



**EUROPEAN  
FORUM  
ALPBACH**

# Digital Production – from material models to circular economy

**European Forum Alpbach 2021  
25.08.2021**

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DI Gernot Mauthner**

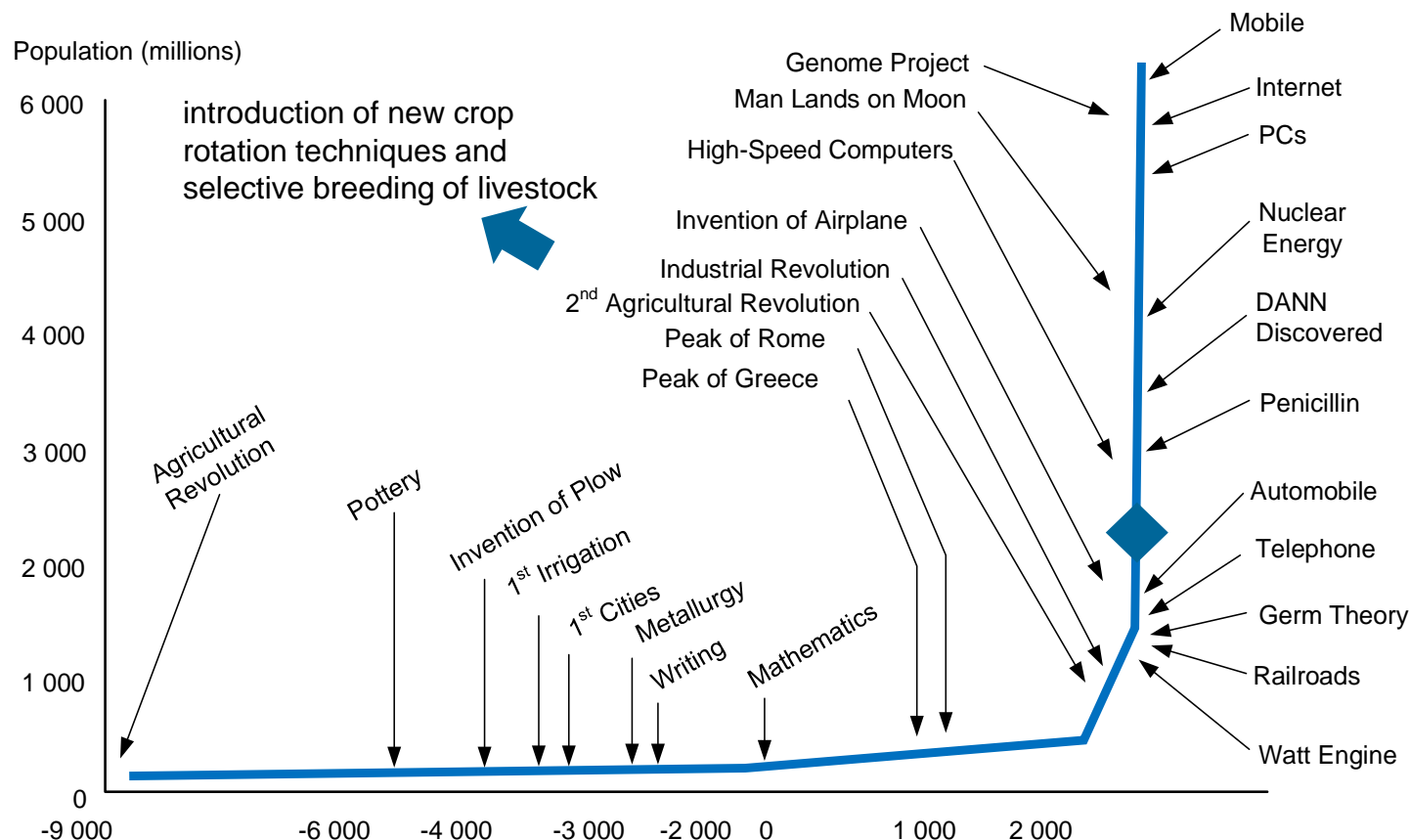


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## Growth of world population and the history of technology

two top priorities of the current European Commission:

