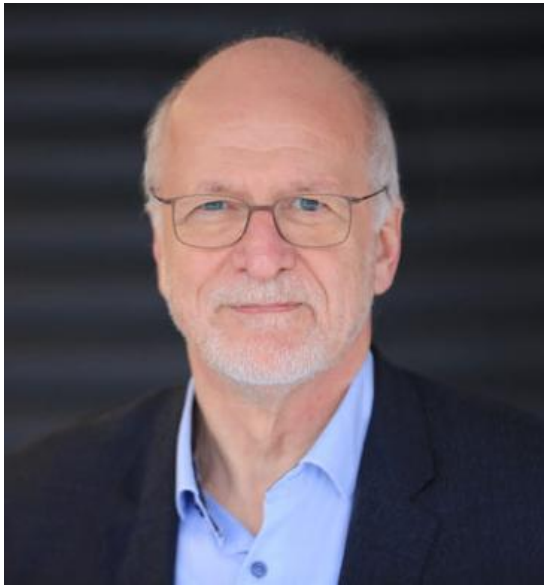
Panel Discussion:
Industrial Sustainability

1. Panelists



Mr. Thomas Hahn
Plattform Industrie 4.0 /
Fellow, Siemens AG

Prof. Ragu Athinarayanan
Professor of Smart Manufacturing
& Industrial Informatics,
Purdue University

Prof. Fumihiko Kimura
Professor Emeritus
The University of Tokyo

Ref:
https://privacysymposium.org/speakers/thomas-hahn/
https://polytechnic.purdue.edu/profile/rathinar
https://monoist.itmedia.co.jp/mn/articles/2011/18/news006.html

2. Motivation

Planetary Boundaries: A concept that clearly indicates that there are boundaries of the global environment that must not be crossed in order for humans to survive sustainably on Earth. These boundaries are presented in concrete terms for each item.
Ref: https://social-innovation.hitachi/ja-jp/article/planetary-boundaries/
Source: Hitachi

3. Motivation

Ref: This is why 'polycrisis' is a useful way of looking at the world right now, World Economic Forum, Mar 7, 2023
https://www.weforum.org/agenda/2023/03/polycrisis-adam-tooze-historian-explains/

Source: Hitachi

4. Motivation

Source: Hitachi

5. Tri-regional joint project

- Experts from Japan, US, and EU to discuss the issue, bringing together key facts from each region.
- Held some online meetings and will publish a discussion paper next spring.

Dr. Youichi Nonaka
Hitachi Ltd. Japan

Prof. Fumihiko Kimura
The University of Tokyo
Japan

Prof. Shinsuke Kondo
The University of Tokyo
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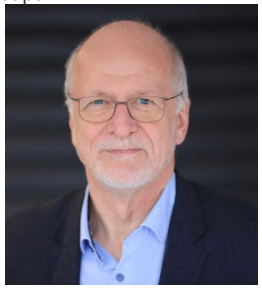
Mr. John Dyck
Clean Energy Smart Mfg. Innovation Institute, USA

Dr. Sudarsan Rachuri
US Department of Energy



Mr. Thomas Hahn,
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Prof. Peter Liggesmeyer,
Plattform Industrie 4.0,
Germany

Dr. Marc Heuske,
VDMA, Germany

Ref. https://www.hitachi.co.jp/rd/about/leaders_td/yoichi_nonaka/index.html, https://monoist.itmedia.co.jp/mn/articles/2011/18/news006.html, http://race.t.u-tokyo.ac.jp/member/%E8%BF%91%E8%97%A4-%E4%BC%B8%E4%BA%AE/, https://unit.aist.go.jp/icps/index_en.html, https://polytechnic.purdue.edu/profile/rathinar, https://www.manufacturingusa.com/news/cesmii-appoints-john-dyck-chief-executive-officer-ceo, https://www.energy.gov/eere/ampedup/articles/rachuri-head-new-smart-manufacturing-institute, https://privacysymposium.org/speakers/thomas-hahn/, https://www.interempresas.net/Sector-Automocion/Articulos/209458-Entrevista-a-Oscar-Lazaro-director-de-la-Asociacion-Innovalia.html, https://itif.org/person/sicco-lehmann-brauns/, https://www.iese.fraunhofer.de/de/ueberuns/directors/cv_liggesmeyer_deutsch.html, https://automationspraxis.industrie.de/news/vdma-gruendet-forum-manufacturing-x/

6. Today's discussion items

1. Current activities for Industrial Sustainability in each region
2. Labor productivity, trade openness, incentives
3. New/lost jobs, Gig work, workforce strategies
4. Policies and concepts for automation of work and digitalization/sharing/utilization of skills/know-how

Session 1.

