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Interior Design Approach With Consideration of Life Cycle Assessment of Furniture

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Abstract
Safety, sustainability, and recyclability are essential characteristics of good interior design along with traditional design elements like form, function, aesthetics, and price. Global warming and climate change are real issues challenging the world. Designers have to play a constructive role in mitigating the risks associated with climate change. Although the exterior architectural structure of a building will not change for several years, interior design changes are very frequent due to the dynamic nature of business. Frequent interior design changes and overhaul produces a huge quantity of furniture scrap with adverse impact on the environment. Sustainability, and recyclability addressing all aspects of environmental impact are essential principles that have to be incorporated into the design approach to build environmentally friendly interiors. The design philosophy has to shift from a "now and here approach" to a holistic approach that considers the Life Cycle Assessment of furniture. Selection of material based on environmental parameters and end-of-life cycle management is required to propose eco-friendly designs. This research paper attempts to document the Life Cycle Assessment of essential raw materials used in interior design and proposes a design approach to increase the life span of designs and also suggests the best possible recycling methods at the end-of-life cycle. Green Ratings of buildings are slowly emerging as a concept. Projects under the Green Rating for Integrated Habitat Assessment (GRIHA) scheme, a public/private initiative in India, are steadily growing in numbers. This paper proposes a design approach to achieve green ratings. Apart from buildings, vehicles also have upholstery and fabric to make the seats and interiors. With a fifteen year rule for compulsory scrapping of vehicles, millions of vehicles will hit the scrap yards in India. Government has issued guidelines to handle and dispose of such waste keeping in mind the possible reuse and environmental impact. As organised industry gets into the vehicle scrapping business, best practices will be evolved for scraping and recycling used furniture from buildings. This paper proposes a framework for furniture and interior design incorporating LCA as key parameter. Concepts of repurpose and reclaimed furniture are presented along with samples of work.

Keywords: **Furniture Repurpose; Green Buildings; Green ratings; Life Cycle Assessment of furniture; Motor vehicle scrapping best practices; Reclaimed Furniture; Recycling furniture; Sustainable Interior design.**

1.0 INTRODUCTION

Life Cycle Assessment concepts originated around 1960 as a concept. During the initial phase, emphasis was on analyses of energy consumption from cradle to grave of a product. The concepts evolved gradually to address the issues of resources, manufacturing processes, wastage and airborne waterborne pollutants. Two decade period from 1970-1990, non-standard frameworks and approaches were used leading to inconsistent results and lack of interest. Decade 1990-2000 is considered a period of standardization under the aegis of International Standards Organization ISO (Guinée, 2012, 1-3).
ISO 1400 series includes standard procedures to conduct LCA studies. LCA studies are conducted to arrive at energy consumption in the entire life cycle of manufacturing and disposing of the product at the end of its life . Environmental impact consideration focuses on resource use, human health and ecological impact (Daellenbach & Flood, 2023).

1.1 LITERATURE SURVEY ON FURNITURE LIFE CYCLE ASSESSMENT

Dietz, Bernhard. 2005. Life Cycle Assessment of Office Furniture Products. Master's Thesis, University of Michigan: Ann Arbor: 1-103. is an exhaustive study related to the subject of this paper (Dietz, 2005, 2-15).
The European Union has standard guidelines for procurement of wooden furniture and designers and manufacturers have to comply with the guidelines (Community Eco-Label for Wooden Furniture, 2009) (CIRCABC, 2019).
In India, the concept of LCA for furniture design is evolving very slowly under the umbrella of Green Building code. Green Building Code is not uniform across the country and is governed by codes and standards contained in the State by-laws, the National Building Code, the Energy Conservation Building Code (ECBC) and in the norms set by the ratings programmes, such as Leadership in Energy and Environmental Design-India (LEED-India) (Kumar, 2014, 1-3). Residential Sector guidelines are available through the Indian Green Building Council (IGBC), TERI-GRIHA and other such certifications. Basic and general guidelines for efficient energy usage in the National Building Code (NBC) do exist but they are merely guidelines. These efficient energy usage guidelines are 18 years old and appeared after an amendment of the NBC in 2005. Adoption and implementation are lacking.
In North America, 80% of wooden furniture is just dumped and ends up in a landfill or gets incinerated leading to environmental issues (The Telcar Group, 2023).

