Designing out waste and driving a circular economy on a university campus

OVERVIEW

If US higher education expenditure was a country, it would be the 21st largest economy in the world.

There is no doubt that **higher education plays a vital role in the global transition to a circular economy.** From teaching and learning, through research and into student action, across the globe there is growing momentum from the sector to move into the circular economy space. But, it isn't only in the classroom or laboratory where real change is possible - how higher education institutions choose to use their immense purchasing power can have significant effects on making both **activities on campus and supply chains more circular**. Making more circular procurement decisions can significantly help shift the economy to being more circular and support universities in their net **zero carbon ambitions.**

INTRODUCTION

Designing out waste and driving a circular economy on a university campus: a complex, multi solution approach

The MIT Office of Sustainability (MITOS) is committed to designing out waste from a campus of 168 urban acres and nearly 170 buildings. Currently, approximately 40% to 50% of MIT's material waste has the potential to feed the circular economy as it leaves campus in a form that is clean enough for reprocessing through regional and global recycling markets that include paper, plastic, and food.

However, this means that 50% to 60% of materials collected from campus are not clean enough for reprocessing. As such, more than half of MIT's consumed materials are destined to become landfilled or incinerated, contributing to a number of downstream, negative environmental and social impacts.

MIT's Office of Sustainability wanted to reduce the overall amount of waste produced on campus and ensure that any waste produced was able to feed the circular economy. In order to deliver this, MIT has taken a comprehensive approach to increasing the amount of consumed materials that can be repurposed, recycled or reprocessed. This approach includes understanding the system, piloting solutions, assessing critical needs, and addressing existing gaps and has made MIT radically rethink its approach to procuring a waste contractor.

SO, WHAT PROCESS DID MIT FOLLOW?

MIT broke the process into a number of phases, each looking at specific aspects of the waste system on campus.

PHASE 1 UNDERSTAND THE SYSTEM AND COMMUNICATE DATA

Inspired by Sustainable Urban Metabolism[1], the MIT Office of Sustainability partnered with one of MIT's PhD students and focused on conducting a material flow analysis (MFA) of the MIT campus. This MFA was designed to understand material consumption impacts and identify opportunities for driving different impacts across campus[2]. This collaborative study used the MIT campus as a test bed by establishing a baseline of material inflows (purchased goods) and outflows (waste). The data from the MFA has been communicated to the campus through Material Matters (see figure 1) as well as internal operations to inform MIT about its consumption and waste patterns. This enables changes in system design that can drive more sustainable impacts. Highlights of the MFA are described below.

Inflows: The findings of the inflow side of the MFA found that 84% of MIT's spend on material goods comes from 10 commodity categories with considerable complexity of product purchasing, consuming nearly 100,000 different products in one year.

Stock: Beyond these annual inputs, nearly 60,000 goods remain in campus labs and offices as capital assets while each year, hundreds of these assets (computers, tables, lab equipment) become available for re-purposing/re-homing from one lab to another.

Outputs: The outflow side of the MFA found that almost 4,500 tons of materials from across campus—including rubbish, recycling, and food waste—were collected and removed from campus[3]:

Approximately 2,000 tons of the total outflows collected were for recycling and food waste.

A typical MIT rubbish bin comprised approximately 50% of material that could be re-processed through organic composting and/or post-consumer material recycling.

Approximately 35% of material collected for recycling was contaminated—materials found in an MIT recycling bin that do not belong (e.g. 25% general rubbish and 5-10% food waste[4]).

