

Growing a Student-Led PLA Recycling Program in an Academic Makerspace

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Abstract

What began as a project for a second-year engineering design course has grown into a fully operational recycling system for a university makerspace in which PLA waste from 3D printing is shredded, pressed into sheets, and made available to students for laser cutting. This work is situated within the Integrated Teaching and Learning Program (ITLP) at the University of Colorado Boulder's College of Engineering & Applied Science (CEAS), which supports faculty directed hands-on project-based education through providing classroom spaces, prototyping facilities, engineering staff support, hands-on curriculum support, and cross-disciplinary learning experiences. A critical step in the development of a recycling system was an upper-level engineering student internship, during which the student translated an initial proof-of-concept into a standardized, repeatable makerspace-ready process. We document the technical process, the pedagogical model underpinning the program's structure, and lessons learned from sustaining student-initiated projects across academic cohorts. The work is framed within the broader context of maker-centered learning, sustainability in higher education makerspaces, and the value of authentic student engagement.

Introduction

The rapid proliferation of 3D printers in academic makerspaces has created a substantial and largely unaddressed waste stream. Polyacrylic acid (PLA), the most commonly used filament material, accumulates in makerspaces as failed prints, support structures, test pieces, and abandoned projects. While PLA is technically biodegradable under industrial composting conditions, in-house reuse and recycling represents both a more immediately sustainable outcome and a richer educational opportunity.

The Integrated Teaching and Learning Program (ITLP) at the University of Colorado Boulder operates a hands-on learning laboratory that serves students across engineering disciplines. The hands-on laboratory includes many resources that are commonly found in makerspaces, including a fleet of 20 3D printers, generating regular PLA waste each semester. Rather than treating this waste as an operational inconvenience, the ITLP "makerspace" (as we will refer to it) and its affiliated faculty, chose to frame it as a design problem—one well suited to student engagement.

This framing of the problem into a client-based class project gave rise to a sustained, student-led recycling program. The program passed through two distinct phases: an initial development phase embedded in a second-year engineering design/prototyping course, and an expansion and formalization phase led by an upper-level engineering student summer intern. Today, the program is fully operational with sheets of recycled PLA being freely available for laser cutting projects. This project led to the publication of an Instructable detailing the technical process and has helped the authors understand the pedagogical rationale and the structural lessons learned from building a program designed to outlast any individual student.

Background

PLA is a renewable bioplastic derived from fermented plant starch. Its popularity in 3D printing stems from its low printing temperature, low warping, and relative safety when printing in enclosed spaces. Although PLA is frequently marketed as compostable, this requires industrial composting infrastructure operating at sustained elevated temperatures, conditions that are rarely accessible to makerspace users [1].

Inspired by the Precious Plastic movement's open-source sheet press process [2], several academic makerspaces have begun exploring in-house PLA recycling. A notable example is the NYU Tandon Maker Space, which documented a process for shredding discarded PLA prints into pellets, pressing those pellets in a convection oven to form sheets, and subsequently laser cutting those sheets for use in student projects [3]. Their work demonstrated the technical feasibility of a closed-loop PLA system within an academic setting and established a reference process that informed the work described here. One important change to the process was our introduction of a t-shirt press to make the sheets instead of an oven. With this addition, direct pressure was used to make flat sheets instead of relying on gravity alone. This dramatically decreased the time it took to make a PLA sheet from a few hours to a few minutes.

The ITLP's contribution to this space lies not primarily in technical novelty but in pedagogical framing. Where prior work has documented the technical process, this paper focuses on how that process was developed and sustained through structured, student-learning experiences—specifically a second-year projects course and a subsequent student internship—and what that model offers to other institutions seeking to embed sustainability into their makerspace operations.

Pedagogical Context: Project-Based Learning at the ITLP

For more than two decades, the ITLP at the University of Colorado Boulder has supported hands-on, experiential learning embedded in the engineering curriculum — partnering with faculty and instructors to create active learning environments through laboratory experiences, prototyping and manufacturing, and skill-building workshops. The ITLP serves as a collaborative facility and resource for faculty and students across multiple departments, supporting both curricular and co-curricular learning. The ITLP fills a key niche in engineering education: lowering the barriers to hands-on learning for students at all levels of experience. By providing the time, equipment, space, and expertise that individual courses and departments often cannot, the program helps students develop technical skills, confidence, and a pre-professional identity as engineers.

Second-year engineering students at CU take a design and prototyping course sequence that's supported by ITL Program resources. These engineering courses introduce students to fabrication tools, iterative design methodology, and project-based problem solving. Critically, the courses emphasize authentic challenges—problems with real stakes, real constraints, and real beneficiaries—rather than purely academic exercises.

