

Rebecca Ross

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This paper will serve to present some issues pertaining to mattresses, including the components and materials which make up an average mattress and the impact they have on the environment. Finally, some examples of the recycling of mattresses will be discussed.

A mattress may be defined as an object covered by a strong cloth cover filled with materials which can be placed on an existing supporting bed structure, is fit for resting and sleeping upon and which has a life span of several years. ¹

A mattress represents about a 23 cubic foot area made up of steel, wood, cotton and polyurethane foam. ² The level of impact of mattress waste amounts to about 20 million mattresses disposed of and replaced per year in the U.S. ³ An average life span of a mattress is 10.8 years. Disassembled, a traditional mattress consists of steel (55%), polyurethane foam (10%), cotton/felt (25%), and wood (10%). ⁴

End results after recycling can be broken down into several categories of use. A mattress' wood frame can be chipped up to use as a biomass fuel source and can be shredded to provide mulch or composted. ⁵ Steel from mattress springs can be used to manufacture new steel products. Steel is actually the most valuable commodity from mattress components although the steel-cabled springs used in the box spring render the material difficult to reuse. Natural Resources Recovery Institute or NRRI, a mattress recycling program profiled later in this paper, is considering procuring equipment to wind the springs into a spool to be able to receive more of the benefits from recycling if the form is more manageable. ⁶ Polyfoam can be used to manufacture high-end carpet pads, reused as backing or underlayment for carpet. Polypad from mattress covers or "toppers" (foam sewn to cover) can be used to make low-end carpet pads. Cotton stuffing can be used as filler for packaging, shipping pads, wall insulation and as material used for road

noise abatement in vehicles. About 18% of processed mattresses and box springs goes into the garbage.

Mattresses are among other household items that contain PBDEs or flame retardant chemicals found to leach onto dust particles in air and groundwater and which travel and bioaccumulate in humans. The various types of brominated flame retardants are also emitted during production of such products as electronics and textiles containing them, such as mattresses. ⁷ During their production, any filter waste and rejected materials are disposed of in landfills, allowing another for another potential avenue of environmental contamination. Waste water releases of PeBDE may also occur from spent scrubber solutions. Polyurethane, one of the main materials of an average mattress is also a petroleum-based fossil fuel product. A 2006 Consumer Product Safety Commission study estimated that the average adult sleeping on a conventional mattress will be exposed to 0.802 milligrams of antimony and 0.081 milligrams of boric acid. ⁸ Other impacts of mattresses to consider include the energy involved in manufacturing, travel and transport from facilities to stores and then to consumer homes as well as emission of CO₂, and use of oil and gas in production of various mattress components. Emissions resulting from production of various components include SO₂, NO_X and C_xH_y. ⁹

There are a few facts unique to mattresses that may have served to impact current and past levels of recycling. The combination of materials used in the mattress and the interwoven nature of these materials may be viewed as one potential difficulty needing to be resolved. Another is the fact that a mattress is an item an average individual will not replace more than once every several years, the disposal of which contributes to an 'out of sight out of mind' predicament. The idea that mattress recycling is not something one thinks about very much until the few times one replaces a mattress may have served to preclude more development than could have occurred around mattress recycling until recent years. Some of the chemicals used in the process of developing a mattress may also present difficulties in managing recycling efforts, as in 2006 when various standard changes became enforced for flame retardant materials. There are areas where legal

constraints to recycling efforts of mattresses exist. Finally, a certain stigma may exist regarding the somewhat intimate personal nature of the products which may have slowed recycling efforts as well. The still emerging mattress recycling industry is a slow growing one.¹⁰ Such factors as the more limited amount of mattresses as compared to glass or aluminum as well as the labor intensive nature of the process are some challenges the industry faces.

One example of a mattress recycling program partly spurred on by an increase in cost of landfill space is NRRI in Duluth, MN. Working along with Goodwill Industries with their mattress recycling program, Goodwill has been given new job creation by the needs of program which started in 2004.¹¹ Statistics from May 2008 show that the program recovered 43,841 mattresses or enough to occupy 438 semi-trailers since the program's inception. Numbers of mattresses recovered increased dramatically in some months during the years of the program showing the program's marketing techniques and potential may be successful in drawing participation. Job opportunities for clients of Goodwill Industries include the physical labor entailed with shredding and separating the materials.

