West Virginia University
Benjamin M. Statler College of Engineering and Mineral Resources
Department of Industrial and Management Systems Engineering

Smart Manufacturing Technologies

& the road to servitization

West Virginia University
SMART MANUFACTURING LAB

September 07, 2022

Morgantown, WV

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Agenda

1. Introduction
2. Smart Manufacturing Technologies
3. Servitization of Industrial Assets
4. Crucial Role of Smart Services
5. Conclusions

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Smart Manufacturing Lab

Smart Manufacturing Systems

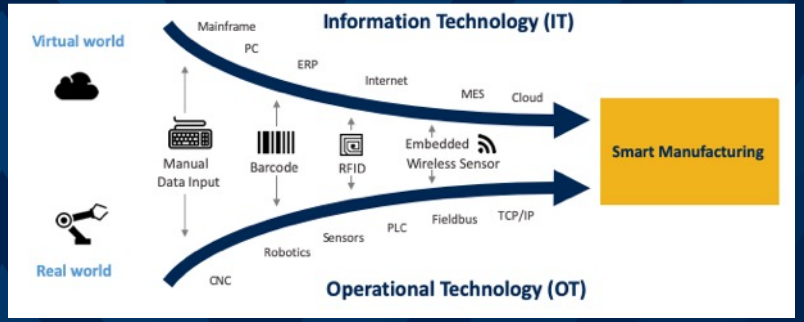
- Multi-stage connected CPS
- Digital Transformation (MNEs & SMEs)

Machine Learning / AI in Manufacturing

- Machine tool data analytics to model quality, energy, etc. (descriptive to prescriptive)
- Hybrid modeling (physics-based & data-driven)

IIoT / Smart Manufacturing Platforms

- SM Apps/Services on IIoT platforms
- New non-ownership business models



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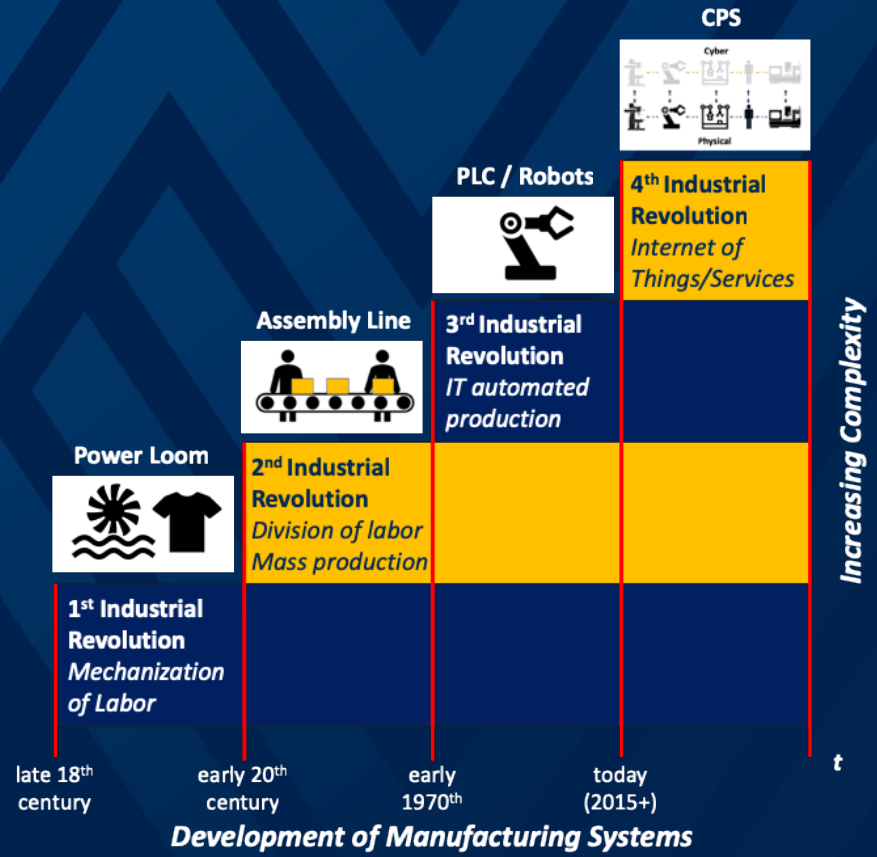
Smart Manufacturing & Servitization

- Focus on *connectivity* on & beyond manufacturing shop floor
  -> Need to rethink *Business Models*
- Connects the *virtual world* and the *physical world*
- Fueled by *data* and *data analytics*
- Enables *competitive manufacturing* of high-quality products
- **Not optional!**



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Source: Wuest, T. (2019). Smart manufacturing builds opportunities for ISEs. *ISE Magazine, 51*(4), 40-44.

