Furniture Remanufacturing and Energy Savings

Sahil Sahni[1], Avid Boustani[1], Timothy Gutowski, Steven Graves

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Environmentally Benign Laboratory

Laboratory for Manufacturing and Productivity

Sloan School of Management

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[1]Sahil Sahni and Avid Boustani have contributed equally to this study.

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1 Introduction

Furniture is a consumer good used for storage, seating, or as tables, case-goods, files etc, used commonly in our day to day life. Based on the their material composition, they are broadly classified into wood and non-wood furniture. In this report we will focus on primarily *Office Furniture*, though the analysis can be easily applied for other furniture too. As per the US Census Bureau, the total value of shipments of office wood furniture in 2002 was approx. $ 2.8billion [2] while the same for non-wood furniture was $ 7.8billion [1]. A typical furniture is expected to last as long as 30 years [7] which means that most often when furniture comes to the end of its first life (usually less than 30 years) it still have plenty of residual life. This means that recycling the furniture back into the market, perhaps after some refurbishing, and selling it to a second consumer can help save the need to manufacture new furniture. This would save not only the energy and other inputs to manufacture new materials but also provide furniture at lower prices in the market. Reselling, refurbishing and remanufacturing of furniture has been practiced for long, as [5] estimated the number of firms practicing remanufacturing of furniture to be 720 around 1995 with a net sales value of $1.663 billion. While benefits of remanufacturing are economic, environmental and social as claimed by Lund et al. [5], this report focusses on evaluating the energy and economic saving potential of remanufacturing / refurbishing / reusing furniture.

2 Methodology, Data Sources

2.1 Life Cycle Energy Assessment

The methodology adopted is the same as that for the other case-studies. Life-cycle assessment (LCA) is the major tool used. The boundary of analysis for LCA includes primarily four phases:

- Material - The energy used to process the raw materials into usable form. This would entail the production of fibers.
- Production - The energy used in manufacturing the furniture.
- Distribution - The energy entailed in the distribution of the furniture to the consumer.
- Use - Use of the fully manufactured product by the consumer. For furniture this would only include the maintenance and repair which can be neglected.

- End of Life - The energy consumed / recovered during the final stage of the product life. This could take several forms such as remanufacturing, recycling, reuse, incineration, landfilling etc.

The primary source of data is a report from the Center of Sustainable Systems at the University of Michigan [**?**].

2.2 Life Cycle Costing

Life cycle costs from the consumers perspective are evaluated. This includes two three parts:

- Upfront Price / Purchase Price
- Use Phase Cost: Since maintenance and repair are neglected, the use phase is assumed to contribute negligibly to the life cycle cost
- End of Life Cost: this is the cost associated the end of life disposal strategy - reselling, repairing, recycling, land filling etc.

The upfront prices were obtained from the SteelCase, Inc online stores and through personal communications with SteelCase salesmen [8, 6].

3 Scope of the Study

This report does a detailed life cycle energy assessment and life cycle costing of an Office Chair as well as an Office Desk. The particular focus is to estimate the energy and economic saving potential of reusing / refurbishing / remanufacturing of furniture. The particular products chosen are:

- Siento chair with polished aluminum base, T-arms, and leather upholstery
- Garland double pedestal desk with cherry finish, cove edge, left pedestal: file/file, right pedestal: box/box/file

Given below (Figure 1) are representative images of what these products look like obtained from the websites of the particular manufacturers.

4 Life Cycle Assessment

The bill of materials obtained from [**?**] are shown below in figure 2. Clearly the Chair classifies as a non-wood furniture while the desk is a wood-furniture.

[**?**] gives the energy required to manufacture (including raw materials) these products and transport them to the consumer. This statistic for the

Figure 1: Representations of the products under study: 1. Office Chair [3]; 2. Office Desk [4]

Siento Chair		
Material	**Weights (lbs)**	**Weight (Kgs)**
Steel	32.3	14.65
Plastic	14.6	6.62
Non-ferrous metals	13.4	6.07
Leather	2.6	1.17
Other	1.7	0.77
Total	**64.6**	**29.30**

Garland Desk		
Material	**Weights (lbs)**	**Weight (Kgs)**
Particleboard	159.3	72.25
Steel	52.9	23.99
Plywood	40.2	18.23
Cherry	8.6	3.90
Otherwood/paper	3.1	1.40
Addhesives and finishes	1.9	0.86
backing material	1.6	0.72
plastics	1.5	0.68
Total	**269.1**	**122.06**

Figure 2: Bill of Materials of the Office Siento Chair and Garland Desk [**?**].