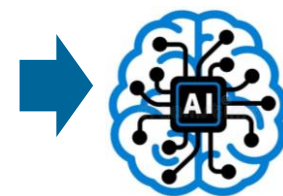
- "Green Deal" - making Europe climate-neutral by 2050
- "Europe Fit for the Digital Age" by new and updated rules for technology and the digital economy



Milken Institute, Robert Fogel/University of Chicago



gene scissors were supposed to cut the faulty gene sequence



- using data and AI to
- increase production flexibility in times of disruption
  - rendering value chains more robust
  - technology that adapts to the worker rather than the other way around
  - using technology for circularity and sustainability

“ **Was kann so absurd, so lächerlich sein wie die propagierte Aussicht, Lokomotiven zu bauen, die doppelt so schnell wie Postkutschen fahren? Ebenso gut könnten sich Leute mit einer Rakete abfeuern lassen, als sich der Gnade einer solchen Maschine anzuvertrauen.**

**»Quarterly Review«**  
angesehene Londoner Zeitung, 1825



1900



1913

““

**Ich glaube an das Pferd.  
Das Automobil ist eine  
vorübergehende Erscheinung.**

**Kaiser Wilhelm II.**

letzter deutscher Kaiser & preußischer König, 1906

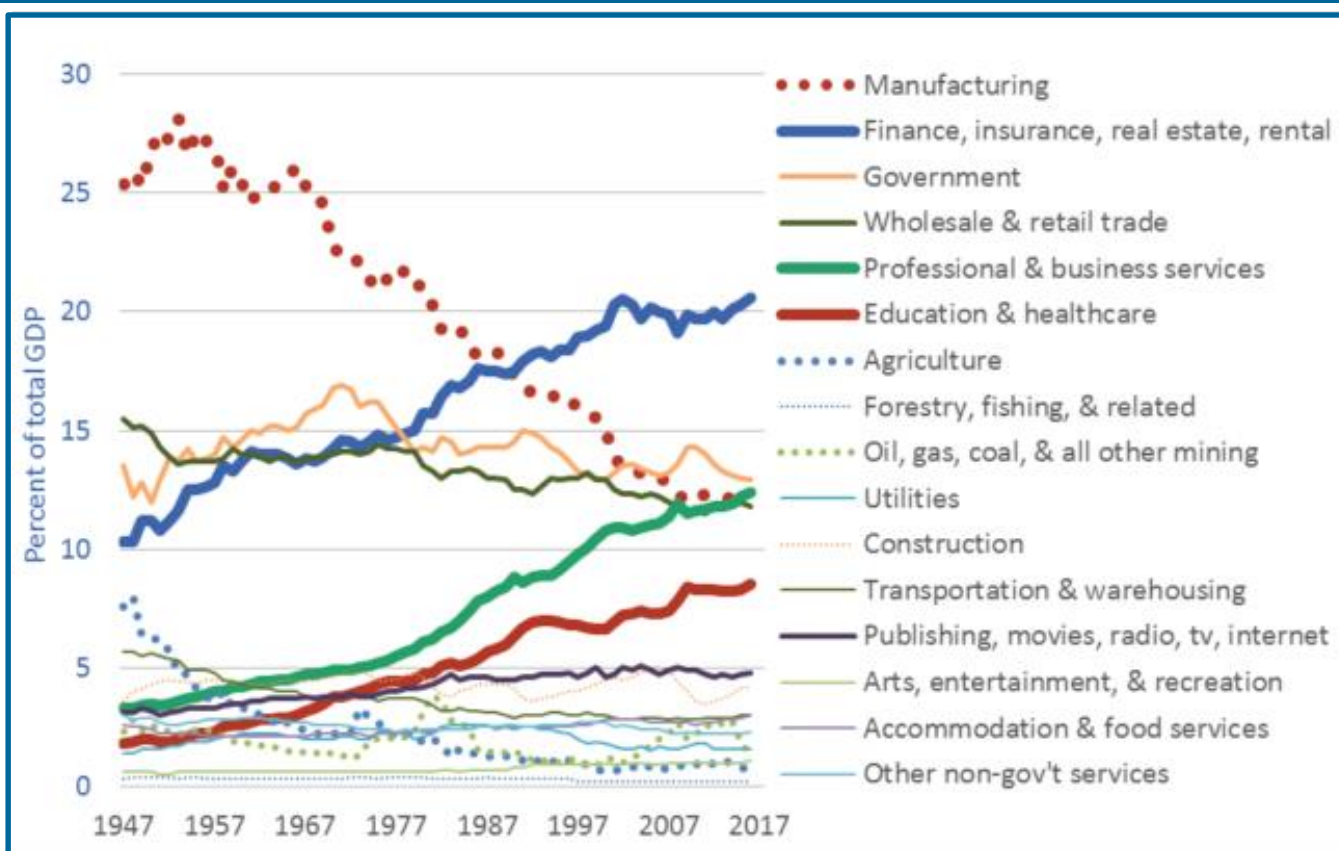
““

**Schwerer als Luft?  
Flugmaschinen sind unmöglich!**

**Lord Kelvin**

Präsident der Royal Society, 1895

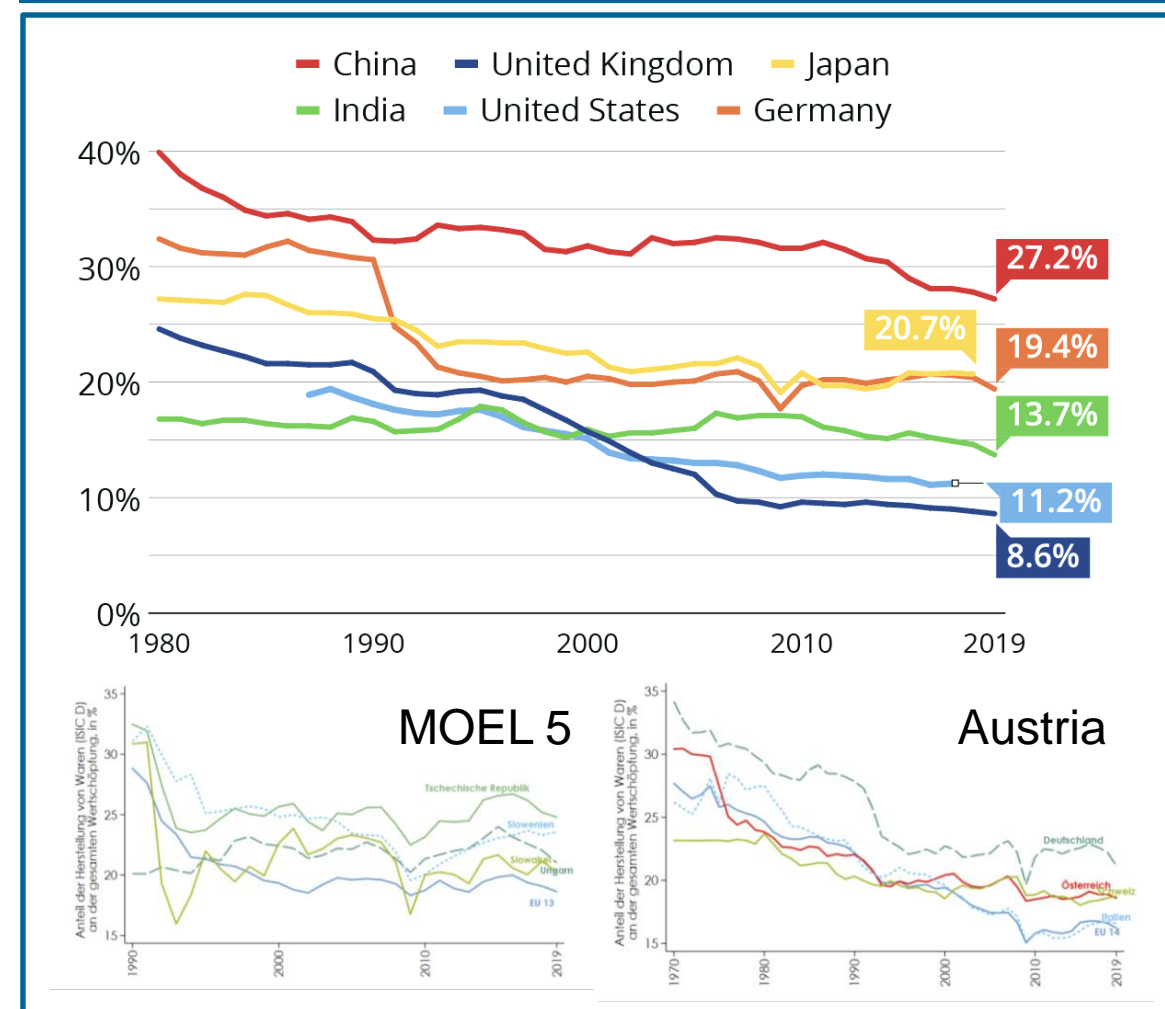
## Sectors of US Economy as Percent of GDP 1947-2017



