Letter to the Editor

Pento, T. 1998. **A Comment on Life Cycles.** Letter to the editor regarding Blum and colleagues' (Summer 1997) "A Life-Cycle Approach to Purchasing and Using Environmentally Preferable Paper: A Summary of the Paper Task Force Report," *Journal of Industrial Ecology* 1(3): 15–46.

A shortened version of the recent EDF Task Force study was recently published in this Journal (Blum et al. 1997). One part of the study "compared energy requirements and environmental releases from 100 % recycled fiber-based and 100 % virgin fiber-based systems. ... By examining entire systems - ... - The Task Force was able to assess the full range of environmental consequences engendered by the choice between producing recycled-content paper and recovering and recycling used paper on the one hand, and producing virgin paper, disposing of it, and replacing it with new virgin paper on the other" (p. 25).

The Task Force did not study entire systems, and the produced results are consequently fuzzy. The life cycle of fibers which are put into virgin paper form a complex industrial system. The task force studied the paths from forest to landfill and used paper recovery to landfill which are both parts of the system. A single wood fiber's life cycle may begin in a freesheet copying paper, continue in SC (SuperCalandered) magazine paper, then in a newsprint, and end up as a part of boxboard. When paper recovery rates are high, and when down-grading from printing papers to other grades such as boards and technical papers takes place, there can be hundreds of different life cycles. Tearing out some parts of these life cycles and comparing them with other parts tends to produce vague results, partly because of arbitrary along-the-life-cycle allocation in open-loop recycling systems (Klöpffer 1996).

The life cycle of virgin newsprint to the landfill is linear and does not require along-the-flow allocation. Let V be the life cycle inventory (LCI) of one ton of virgin newsprint. When three editions of a printed newspaper each use a ton of virgin news-print, the total LCI is V + V + V. Let R be the LCI of a ton of recycled news-print, and assume that the fibers in virgin newsprint are recycled two times back into newsprint. The total LCI of the recycling life cycle is V + R + R. The comparison made by Blum and colleagues of a single V against a single R is hard to justify because R can never exist alone. Recycled paper needs an input of used virgin paper, which is not manna from heaven, and a part of the environmental rucksack of V has to be allocated to R. A more valid comparison could be made between complete life cycles: (1/3V+1/3V+1/3V) for virgin paper and (1/3V+2/3 R) for recycled paper. Unfortunately, the flows of fibers within the modern paper recycling systems produce too many life cycles for making such comparisons with reliability. Analyses of existing life cycles of fibers suggest, for example that the selection of a (1/3V + 2/3R) life would not likely be correct. Fibers are seldom recycled more than once even when recovery rates are over 65 percent (Huuhtanen and Pento 1995). A more accurate comparison might be between V and (1/2V + 1/2R), which implies that half of the environmental load of virgin paper should be assigned to the recycled papers.

The study of V and R separated from their material flow system gives only indicative results, which are not always satisfactory for policy decisions. For example, if a policy hangs on the balance between amounts of BOD and other effluents, the results obtained with partial life cycles of virgin and recycled papers may lead to a wrong decision, because their BOD discharges are different. Another example is the quantity of solid waste, which one expects to be reduced with the recovery of papers from landfill to recycling. A study of a larger system has shown that increased recovery may increase the total amount of solid waste after some point, mostly because of declining yield of de-inking and the declining quality of recovered papers (Pento 1998a).

Comprehensive LCI's of paper recycling material flow systems have been made with models which incorporate the major flows of each system and thus most of the life cycles of fibers. Virtanen and Nilsson (1993) and Kärnä and colleagues (1994) count the total LCI of both virgin and re-cycled newsprint at different recycling rates. Pento and co-workers (Pento 1994, Gronow and Pento 1995) have made industry-level flow models of newsprint, fine and magazine paper and calculated total LCI's at various re-cycling rates. One promising recent approach studies the effect of incremental changes in paper recycling rates on the total LCI of a large paper flow system (Kärnä and Pajula 1996). Dynamic models, which calculate total LCI's of large paper flow systems at changing paper recovery and recycling rates over periods of time (Pento 1998b) may also produce more realistic results than the analysis of "life-cycles" of parts of a larger system.

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