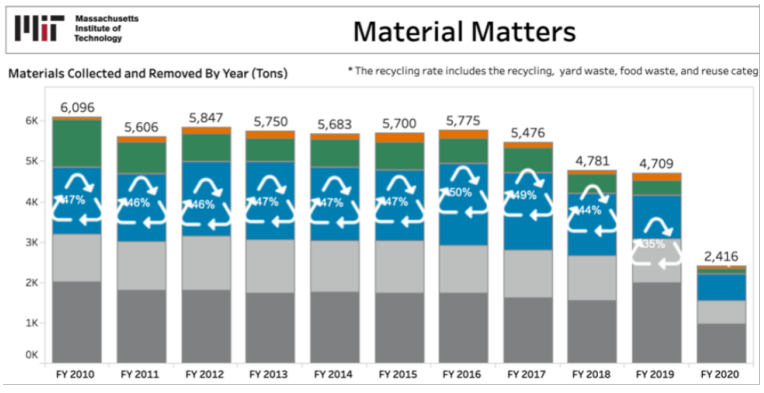

Figure SEQ Figure * ARABIC 1 MIT Material Matters is an open-source data pool communicating waste material flow findings on approximately 20 waste streams to the MIT community. The tableau-based tool enables use by students, faculty, research scientists and operations.

1 A concept described by Professor John Fernandez as a systems-oriented approach to understanding the flows of materials through a city while linking environmental, economic, social, and technical infrastructure issues in Sustainable Urban Metabolism, 2013. MIT Press.

2 PhD Dissertation 2020 by Rachel K Perlman...

3 MIT Material Matters Dashboard, Data for FY2019, annualized totals.

4 MIT Waste Audits 2016-2018, R. Perlman and MIT Office of Sustainability and Department of Facilities.

PHASE 2 PILOT TEST SOLUTIONS

By utilising the findings of the MFA, several pilot solutions were put forth and tested in various spaces throughout campus to drive more sustainable impacts by way of system and behavior changes:

Pilot 1 Roll out of Rheaply across campus: Third-party circular asset management tool, Rheaply, was rolled out across the entire campus in 2019. The tool matches surplus items with those in need across campus. It facilitates reuse of items (office and lab equipment) that would have otherwise been discarded. This ensures products and materials are kept in use longer.

Pilot 2 Building-Scale Study: To reduce contamination of MIT's waste stream, a team led by MITOS worked to turn the 300 person Media Lab into a living laboratory for testing infrastructure changes and behavioral impacts. During the six-month pilot programme, custodians collected and monitored the rubbish bins and recorded daily contamination levels of the recycling bins (i.e. presence of food waste in recycling) from test labs and offices. A waste audit was conducted before and after the pilot, to gather data and analyse the effects of the changes that had been made, in order to see if there was any correlation with better recycling and food waste collection practices. Solving these challenges at the scale of the Media Lab would enable exploring scaling up solutions across campus.

Pilot 2b Multi-Departments and Buildings Study: Pilot efforts Phase 2 in the Media Lab built a case for expansion of waste reduction strategy testing to additional building types on campus, including one undergraduate dormitory. Although the COVID-19 pandemic closed campus and halted the launch of this trial, the experiment has been designed to evaluate the impact of interventions which appear to be most effective, feasible, and scalable. Randomised control testing of community behavior across multiple buildings and MIT departments, labs, and centres included evaluation of several interventions:

- Signage design
- Centralised sorting stations
- Introduction of food waste collection
- Community engagement
- Real-time data feedback loops
- Education
- Training

Students were engaged for daily monitoring of waste, sorting quality and quantity with research leadership provided by MIT behavioral and lifecycle scientists. Waste technology start-up Spare-It was engaged to provide data collection, data feedback, and gamified-engagements.

Prior to the COVID-19 campus closure, a baseline waste audit of 172 recycling bins in one building revealed that 114 (66%) were contaminated with items that do not belong. 80% of the contamination was coffee cups, used napkins, food containers, utensils, and straws. Key informant: These findings about common contaminants are now informing kitchen procurement decisions in the building, which is aiming to design out waste by eliminating common contaminants from the purchasing/input stream.

PHASE 3 IMPLEMENTATION AT BUILDING SCALE AS MODEL FOR MIT

While the Phase 2 testing was intended to precede and inform Phase 3 Implementation Testing, the COVID-19 campus closure required a pivot.

