Doing less bad is not enough. While for most of us in the sustainability field have long known this - if just for the realisation that we are past a point of saving the world through reduction - there is a temptation to focus on an ecomodern approach where a lean efficiency is king - less bad but without an ethos of more good. More recently, restoration and regeneration have emerged to capture this positive effect, and in this paper Boyle, O'Brien and Sellar apply this lens to questions around institutional organic waste.

A CASE STUDY APPLYING MANG AND REED'S MODEL OF SUSTAINABILITY TO ORGANIC WASTE PROCESSING

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ABSTRACT

This article presents a case study applying Mang and Reed's model of sustainability to identifying and addressing organic waste management issues in a New Zealand tertiary education institution. Globally, there is an increasing awareness of the urgency required to address climate change. Many organisations will need to find ways to transform their operations to achieve this. While tertiary education institutions are not exempt from this need for change, there are few clear examples of how to achieve this transformation. This research project first identified the challenges presented by organic waste management in the context of a New Zealand polytechnic. A range of organic waste management solutions were then evaluated through an integrated systems approach, embracing a range of value propositions including those based on environmental, financial, social and, critically, educational values. The project took a pragmatic approach to context-specific case-study research design in order to develop a set of recommendations for an institutional solution. The findings extend beyond the institution's solving of its immediate problems (organic waste) and into socio-ecological regeneration seen in a wider context.

BACKGROUND

This case study was initiated following concerns that the organic waste management systems at Otago Polytechnic's Dunedin campus had reached capacity and could no longer process the quantities required. Mismanagement of organic waste streams is a significant source of greenhouse gas (GHG) emissions (Lim, Lee, & Wu, 2015) and is therefore an area worthy of focus for any organisation looking to reduce its environmental impact. As well as presenting a disposal problem, organic waste materials also represent a resource that can be used to enhance and restore ecological systems, if managed appropriately. Because the same issue is faced by many large institutions, including similar educational bodies, we believed that an effective solution developed at OP might inform the practices of other organisations looking for solutions.

In an initial search of the literature, the researchers did not identify any material directly applicable to the situation of OP. Sullivan (2010) provides a brief description of campus-based organic waste processing systems across several institutions, systems that are each integrated into educational programmes in some way. Although these integrated models provided valuable information, none of the systems described were directly translatable to the context of Otago Polytechnic. The key differences that make OP unique are: the composition of the waste, the sources of waste materials and the quantities involved, and the level educational engagement available through the existing curriculum. A further aspect of the context at OP is the values and strategic goals of the institution. These values and goals (Otago Polytechnic – Te Kura Matatini ki Otago, 2018) provided major reference points and guides when developing recommendations from the findings of this investigation.

METHODS OF INQUIRY

This research project was carried out as a context-specific case study of organic waste management at the Dunedin campus of Otago Polytechnic. This case study approach (Baxter & Jack, 2008) was adopted with a view to understanding the wider issues (or opportunity) presented by organic waste management in educational institutions. This process was informed by models including the Design Double Diamond (Design Council, 2017) and Permaculture Design Principles (Mollison, 1988). The Double Diamond is a design model which describes a process that moves from problem to problem definition, to outcome (Design Council, 2017). This model proved useful in defining the stage that our design process had reached, and in turn in identifying the processes yet to be considered. Elements of the Permaculture Principles (Mollison, 1988; Ulbrich, 2016) were used as a reference point for describing the various values that were upheld or created in the design process.

THE EXISTING WASTE PROCESSING SYSTEM AT OTAGO POLYTECHNIC

Before discussing possible changes to waste processing, it is important to evaluate the current systems at OP. The organic waste that is produced at OP includes food waste, materials from teaching activities, and waste from campus operations such as maintenance. At present, all successfully diverted food waste and some other organic materials are processed through a range of composting methods overseen by the staff and learners involved in the New Zealand Certificate in Horticulture. By using a variety of processes working in parallel, the current system is highly resilient, has reasonable capacity and requires only a moderate input of labour and resources. One of the core values of this established system is its role as an educational platform – it is primarily managed by students and allows for a lot of hands-on learning.

