

## DESIGN METHODOLOGY OF AUTOMATED MODULAR FURNITURE SYSTEMS USING ECO-FRIENDLY MATERIALS

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**Abstract:** *This article analyzes the methodologies for designing contemporary modular furniture utilizing ecologically sustainable materials. The research explores various types of bio-based and their role in enhancing furniture functionality and ergonomics. The findings demonstrate that the integration of sustainable materials and modular principles not only facilitates the creation of modern and highly adaptable furniture but also significantly contributes to environmental conservation and resource efficiency. This work is highly relevant for furniture designers, industrial engineers, and manufacturers committed to green innovation.*

**Keywords:** *Methodology, Smart Control, Sustainable Materials, Modular Design, Actuator System, Subjective Ergonomics.*

### INTRODUCTION

Global design practices currently stand at the epicenter of two conflicting demand. On one hand, the imperative to increase ecological responsibility due to resource scarcity, and on the other, the necessity to ensure spatial dynamics and maximal functionality under urban constraints. Conventional furniture construction is fundamentally unable to address this dual challenge. Therefore, our research focuses on creating a unified systematic design methodology that synthesizes a sustainable raw material base with high-tech digital control (IoT) system. This approach elevates furniture from a static object to an adaptive and active system.

Systematic Solutions of the Research Methodology.

The methodological foundation of this study incorporates three interconnected approaches: Eco-design (Design for Disassembly).

1. Ecological Foundation and Resource Efficiency. Material selection was synchronized between Life Cycle Analysis findings and the mechanical load requirements of the actuator system. This solution minimizes the ecological footprint by prioritizing lightweight, renewable composite materials bamboo composites, while simultaneously optimizing the energy consumption of the transformation mechanism.

2. Modular Construction and Automation. The structural solution is grounded in electromechanical actuators. The safety and reliability of the system are guaranteed through an array of safety sensors.

3. Smart Control and Adaptive Ergonomics. Furniture control is executed by a central controller an (IoT) platform. The most significant scientific outcome is the implementation of adaptive algorithms. These algorithms automatically adjust the furniture’s functional parameters to user’s personal anthropometric metrics.

### CONCLUSION

As a result of this research, a complex design methodology successfully unifying ecological Sustainability, modular flexibility, and smart control has been developed and scientifically substantiated.

Primary result. The developed methodology encompassed the entire design cycle, from material selection to the validation of energy-mechanical efficiency. The production of resource- efficient and intellectual furniture solutions for urban interiors, directly applicable to modern industrial practices.

### REFERENCES:

1. Ashby, M. F. (2012). *Materials and the environment: Eco-informed material choice*. Butterworth-Heinemann.
2. Wang, L., & Liu, X. (2021). Optimal design and energy-saving strategy of linear actuators for automated furniture systems. *IEEE Transactions on Industrial Electronics*, 68(11), 11453–11462. <https://doi.org/10.1109/TIE.2020.3046788>
3. Ахмеджанова Умида Баходировна Особенности профессии дизайнера // Наука, образование и культура. 2019. №6 (40). URL: <https://cyberleninka.ru/article/n/osobennosti-professii-dizaynera>
4. ERGONOMIK MEBEL QONUNIYATLARINING DIZAYNDA QO ‘LLANILISHI. AU Baxodirovna - CONFERENCE OF MODERN SCIENCE & PEDAGOGY, 2025 <https://tijst.org/index.php/USA/article/view/262>
5. Shatskaya, T. V., & Raximbekova, Z. (2023). O'zgaruvchan mebellardagi zamonaviy materiallar. *SCIENTIFIC PROGRESS*, 4 (3), 157–160. Quyidagi manzilda mavjud: <http://www.scientificprogress.uz/storage/app/media/4-3.%20031.%20157-160.pdf>.