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Industry 5.0 in the World of Smart Corrugated Board

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Abstract: Corrugated board, a material patented in 1871, has evolved from a simple packaging medium into a multifunctional engineering product. Traditionally valued for its light weight, recyclability, and low cost, it is now emerging as a key material in the transition toward Industry 5.0—a paradigm centered on human-AI collaboration, sustainability, and personalized design. This talk outlines the historical evolution of corrugated board across five industrial revolutions, highlighting its transformation from a passive transport material into an active, data-carrying component of the digital ecosystem. With printed electronics, environmental sensors, and integrated RFID/QR codes, corrugated board now supports smart packaging, real-time tracking, and adaptive product–environment interactions. From a mechanical standpoint, the geometry of the fluted core layer presents significant opportunities for performance optimization. Recent studies by Garbowski (2025a, 2025b) have demonstrated how non-standard fluting shapes, combined with finite element analysis (FEA), can improve the predictive accuracy of edge crush resistance (ECT), bending stiffness, and transverse shear. Moreover, Cornaggia et al. (2024) explore how digital twins and dynamic simulation models—especially in the context of transport conditions—can enhance the structural reliability of packaging while minimizing material usage. These advances align with the goals of sustainable design, reducing the carbon footprint and material waste. Further innovations, including biodegradable coatings, localized manufacturing, and digital material passports, support corrugated board as a model of circular economy principles. Beyond traditional packaging, it is being adopted in foldable furniture, temporary architecture, and participatory educational installations. In conclusion, corrugated board exemplifies how a humble material can reflect the values of Industry 5.0—human-centered, data-informed, and ecologically responsible—and inspires us to reconceptualize even everyday materials as advanced, intelligent products of the future.

Keywords: Industry 5.0, corrugated board, smart packaging, digital twin, circular economy, finite element analysis, mechanical optimization

References

Garbowski, T. Numerical analysis of transverse shear in corrugated board with non-standard fluting geometry. (Numeryczna analiza ścinania poprzecznego płyt z tektury falistej z warstwą pofalowaną o niestandardowej geometrii). *Przegląd papierniczy* **2025**, 81(05), 249-257. DOI: 10.15199/54.2025.5.1

Garbowski, T. Flat crush analysis of corrugated board with futuristic fluting geometries. (Analiza zgniatania płaskiego tektury falistej z warstwą pofalowaną o futurystycznych kształtach). *Przegląd papierniczy* **2025**, 81(04), 205-212. DOI: 10.15199/54.2025.4.1

Cornaggia, A.; Mrówczyński, D.; Gajewski, T.; Knitter-Piątkowska, A.; Garbowski, T. Advanced Numerical Analysis of Transport Packaging. *Applied Sciences* **2024** 14(24) 11932. DOI: 10.3390/app142411932