

IMPLEMENTATION OF INNOVATION MANAGEMENT IN THE PRODUCTION OF WOODEN COMPONENTS AND PARTS IN THE AUTOMOTIVE INDUSTRY

Assoc. prof. M.Sc. **Alena Pauliková**, Ph.D.

Assoc. prof. M.Sc. **Henrieta Hrablik Chovanová**, Ph.D.



Institute of Industrial Engineering and Management
Faculty of Materials Science and Technology in Trnava
The Slovak University of Technology in Bratislava
The Slovak Republic

Bioeconomy Moves Forward: Wood in Automotive

- ◎ Transition to a circular bioeconomy and overall CO₂ footprint reduction across the entire vehicle life cycle (LCA);
- ◎ **Automotive sector demand:** Annual consumption in the EU exceeds 80,000 tonnes of plant and wood fibers;
- ◎ **Structural lightweighting:** 30% to 40% weight reduction vs. conventional plastics/metals extends the operational range of electric vehicles (EVs);
- ◎ **Paradigm shift:** Moving from purely decorative elements (luxury veneers) to functional, load-bearing engineering components.

Engineered Wood Materials for Mobility

- ◎ **Silver Birch (*Betula pendula*):** Primary model hardwood selected for its mechanical homogeneity and favorable structural properties;
- ◎ **Wood Foam (Fraunhofer WKI):** Porous bio-material (density 45–200 kg/m³) produced without synthetic adhesives; applied in sandwich cores, acoustic and thermal insulation;
- ◎ **Densified Birch Veneers:** High tensile strength and energy absorption capacity for structural crash-boxes and side-door reinforcements.



Material Property Comparison

- ⦿ Densified birch veneer reaches tensile strength up to 400 MPa, rivaling conventional metals at a significantly lower density;
- ⦿ Wood foam provides an ultra-lightweight core with high shock absorption (0.62 MPa).

Material	Density [kg/m³]	Tensile Strength [MPa]	Key Application
Wood Foam	45 - 200	0.62	Core material, acoustic/thermal insulation
Densified Birch Veneer	920 - 1190	Up to 400	Structural load-bearing components, car doors
Hemp and Kenaf Composite	700 - 900	Up to 50	Sunroof frames (Mercedes-Benz E/A-Class)

Virtual Engineering: MAT58 vs. MAT143 Models

- ◎ Results from the **Wood C.A.R.** project proved that dynamic crash behavior of wood composites can be accurately simulated;
- ◎ **MAT58:**
 - ◎ Orthotropic material model for layered veneers and plywoods,
 - ◎ Independent property definition across 3 principal anatomical directions (L, R, T);
- ◎ **MAT143:**
 - ◎ Transversally orthotropic/isotropic model developed specifically for solid wood,
 - ◎ Automatic accounting for moisture, temperature (-30 °C to +90 °C), and wood quality grading.

Transition to ISO 56001:2024 Certification

- © Published in September 2024 as the first certifiable requirement standard for Innovation Management Systems (IMS/InMS);
- © Transition from non-certifiable guidance (ISO 56002) to binding "shall" requirements;
- © **Goal:** Managing uncertainty during R&D of variable bio-materials and achieving repeatable innovation outcomes.

Requirement Integration in Automotive Chains

- ◎ **Common Requirements (HLS/HS):** Clauses 4, 5, 8, and 9 easily integrate into a single Integrated Management System (IMS);
- ◎ **Specific Requirements:** IATF 16949 strictly enforces zero-defect mass production, whereas ISO 56001 manages exploratory risk and learning from prototype failures.

Clause	Common Area (HLS/HS)	IATF 16949 (Specific)	ISO 56001 (Specific)
4	Context and Interested Parties	Automotive Tier customer requirements	EUDR compliance, raw material geolocation
5	Leadership and Policy	Zero-defect target, PPAP approval	Supportive culture, risk-taking allocation
8	Operation & Processes	Mass production control, APQP	Exploratory R&D, Phase-Gated Validation
9	Performance Evaluation	PPM defects, warranty rates	KPIs on value realized, learning indicators

