

# Agile Development at Industrial Scale through Circular Large-Scale 3D Printing

---

Eve Saarikoski  
KCL Biocomposites  
2026

# Big Ships Can Turn Fast

Industrial-scale manufacturing is often seen as rigid and slow.

Circularity is frequently viewed as a constraint, not an enabler.

*With the right material and production logic, even large industrial systems can become agile.*



The Core Challenge:

## Why Industrial Learning Is Expensive?

- Production systems are optimized for scale, not iteration
- Materials follow a linear path: **virgin** → **product** → **waste**
- Feedback loops are slow and costly

### **Result:**

High material cost,  
wasted side streams,  
and limited learning speed.

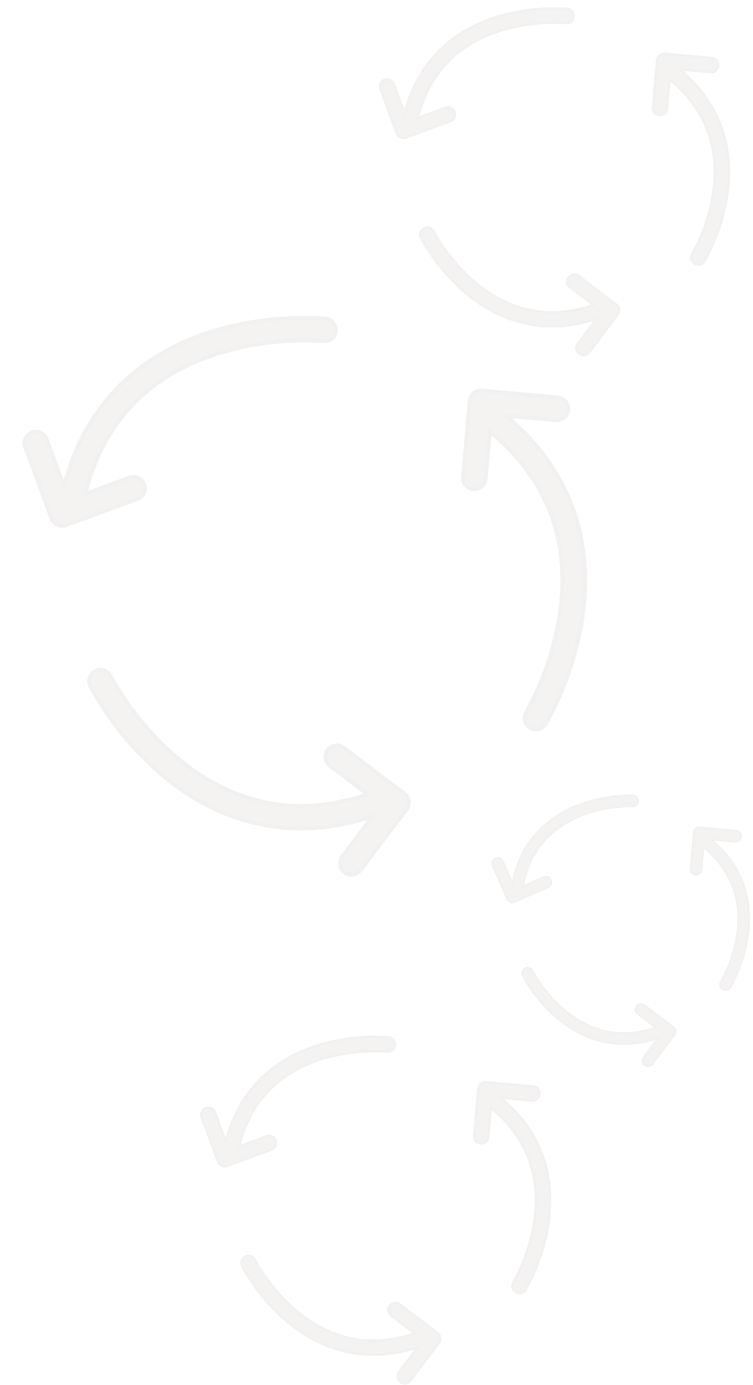
Target State:

## Waste-Free Large-Scale 3D Printing Ecosystems

**Ecosystems where:**

- Materials remain in continuous use
- Side streams are captured and reused
- Waste is treated as a resource, not a by-product

*Waste-free manufacturing is a system-level design choice.*



# Why This Was Not Obvious

Three Assumptions That Shaped Industrial Thinking

1. Virgin material is the only truly reliable option
2. Circular materials increase cost and complexity
3. Biomaterial recycling requires heavy new infrastructure

*All three were reasonable assumptions – until the technology changed.*

## *Only Virgin Material Is Reliable*

- Virgin feedstock = predictable quality
- Recycled materials associated with variability and risk
- Especially critical for performance-driven applications

### **What changed:**

- Additive manufacturing
- Material traceability and history control
- Closed, well-defined material loops

## Case: RISE

RISE is Sweden's national research institute and one of Europe's largest, working with industry to develop sustainable, industrially scalable technologies.

- Continuous use of Formi materials since 2019
- 100% Recycled Material in Large-Scale 3D Printing
- Extensive prototyping and testing
- Material thermal history is tracked and managed

*Reliability comes from controlled systems, not from virginity.*

**RISE**



## Circular materials increase cost and complexity

- Bio-based materials are often premium-priced
- Circularity is seen as added complexity

### **Reality:**

Cost is determined by system design – not by circularity itself

## Case: JKR Muovi

JKR Muovi is a Finnish plastics manufacturer specializing in thermoforming and circular material solutions, with a strong focus on utilizing industrial side streams.

### rPETG from Thermoforming Side Streams

- Clean PETG leftovers from thermoforming
- Locally collected and reprocessed with KCL

### Outcome:

- Performance comparable to virgin PETG
- Short, traceable, local material loop
- Reduced cost and environmental impact



## Case: KCL Materials

- Lower Cost through Side-Stream Cellulose
- Industrial side-stream cellulose replaces virgin input
- Same or improved technical performance
- No process changes required for customers

### Examples:

- Tooling and mould materials
- Injection-moulded composites

*Circular materials can be cheaper and better when designed correctly.*



## Biomaterial recycling requires heavy new infrastructure

- Recycling usually linked to public waste systems
- High investment perceived as a major barrier

### Alternative approach:

- Use existing industrial equipment
- Close loops inside the production value chain

# Automotive Case

## Proof that Big Ships Can Turn Fast

### Closed Loop for One-Time-Use Moulds

- Thermoforming and vacuum infusion moulds used once
- Moulds returned after use
- Material recycled into new production

### Business logic:

Customer receives material discount based on returned mass

### Result:

No new infrastructure – loop closed within industry.



# NEW DESIGN PRINCIPLE

Designing Circular Large-Scale 3D Printing Systems

- **Assume materials will circulate**
- **Design for local, closed loops**
- **Separate learning from expensive production materials**

Waste-free systems don't emerge by accident – *they are designed.*



## What This Enables

### Industrial Impact

- Faster iteration and learning
- Lower material risk and cost
- Local production and resilience
- Circularity as a competitive advantage

## Looking Forward

If materials can circulate,  
if recycled materials can perform,  
and if learning no longer needs to  
be expensive

**–Where is the greatest unused  
potential in your production?**

## Our 3D Materials

A material's application suitability depends on its grade – most items have several grades, some only one.

Granules are available for 3D printing as well as compounding, and KCL Formi® 3D Nordic Birch PLA10 is also offered as filament.