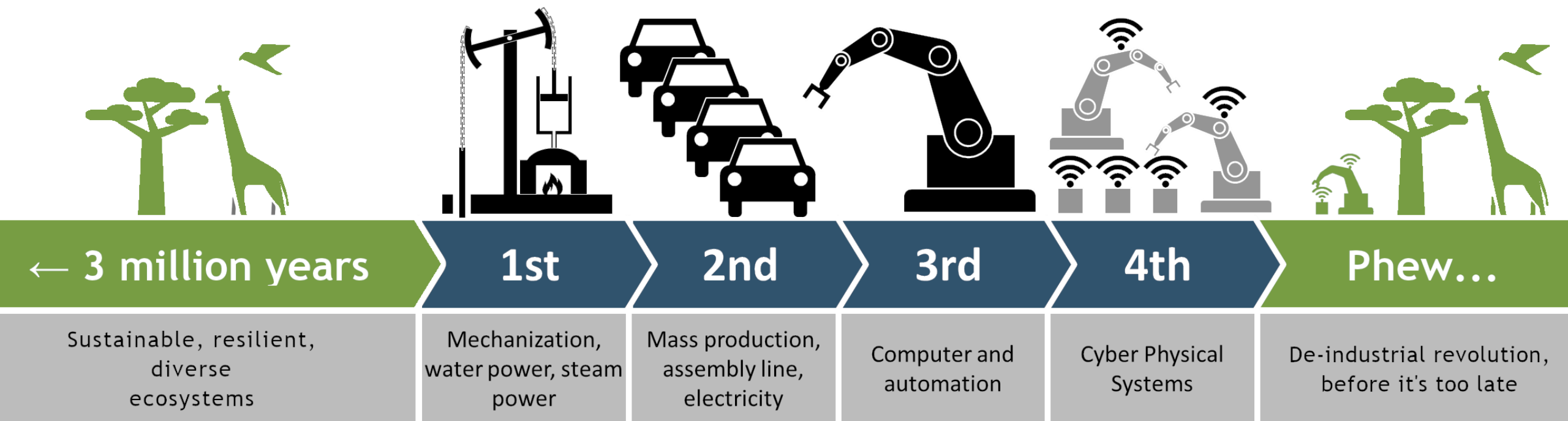
US Bureau of Labor Statistics, goods-producing industries

United Nations and World Bank

## Manufacturing value added as a percentage of GDP in selected countries (1989 – 2019)



Society 5.0 was presented by Keidanren, Japan's most important business federation, in 2016.

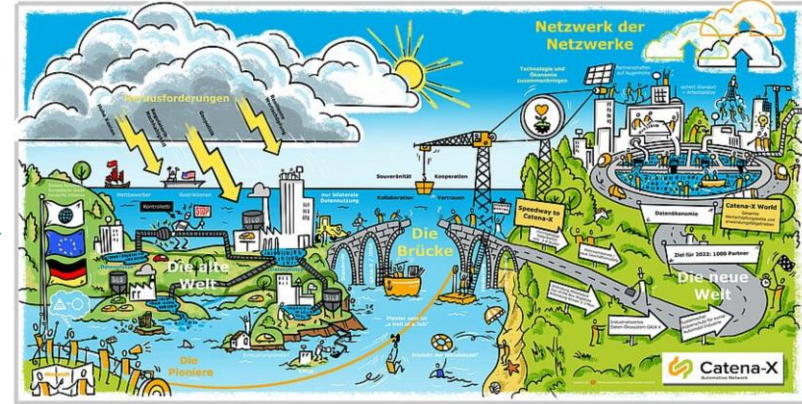


Letmeseenow and ChristophRoser, based on File:Industry 4.0.png, CC BY-SA 4.0 <<https://creativecommons.org/licenses/by-sa/4.0/>>, via Wikimedia Commons