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Schmid & Wuest, 2017

Smart Manufacturing Technologies

AI, Machine Learning & Advanced Simulation

Cloud, Fog, & Edge Computing

Additive Manuf.

IIoT & CPS

AR, VR, & Digital Twins

Automation & Robotics

Cybersecurity

Blockchain

Smart Sensor Systems

5G Networks

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Source: Wuest, T., Romero, D., Khan, M., & Mittal, S. (2022). *The Triple Bottom Line of Smart Manufacturing Technologies: An Economic, Environmental, and Social Perspective*, pp. 311-332. In: Kurz et al. (2022). Handbook of Smart Technologies: An Economic and Social Perspective. Routledge, London.

SMART MANUFACTURING MARRIES TECHNOLOGY, DATA AND HUMAN INGENUITY

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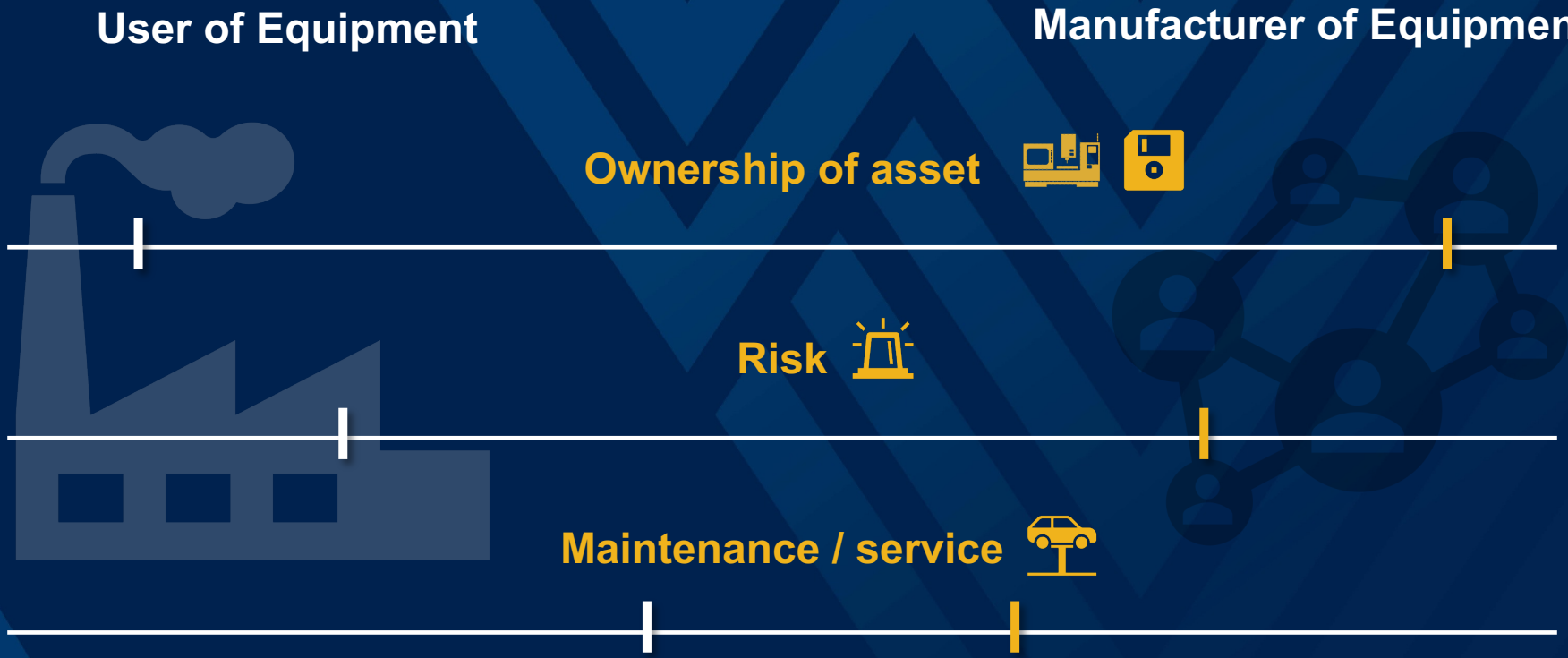
Schmid & Wuest, 2017