Current activities for Industrial Sustainability in each region

U.S. Long-Term Initiatives for Planetary Boundaries and Human Well-Being

1. U.S. Commitment to Sustainable Development Goals (SDGs) [1]
2. U.S. National Climate Strategy (Net-Zero by 2050) [2]
3. America's Climate Resilience and Adaptation Efforts [3]
4. The Circular Economy Transition [4]
5. Sustainable Agriculture and Food Systems [5]
6. The Justice40 Initiative [6]
7. Innovation and Transition to Clean Energy Technologies [7]
8. Energy Storage and Grand Challenge [8]
9. Mainstreaming Nature Initiative [9]

[1] https://www.usaid.gov/sdgs
[2] https://www.whitehouse.gov/wp-content/uploads/2021/10/us-long-term-strategy.pdf
[3] https://www.sustainability.gov/federalsustainabilityplan/resilience.html
[4] https://www.epa.gov/circulareconomy
[5]https://www.usda.gov/oce/sustainability/foodsystems#:~:text=USDA%20supports%20many%20programs%20to,all%20communities%2C%20building%20new%20markets
[6] https://www.whitehouse.gov/environmentaljustice/justice40/
[7] https://www.energy.gov/eere/clean-energy-innovation
[8] https://www.energy.gov/energy-storage-grand-challenge/energy-storage-grand-challenge
[9] https://www.whitehouse.gov/ostp/news-updates/2024/08/01/ostp-climate-environment-leaders-emphasize-key-role-of-nature-in-u-s-federal-policy/

Industrial Sustainability: Private Sector & Government Programs

1. **Private Industry:**
   - **Resource Efficiency & Waste Reduction**: Focus on energy, water, and material nexus & implementing ReX (Reduce, Reuse, Recycle) with circularity practices.
   - **Regulations and CSR**: Compliance with EPA standards, Corporate Social Responsibility initiatives.
   - **Climate Risks Disclosures**: SEC requirements for GHG Protocol (Scope 1, 2, 3) disclosures, financial impacts, and climate transition plans.
   - **Chief Sustainability Officers (CSOs)**: CSOs for accountability.
2. **Government Programs:**
   - **DOE**: Clean Energy transition, Industrial Decarbonization, Carbon Capture and Storage (CCS), Hydrogen Roadmap, and Circular Economy.
   - **Energy Storage & Mobility**: Grid-level energy storage and clean mobility investments.
   - **Equity and Sustainability**: Justice40 (EJ40), EPA guidelines, and the OSTP Mainstreaming Nature initiative.
   - **State-Level Initiatives**: Numerous state-led initiatives, with California leading on net-zero and clean energy policies.

A Public-Private-Partnership To Promote a Sustainable National Manufacturing Infrastructure in the U.S.

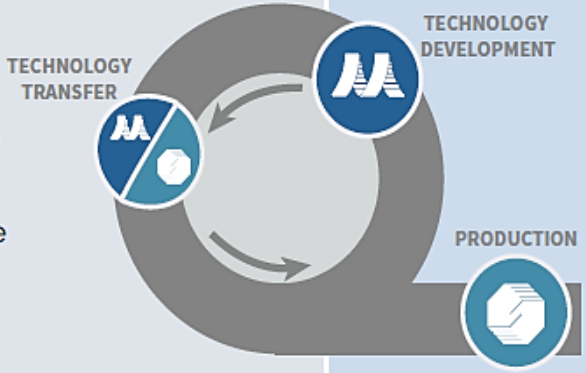
Manufacturing USA

Manufacturing USA is a national network of 16 manufacturing innovation institutes created to secure U.S. global leadership in advanced manufacturing through large-scale public-private collaboration on technology, supply chain, and education and workforce development. The institutes, sponsored by the U.S. Departments of Defense, Energy and Commerce, partner with six additional federal agencies.

NIST MANUFACTURING EXTENSION PARTNERSHIP

MEP is a public-private partnership with Centers in all 50 states and Puerto Rico – with over 1,400 trusted advisors and experts at more than 385 MEP service locations working side-by-side with manufacturers to reduce costs, improve efficiencies, develop the next generation workforce, create new products, find new markets and more.

Manufacturing USA: Builds future manufacturing capabilities through applied research for technology development, along with the requisite workforce skills.



MEP: Focuses on deployment of available technology and business practices primarily to small and medium-sized manufacturers (SMMs).

https://www.manufacturingusa.com/pages/manufacturing-usa-and-manufacturing-extension-partnership

11. Current activities for Industrial Sustainability in Japan
National vision and programs for industrial sustainability

Council for Science, Technology and Innovation: CSTI (Cabinet Office)

The 6th Science, Technology, and Innovation Basic Plan (2021-2025)
sustainability + well-being

Society 5.0: "a sustainable and resilient society to realize diverse well-being via CPS"

- The **Moonshot** Research and Development Program

  Ambitious goals to yield significant impact

- Cross-ministerial Strategic Innovation Promotion Program: **SIP**

  Research and development from basic research to social implementation through industry-academia-government collaboration.

  Phase 3 (2023-2027): 28 billion yen/year, 5-year project, 14 projects

National basic plans towards sustainable society

- GX basic plan (METI)
- Strategic energy plan (METI)
- Global warming basic plan (Ministry of the environment)
- Policy for climate changes (Cabinet Office)

Examples of national development programs

- Green technology of excellence program: GteX (JST)
  battery, hydrogen, bio-manufacturing, etc.
- Advanced low-carbon NEXT research and development program: ALCA-NEXT (JST)
  energy storage, green biotechnology, green computing, etc.
- Carbon footprint: guideline (METI, ME)