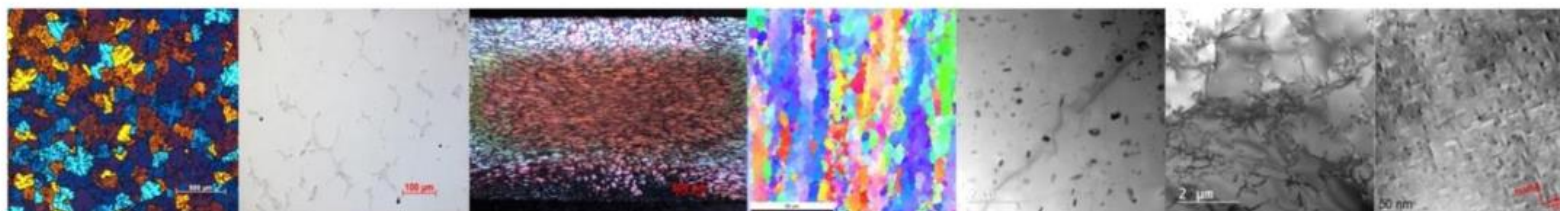
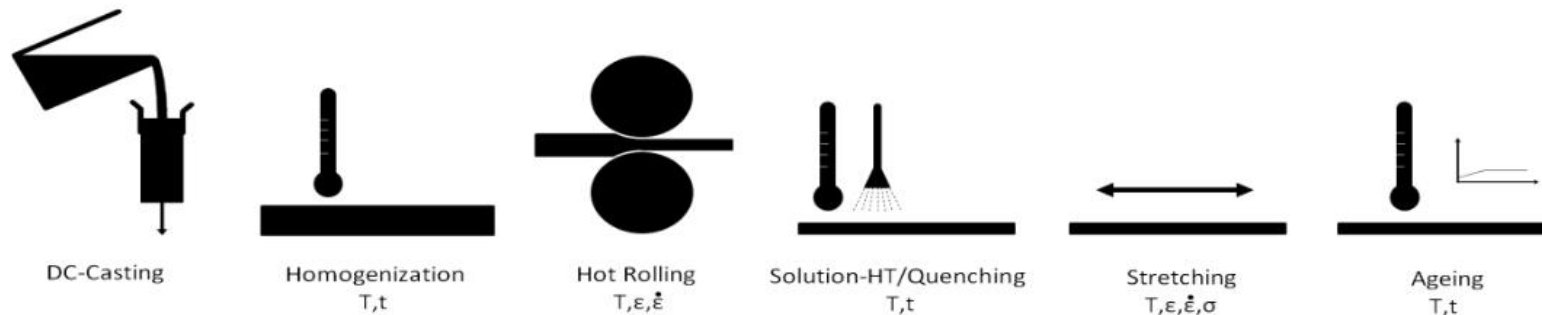
## Transforming from Shareholder to Stakeholder Value Generation

Solid to Vapor  
Heavy to Weightless  
Dense to Diffuse  
Concrete to Abstract  
Slow to Fast  
Energy-intensive to Efficient  
Expensive to Cheap  
Scarce to Abundant  
Paid to Free  
Fixed to Flexible  
Unchanging to Versions  
Outdated to up-to-date