Managing Uncertainty: Moisture Impact on Bio-composites

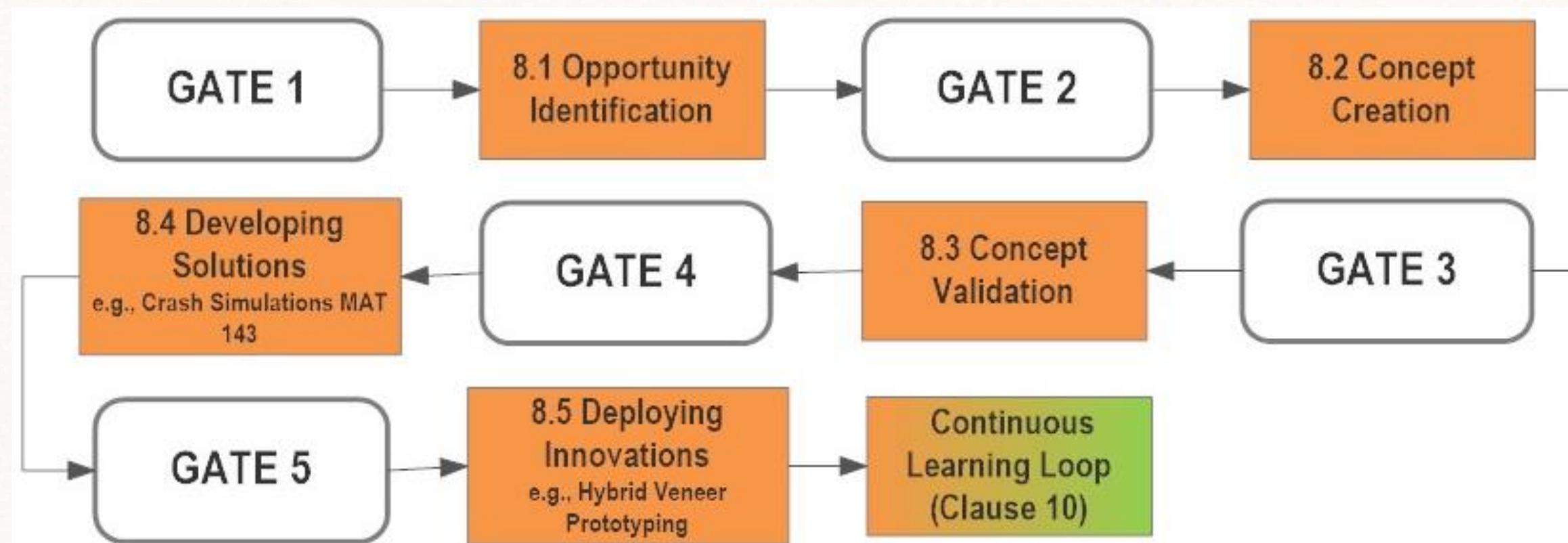
- Moisture content is a critical variable influencing dimensional stability and mechanical strength;
- Mathematical model for water absorption:**

$$W_A = \frac{m_2 - m_1}{m_1} \cdot 100,$$

where W_A is water absorption (%), m_1 is dry specimen mass, and m_2 is mass after exposure/immersion (kg);

- Threshold W_A values are embedded directly into Stage-Gate approval criteria.

Operational Innovation Control under ISO 56001 (Clause 8.3 Innovation Processes)



- ◎ Strict alternation between creative R&D execution stages (Stages 8.1–8.5) and formal decision gates (Gates 1–5);
- ◎ Integration of Safe and Sustainable by Design (SSbD) principles at early gates before committing capital to full development.

Transition from R&D to Mass Production

- ◎ **Stage 8.4 (Developing Solutions):** Full-scale FEM crash simulations (MAT58, MAT143) and physical impact testing;
- ◎ **Stage 8.5 (Deploying Innovations):** Hybrid veneer prototyping and PPAP documentation under IATF 16949;
- ◎ **Continuous Learning Loop (Clause 10):** Feeding data from halted/unsuccessful prototypes back to refine material formulations.

Auditing an Innovation Management System

- ◎ Auditing under ISO 19011 focuses on searching for objective evidence of innovation capability, rather than penalizing failure;
- ◎ **Key auditor evidence:**
 - Documented proof of concept (PoC) results from discontinued or redirected projects,
 - Allocation of dedicated R&D time and resources by senior leadership,
 - Structured intellectual property (IP) management frameworks.

Raw Material Traceability under EUDR

EUDR Step	Requirement Details	Automotive Application
1. Data Gathering (Art. 9)	Plot geolocation coordinates (polygons) & species identification	Tracing veneer wood or natural rubber back to the specific forest parcel
2. Risk Assessment (Art. 10)	Evaluation of country risk levels, governance, and traceability data	Continuous mapping of Tier 1-3 suppliers on deforestation risk
3. Risk Mitigation (Art. 11)	Implementing corrective measures where risk is non-negligible	Deploying RFID tags on logs or deep-learning image-based tracking

- ⦿ **EUDR (EU 2023/1115):** Mandatory deforestation-free verification (post-31/12/2020) via plot-level geolocation;
- ⦿ **Technologies:** Deep learning tracking (YOLOv8) and RFID tags for full traceability.

Conclusions and Industry Recommendations

- ◎ **Bridge between requirements:** ISO 56001:2024 provides the necessary bridge between natural material variability and strict automotive engineering demands;
- ◎ **Process efficiency:** Common management requirements eliminate administrative redundancy; specific R&D gates protect series production stability;
- ◎ **Competitive advantage:** Embedding EUDR traceability into the IMS transforms regulatory burden into a green premium competitive advantage.

Thank You for Your Attention

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Contacts:

- ⊙ Assoc. prof. M.Sc. Alena Pauliková, Ph.D. (alena.paulikova@stuba.sk)
- ⊙ Assoc. prof. M.Sc. Henrieta Hrablik Chovanová, Ph.D. (henrieta.chovanova@stuba.sk)



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