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Wooden furniture and upholstery are very difficult to compost. The process of composting is still under research and experimentation (Borazjani et al., 2000, 1-4).
In India, the government has announced scrapping of certain categories of vehicles after completion of fifteen years. Millions of vehicles are likely to be scrapped every year. The government has issued draft policy guidelines and procedures to scrap the vehicles (Draft Guidelines: Authorised Vehicle Scrapping Facility, 2019).
Recycling of metal parts can be handled effectively with limited environmental impact. However,. car interiors fabric, upholstery remain a challenge for safe disposal. A new organised industrial sector is likely to emerge under close scrutiny of the government to deal with huge quantities of scrap. Fresh out of box thinking and best practices may emerge and designers can utilize the know-how to deal with used furniture at the end of a useful life cycle (Dalvi et al., 2023).
This paper proposes a feasible approach to incorporate the concepts of LCA at the time of design. Effective design should include detailed instructions on selecting raw material and how to modify and reuse the furniture at the end of life cycle to extend the useful life of furniture.

2.0 OBJECTIVE OF THE RESEARCH STUDY

While building superstructures last for several decades, furniture and interiors at commercial and residential premises undergo changes every 3-5 years due to change of business and functional requirements. Designers seldom consider end of life scenarios. Steel, wood, plastic, upholstery, partitioning/false ceiling material require different approaches while disposing. Objective of this research study is to understand the best practice to deal with different types of furniture at the time of discarding them for any reason. Objective is to reuse and repurpose them to extend the useful life span and also explore the best possible way to dispose of furniture with minimum environmental impact.

2.1 SIGNIFICANCE OF THE RESEARCH STUDY

Climate change and global warming are the biggest challenges which need immediate attention. Designers have a significant role to play and responsibility to address this global challenge. Good designs incorporating Life Cycle Assessment parameters drastically reduce adverse impact on the environment. Approach presented in this research study will enable designers to recommend to their clients effective approaches to re-purpose and dispose of used furniture.

3.0 STEEL AND ALUMINIUM FURNITURE

Only 5-10% of energy is needed to extract useful metal from scrap when compared to the metal extraction process from mined ore. Steel and metal furniture have great resale value as the recycling industry is very matured. Hence metal furniture are ideal candidates from LCA point of view.

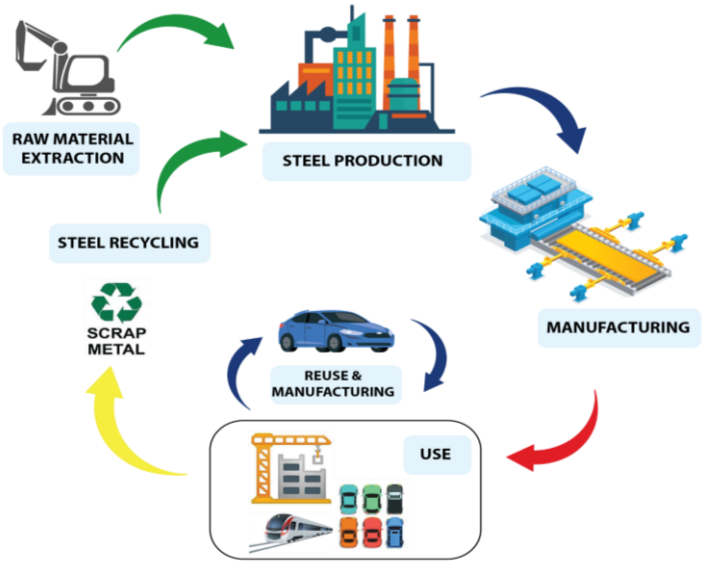

Figure 1: Life Cycle of Steel (Kanchana, 2023)

3.1 PLASTIC FURNITURE

There is a tendency to demonise plastics. Plastics are here to stay. Plastic furniture is light in weight, economical as they are mass produced. Most of the manufacturers use recycled plastic to make furniture thereby reducing the overall environmental impact (Nilkamal, 2023) (Vinoski, 2019) (Train, 2022). After the useful life span, plastic furniture can be recycled again (SUMMARY REPORT FOR LIFE CYCLE ASSESSMENT OF FURNITURE, n.d.).