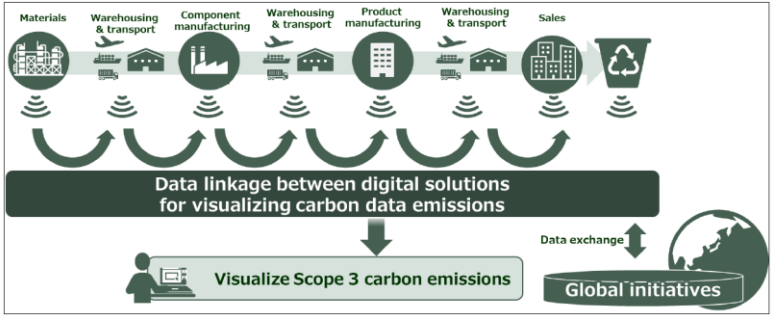
JST: Japan Science and Technology agency

12. Current activities for Industrial Sustainability in Japan
National and industrial initiatives for industrial sustainability

Ministry of Economy, Trade and Industry (METI)

Green Growth Strategy Through Achieving Carbon Neutrality in 2050 (2023)

- GX League (METI)
  Aiming for economic and social reform to achieve 2050 carbon neutrality.
  679 member companies
- Green x Digital Consortium (JEITA)
  CO2 Visualization Framework, etc.
  150 member companies



JEITA: Japan Electronics and Information Technology Industries Association

Individual projects funded by NEDO

- CCUS implementation
- Innovative circular process for plastics
- Innovative circular process for aluminum
- Basic process technology for used electric and electronics products
- etc.

Individual projects funded by JST

- Social scenario research program towards a carbon neutral society
- etc.

NEDO: New Energy and industrial technology Development Organization (METI)
JST: Japan Science and Technology agency MEXT)

13. Current activities for Industrial Sustainability in Japan
National and industrial initiatives for industrial sustainability

Initiatives for supporting industrial sustainability

- Green Japan, Green innovation: Green innovation fund (NEDO)
- Asia zero emission community: AZEC (METI)
- Climate change adaptation platform: A-PLAT (National institute for environmental studies)
- Action plan for low carbon society (Keidanren)
- etc.

Science Council of Japan: SCJ (MEXT)

academic advice to CSTI

- Recommendation

  Transforming Society to Become Resilient and Sustainable beyond Catastrophic Disasters (2023)

  Designing Society by Implementation of Automated Driving for Future Generation Mobility (2023), etc.

- Advisory opinion

  Toward Sustainable Development of Offshore Wind Power at Active Margins -Importance of Submarine Geohazard Risk Assessment- (2023), etc.

- Report

  Issues toward circular economy: balancing of resource circulation and carbon neutrality (2023), etc.

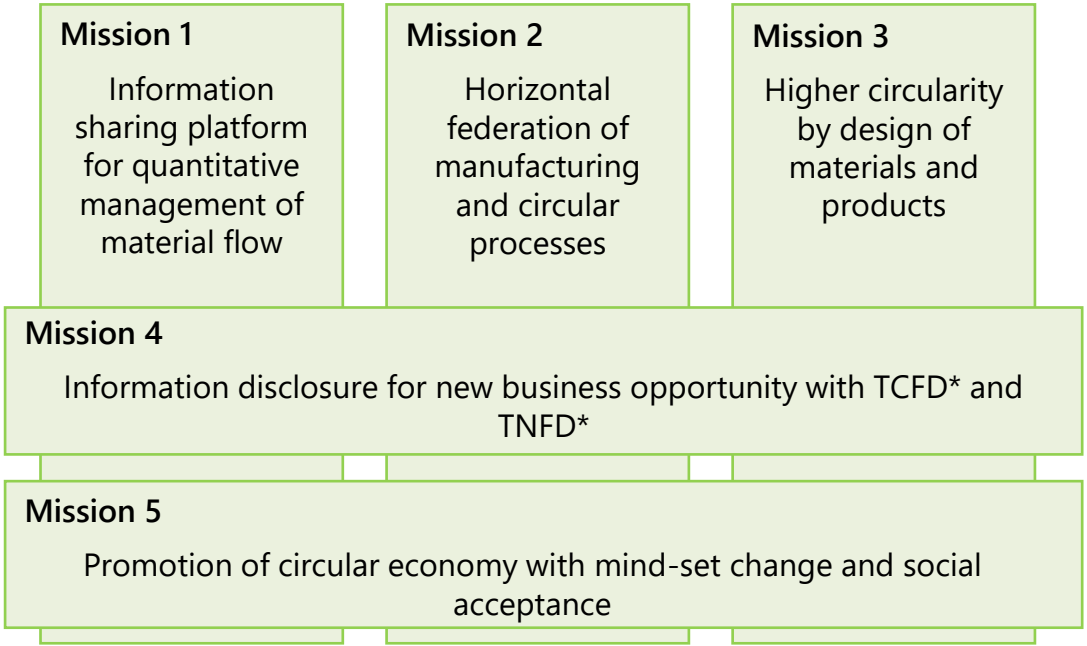
14. Current activities for Industrial Sustainability in Japan in context of research and development at a national level

SIP program: Circular Economy System based on Information Sharing Platform
(2023-2027) 19 companies, 12 universities, 3 national laboratories, 1.3 billion yen/2024

- Objective
  Establishment of upgradable material circular processes for plastics integrated with sustainable product design

- Task
  a. Information sharing platform for material, production, etc.
  b. Digitalization of circular processes for traceability and horizontal processes
  c. Establishment of circular value chain with proper data collection