At the same time of Phase 2 testing, Phase 3 was launched to integrate Phase 2 pilot findings into a circular economy strategy for operational material flows in Site 4 (a 426,146 square foot building designed to be the "new front door to MIT."). Site 4 will house a graduate dorm of 400 units, MIT Welcome Centre, MIT Admissions, Innovation and Entrepreneurship Centre, Sustainability Research Floor, child care centre, and retail food hall, presenting a unique opportunity for a building-wide, circular economy strategy. One aim of this strategy for Site 4 is to serve as a demonstration model of innovative system policies and processes for adoption throughout the campus.

The circular economy strategy for Site 4 and its tenants includes the development of integrated procurement and waste management policies. Strategies to guide collaborative purchasing, education and training, and comprehensive building-wide waste management approaches that encompass infrastructure, communications, handling, and hauling. The consensus-based stakeholder engagement process being led by MITOS and the Department of Facilities is establishing new planning, design, and operations standards for sustainable purchasing, waste management, and multi-departmental space collaboration.

A NEW APPROACH TO PROCURING A WASTE PARTNER

Across all three phases described above, the need for a campus waste hauling partner that shared the campus commitment to design out waste and grow a data-driven platform of strategies, began to emerge. In 2019, the Department of Facilities and MITOS teamed together to develop a Request For Proposal (RFP) for Waste Management Services. This RFP described the campus need for a partner committed to achieving circular economy goals by demonstrating best practice approaches and testing new models while growing a data-driven system for informing campus decision-making. The process resulted in identification and selection of a new campus waste hauling partner with sustainability and data collection performance goals integrated within the new scope of work. The multi-year contract commenced in January 2020. At the time of writing, the new waste hauling partner is still transitioning to full operations on the 24,000-person campus as well as beginning to engage as a key stakeholder in some of the solutions described above.

WHY IS THIS COMPREHENSIVE APPROACH CIRCULAR?

This approach is helping MIT to design out waste and pollution by utilising data to make upstream decisions such as:

- Identifying appropriate pilot testing of system design and behavior change approaches
- Centralised waste sorting stations with educational campaigns produced cleaner recycling streams with 6.5% less contamination
- Increase user confidence in recycling. Confidence in recycling rose from 20% (pre-pilot) to 90% (post-pilot), demonstrating that these campaigns can significantly shift behavior towards better rubbish, recycling, and food waste collection practices.
- Identifying items that can inform procurement to be designed-out

This comprehensive approach has also helped to keep products and materials in use by utilising a variety of online and in person sharing platforms:

- Using **Rheaply** for just 6 months resulted in nearly 500 items being shared across campus laboratories and departments and saved USD 50,000 in avoided purchasing costs
- **MIT Choose to Reuse** provides monthly material swaps among the campus community, re-homing approximately 300 small items every month
- **Trash2Treasure** captures student move-out goods in spring and re-sells goods to incoming students in the fall

Finally, this comprehensive approach and new way of working with a waste partner has enabled MIT organic waste to be put back into the soil as nutrients, regenerating the natural system:

- More than 400 tons of food waste has been collected and processed since 2017 via compost and anaerobic digestion systems, returning nutrients to the ecosystem
- During the 6 month pilot, the Media Lab programme diverted just over a tonne of food waste towards soil production on regional farms—a waste material that had previously contaminated recycling bins or had been placed in the rubbish bins

LESSONS LEARNED

- Development of circular economy strategies at a building scale requires collaborative engagement among procurement and waste management staff, as well as users of existing spaces (i.e. researchers, students, faculty, department staff, etc.)
- Local level data monitoring and collection helps galvanise groups to see their impacts and troubleshoot opportunities to address challenges
- Data collection that can enable before/after comparisons (i.e. testing of interventions with waste audits) can support evidence-based decisions about interventions rather than anecdotal-driven ideas of effectiveness
- Randomised control trials/research offer opportunity for testing strategies to see what works with different communities
- Testing creates a 'safe to try environment' as waste policies are not a one-size-fits-all solution.
- When possible, leverage the disciplinary strengths to each group (i.e. architecture students used signage design as a way to contribute to testing in their space)