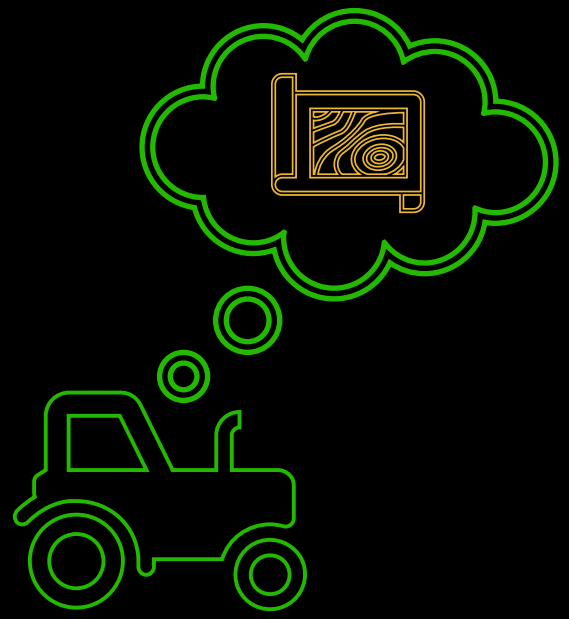

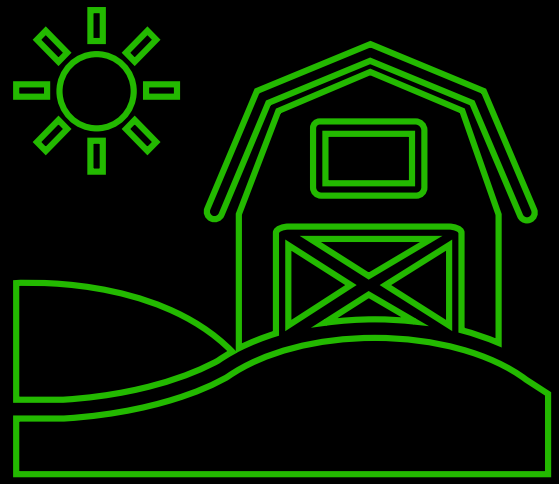

Lea Hannola

Antero Kutvonen

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LEVITOI Final Webinar 12.12.2024

SUSTAINABLE VALUE THROUGH SIMULATION OF AGRICULTURAL MACHINES

Lea Hannola

LUT University

DIGITALISATION IN WORKING MACHINES

- The technological foundation for working machines is rapidly changing in the intersection of 3 major emerging trends: Electrification, Digitalisation and Autonomy
- Working machine manufacturers have outlined a vision for the future supported by joint research roadmaps and resources, where

”The future mobile machine is not just sustainable. It is enabling totally new, unseen value over the value chain the machine is operating in.”

The mobile machine of 2030

FUTURE MOBILE MACHINES ARE MISSION-DRIVEN, ENABLE SEAMLESS OPERATIONS AND DELIVER NEW, UNSEEN VALUE ACROSS THE VALUE CHAIN. SUSTAINABILITY IS BUILT INTO EVERYTHING.