- Target objects
  Plastics materials and products



(*: TCFD: taskforce on climate-related financial disclosure, TNFD: taskforce on nature-related financial disclosure)

https://www8.cao.go.jp/cstp/gaiyo/sip/sip_3/keikaku/circulareconomy.pdf (in Japanese)
https://www8.cao.go.jp/cstp/gaiyo/sip/sip_3/230324gaiyo_1.pdf (in Japanese)

15. Current activities for Industrial Sustainability in Japan in context of research and development at a national level

SIP program: Human-Machine Collaborative Robotics in Human-Cyber-Physical Space

(2023-2027) 12 companies, 3 universities, 1 national laboratory, 1.13 billion yen/2024

- Combining human physiological, physical, cognitive, and psychological information with AI and robotics in physical and cyber spaces.
- Developing robots that can work alongside humans, enhancing their capabilities and supporting their daily activities.
- Enhancing productivity and safety in various industries
- Use case implementation in 2027

https://www.sip.go.jp/sip/05.html (in Japanese)

https://www8.cao.go.jp/cstp/gaiyo/sip/sip_3/230324gaiyo_2.pdf (in Japanese)

16. Current activities for Industrial Sustainability in Germany/Europe

International Manufacturing-X (IM-X): Make Data Work

IM-X will implement a federated, decentralized and collaborative data ecosystem for smart manufacturing. Open, global and cross-industry, following FAIR Data Principles.

Reorganize and increase flexibility and autonomy of industrial value chains and networks.	**Resilience**
Increase efficiency and enable data-driven solutions for GHG/CO2 balancing and circular economy.	**Sustainability**
Accelerate digital innovations and enable new data-driven business models to create new value for manufacturing	**Competitiveness**

17. Current activities for Industrial Sustainability in Germany/Europe

E.g. sustainability related Use Cases of Factory-X

11 Use Cases for horizontal and vertical data transfer

- Integrated Toolchains and Collaborative Engineering
- Information Update and Change Service
- Collaborative Information Logistics
- Condition Monitoring led Services
- Modular Production
- Manufacturing as a Service – On Demand Manufacturing (Demand / Deliver)
- Autonomous Operation-as-a-Service (24/7)
- Traceability
- Energy-Consumption and Load Management
- Carbon Footprint Management
- Circular Economy

Resilience

Kernel & Basis Services esp. interoperability addressing multi-vendor/multi-regions
(working items addressed with IMXC - partially)

18. Current activities for Industrial Sustainability in Germany/Europe

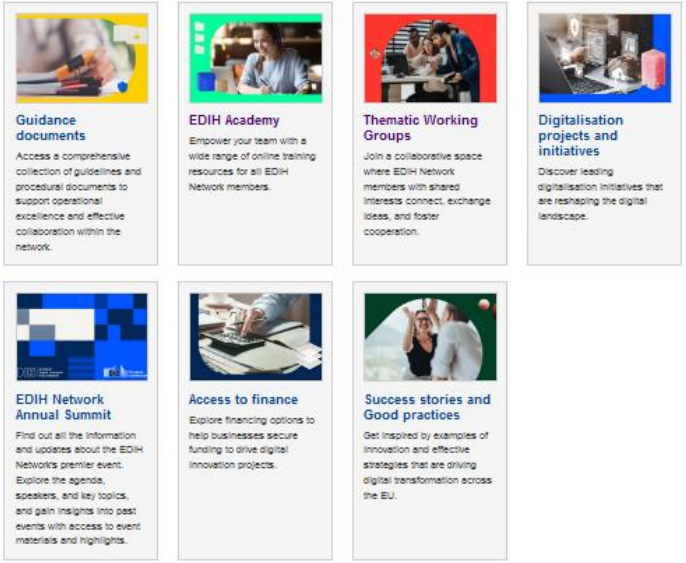
The European Network of DIHs (EDIHs):

Vibrant and collaborative pan-European network of regions & experts in digital technologies and their business applications, who are dedicated **to supporting small and medium-sized enterprises (SMEs)** in their journey towards **digital transformation.**

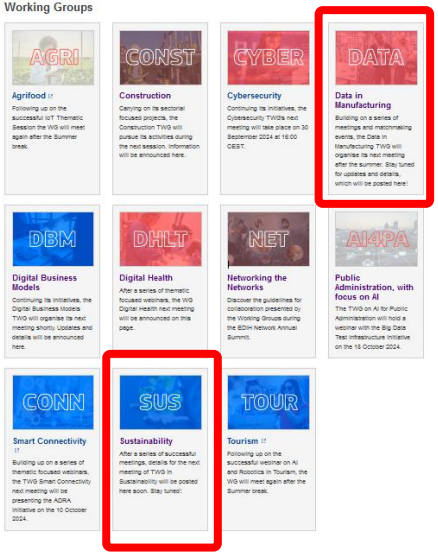
Each individual DIH brings together the key players of the quadruple helix (corporates, investors, academics & innovators)