3.2 WOODEN FURNITURE

Wood is extensively used in making furniture and other interior elements like partitions. Natural wood is considered a renewable resource. However, indiscriminate and excessive cutting of trees by the lumber industry has an environmental impact. Forest restoration is a slow process and takes several decades to replenish (Borazjani et al., 2000, 1-4). Manufacture of plywood, particle board,chipboard and cladding laminates have different levels of environmental impact (SUMMARY REPORT FOR LIFE CYCLE ASSESSMENT OF FURNITURE, n.d.). Painted wood is not very easy to compost and the process is under research and experimentation.

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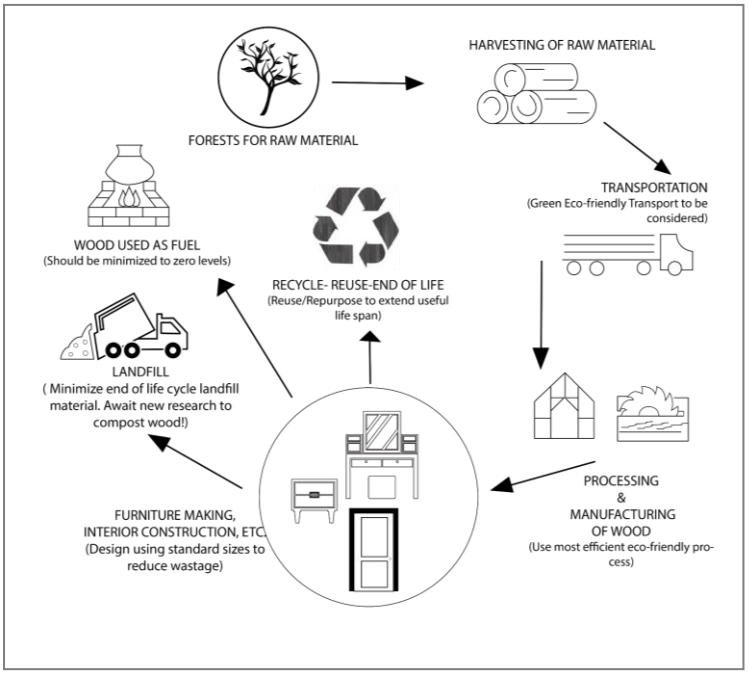


Figure 2: Life Cycle of Wood (Kanchana, 2023)

4.0 DESIGN FRAMEWORK TO INCORPORATE LCA

Life Cycle Assessment or Life Cycle analysis LCA evaluates environmental impact at every stage design(cradle) to grave(end of useful cycle). Reuse and recycling give new life to a product starting a new cycle from Cradle to Grave. Ideal situation is where a product encounters several such cycles and eventually gets composted. Cradle-Gate is an intermediate phase mainly involving design and manufacture. Every Stage there is wastage and scope to optimize the design / minimise the wastage to reduce the environmental impact.

4.1 MATERIAL SELECTION

In an ideal situation,a designer or group of designers should have multiple concurrent projects to get optimum results. During the design stage, material which is produced with least environmental impact should be considered. In the bill of material, effort should be made to design using recycled material wherever it is possible. Material with a long life span and material that can withstand specific weather conditions like rain,wind, snow, heat, local pollutants should be selected. Material which has potential for recycling at the end of life should be preferred.

4.2 PRE-DESIGN AND DETAILED DESIGN

Furniture, partitions and other elements should be designed using Standard size sheets and assemblies to minimize the wastage during manufacture and installation. Designs have to be made with due consideration of installation and uninstallation at the end of life cycle. Detailed instructions for manufacture, installation, repair and recycle should be given as part of detailed design documentation.

