THE FUTURE OF GLOBAL SUPPLY CHAINS
When 3D printing is commonplace, will we still need warehouses?

The better the question. The better the answer. The better the world works.
Innovation Concern for Logistics

“LSPs are not very innovative ………
logistics-related improvements are mainly
driven by LSP customers although customers
increasingly expect new and innovative
solutions from their LSPs and improvements
of delivered services over time”

Busse and Wallenburg, 2011

Gap in Academic Research Too!

“Logistics research has
largely ignored
the concept of innovation”

Flint et al. 2005
A DRAMATIC CHANGE FOR OUR CUSTOMERS…

[Graph showing the evolution of production methods from 1850 to 2020, with key points labeled: 1850, Craft production; 1913; Mass production; 1955; Lean MFG; 1980; Mass customization; Personalized Production.}
GLOBAL SUPPLY CHAINS ARE CHANGING

Globalisation

The previous decades have witnessed a huge increase in the international flow of goods

Offshoring

- Transfer of production to low cost geographies
- Outsourcing of manufacturing and supply chain activities
- Supply chains became elongated and complex

Stagnation

Between 2011 and 2014 export of manufactured goods has stabilized and even declined in 2015 and 2016

OECD 2017
CHINA WAS THE FACTORY OF THE WORLD
THE SINGLE BIGGEST CHANGE TO SUPPLY CHAINS IS NEW BUYING BEHAVIOURS

The Millennials:

- 25% of the world population in 2017
- Major influence on how things are purchased
- Most do not even remember the times without the Internet

27% of the world’s trade will be done on-line by 2020
INVENTORIES ARE INCREASING

What worked for the last two decades is no longer fit for today’s e-com driven world.

OEMs rely on 3PLs as subcontract manufacturers of aggregated services, turning fixed cost into variable cost.

Customers are struggling to adapt; inventory is rising because the Take Make Dispose supply chain doesn’t satisfy market demand – demand has outpaced supply chains.
SUPPLY CHAINS ARE BADLY DESIGNED, INEFFICIENT AND RIGID

http://www.wbs.ac.uk/news/the-50-000-mile-journey-of-wimbledon-s-tennis-balls/
HOW ARE SUPPLY CHAINS CHANGING

**YESTERDAY**

- Centralized Manufacturing far from local demand

**NOW & FUTURE**

- Distributed Manufacturing close to local demand
- Co-designed, modular products, personalized and 3DP close to demand
- Circular supply chains focused on Extended Product Life Cycles
WHAT WE ARE DOING TO RESPOND

Demand Driven Inventory Dispositioning

An inventory planning and optimization modelling tool

Clear Data  Input Demand  Input Purchase Orders
Classification Forecasting  Order Levels  Inventory Checking

Tool Guide

Output Summary

This is a proprietary inventory control solution owned by Panalpina World Transport Ltd, the development of which was made possible through Knowledge Transfer Partnership no. KTP009287.
ADDITIVE MANUFACTURING IN SPARE PARTS SUPPLY CHAIN

CONVENTIONAL SUPPLY CHAINS

Product design

Manufacturing specification

Mass Production

Consolidation

Regional Spare Part Distribution Center

Forward Stocking Locations

END USER

ADDITIVE FULLFILMENT

Prototyping
ADDITIVE MANUFACTURING IN SPARE PARTS SUPPLY CHAIN

TOMORROW

CONVENTIONAL SUPPLY CHAINS

Product design

Manufacturing specification

Mass Production

Consolidation

Regional Spare Part Distribution Center

Forward Stocking Locations

END USER

ADDITIVE SUPPLY CHAINS

Prototyping

Digital Manufacturing Specification

Digital Inventory

On-Demand Digital Manufacturing

Consolidation

Regional Spare Part Distribution Center

Forward Stocking Locations

END USER
## 3D Printability Analysis

### Demonstrator

3D Printing has been proved that can facilitate the improvement of both manufacturing and supply chain aspects. However, the critical question is at which products the companies should turn their focus first? The 3D printability analysis has been designed to investigate which single-material components are most likely to benefit from shifting the manufacturing process from traditional to 3D printing taking into account the objective to be achieved.

<table>
<thead>
<tr>
<th>Engineering</th>
<th>Weight: 50%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geometry</td>
<td>Purpose</td>
</tr>
<tr>
<td>Part Size (Sphere with diameter)</td>
<td>Design Complexity</td>
</tr>
<tr>
<td>5 cm &lt; D &lt; 15 cm</td>
<td>Design with major inner/outer features</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Supply Chain</th>
<th>Weight: 50%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand</td>
<td>Part Criticality</td>
</tr>
<tr>
<td>Level (Annual demand)</td>
<td>Volatility</td>
</tr>
<tr>
<td>Hundreds</td>
<td>Low volatility</td>
</tr>
</tbody>
</table>

### Instructions:

**KTP OUTPUT:** PRINTABILITY INDEX

![Forecast button](image)

![Cardiff School of Engineering](image)

![Innovate UK](image)
**PROOF OF CONCEPT – 3D PRINTING**

<table>
<thead>
<tr>
<th>DESIGN</th>
<th>PROTOTYPE</th>
<th>FINISHED PRODUCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Design Image]</td>
<td>![Prototype Image]</td>
<td>![Finished Product Image]</td>
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