19. Current activities for Industrial Sustainability in Germany/Europe

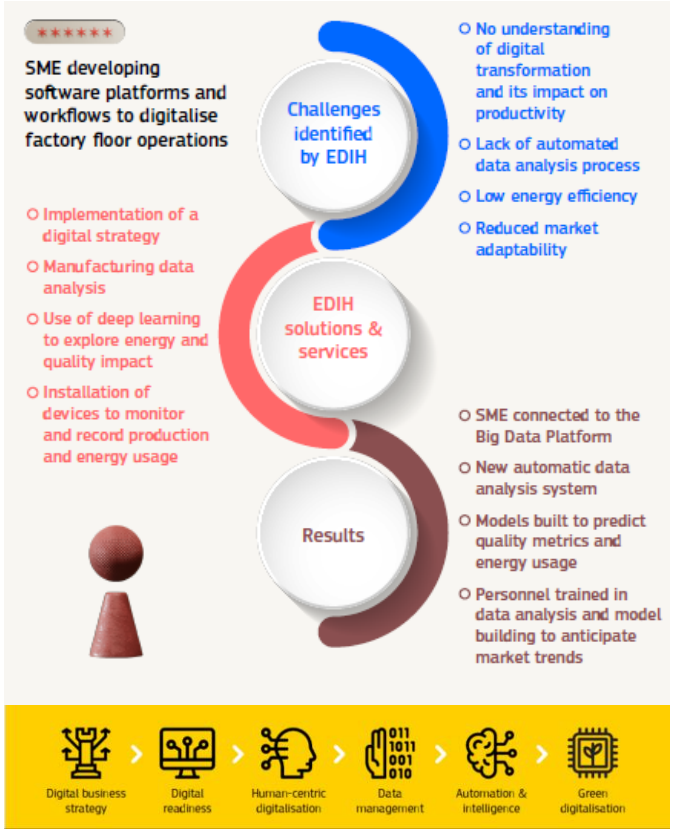
Knowledge Hub



TWG



SME Transformation Journey



The **EDIH Network Thematic Working Group (TWG) on Data in Manufacturing (DiM)** provides an active **community for EDIHs to agree on areas of collaboration**, investment as well on effective mechanisms for cooperation and support to drive AI and data economy of manufacturing SMEs.

20. Current activities for Industrial Sustainability in Germany/Europe

e.g. application project
“Digital ecosystem for AI-based robotics”

RoX

- The comprehensive use of robotic systems enables a significant strengthening of a large number of industries - e.g. for manufacturing companies and companies with large logistical efforts or service components (loading/unloading, order picking, etc.).
- Focus is on Technology Readiness Level TRL 5-8
- Very strong consortia will address this opportunities!
  24 partners from industry, research and associations are partner
- Use cases are
  - Loading and Unloading
  - Order picking and kitting
  - Automation of production
  - AI for robot commissioning

Session 2.

Labor productivity, trade openness, incentives

22. Labor productivity

Definition in US

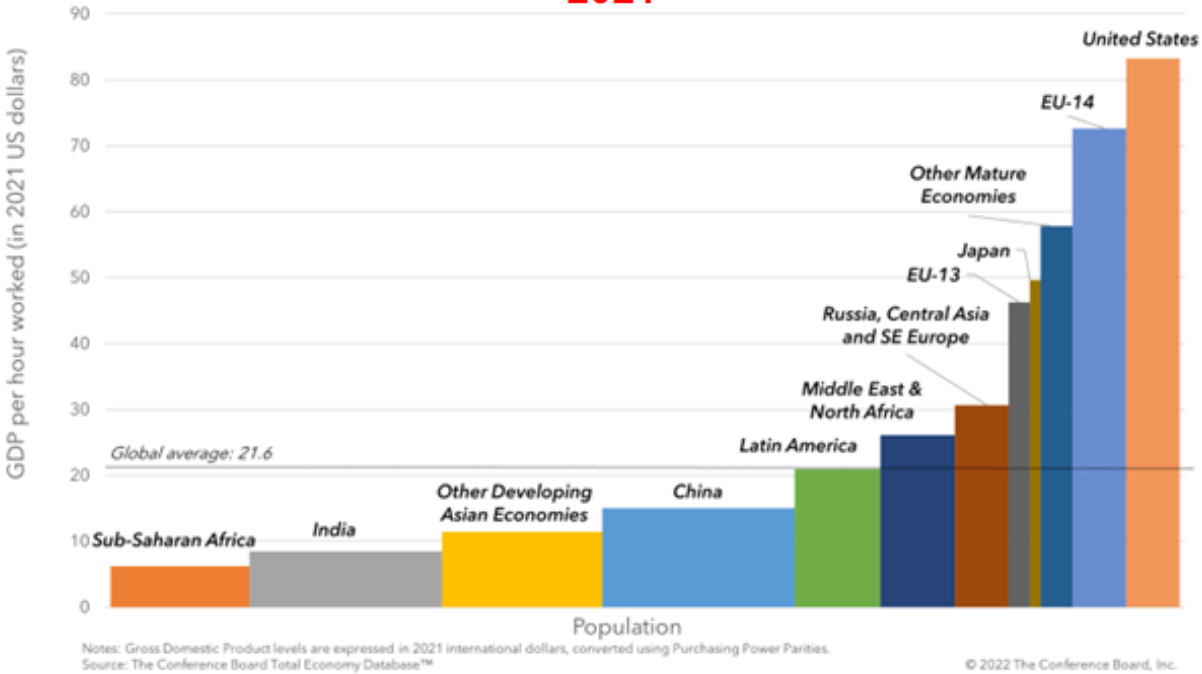
$$\text{Labor Productivity} = \frac{\text{Total Output}}{\text{Total Hours Worked}}$$

1. **Total Output**: This is usually measured in terms of **Gross Domestic Product (GDP)** or the total value of goods and services produced. In manufacturing, it may refer to specific output units like goods produced.
2. **Total Hours Worked**: This includes the sum of all hours worked by employees in the economy or specific sector. It accounts for both full-time and part-time workers.