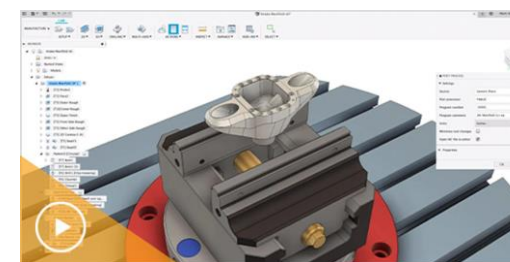
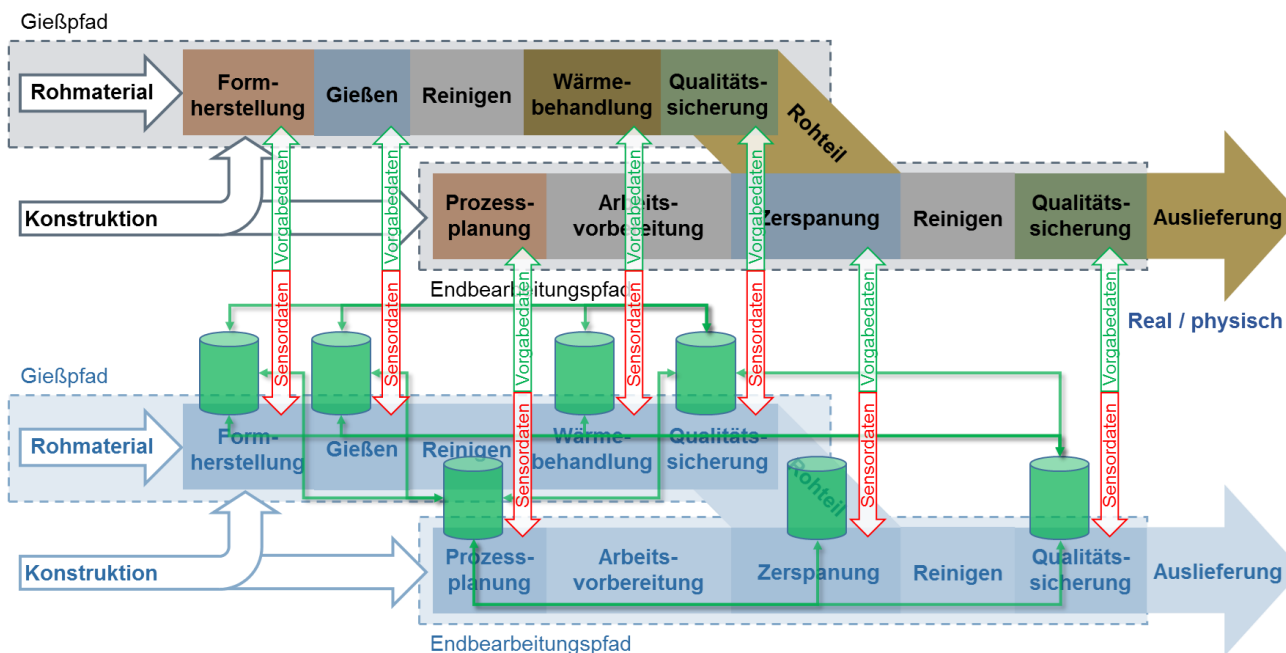
Tangible to Intangible  
Visible to Imperceptible  
Steady to Dynamic  
Owned to Shared  
Exclusive to Communal  
Mass-produced to Personalized  
Centralized to Decentralized  
Controlled to Democratic  
Regional to Global and Transnational  
**Supply Chain to Ecosystem**  
Channel to Marketplace  
Literal to Metaphoric



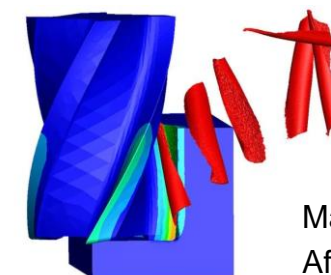
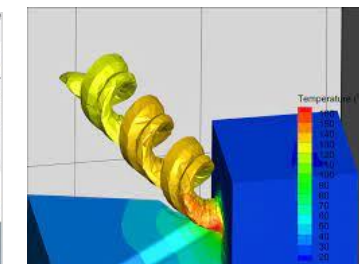