EMBRACING AUTONOMY

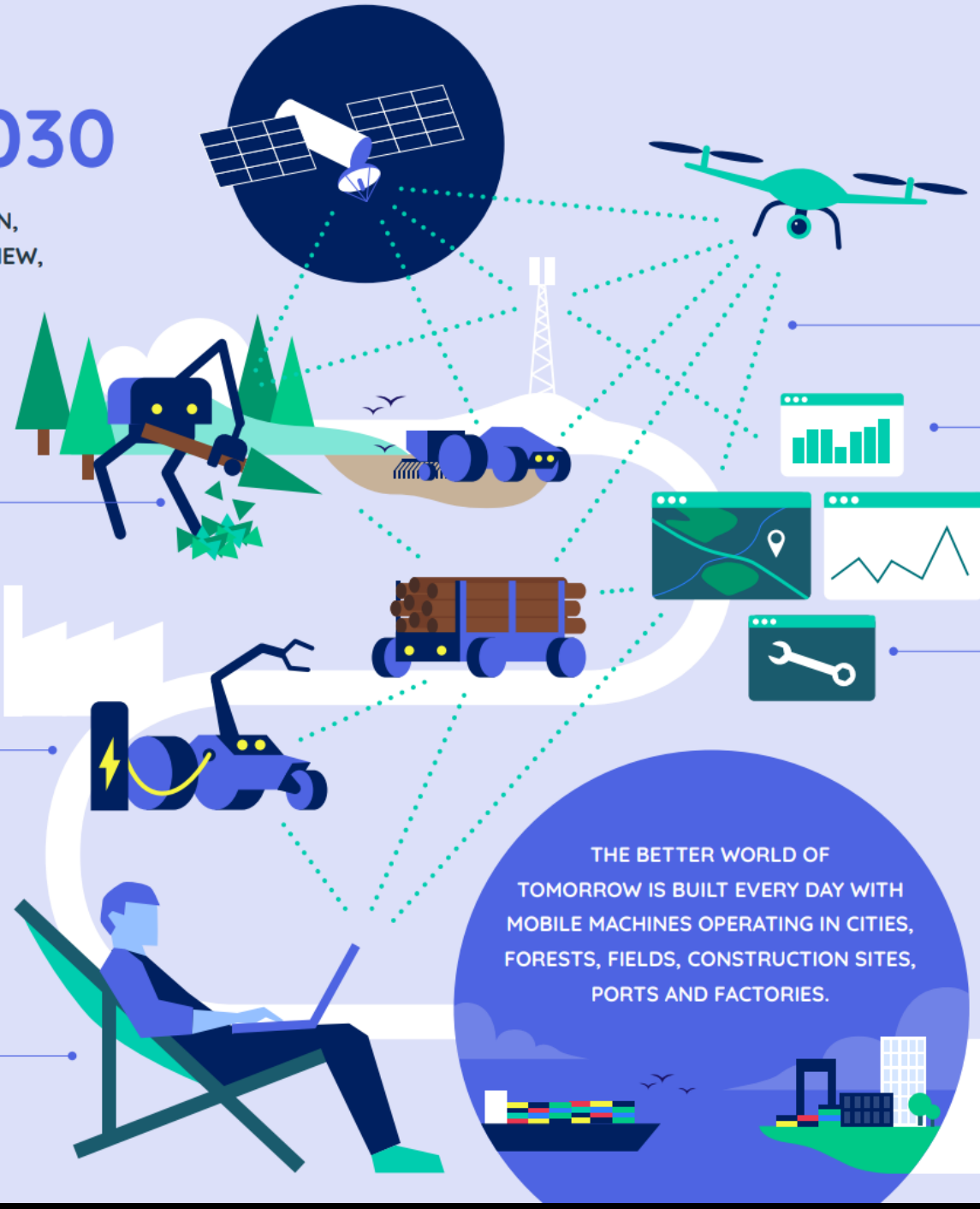
- The level of autonomy ranges from full autonomy to driver assistance systems depending on the application (open/closed environment).
- Autonomy is extended from machine level to mission-driven fleet autonomy.
- Autonomy increases the efficiency of the whole operation process.

ELECTRIFICATION ENABLES ZERO-EMISSION OPERATIONS AND NEW VALUE

- Electrified machines produce no emissions and are efficient, safer and more reliable.
- The fit-for-purpose design offers precise functionalities and improved performance.
- As a result, machines no longer limit their function.

HUMAN IN THE LOOP - BETTER JOBS

- As machines and systems become smarter, people are freed from monotonous work and can focus on more complex tasks that require decision-making skills.
- As a result, work becomes more meaningful and motivating. Employees suffer from less stress and fatigue and their cognitive load decreases.
- A whole new level of safety is achieved. Intelligent, integrated safety systems allow people and machines to work safely in the same area.
- Work is no longer location-specific thanks to remote operations and increased levels of autonomy.



THE BETTER WORLD OF TOMORROW IS BUILT EVERY DAY WITH MOBILE MACHINES OPERATING IN CITIES, FORESTS, FIELDS, CONSTRUCTION SITES, PORTS AND FACTORIES.

CONNECTED AND COMMUNICATING

- All is connected: Mobile machines operate as efficient, autonomous teams, interacting with each other and exchanging information in real-time in a highly systemic environment.
- All machines are connected to operations management systems and operated with minimal human interference.
- Operations centres have a complete overview of the sites and operational data at all times.
- Ultra-reliable, low-latency connectivity enables high levels of autonomy and maximises the efficiency of operations.

INTELLIGENT CONTROL SYSTEMS AND BETTER DECISION-MAKING

- Decentralised AI enables autonomous decision-making also on a machine-level.
- Information is processed and refined on the machines before it is shared.
- Machines optimize their performance and routines autonomously based on perceived data and information.

LEVERAGING DATA FOR NEW BUSINESS OPPORTUNITIES

- Maintenance needs are predicted and services optimized using data throughout the entire life cycle of the machines.
- Machines are transparent in terms of condition and cost. Open interfaces enable data sharing.
- Each machine has a digital identity for full traceability of lifecycle services, re- and de-manufacturing, recycling and novel value adding services.
- Focus is on results instead of machines and services – that is what customers are paying for.
- Machine-generated data creates new business opportunities and added-value.