Regarding landfill space saved, the compaction rate of garbage in a landfill without mattresses is 1,600 pounds per cubic yard while compaction rate of only mattresses is 360 pounds per cubic yard. The program also reports to have saved \$161,967 on landfill fees that would have been incurred had disposal occurred.¹²

Conigliaro Industries offers another mattress recycling program. Several years ago the Massachusetts Department of Environmental Protection offered a \$10,000 grant to anyone who could come up with a mattress-recycling solution to their problem of crowded landfills. In 2002, Framingham, Massachusetts-based Conigliaro Industries filled this need and became the first commercial mattress recycler in the U.S. The company can process in excess of six million pounds of materials annually. Springs, padding and wires are more tightly sealed together the greater the mattress quality, rendering more expensive mattresses more difficult to recycle. At Conigliaro, it takes a minute and a half to completely break down an average mattress. The majority of the

company's clients are businesses that have a large number of items to dispose of, paying anywhere from \$8.00 up to \$30.00 per mattress. Mattresses from institutions (schools, prisons, hospitals) are put through the shredder, separating the polyurethane foam from the springs and wood frame, and the foam is baled. Approximately 60% of each mattress is recycled. Mattresses from brand-name consumer sources need to be filleted and then run through the company's shredder, recycling up to 90% of the product in this case. ¹³

Another agency engaged in mattress recycling is St. Vincent de Paul Society of Lane Co, Inc. in Eugene, OR. The agency also includes a mattress diversion and recycling center in Oakland, CA. The DR3 Mattress recycling facility diverts up to 600 mattresses per day from the Bay Area waste stream and works in partnership with local landfills and waste haulers. Mattresses are stripped down and separated into their various parts. The facility employs fifteen people full time and is recognized throughout the region for its commitment to recycling. ¹⁴

In 2001, St. Vincent de Paul acquired a garnetting machine, allowing the agency to branch out into the field of non-woven textile development with the recycled fibers they had available to them. The machine allowed for the creation of non-woven textiles such as upholstery stuffing, carpet padding and other felt-like products from textile fiber. Post consumer textiles are fed into the garnetting equipment, producing a thick, soft padding. Pet beds are one of the products the agency creates from these recycled fabrics, and some proceeds go back to benefit this non-profit organization. The beds are pet-sized, made from the agency's recycled mattress materials and stuffed with recycled cotton. The process shows a creation of new material from recycled diverted waste, further job creation for new products as well as proceeds to benefit the organization's mission. The beds are known as 'Dogma Dog Beds'. ¹⁵

As an example from the United Kingdom, Britain's Prison Service was looking for a solution to its mattress waste, as the service uses 50,000 mattresses annually, enough to fill 30 double decker buses. ¹⁶ In looking for a solution towards zero waste the institution looked to alternative solutions such as using the material in tiles and carpet backing. Solutions such as this can be win-win in that entities looking to dispose of

materials save money on disposal costs and can earn money from materials which would otherwise be discarded. The more industries that develop to utilize such recycled materials the more valuable the materials may become.

The prison system's search for a mattress recycling 'zero waste' model was designed to fulfill goals of the Forward Procurement Commitment procurement model. The model was conceived and developed by the UK Government's Environmental Innovation Advisory Group (EIAG) in 2003-2008, to help to create market conditions in which the environmental goods and services sector can thrive, to address a lack of market pull for environmental innovations and to deliver cost effective environmental products and services to the public sector.

By 2012, Her Majesties Prison Service would like all of its mattresses and pillows not classified as hazardous waste to be recycled, repurposed or reused rather than going to landfill, as well as to reduce to 2 percent the number of mattresses disposed of as hazardous or clinical waste. This requirement was communicated to the market to call for proposals of solutions. Option choices are being finalized to help HMPS meet stated sustainability goals for a 'cradle to cradle' managed service to supply needed mattress and pillows in a zero waste fashion. ¹⁷

The mattress recycling operations profiled here, such as NRRI in MN and Conigliaro Industries in MA, responded and were formed in part to external pressure and economic signals from landfill operations' lack of space and increased tipping fees required in order to dispose of mattresses. These factors may have served to incentivize mattress recycling initiatives to take shape allowing for an increased sense of necessity for these programs.

One way to avoid part of the issue or to decrease the impact of mattress disposal such as the use of landfill space and some of mattresses' harmful additives is to purchase a newly designed 'eco-friendly' bed. Although it is not clear whether universally understood standards yet exist for what constitutes a 'green bed', cursory research suggests such features as soy-based foam, the use of rubber and organic cotton. These

mattresses also look to be more costly than traditional mattresses, perhaps representing a lower demand at this stage. It is conceivable that if these products become more in demand and more readily available that cost could become less of a factor. Ideally consumers will be able to move toward a more sustainable mattress choice in order to build consumer options while reducing the existing pressure and impact on landfills from traditional mattresses. It remains to be seen how institutions, which use and replace mattresses on a large scale, may be impacted by green mattress choices.

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