It is within this context that the PLA recycling program began. Makerspace staff and faculty identified PLA waste as a genuine operational problem with clear environmental implications and

proposed it as a project challenge to a cohort of second-year students. This framing—asking students to solve a real problem for a real community—aligns with the broader literature on authentic learning and problem-based design education [4].

Phase 1: The Class Project

A team of second-year engineering students was tasked with investigating options for recycling or reusing the PLA waste generated by the ITLP lab's 3D printers. The instructor for this course made the brief intentionally open: students were asked to research existing approaches, assess feasibility given available equipment and space, prototype a process, and document their findings for potential handoff to future students or staff.

This open-ended framing served multiple pedagogical purposes. It required students to engage in genuine research and synthesis rather than executing a prescribed procedure. It demanded that they consider operational constraints—budget, equipment availability, space, safety—alongside technical ones. And it explicitly positioned their work as a foundation for future development, introducing the concept of design for handoff and sustainability of outcomes.

Drawing on publicly available resources, including the Precious Plastic sheet press method, the Teaching Tech 3D Printing site (<https://teachingtecht.github.io/>), and documented work from peer institutions [3], the student team developed and tested an initial process for recycling PLA at the ITLP makerspace. Their process followed the core logic of the established approach:

- Collected PLA waste (failed prints, discarded prototypes, purge material) is sorted and cleaned to remove non-PLA contaminants.
- Sorted PLA is shredded
- Shredded plastic is spread onto the bed of a t-shirt press, inside an aluminum mold and heated to melting temperatures and pressed into shape.
- Resulting sheets were tested for laser cuttability on the ITLP makerspace's CO₂ laser cutter.

The students documented their process, identified key failure modes (difficulties of shredding waste PLA, amount of polymer added to the molds, time of heating, and cooling modes that minimize warping) and produced a preliminary procedural guide. Their work constituted a functional proof of concept—rather than a polished operational system—that was appropriate to the course context and explicitly positioned as such in their documentation.

Pedagogically, the experience engaged students with sustainability as an engineering design challenge, required them to learn fabrication processes not covered in standard coursework, and produced a tangible artifact—both the physical sheets and the procedural documentation—that would serve as the foundation for the next phase.

Phase 2: The Summer Internship

The following summer, an engineering student was hired as a makerspace intern, and one of the intern's goals was to take the class projects proof of concept and develop it into a fully operational program. This internship structure—using a more advanced student to build on the work of an earlier student—was both practical and intentional.

Practically, it addresses a core challenge of course-embedded projects: the academic semester ends before projects can be fully developed, and without deliberate continuity mechanisms, promising work is lost. By leveraging a paid internship role that spent a portion of their time continuing the project, the ITL Program demonstrated an institutional commitment to the work that a class project alone could not sustain.

Pedagogically, the internship offered the upper-level student a qualitatively different learning experience than a course project. Working over a summer with significant autonomy and mentorship from an ITLP engineer, they were responsible for executing a defined process and for evaluating, iterating, documenting, and institutionalizing a program. This experience more closely resembles professional engineering practice than most undergraduate coursework.

The intern began by reviewing and replicating the class project's documented process, identifying areas that needed refinement for reliable, repeatable operation. Key areas of development included:

- Purchasing a dedicated polymer shredder from Polystruder to create suitable raw material for sheet making.
- Iterating heat press temperature and timing, polymer loading weight, and cooling procedures, to eliminate the variability observed in initial student testing.
- Establishing clear collection, sorting, and contamination-screening procedures to ensure sheet quality, including a dedicated PLA-only bin system and staff training guidelines.
- Systematically testing engraving and cutting settings on the ITLP laser cutters across multiple sheet thicknesses and colors, producing a reference table for makerspace users.
- Creating a comprehensive staff guide for producing sheets and a user-facing quick reference for laser cutting recycled PLA.
- Publishing a freely available, step-by-step guide on Instructables.com ("Recycled PLA Sheets From 3D Printer Waste!") documenting the full process with photographs, so that any makerspace can replicate or adapt the program without starting from scratch.

By the end of the summer, the program was operationally ready: recycled PLA sheets were being produced regularly and made available to students alongside other makerspace materials. The Instructable—publicly accessible at [instructables.com/Recycled-PLA-Sheets-From-3D-Printer-Waste/](https://www.instructables.com/Recycled-PLA-Sheets-From-3D-Printer-Waste/)—stands as a freely shareable artifact of the intern's work, extending the program's impact well beyond CU Boulder.

Current State of the Program

The PLA recycling program is now fully operational at the ITLP makerspace. PLA waste collection bins are available near the 3D printing station. Collected material is processed on a regular schedule by makerspace staff following the intern's standardized procedures. The ITLP is able to produce approximately 5 sheets per week which are used to make enclosures, gears and accessories for engineering products. Recycled PLA sheets are stored with other makerspace materials and are available to all students for use in their projects, at no additional cost.