Chair is 1,350 MJ, while for the desk is 3,290 MJ. Extending the analysis to the total life cycle, and assuming that the use phase energy consumption for these products is negligible (that is, neglecting maintenance and repair), the total life cycle energy consumption for the two products would again be 1,350 and 3,290 MJ respectively. This is shown graphically below in Figure 3. Note that the energy associated with the end of life stage is not considered since it is assumed to be the same for both the new and remanufactured product.

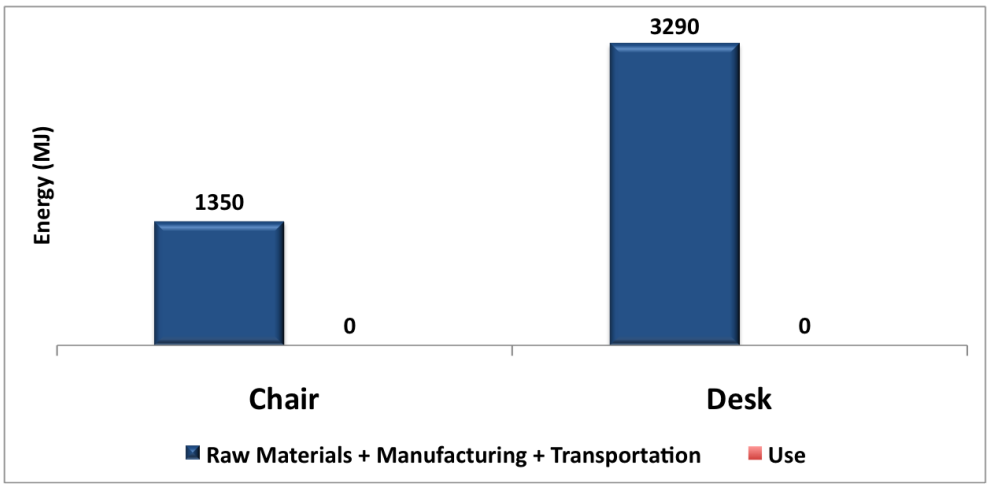

Figure 3: Life cycle inventories of the Office Siento Chair and Garland Desk [?].

5 Remanufacturing / Refurbish / Reuse Energy Savings Potential

Consider the scenario where the consumer has a choice to either buy a new piece of furniture or to buy an old one. The old one has perhaps been refurbished / remanufactured and brought back to a state of like-new. In the case of choosing to buy new, the energy to manufacture the new product would have to be invested, while in the latter no such energy is required. As a result, by choosing to buy an old refurbished / remanufactured piece of furniture there is a direct savings corresponding to the manufacturing of a new one. This is again shown more clearly in the graph below (Figure 4).

Note that the energy associated with reselling the refurbished / remanufactured product is the energy associated with transporting the product from the first consumer to the second. In the above analysis this has been assumed to be equal to the total life-cycle transportation energy required