The Horticulture programme at OP employs three primary composting systems: aerobic hot composting (Gajalakshmi & Abbasi, 2008), in-vessel anaerobic composting (Bokashi: Tomash, 2016) and vermicomposting (Worm Farm: Asha Aalok, 2008). Although none of these systems has a very high capacity on its own, when combined and well managed the OP facility is capable of processing all the waste currently diverted or retrieved on campus, which is roughly 50kg per day. However, the existing systems need some reworking and scaling to deal with significantly increased input – the result of a new accommodation facility on campus and plans to increase the effectiveness of waste sorting, meaning that less organic waste will go to landfill.

From a two-week sample based on weighing organic waste at its source, it became clear that significantly more organic waste was being produced than was being diverted to composting. Using data derived from multiple audits and reports on waste produced at OP over the last few years, combined with data from the polytechnic's waste collection contractor, we estimated that 64 tonnes of organic waste is produced annually at OP. If OP reaches the point where all organic materials are successfully diverted from landfill, we would need processing systems with a capacity of more than 300kg per day – a six-fold increase in the capacity of the current systems. However, if achieved, this could result in a cost reduction of around $12,000 for waste managed in-house rather than sent to landfill.

A key challenge raised by this evaluation related to particular types of waste that the current system cannot process, including compostable food packaging (such as coffee cups) and boiler ash (from a woodchip boiler). As we believe that an appropriately designed system would be capable of processing these inputs, this feature was identified as a key capability to integrate into any new system.

While there is clearly a challenge to the capacity of the current system, it is important to recognise the value it represents. The current system is not only successful at managing organic waste, it is integrated into the operations of the organisation and, specifically, into the delivery of horticulture education. It is also a very resilient system that is not dependent on a single person or machine to continue to deliver value.

Based on an evaluation of the current systems, various options to increase the institution's capacity and capability for effective organic waste management were investigated. This investigation explored immediate, medium-term and long-term solutions.

IMMEDIATE IMPROVEMENTS TO THE EXISTING SYSTEM

Several improvements to the organic waste collection system can be actioned immediately:

1. Collect and process post-consumer waste from food service at the new student accommodation facility – average 10kg/day
2. Improve inter-departmental communication. Some questions asked in this inquiry could have been addressed sooner, given more effective communication
3. Enhance waste collection sites and education across the campus to increase diversion rates
4. Experiment with processing PLA (polylactic acid) packaging in the existing hot composting system
5. Review policy and guidelines for compostable food packaging used on campus (including local vendors such as Fluid Café and food trucks and mobile vendors).

While these initiatives will reduce the amount of waste going to landfill, they will also add to the volume of organic waste that the current system will need to process. This will add extra pressure to the system's already strained capacity.

EXPLORING ESTABLISHED SOLUTIONS IN NEW ZEALAND

In order to identify longer-term solutions, we investigated the actions undertaken by several other institutions, mainly through an inquiry carried out in June and July 2018. The researcher travelled New Zealand, visiting a range of facilities that specialise in processing food waste and/or organic waste. Stretching from the Bay of Islands to Dunedin, the investigation required visits to 12 separate sites, each employing technology and processes appropriate to their context. These facilities ranged widely in scale and scope – from a single home-kitchen to a community-level initiative on Waiheke Island, through to an enormous, centralised city-wide facility in Christchurch. The processing capacity of these facilities ranged from 2 kg to 250 tonnes/day. (See Appendix A for further details of the venues visited and the systems observed.)

This investigation uncovered a broad range of methods, techniques and technologies used in organic waste processing in New Zealand, enabling the researcher to evaluate how and why the chosen processes were used, particularly in relation to their scale and to the nature of the materials processed. Having been exposed to wide range of problems and solutions, the researcher formed a much better idea of the questions to ask, data to gather and opportunities to seek in designing solutions for OP.

THEORY

The primary outcomes of this project took the form of three conceptual solutions which could serve as pathways for designing and implementing a solution to the organic waste problems faced by OP. The principle theory used in developing these concepts is known as the Trajectory of Ecological Design (Mang & Reed, 2012), developed by Bill Reed (Figure 1).