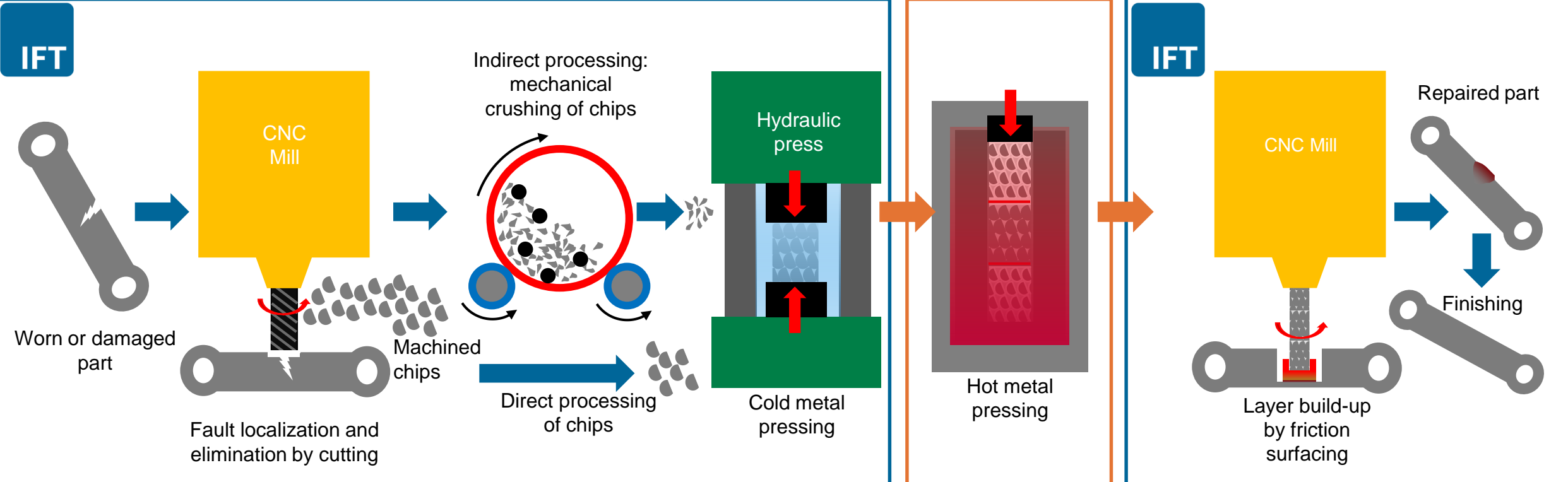
MatCalc.de



Autodesk.de



Mav-industry.de  
Afe-net.de



**Use-Case: Repairing of damaged parts**

- A use-case can be defined, or a damage can be simulated
- Components which can not be repaired using conventional welding technologies

**Machining of feedstock material**

- Part from the same material, or even the component itself is machined
- Smallest possible uniform chip form using
  - VAM (Vibration assisted machining)
  - Small chip cross section

**Crushing**

- Additional mechanical reduction of chip size
- Change of morphology

**Pre-pressing process**

- Die with defined aspect ratio
- Ratio of 1 (10 x 10 mm)
- Production of single pellets
- Molding purely by mechanical forming
- Robust and transportable

**Post-pressing process**

- Bonding of multiple single pellets
- Production of solid and transportable rod
- Molding by a hot pressing process

**Additive processing**

- Using the monolithic rod material for layer build up
- Friction surfacing as additive technology
- Tests will be elaborated on milling machine
- Parameter testing at IFT