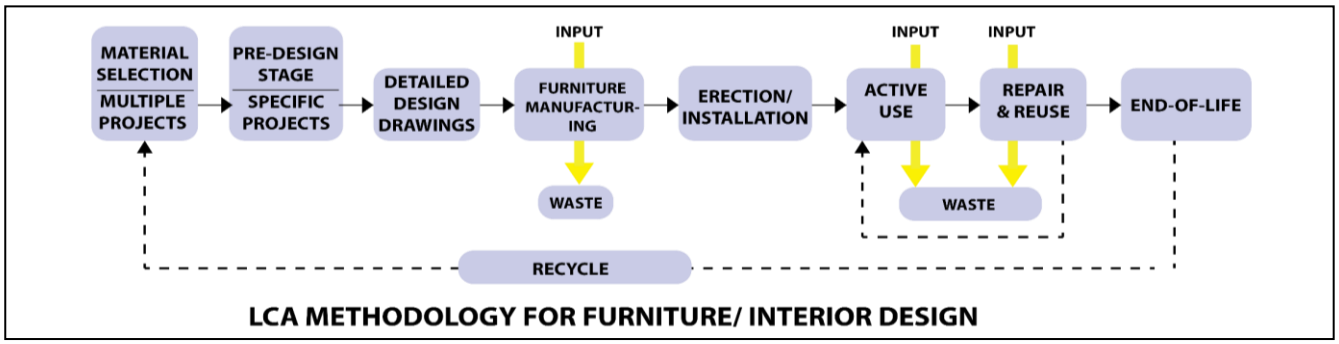
4.3 FURNITURE MANUFACTURE

Best in class manufacturing methods should be adopted to minimize wastage.

4.4 INSTALLATION

Proper tools, fasteners should be used during installation. Skilled technicians should be employed so that installation is smooth without wastage and rework and also uninstallation at the end of active life of an element is easy.

Figure 3: LCA Methodology for Furniture/interior design
(Daellenbach & Flood, 2023) (Kanchana, 2023).



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4.4 END OF LIFE AND RECYCLING

Detailed design should establish the end of life parameters along with recycling recommendations. Recycled material should be used in new projects to constructively close the LCA loop.

5.0 REUSE AND REPURPOSE TECHNIQUES AND SAMPLES OF WORK

Reuse/Repurpose is a key concept to extend the active life of any furniture element. Old furniture parts can be reused to produce useful products with minimum wastage to infuse new life. The following are such examples.
Chowki writing floor table and Chowki pooja floor stool are traditional Indian furniture extensively used by people. Old furniture recycled wood is extensively used to make traditional inexpensive Indian furniture.

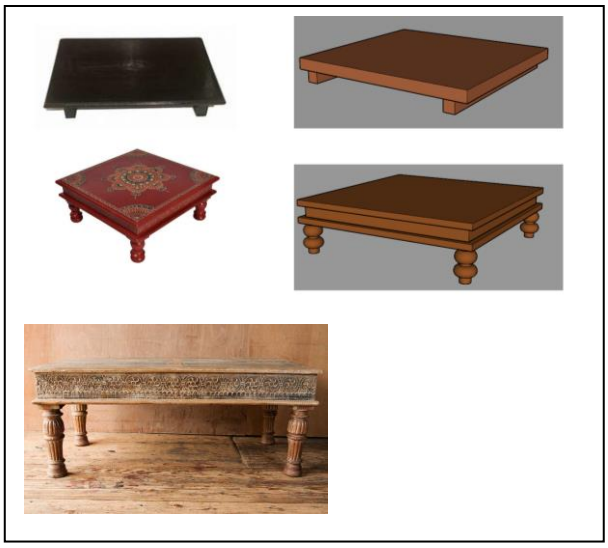

Figure 4: Chowki floor tables and pooja stools

Figure 5: Sample works of repurposed furniture.