Servitization

- *Integration of products and services* into innovative offerings
- Transition of manufacturers' value propositions from sale of products to incorporating additional services with their products or by offering their *products 'as a service'*
- Targeted to fulfil *customers' needs*
- *Decouple consumption* from production
- Technology *key enabler* of servitized business models


Jet Engines

Servitization – Key Differences



Servitization of Industrial Assets - Selected Benefits

Operational Benefits

- Competition outside of ‘cost’
- *Monetize ’installed base’* (No. unit sales vs. No. of units in operation)
- Continuous revenue generation
- *Data & insights in operation* of large number of machine tools (valuable insights for next gen. developments, optimizing operations/parameters, pred. maintenance, etc.)
- …

Strategic Benefits

- *Lock-in* effect (*customers*)
- Lock-out effect (*competitors*)
- Reduction of direct competition through customization
- *… customer demand!*
- *…*

Sustainability Benefits

- Less waste
- Extended lifecycles
- …

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Servitization comes in different shapes and forms

Based on Menon et al., 2018

- Different business models are often *offered simultaneously*.
- It is a *collaborative process* and evolution to establish the best 'fit'

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How does that connect to Smart Services?

- *Risk and responsibility* for assets remain with manufacturer in servitized BM
- Including *variating levels of service* responsibilities, e.g.,
  - Remote monitoring via sensors systems
  - Training and/or managing of local operators & maintenance teams
  - Scheduled and/or emergency service provision (‘guaranteed uptime’)
  - Etc.

With increasing numbers of systems in the field, that can mean significant travel (‘time waste’)

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Smart Manufacturing Tech. for Smart Services

AI, Machine Learning & Advanced Simulation

Cloud, Fog, & Edge Computing

Additive Manuf.

IIoT & CPS

AR, VR, & Digital Twins

Automation & Robotics

Cybersecurity

Blockchain

Smart Sensor Systems

5G Networks

Predictive analytics for tool wear monitoring, energy optimization, predictive and prescriptive maintenance.

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Virtual 'Boots on the Ground' via AR technology. Enabling local team perform maintenance on complex machines.

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Remote locations and legacy systems can be connected via 5G networks.

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Smart Services must embrace Servitization

- *Servitization is a process* for both, provider/manufacturer and user/customer
- SM tech enabled smart services play *crucial role in sustaining* the servitized BMs
- And vice versa, future Smart Services must be *embedded in servitized BM* to activate their full potential

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Key messages of today‘s talk

Smart Mfg. technologies such as AR create new opportunities

Much progress in implementing digital solutions in manufacturing

Difficult to translate technological progress in business success

Companies with digital core AND mindset have advantage

Smart Mfg. needs to be approached holistically, and that includes rethinking business models and value proposition

PPU/PPO BMs are promising, yet their development is challenging

Tech.-enabled Smart Services are crucial element of servitized mfg. BMs!

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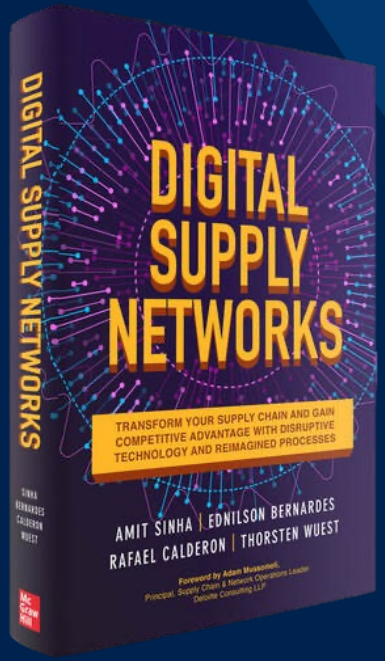
Thank You!



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