SIX Sustainable Industry X | MOBILE WORK MACHINES

SIX Mobile Machines is an industry driven cluster of Finnish mobile machine manufacturers and their key technology providers.

FIT FOR AGRICULTURAL CONTEXT

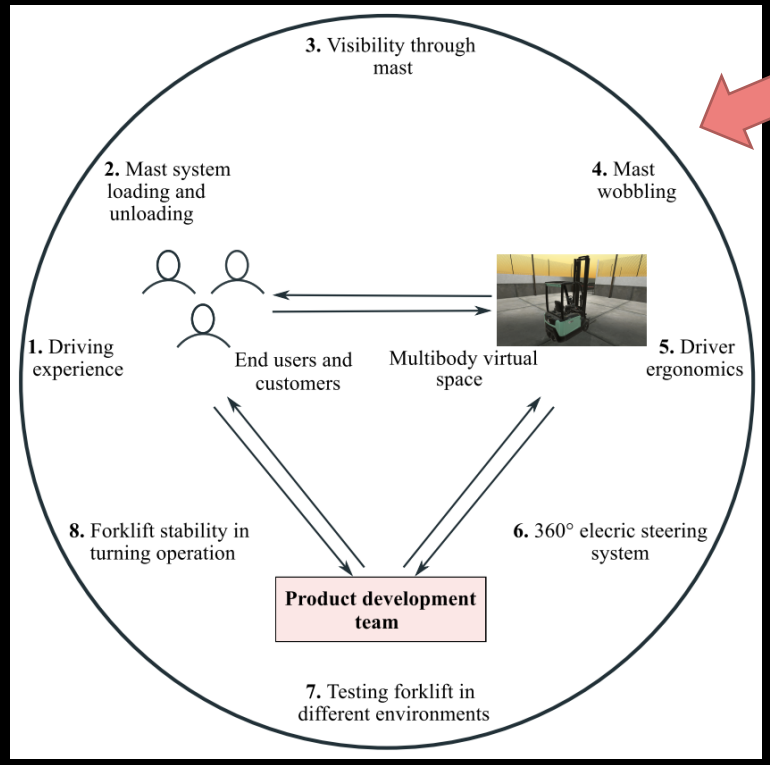
- Agricultural markets have unique requirements to digital innovation
- End-user demand for digital innovation and automation is modest
  - Labor costs are often low enough to not invest in automation
- Different user segments have heterogenous needs (and willingness to pay) for digital innovation
- Product use is highly seasonal (e.g. heavy use only during harvest)
  - Reliability is critical: easy to maintain, resistance to complex / sophisticated features
- Collaborative innovation is relatively uncommon still

MOTIVATION AND PURPOSE OF D4.2

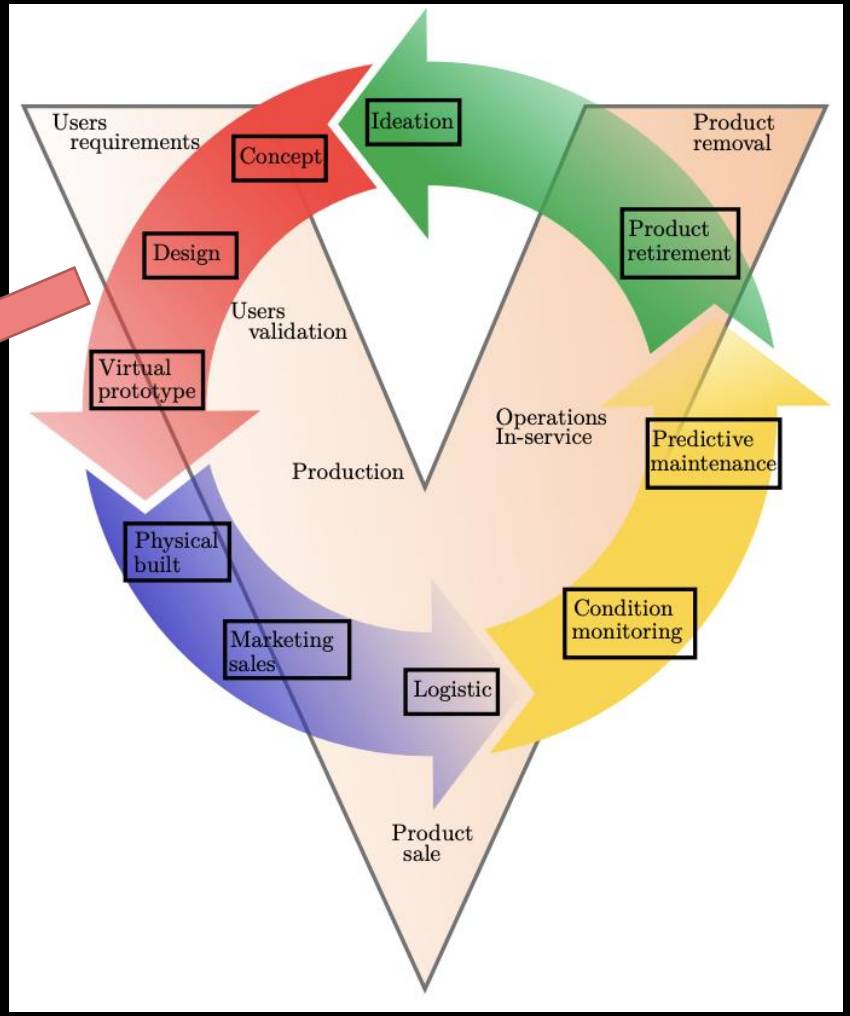
- In LEVITOI, WP4 supports adoption of LEVITOI technologies with research focusing on **sustainable value creation through simulation**, to support future-oriented decisionmaking

