EM and an Innovative Composting Toilet

Keith Morrison[1], Fiona Cox[2] and Mark McGrath[3]

Lincoln University, New Zealand[1]
Montgomery and Watson Environmental and Engineering Consultants, Christchurch, New Zealand [2]
New Zealand Nature Farming Society[3]

***Abstract** : The use of EM in an innovative composting toilet design is underway in New Zealand. It has been developed at Lincoln University in response to a serious waste management issue in Samoa. The introduction of "flush pour" or "Peace Corp" toilets into Samoa in the 1960s had a detrimental effect on the ground water. This is serious as ground water is the main source of potable drinking water. Due to the lack of running water, the "flush pour" toilet also brought about a water shortage. Moreover, both adequate water borne waste management and existing commercial composting toilets are far too expensive for the rural districts of Samoa, and so the design of an appropriate composting toilet has been a high priority for village development in rural Samoa.*

The innovations present in the composting toilet design are a highly efficient urine and faeces separator, with a continuous composting process for the faeces and continuous self-sterilising process for the urine. The result is an easy to manage system that is both compact and inexpensive. Furthermore, the outputs are a urine-based liquid fertiliser and a compost fertiliser. Both fertilisers can be easily removed from the toilet on a regular basis without interrupting the operation of the toilet. EM is used in a fermentation process to produce a Bokasi that is fed through a hopper arrangement to form alternate horizontal layers with faecal deposits, with adequate airflow in a tropical temperature and humidity regime to give optimum aerobic composting conditions.

Introduction

Ecological engineering takes an approach to waste management that respects the integrity of ecosystems. It is not only for ethical reasons, but also because of the utility to be gained from doing so. Ecosystems have evolved through co-evolution of species over several billion years to spectacularly fulfil the second law of thermodynamics in a way that maintains the continuing diversity of life. Our species is but one that has evolved within this process. It would be foolish to consider that our evolved mind could imagine and design more efficient and effective systems than what evolution over that period has brought into being.

Realisation of this makes it rational to develop an attitude of trust in the dynamics of ecosystems. It involves a trust in the flow and resonance of energies of the ecosystem as well as a trust in the integrity and autonomy of ecosystems and of life in total. Even though we do not have the mental capability to rationally improve on evolution, we do appear to be able to recognise the effectiveness and efficiency that has evolved. We do so in the intuitive recognition of system integrity as beauty. This gives us a basis with which to seek to enhance degraded ecosystems. Moser (1996) implies that recognition of the beauty of Nature is the summary principle of ecological engineering.

This ecological engineering approach to ecosystem “management” is philosophically congruent with Higa’s (1996) philosophy of EM technology. What Higa argues is the correct approach to the “management” of micro-organisms in ecosystems, ecological engineering applies to natural systems generally. Higa argues for innoculating ecosystems that are degraded with respect to their micro-organisms to enable the ecosystem recover its health. Ecological engineering argues for the enhancing of all aspects of ecosystem integrity. It could be argued that EM is a tool within ecological engineering, and maybe one day it may seen in this way.

There are two main concerns of ecological engineering: production, and waste management. They refer to the two main features of our interaction with ecosystems. In both cases, if we learn to fit in with the naturally evolving resonance of energies we will gain the benefit of billions of years of natural selection for efficiency and effectiveness. To the extent micro-organisms are an important part of both production and waste management, EM technology should feature as an important component of ecological engineering.

The Design Process

In Samoa during November and December of 1999 a compost toilet was designed and built from local materials and within the social context of a rural Samoan village. Traditionally Samoanís had coastal toilets. These were simply holes over the sea and relied on fish eating the waste and dilution. During the 1980’s the American Peace Corps introduced “flush pour” toilets. These look similar to western flush toilets but instead of having an automated flush they require a bucket of water to be manually poured in after use. The wastewater enters the ground untreated and has the potential to contaminate groundwater and sensitive coastal areas (Rapaport 1996). Due to the scarcity of water these toilets are often left unflushed. In addition, toilet paper blocks the toilet, so it is stored in buckets within the toilet house. Both of these situations pose a health risk to humans.

Potentially compost toilets offer many advantages over the existing toilet systems. The key advantages are:

- no water is needed for flushing;
- groundwater and sensitive coastal areas are protected; and
- nutrients taken from the ground can be returned.

To date however there has been little uptake in the use of compost toilets. Most people also spoke of wanting a “Western style” flush toilet. This was however in the context of complete lack of exposure to composting toilets. Once the general principles of how a compost toilet worked were explained people generally saw in principle the benefits of having a compost toilet over a flush toilet.