This is different from the indicators that Japan, including the Japan Productivity Center, has used for the past few decades. It appears that the Japan Productivity Center also began using this indicator mainly in 2011.

23. Labor productivity in several countries

2021



2022

Ranking	Country	Labor productivity ($)
1	Ireland	154.1
2	Norway	149.9
9	U.S.	89.8
11	Germany	87.2
13	France	83.9
OECD average (65.2)		
29	Portugal	52.6
30	Japan	52.3
31	Slovakia	51.7
38	Colombia	19.8

(Source: Japan Productivity Center)

The Yomiuri Shimbun

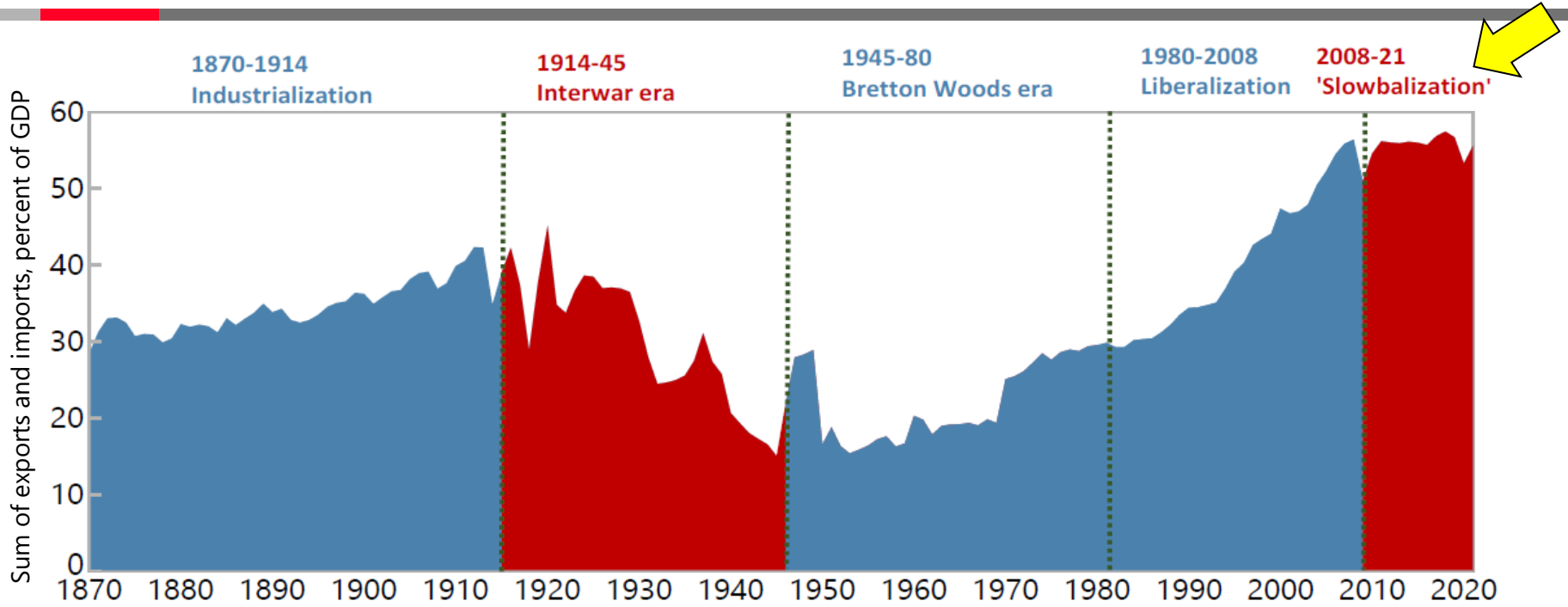
- Japan's labor productivity is low compared to Europe, US, and the OECD average.

24. Labor productivity in US

- How should we view the relationship between Industry 4.0 results and labor productivity ?