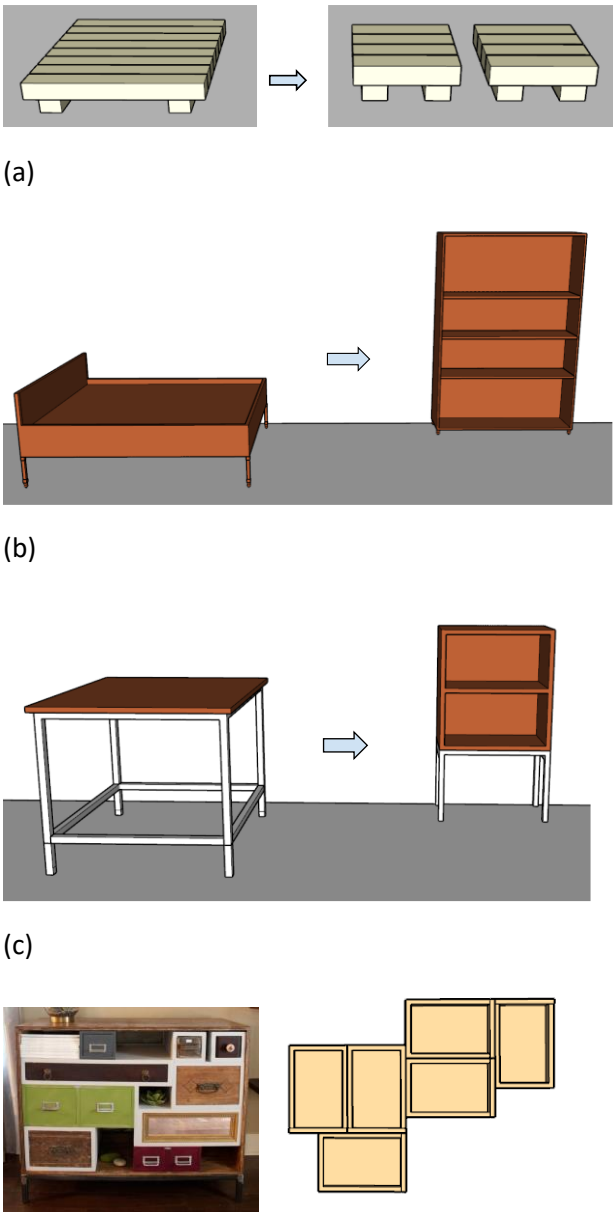

Figure 6: Design Examples of repurposed Furniture, (a)Converting packing wooden pallet into set of two stools, (b)Converting an old cot into Storage unit, (c) Converting an old table into an open storage unit, (d) Old Drawers can be reused as furniture storage or wall storage, (Kanchana, 2023).

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5.1 RECLAIMED FURNITURE

Antique furniture and old carved furniture components are commercially used to produce contemporary furniture. The following are the examples of reclaimed furniture.

Figure 7: A visit was made to Accurate Demolishers, Bangalore. They specialise in working with recycling and repurpose of furniture. The above images show samples of their work.

Figure 8: The above images show repurposed furniture parts being sold on roadside as open storage units, stools, writing tables etc.

Designers should interact with reclaimed furniture manufacturers and include their recommendations in the design so that after the useful life, furniture can be sold to such manufacturers for recycling.

5.2 RECLAIMED LUMBER

Reclaimed wood is processed wood from old wooden structures.

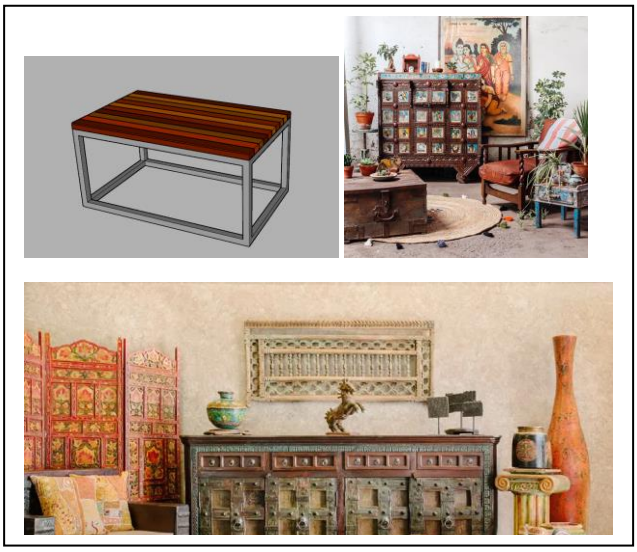

Figure 9: Reclaimed wood from old structures used in furniture .

Reclaimed wooden planks are commercially available in India and designers can consider them as a choice of raw material (Reclaimed Lumber, 2022) (There Are Many Uses for Our Reclaimed Redwood Boards, 2019) (Brown Old Reclaimed Wood, n.d.).

6.0 CONCLUSION

Life Cycle Assessment of Furniture is an important parameter to minimize environmental impact. Designers should be conscious of this vital concept . This paper proposes a simple framework for designers to incorporate LCA concepts material selection to end of life cycle. Literature surveys and samples of work presented in the paper will help designers to produce eco-friendly and sustainable designs. End users of such designs will have clear recommendations to deal with furniture efficiently at the end of intended functional life of furniture. Reuse and Repurpose concepts proposed in this paper can extend the useful lifespan of the furniture and thus reduce environmental impact.

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