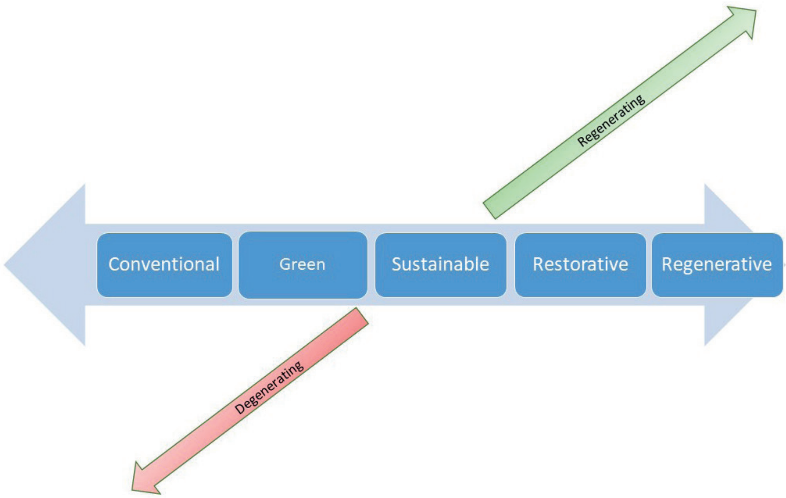

Figure 1. The Trajectory of Ecological Design (based on Mang & Reed, 2012).

In this framework, systems can be placed on a scale from conventional and degenerating examples – which take more energy to maintain and cause ecological harm – through to regenerating and living systems that generate ecological health. The term ecology is used in this instance to describe a living or dynamic system such as a habitat, people, buildings or infrastructure. The present case study – organic waste management in an educational institution – includes all these features, meaning that Otago Polytechnic can be properly described and evaluated as an ecology.

INTEGRATION OF PRACTICE AND THEORY

Using Reed's model (Mang & Reed, 2012), we developed three possible solutions to meet the needs of organic waste management at OP. Focusing on three points on the Trajectory of Ecological Design – "sustainable," "restorative" and "regenerative" – for each stage we developed a conceptual pathway to be used as a guide in designing solutions.

THE SUSTAINABLE PATHWAY – AN EFFICIENT SOLUTION TO WASTE

This pathway is primarily aimed at solving the problem of organic waste on campus by developing a simple, efficient method of reducing the environmental harms resulting from ineffective organic waste management. The primary value in this concept is the efficiencies gained in terms of energy, expenditure and time. According to Mang and Reed's theory, the goal of a sustainable pathway of this kind is to do less harm or halt degenerating processes (2012).

Adopting this pathway would redesign OP's on-campus waste processing systems to form a single, primary process such as the on-site composting apparatus (OSCA) built by Worms Down Under in Australia (OSCA systems, 2018). Although this pathway would involve a high initial cost (NZ$60-80,000), it would also incur very low running costs. This choice would allow for a simple, self-contained solution capable of processing all organic waste inputs from OP, including PLA packaging (in moderate quantities).

Installing technology like the OSCA would use very little energy and require minimal labour inputs. As this kind of machine is simple to operate, no specialist knowledge would be required for its day-to-day operations. However, as it would perform almost all the processing necessary internally and automatically, it would provide very little opportunity for hands-on engagement. This system could either replace the existing systems managed by Horticulture, or these systems could be retained for their educational value. As this pathway relies on a single mechanised process, it could be vulnerable to disruption or faults. Although this could be mitigated by in-house expertise in repairs and maintenance, it would require specialist training of OP staff.

This pathway is not recommended as a course of action, as it fails to fully align with the strategic goals and values of OP. Specifically, if adopted it would reduce the amount of learner involvement in the waste management process, and thus reduce the opportunity for the hands-on involvement required for learners to develop as sustainable practitioners (Otago Polytechnic – Te Kura Matatini ki Otago, 2018).

THE RESTORATIVE PATHWAY – A MEDIUM-TERM SOLUTION

Citing Jenkin and Zari (2009), Mang and Reed (2012, p. 2) describe restorative design as "a design system that combines returning 'polluted, degraded or damaged sites back to a state of acceptable health through human intervention' with biophilic designs that reconnect people to nature." Here biophilic refers to the love of life or living systems (Fromm, 1964).

In this pathway, the design of the solutions required is undertaken through an integrated systems approach. In the case of OP, this would focus on retaining and multiplying the social and cultural values (such as learner engagement) of the established systems, as well as ensuring that those systems have the capacity and capability to process all organic waste produced on campus. This concept also seeks to reframe "organic waste management" as "organic resource recovery," thereby shifting the focus from (merely) solving a problem to utilising an opportunity for transformation and restoration.