25. Trade openness

Sum of exports and imports, percent of GDP
IMF Staff Discussion Note, Jan.2023



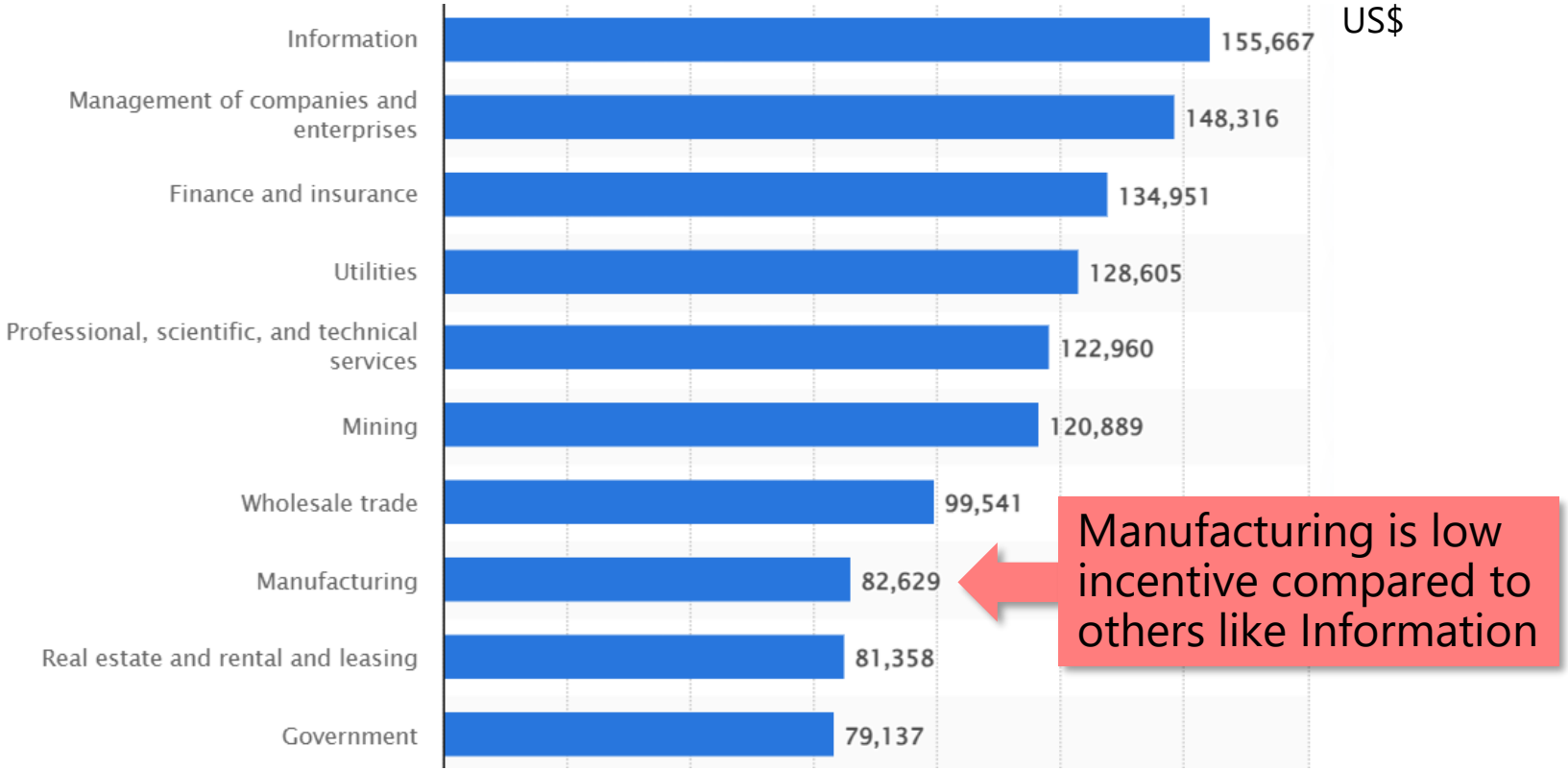
- Is there a correlation between labor productivity and trade openness?
- Was the reality up until 2008 that value-added work was kept in the country and the rest was imported from other countries?

Ref: Geoeconomic Fragmentation and the Future of Multilateralism, IMF Staff Discussion Note, Jan.2023
https://www.imf.org/en/Publications/Staff-Discussion-Notes/Issues/2023/01/11/

IMF: International Monetary Fund

26. Salary and wages in US

Excerpt
Per full-time equivalent employee in US, 2022
Statista Research Department, May 22, 2024

