experiences when they are implemented. They support a cultural shift towards sharing and valuing experiences more than ownership. LoTs have the ability to empower communities to do and experience more as well as learn new skills (Lax, 2020). One of the key points identified by (Baden et al., 2020) is the importance of tailoring the contents of the library to community's needs.

The project aims to reduce the purchase of seldom-used items, helping students save money and enhancing their experience. The items being lent fall into 4 categories being Wellbeing, DIY, Travel and General Use. This would mean that students could borrow things such as games, small kits to help them monitor the energy consumption of their electric items, thermal imaging cameras to see where draughts are coming in, pop up tents or even popcorn machines.

The library of things promotes sharing, sustainability, and community spirit. It gives students access to things that they wouldn't otherwise be able to afford or possibly even consider trying out. Consequently, this approach not only assists students in saving money but also enhances their overall experience. Noting that many students at UCL are from diverse backgrounds, the UCL Library of Things could stimulate and encourage them to start such initiatives in their hometown and/or community should they return.

Initial trials at the maker space using a few items have been successful. From an educational perspective, the trials have shown students the meaning of designing a product to be reliable and robust. Following a reflective discussion, students highlighted that products should be clear to use and must be designed to be failsafe. The environmental benefits were also acknowledged although not necessarily at the scale of operation conducted at the maker space as yet. While the current sentiment is that students find this beneficial, processes need to be put in place to ensure smooth running of the service and reduce workload on staff. More autonomous deposit and retrieve systems would need to be installed which require significant investment.

Scaling the offering up has proved to be a challenge. An array of challenges have been encountered relating to space and cost restraints, liability, human resources and IT, to name a few. Concerns relating to tampering, improper use and damage/loss of higher value items mean that further work needs to be carried out to make this available for a wider audience.

3 Educational Assessment

Each of the pilot projects provided students with a different educational experience compared to lectures, tutorials, or teaching labs. These activities enabled students to learn through hands-on involvement and by teaching others. This was particularly evident in the repair shop pilot project, where strategies for effectively assessing and subsequently conducting repairs were shared among participants and quickly became a topic of discussion. The non assessed nature of the initiative led to open conversations without hesitation. These where not limited to the specific sustainability initiatives trialled at the maker space but instead expanded to a broader scope including air travel, EV batteries, and food waste.

Students who were involved in these pilot projects acquired practical experience in various professional skills that are not typically covered in their academic modules. These skills include customer dialogue, conflict resolution, and accountability. Other professional skills were reinforced, particularly self-reflection.

4 Student Feedback

Student feedback was collected and received several positive comments. The feedback highlighted various aspects of the educational experience of these projects that students appreciate and wish to see more of. Some comments recorded are:

- *"A good way to make a positive impact on sustainability at UCL"*
- *"Exciting"*
- *"Very fun- love practical work "*

In addition to the formal feedback collected through surveys and meetings, positive feedback was also received by word of mouth. Various students and members of staff highlighted the positive impact that these pilot projects had so far and asked whether there were any plans for scaling up.

5 Conclusions

As explained above, these pilot projects have been lightly integrated into some mechanical engineering teaching modules. The projects have given students the opportunity to gain first hand experience in creating and running a circular economy using the MechSpace as its test site. Modules such as design and professional skills have benefited greatly from these initiatives as they have given various topics practical context. These practical experiences provided a foundational basis for dialogue between staff and students, fostering a relatable and constructive exchange.

Besides reducing waste, these projects have fostered valuable dialogue between staff and students on sustainability, circular economy, safety and risk. The projects have exposed students to

- the difficulty in repairing products
- the amount of effort it takes to recycle
- the logistical challenges of creating a community network sharing goods and the added difficulty in designing robust goods that are clear to use and repairable

These sustainability initiatives were pivotal in the Department of Mechanical Engineering securing the UCL Gold Green Impact award and also ranking highly commendable in a special sustainability award. The MechSpace team is dedicated to further developing these projects and investigating additional avenues to maximise value extraction.

References

Baden, D., Peattie, K., & Oke, A. (2020). Access over ownership: Case studies of libraries of things. *Sustainability (Switzerland)*, *12*(17). https://doi.org/10.3390/su12177180

Claudelin, A., Tuominen, K., & Vanhamäki, S. (2022). Sustainability Perspectives of the Sharing Economy: Process of Creating a Library of Things in Finland. *Sustainability (Switzerland)*, *14*(11). https://doi.org/10.3390/su14116627

Lax, B. (2020). What Are These Things Doing in the Library? How a Library of Things Can Engage and Delight a Community. *OLA Quarterly*. https://www.instagram.com/p/BuCsvkmn_r9/

Mugwagwa, J. (2020). *Identifying "turning points" for successful innovations during Covid-19*. https://bmjopen.bmj.com/content/4/6/e005548

Muñoz, V. G., Muneta, L. M., Carrasco-Gallego, R., Marquez, J. de J., & Hidalgo-Carvajal, D. (2020). Evaluation of the circularity of recycled pla filaments for 3D printers. *Applied Sciences (Switzerland)*, *10*(24), 1–12. https://doi.org/10.3390/app10248967

One Army. (2023). *Precious Plastic*. https://preciousplastic.com/

Reid, H. T., Fordham, A., Rasha, L., Buckwell, M., Brett, D. J. L., Jervis, R., & Shearing, P. R. (2023). Up in smoke: Considerations for lithium-ion batteries in disposable e-cigarettes. *Joule*, *7*(12), 2749–2759. https://doi.org/10.1016/j.joule.2023.11.008

Sustainable UCL. (2024). *Repair Café | Sustainable UCL - UCL – University College London*. https://www.ucl.ac.uk/sustainable/events/2024/nov/repair-cafe

Saorín, J. L., Melian-Díaz, D., Bonnet, A., Carbonell Carrera, C., Meier, C., & De La Torre-Cantero, J. (2017). Makerspace teaching-learning environment to enhance creative competence in engineering students. *Thinking Skills and Creativity*, *23*, 188–198. https://doi.org/10.1016/j.tsc.2017.01.004

UCL Mechanical Engineering. (n.d.). *MechSpace | Mechanical Engineering - UCL – University College London*. Retrieved May 10, 2025, from https://www.ucl.ac.uk/mechanical-engineering/about/facilities/mechspace