This pathway is considered complementary to the regenerative pathway, as the technologies and systems involved can be integrated into a larger, more extensive solution undertaken at a later stage, without any investments or infrastructure being made redundant. Thus, this pathway is a stepping stone to a regenerative approach.

Following the restorative pathway, we would recommend that existing systems be scaled and adapted to meet the projected quantity of organic waste diversion within OP, while maintaining learner engagement. Utilising medium-scale processes operating in parallel would allow lots of hands-on human engagement and mean that redundancy could be designed into the system. This would make for a system that is highly resilient, as complex systems with designed redundancy are inherently resilient (Mollison, 1988; Asokan, Yarime, & Esteban, 2017). Such processes can also be designed to require minimal mechanical or technological inputs, thus allowing little opportunity for mechanical or technical faults to cause delays.

Designing and building this system for OP would open up great potential for collaboration between departments, including Horticulture, Engineering, Foundation Studies and Design. This would enable a good deal of of student engagement in both the design and implementation of the system, as well as in its running and upkeep.

We believe that this pathway could be followed without the need to develop major infrastructure. We recognise the opportunity that the redevelopment of campus buildings, including those where Horticulture is based, affords for the requirements of these systems to be incorporated into the redesign process. Existing processes could be scaled up one by one, allowing for a simple transition and integration procedure.

In following this pathway, we recommend that the implementation of technologies for hot composting such as a small OSCA unit, which is estimated to cost around $30,000, be considered. This would cut energy inputs (labour, time and power) sufficiently to allow the processing volume required, while still maintaining educational values. This kind of mechanisation would allow easier processing of problematic inputs such as PLA packaging by ensuring a prolonged, high-temperature composting environment.

This pathway is estimated to cost $20-40,000 depending on the specific design and operation chosen. This figure is an estimate based on discussions with operators. This cost would be offset by the $12,000 currently spent on the off-site disposal of organic waste.

THE REGENERATIVE PATHWAY (CREATING SYSTEMS-LEVEL CHANGE IN THE LOCAL COMMUNITY) – A LONG-TERM SOLUTION

Mang & Reed (2012, p. 2) describe regenerative design as "a system of technologies and strategies, based on an understanding of the inner working of ecosystems that generates designs to regenerate rather than deplete underlying life support systems and resources within socio-ecological wholes."

This pathway would take a regenerative approach to designing solutions. In addition to the cultural value of learner engagement outlined in the restorative pathway, this concept would allow OP to generate systems-level change in its wider community. This could mean developing solutions to organic waste that have capacity beyond the needs of the OP campus – catering for the wider community's organic waste issues. OP would also act as a leader in the tertiary community, exemplifying a transformative way of approaching waste management and problem-solving.

Following this route, OP could seek to collaborate with local entities, such as other education institutions or businesses, to design and implement a highly capable, high-capacity processing system.

It is reasonable to assume that there are several local organisations in Dunedin collectively producing around 1 tonne of organic waste per day, and we know that no local service is currently capable of processing these quantities. If OP was seeking to provide processing capacity for this volume of waste, a large in-vessel processor like an OSCA II machine could be the simplest option. This device has a 1 tonne/day capacity, with an initial cost of approximately $130,000. We believe it is possible to build an effective business case for this option, or alternatively explore funding for not-for-profit models. The Waste Minimisation Fund administered by the Ministry for the Environment could be a key funding source (Ministry for the Environment, 2018).

The regenerative pathway has other advantages. It takes a pre-emptive course in respect to the Dunedin City Council's (DCC) waste management strategy (see below). As this pathway builds on that described in the Restorative Model, its adoption would also enable extensive opportunities for interdisciplinary collaboration, as well as providing ongoing engagement and educational value for learners.

CONSIDERING OP WASTE WITHIN A WIDER CONTEXT – AIMING HIGHER

This inquiry into food waste is situated in the wider context of Dunedin and New Zealand in general. The primary factor to consider when choosing a path for OP is the reality that, in 2018, there is no facility in Dunedin that processes food waste or other organic waste at the scale required. This issue is also positioned in a wider national context in which waste management, – or rather, *resource recovery* – is an issue that carries a good deal of momentum and public awareness. Thus it presents a very potent opportunity in terms of social and environmental impact, but also in terms of making a business case.