**Finishing**

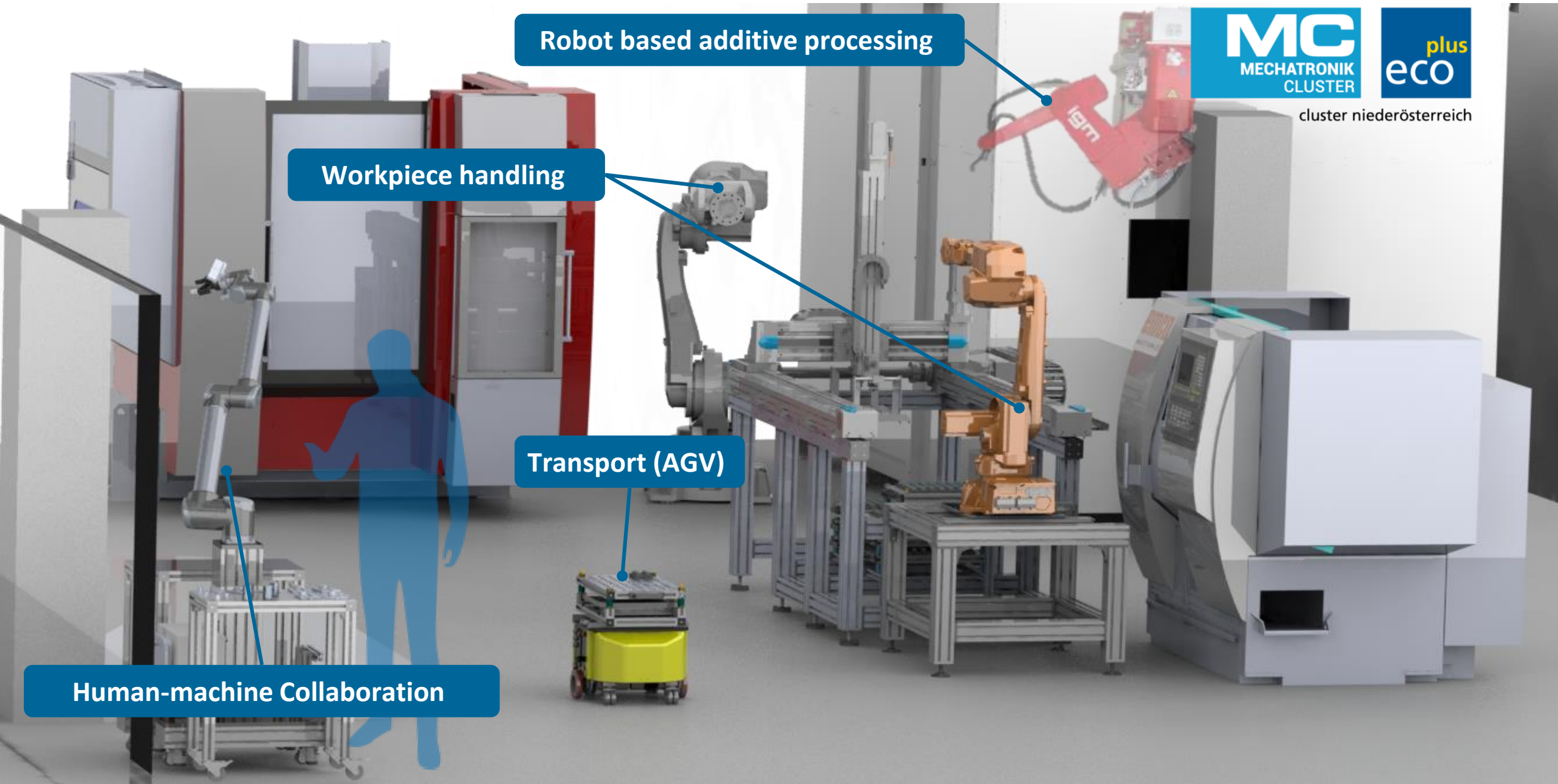
- Subsequent machining of surface
- Investigation on microstructure and mechanical properties
- Re-use of "refurbished" part

Robot based additive processing

Workpiece handling

Transport (AGV)

Human-machine Collaboration



Human-centred factory: augmented and virtual operator, social and collaborative operator, super-strong operator, healthy and happy operator, and one-of-a-kind operator



super-strength operator



augmented operator



virtual operator



healthy operator



Wireless Data Link

Real-time section  
Signal processing  
Rule engine  
Counter-measures



smarter operator



collaborative operator



social operator



analytical operator



© Romero et al, 2016

1

## Human-centricity

- education, education, education...
- increased funding for education and training activities
- tackling the issue from all angles

2

## Sustainability

- 17 SDGs as guideline
- moving from “sustainable” branding to real value generation
- circular economy concepts

3

## Resilience

- moving away from “fragile” pre-COVID19 ages
- autonomous flexible machining systems
- rethinking strategic supply-chains
- a clear positioning of EU and its industry

“  
**Alles, was man erfinden kann,  
 ist schon erfunden worden.**

**Charles H. Duell**

Beauftragter des US-Patentamts, 1899

“  
**Industrie 4.0 wird die Welt  
 der Produktionstechnik völlig verändern!**

**Friedrich Bleicher**

Universitätsprofessor, 2021