The process is also fully open and reproducible. The intern's Instructable—"Recycled PLA Sheets From 3D Printer Waste!"—is freely available at [instructables.com/Recycled-PLA-Sheets-From-3D-Printer-Waste](https://www.instructables.com/Recycled-PLA-Sheets-From-3D-Printer-Waste/) and walks through each step of the process with photographs: waste collection and sorting, shredding, oven pressing, sheet finishing, and laser cutting parameter selection. This public documentation reflects a deliberate choice to contribute back to the broader makerspace community rather than keeping institutional knowledge internal.

Student awareness of the program's origins has been maintained through brief onboarding content that tells the story of how the program came to be. This framing—making visible the student work behind an operational facility—serves both to honor that work and to signal to current students that the makerspace is a place where their projects can have lasting impact.

Due to the high demand for recycled material, the makerspace is currently exploring options for the next phase of the program, which may include standardizing the process of material collection from nearby facilities (other maker spaces on campus), investigating methods to break down large PLA pieces into manageable chunks, and embedding program maintenance into future course projects as a recurring design challenge.

Discussion: A Model for Sustainable Student Projects

The PLA recycling program offers a replicable model for how academic makerspaces can develop student-initiated projects into durable institutional programs. Several structural features appear central to this success:

- **Authentic problem framing:** The project began with a real operational challenge, not a synthetic exercise. This created genuine stakes and a natural institutional interest in the outcome.
- **Explicit continuity planning:** The course project was designed from the outset with handoff in mind. Students knew their documentation would be used, which elevated its quality.
- **Bridging resource:** The internship served as the critical link between course project and operational program. Without it, the class project would likely have remained a proof of concept.
- **Institutional commitment:** By funding the internship and dedicating a portion of its time to a project that improves program operations, the ITL Program signaled that student work has real value—encouraging future engagement.
- **Open knowledge sharing:** Publishing the process as a freely available Instructable reflects a community-of-practice ethos and positions the program as a contribution to the broader academic makerspace field, not just an internal operation.

From a pedagogical perspective, the program illustrates how making can be integrated into engineering education in ways that go beyond technical skill development. The second-year students engaged in research, systems thinking, and design for sustainability—competencies central to contemporary engineering practice. The junior intern developed project ownership, operational thinking, and documentation skills that coursework rarely demands at that depth.

The multi-cohort structure also introduces an implicit dimension of legacy and responsibility. Students who know their work will continue to produce more thoughtful documentation and design decisions. This observation aligns with constructivist learning theory's emphasis on authentic audience as a driver of meaningful work [4].

A noteworthy aspect of this structure is the implicit mentorship relationship it creates across student cohorts. The second-year students who initiated the project produced work that was meaningfully extended by an upper division student. One of the members from the class team was able to meet with the engineering intern who was able to engage substantively with the earlier students' documentation, building on it, correcting it where needed, and acknowledging its contribution in their own documentation.

This form near-peer learning is an underexplored dimension of project continuity in maker education. It models professional practice—where engineers regularly build on prior work—and creates a sense of shared ownership in the program across student generations. The decision to publish the intern's process documentation as a public Instructable extends this logic outward: other makerspaces can now build on CU Boulder's work in the same way the intern built on the second-year students', creating a wider community of practice around open, reproducible makerspace sustainability programs.

Several challenges merit acknowledgment. Sustaining material quality requires consistent staff attention to contamination screening—a demand that increases as volume grows. The program currently depends on institutional memory held by makerspace staff; further documentation and onboarding infrastructure would reduce this fragility. And while the technical process is functional, the physical properties of recycled PLA sheets (compared to virgin material) have not been formally characterized, limiting the applications for which they are reliably suitable.

Perhaps the most fundamental challenge is institutional: creating the intern role requires administrative will and budget. Makerspaces without access to such resources may need to find alternative continuity mechanisms—structured course sequences, volunteer graduate student involvement, or faculty research projects—as vehicles.

Conclusion

The ITLP makerspace PLA recycling program demonstrates that a course project, thoughtfully designed and supported by deliberate continuity mechanisms, can become a lasting operational reality. In doing so, it creates educational value well beyond what either the course or the internship could produce independently: a living example of how student engineering work can address real environmental challenges and remain visible and useful long after the semester ends.

We offer this work as both a technical reference and a pedagogical model. The technical process—PLA shredding, sheet pressing, and laser cutting—is documented in sufficient detail for adaptation at comparable facilities. The program development model—course project to internship to operation—is offered as one approach to the broader challenge of sustaining student-initiated work in academic makerspaces.

Future work will focus on characterizing the material properties of recycled PLA sheets, expanding collection and processing capacity, and exploring how the program's maintenance can itself become a recurring pedagogical exercise for future student cohorts.

References

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