However, there are some specific problems which present market gaps. One of these gaps relates to the processing of compostable packaging made from PLA – no facility within 500km of OP accepts this particular waste stream (Renshaw, 2015). If OP was to put its resources into developing a solution for this unharnessed resource stream, a very tangible impact could be made as well as gaining potential revenue.

This investigation has given rise to a significant concept – that of OP becoming a central hub for organic waste processing across Dunedin's tertiary precinct. This approach holds great potential for regenerative change that could potentially affect the wider community. Currently, there is no organic waste processing system to serve the wider Dunedin tertiary precinct. This deficit is not only costing institutions financially, and our environment ecologically, but it is putting additional strain on the city's municipal waste facilities (landfill). OP is well placed to take leadership in this area and lead the way in Dunedin to provide a model for other institutions around the country.

Dunedin City Council's waste management and environmental solutions department is currently revising the city's Waste Management Plan (Dunedin City Council, n.d.). This plan will include frameworks for establishing organic waste processing systems. It is reasonable to expect that a localised model could devise a resource recovery system that could process 1 tonne of organic waste per day. This would make it more accessible to local communities and give people agency over their local waste management systems. As part of its review of the Waste Management Plan, the DCC is currently exploring how various systems could function in Dunedin. This strategy sets the stage for OP to be a core player in devising and running local resource recovery systems.

CONCLUSION – THE NEXT STEPS

In applying Mang and Reed's model of sustainability to food/organic waste processing systems, Otago Polytechnic sits at a crossroads, facing paths that lead in three conceptual directions. These paths are characterised by different models – sustainability, restoration, regeneration. We recommend that OP choose one of these frameworks in developing its organic waste processing systems.

The final choice will affect many elements of the waste management systems that operate within OP and the teams that maintain them. Considering this, the decision on choosing a particular path should take into account the many actors and levels of management involved.

The information and recommendations contained in this report are intended *as guides to choosing a path* to follow in this endeavour. Moving forward along any one of these paths will require *significantly more in-depth discussion and evaluation* than we have attempted in order to determine exactly what form a new or upgraded system will take.

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Site & Location	Size/scope	Method/Process	Inputs/feedstock
Living Earth Christchurch www.livingearth.co.nz	250 tonne/day Whole city	Hot compost: aerated semi-static pile & windrow maturation	Residential food & garden + commercial green waste
Envirofert Tuakau – Waikato www.envirofert.co.nz	>10 tonne/day Regional facility	Hot compost: aerated static windrow	Residential food & garden + commercial green waste + chipped timber/wood
Xtreme Zero Waste Raglan http://xtremezerowaste.org.nz/foodwaste-collection-service/hcu/	2 tonne food/week (4 tonne total) Town contractor	Hot compost: in-vessel, regular turning/aeration	Residential food waste + green waste
Cultivate Christchurch www.cultivate.org.nz	2.5 tonne/week Services local hospitality businesses	Hot compost: conventional multi-bin system – turned weekly	Commercial food scraps + chipped wood + green waste
The Compost Co. Waiheke www.wrt.org.nz/projects/compost-co/	250kg/week food 500kg/week total Services local hospitality businesses	Hot compost: conventional multi-bin system – turned weekly	Commercial food scraps + chipped wood + green waste
Devonport Naval Base Auckland https://www.bighanna.co.nz/news/big-hanna-makes-navy-resource	160kg/day Barracks food-service	Hot compost: mechanical in-vessel – Big Hanna T240	De-watered food scraps + wood-pulp pellets
Waikato University Food Service Hamilton https://www.waikato.ac.nz/news-events/media/2018/and-the-osca-goes-to	150kg/day Student hall of residence kitchen	Hot compost: mechanical in-vessel – OSCA Bite Size II	Food scraps + campus green waste (leaf litter)
My Noke Tokoroa www.mynoke.co.nz	Varied – very large scale 250-95,000 tonnes/year	Worm farm: industrial vermicomposting – static windrow	Varied – includes municipal bio-solids, dairy effluent
Central Wormworx Cromwell www.centralwormworx.com	20-30 tonnes/week Large-scale commercial customers	Worm farm: industrial vermicomposting – semi-static windrow	Food industry waste from orchards, vineyards, etc.

Appendix A- Facilities investigated in the course of this research project