Systems theory was used to more explicitly and rigorously incorporate the social and ecological contexts into the design process. This was to take advantage of the design project being nested within on-going action research where there are well-defined social and ecological systems providing feedback as to the appropriateness of development projects. It is necessarily an iterative process whereby the success or otherwise of designs provides information not only about the technical efficacy and efficiency of the designs, but also about the social and ecological systems being interacted with. Holistic design needs to recognise the efficacy of natural systems and functional social systems rather then attempting to use resources to impose a transformation on existing systems. It is more ethical, effective and efficient to seek ways to integrate within and to integrate together the existing social and ecological systems. The disruption to villagers' lives of a necessarily iterative process has to be minimised.

In the Samoan village the main systems a toilet needs to be integrated with are:

- the biology of a person
- the family unit and its daily needs for waste management
- the cultural system of activities determining viable ways to manage the use of the toilet
- the economic system providing resources available to purchase and manage a toilet
- the ecological system of composting faeces;
- the agro-ecological system of Samoan semi-subsistence agriculture;
- the water supply and use system.

Initial study of the above systems lead to the following objectives for the toilet. The toilet:

- needs to be chosen over a flush toilet in rural Samoa, relying purely on competitive pricing, ease of management and prestige factors;
- needs to be made as much as possible from locally available materials with locally available tools and labour;
- needs to be of a low key size and to not require water;
- needs to be easy to manage within existing cultural practises; and
- needs to be integrated into nutrient recycling and composting within the agro-ecological system.

The trial of an initial design provided much feedback about the need to integrate into the social system. A design that allows weekly management of compost output was recognised as being likely to be more successful.

There are other crucial features that were required to be incorporated:

- the size of the family unit;
- the maximum number of people who can use a single toilet a day before queuing; problems at critical periods of the day leads to the need to construct a second toilet;
- a urine separator works for all age groups;
- a continuous aerobic compost process.

From consideration of these the following design features were considered to be imperative:

- 100 percent urine separation from faecal material:
- separation of new pathogenic material from the final composted material;
- ease of removal of the final compost;
- maximum height of approximately one meter;
- maximum cost has to be less than a flush toilet.

The holistic approach taken has meant that social and ecological processes whose integrity needs to be respected and maintained were described as whole entities and represented by easily monitored indicators. The main indicators were:

- the number of people in a social system family who will use one toilet;
- the volume of faeces produced by a person each day;
- the rate of decomposition of faecal material.

It was during a scenario modelling stage in the design that EM technology became incorporated. It involved the discovery that adding bulking material through a person throwing in a handful of leaves immediately before or after using the toilet, introduces a degree of imprecision into the design process that makes it irrelevant to try to optimise other aspects of the design. This is because the effect of the uncertainty of the amount of bulking material swamps all other impacts of possible design improvement. Thus it was decided to adapt the design to artificially determine the amount of bulking material that gets added through the use of a hopper. Doing this opened up the opportunity to incorporate the use of EM Bokashi to enhance the composting process. It involves the addition of another step into the management process and the addition of another mechanism, however the benefit far outweighs the cost. A hopper has to be filled with EM Bokashi, but it is an activity that can be incorporated into the weekly cycle. The additional hopper mechanism, although an added cost and potential source of system failure, decreases the size and cost of the overall unit because the design then considerably more efficiently fulfils the precautionary principle.

Conclusion

As well as EM being expected to increase the efficiency of the design, EM can be expected to add to the general social acceptability of compost toilets. EM will be used to clean the urine separator, in a manner very similar to how flush toilets are occasionally scrubbed. In doing so potential odours will be avoided. Furthermore, the use of EM in the composting process will minimise the risk of odours from the toilet.

A compost toilet exists within wider socio-cultural and agro-ecological systems. Staring 2002 the composting toilet will be commercially manufactured in Samusu village. It is expected that if the design can be made locally at a cost cheaper than the use of imported flush model components, there is likely to be uptake of the compost toilet design. To help assure this, the use of the high quality fertiliser produced from the toilet for organic agricultural development is to be researched as well. The availability and use of EM within the wider agro-ecological system is very likely to produce synergies with this and will assist in the uptake of the compost toilet technology. As long as all relevant natural systems, including socio-cultural and economic systems are recognised, health to them all can be enhanced through the judicious use of EM technology.

References

Del Porto D. and C. Steinfield. 1999. *The Composting Toilet System Book.* The Centre for Ecological Pollution Prevention (CEPP), Massachusetts, U.S.A.

Higa, T. 1996. An Earth Saving Revolution: A Means to Resolve our Worldís Problems Through Effective Microorganisms (EM). Sunmark Publishing, Tokyo.

Moser, A. 1996. Ecotechnology in industrial practice: implementation using sustainability indices and case studies, Ecological Engineering, 7, 117-138.

Rapaport, D. 1996. Aerobic composting toilets for tropical environments. BioCycle, 37(7) 77-82.