NEEDS AND STRATEGIES FOR GENETIC CONTROL: MUNICIPAL WASTES

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INTRODUCTION

Municipal wastes mainly consist of sewage, sludges generated from treatment of sewage, and refuse. All three types of waste are generated whenever sizable numbers of people live together; treatment and disposal are usually considered a municipal problem, even though private firms sometimes carry out the operations. Table 1 lists approximate values for the total masses of sewage, sludge, and refuse generated annually by all Americans. Although the waste materials have small economic value, their very large mass generation rates make them of major economic significance to the local economy. For urban areas and towns, treatment and disposal often are functions performed by local or regional governmental agencies.

The purposes of this paper are to identify problems encountered in the treatment and disposal of municipal wastes and to indicate how genetic control can be applied fruitfully to ameliorate some of the problems. First, three general classes of problems are identified. Second, strategies, especially those including genetic control, are presented. Third, problems of treatment and disposal are enumerated and placed into the classes for problem type and solution approach. Finally, possible stumbling blocks are addressed.

PROBLEM CLASSES

The problems encountered in the treatment and disposal of municipal wastes can be classified into three types:
problems for which no feasible solution is currently identified

2. problems for which the existing solutions are expensive

3. problems for which the existing solutions have poor efficiency and/or reliability.

Identification of the problem type is valuable because it allows us to point toward an appropriate goal. For example, if an existing method is feasible, economical, but unreliable, the emphasis should be on determining the cause of and mitigating the unreliability. Looking for entirely new approaches is probably unnecessary and unfruitful, as is making changes unrelated to the cause of the unreliability. On the other hand, classes or problems for which no feasible solution exists need a wide-ranging, exploratory (and high risk) approach. Most municipal waste problems fall into the classes characterized by poor economics and poor reliability/efficiency.

SOLUTION APPROACHES

Potential solutions come about through four different strategies, only two of which rely on genetic control. Fruitful use of genetic control techniques requires that they be applied to problems whose solutions require them. Attempting genetic control when it is unnecessary or inappropriate wastes valuable resources and is likely to be unsuccessful.

The first strategy involves enhancing a currently used method by making a process-related improvement. Genetic control is not part of the strategy. Since the current process is feasible, the process improvement strategy addresses problems in economics and efficiency/reliability. An example of a process improvement that can enhance economics is the use of denitrification as the first step in wastewater treatment for biochemical oxygen demand (BOD) and

Table 1. Approximate annual generation rates of sewage, sewage sludge, and refuse by all Americans in the 1980s.

<table>
<thead>
<tr>
<th>Waste</th>
<th>Generation rate, tons/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sewage</td>
<td>$2 \times 10^{10}$</td>
</tr>
<tr>
<td>Sewage Sludge</td>
<td>$1 \times 10^{7}$</td>
</tr>
<tr>
<td>Refuse</td>
<td>$2 \times 10^{8}$</td>
</tr>
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