- We identified general changes from digitalisation (presented in the earlier webinar) and later focused more on added value of simulation in different product processes to support simulation-based product, process and service development

SIMULATION-BASED VALUE CREATION



Khadim 2021



Khadim 2021

Example applications in different product processes

FORMS OF SIMULATION-BASED VALUE CREATION

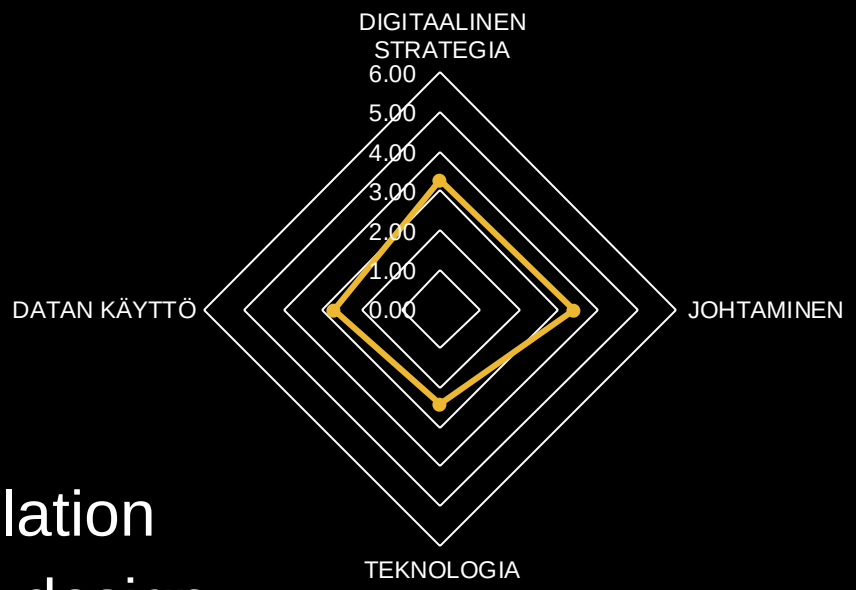
- Research and development: Gamification, (AI-)software testing, safety assessment and validation
- Manufacturing: Analysis of manufacturing and assembly lines, Precise manufacturing management (*zero defect / zero waste*), remanufacturing
- Marketing: User training and commissioning services, customer value analysis, sales configurators
- Service: Remote diagnostics, digital twin as a service, model-based maintenance / service
- New business opportunities: System level optimization, dynamic supplier management, co-developed autonomous features

Legend: 1 = Low cost / high value 2 = Medium cost / value 3 = High cost / low value

EXAMPLE CONCEPTS ENABLED BY SIMULATION

Lifecycle stage	Simulation-based business concept			
R&D / Design	Virtual prototyping and testing	1	1	1
	Model-based system engineering	2	1	1
	Sales configurator	1	1	2
	Gamification (in R&D)	2	1	2
Manufacturing	Data-driven supply chain	3	2	1
	Zero-defect manufacturing	3	3	2
	Digital Lean	2	2	2
Operation	User training simulators	1	1	2
	Prescriptive maintenance	2	3	1
	Remote operation	1	2	2
	Optimized control and autonomy	2	2	1
End of Life	Re-X circularity	3	2	2
	Extended producer responsibility	2	1	3
Data-based services	Precision agriculture	2	2	1
	Remote diagnostics	1	1	3

CONCLUSIONS AND SUMMARY



- Agricultural machine manufacturers digital maturity is still developing, and they have unique contextual factors influencing adoption of digital tools like simulation
- Most quick wins are found to be in R&D and design as well as in forming new data-based services to support end users
- Simulation-based value in manufacturing and operation stages can be substantial too, but is further away from being realized
- Agricultural machines will benefit from other working machines development and should remain curious and collaborate early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