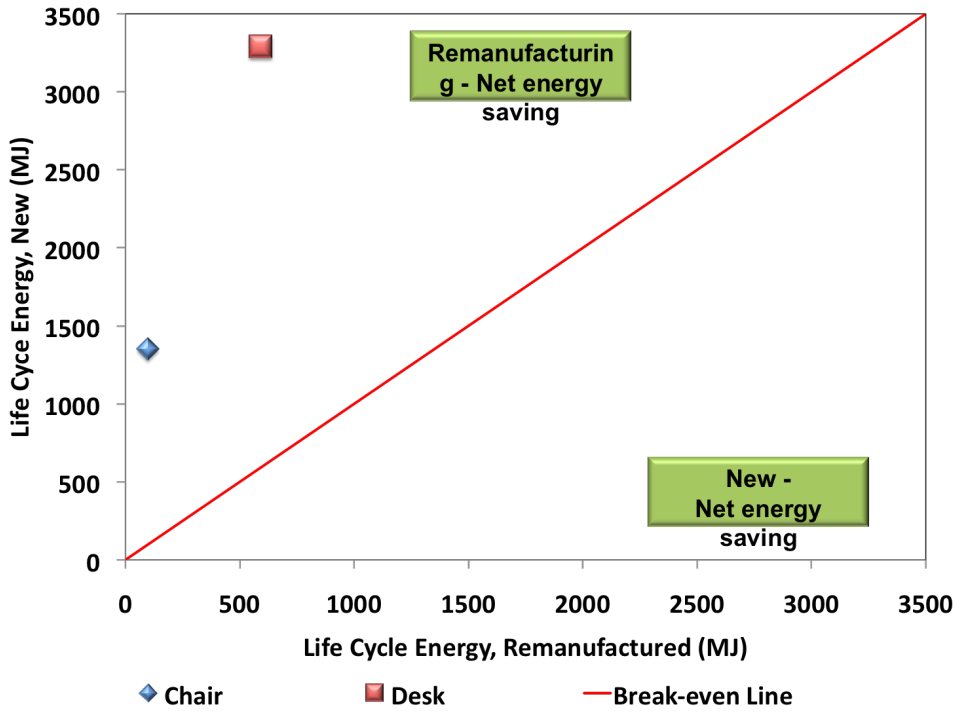

Figure 4: Comparing the life cycle energy consumption for the two scenarios - choosing a new piece of furniture or choosing an old remanufactured one. This is shown for both the products under consideration - The Siento Chair and the Garland Desk.

for the new product, which is an over estimate. In spite of this, choosing the remanufactured product is the net energy saving strategy. This analysis also holds true for the case of extending the life of furniture already in use. In other words, between choosing to replace an existing furniture and continuing to use it for longer, the latter strategy yields net energy savings. Note in this case, there would be no transportation required since the same consumer is extending the use. As a result the relative energy savings would be even larger and the points on the chart would have no abscissa and would lie on the Y-axis.

6 Life Cycle Costing

Remanufactured products though like new are often perceived lower by the consumer and is thus sold for lower prices. [5] estimates the price of remanufactured products to be roughly 40 - 60% of the price of the new product. For this analysis we assume it to be 50%. This means that from the consumers perspective, choosing to buy remanufactured furniture can yield a saving of $768 in the case of the Siento Chair (Original Selling Price: $1799 [8]) and $807 in the case of the Garland desk (Original Selling Price: $1890 [6]). Note both the saving values have been estimate in 2000 dollars to conform with the other case studies, while the original selling prices are for 2009. Also note that since the End of Life for the new and reused / remanufactures / refurbished product was assumed to be the same, it was not taken into account.

7 Conclusion

The above analysis has shown that reusing / refurbishing / remanufacturing furniture products like chairs and desks leads to both energy and economic savings. Furniture product life can be extended in two ways - by either continued use or by reselling it, perhaps after some refurbishing / remanufacturing. Remanufacturing of products avoids expending energy required for the production of new products. On the other hand reselling the product only entails the energy and cost associated with transporting it to the new consumer. In the case of reuse by the primary consumer, even these are saved. Thus because of the dominant manufacturing phase for furniture products, it is advisable to extend their life as much as possible.

8 Assumptions and Comments

Though the analysis above utilized reputable references, there are some assumptions that must be brought out:

- It is assumed that the transportation energy associated with reselling the remanufactured / refurbished product is equal to the life-cycle transportation energy of a new piece of furniture. This way we are over-estimating the remanufactured product life cycle energy.
- The end of life stage is not considered within the boundaries of the analysis since both the new and remanufactured furniture are assumed to have the same EOL and hence do not effect the comparative analysis.
- The resell price is assumed to be at 50% of the new price.

References

[1] US Census Bureau. Office furniture (except wood) manufacturing: 2002. *2002 Economic Census*, 2002.

[2] US Census Bureau. Wood office furniture manufacturing: 2002. *2002 Economic Census*, 2002.

[3] William Hauser and Robert T. Lund. 2003.

[4] William Hauser and Robert T. Lund. 2003.

[5] William Hauser and Robert T. Lund. The remanufacturing industry: Anatomy of a giant. 2003.

[6] link from Steel Case Website. Internet price: http://www.csnstores.com/steelcase-ts5tlb24272-sca1137.html#proddetails.

[7] David V. Spitzley, Bernhard A. Dietz, and Gregory A. Keoleian. Life-cycle assessment of office furniture products. *Center for Sustainable Systems, Report No. CSS06-11*, 2006.

[8] Steel Case Website. Internet source: http://store.steelcase.com/go/products/detail/499121sx/.