1993: The Optimal Composting Problem

An environmentally conscious institutional cafeteria is recycling customers' uneaten food into compost by means of microorganisms. Each day, the cafeteria blends the leftover food into a slurry, mixes the slurry with crisp salad wastes from the kitchen and a small amount of shredded newspaper, and feeds the resulting mixture to a culture of fungi and soil bacteria, which digest slurry, greens, and paper into usable compost. The crisp greens provide pockets of oxygen for the fungi culture, and the paper absorbs excess humidity. At times, however, the fungi culture appears unable or unwilling to digest as much of the leftovers as customers leave; the cafeteria does not blame the chef for the fungi culture's lack of appetite. Also, the cafeteria has received offers for the purchase of large quantities of its compost. Therefore, the cafeteria is investigating ways to increase its production of compost. Since it cannot yet afford to build a new composting facility, the cafeteria seeks methods to accelerate the fungi culture's activity, for instance, by optimizing the fungi culture's environment (currently held at about 120° F and 100% humidity), or by optimizing the composition of the mixture fed to the fungi culture, or both.

Determine whether any relation exists between the proportions of slurry, greens, and paper in the mixture fed to the fungi culture, and the rate at which the fungi culture composts the mixture. If no relation exists, state so. Otherwise, determine what proportions would accelerate the fungi culture's activity.

In addition to the technical report following the format prescribed in the contest instructions, provide a one-page nontechnical recommendation for implementation for the cafeteria manager.

Table 1 shows the composition of various mixtures in pounds of each ingredient kept in separate bins, and the time that it took the fungi culture to compost the mixtures, from the date fed to the date completely composted.

Table 1.
Composting data.

Slurry (pounds)	Greens (pounds)	Paper (pounds)	Fed (date)	Composted (date)
86	31	0	13 Jul 90	10 Aug 90
112	79	0	17 Jul 90	13 Aug 90
71	21	0	24 Jul 90	20 Aug 90
203	82	0	27 Jul 90	22 Aug 90
79	28	0	10 Aug 90	12 Sep 90
105	52	0	13 Aug 90	18 Sep 90
121	15	0	20 Aug 90	24 Sep 90
110	32	0	22 Aug 90	8 Oct 90
82	44	9	30 Apr 91	18 Jun 91
57	60	6	2 May 91	20 Jun 91
77	51	7	7 May 91	25 Jun 91
52	38	6	10 May 91	28 Jun 91

Comments by the Contest Director

The problem was contributed by Yves Nievergelt (Mathematics Dept., Eastern Washington University, Cheney, WA), based on a situation and data at the cafeteria of the Washington State penitentiaries in Medical Lake, WA.

The Outstanding papers were by teams from University of California–Berkeley Dept. of Statistics and Nazareth College of Rochester. Their papers, together with commentaries, were published in *The UMAP Journal* 14 (3) (1993): 201–228.