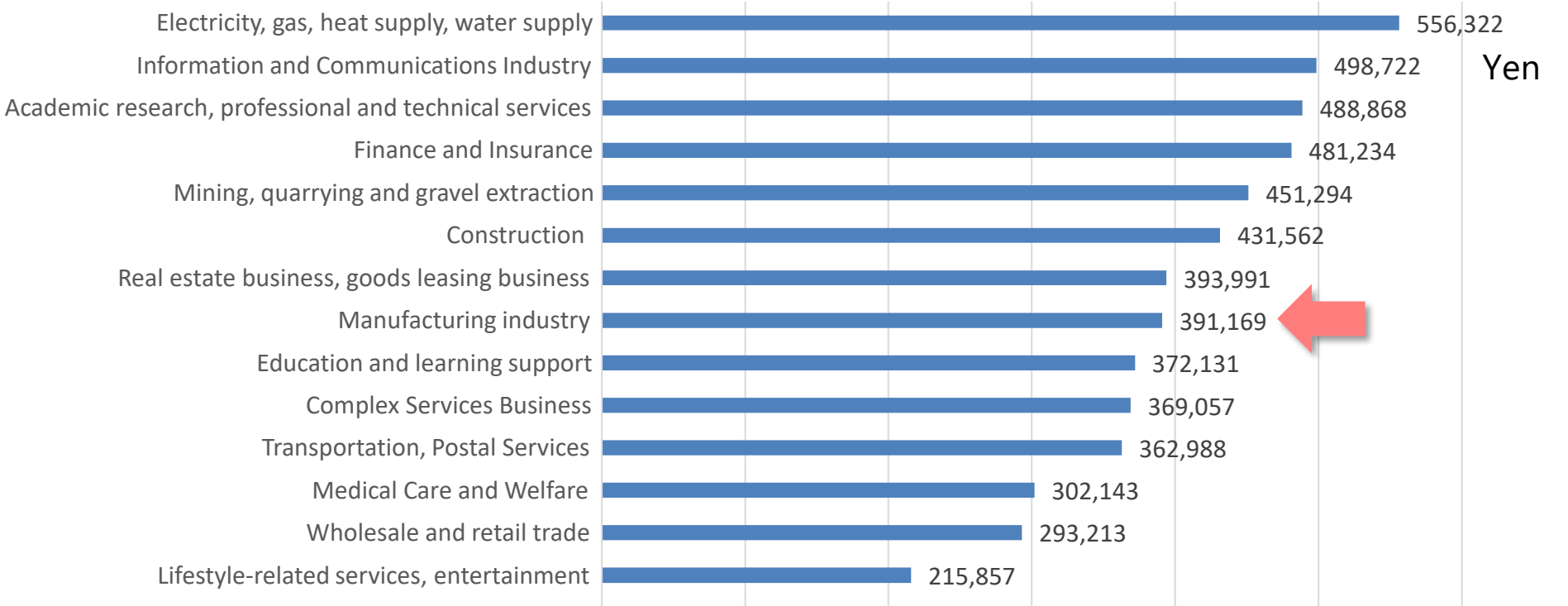


Ref: https://www.statista.com/statistics/243834/annual-mean-wages-and-salary-per-employee-in-the-us-by-industry/

27. Salary and wages in Japan

Excerpt

Average monthly cash salary per regular worker by industry in Japan, 2022
Statistics Bureau, Ministry of HR Dep., Japan



Labor shortages in the manufacturing industry are a problem in many countries. Is the main cause of this problem the declining birthrate and aging population, as is often said in Japan? Or is it because incentives are lower than in other industries, as shown in the graph above?

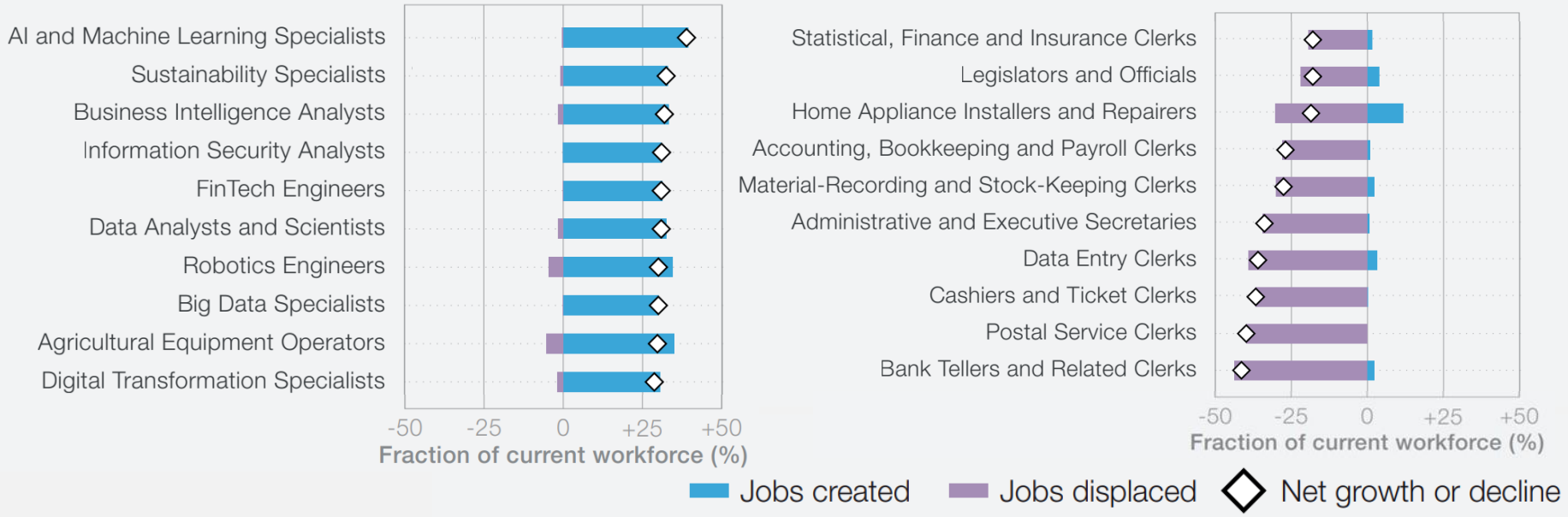
Ref: https://www.stat.go.jp/data/nihon/19.html

Session 3.

New/lost jobs, Gig work, workforce strategies

29. New jobs and lost jobs, 2023-2027

Excerpt(Top10s)
Future of Jobs,
World Economic Forum, May 2023



- Do countries recognize the importance of STEM education for the younger generation and are they taking concrete measures to promote it?
- As part of lifelong education, are countries taking concrete measures to enable workers to keep up with the ever-changing nature of work?

Ref: https://www3.weforum.org/docs/WEF_Future_of_Jobs_2023.pdf, STEM: Science, Technology, Engineering and Mathematics

30. Gig Workers in U.S. Manufacturing 1/2

1. A 2020 study by ADP Research Institute found that skilled professionals make up a significant portion of gig workers across industries[1].

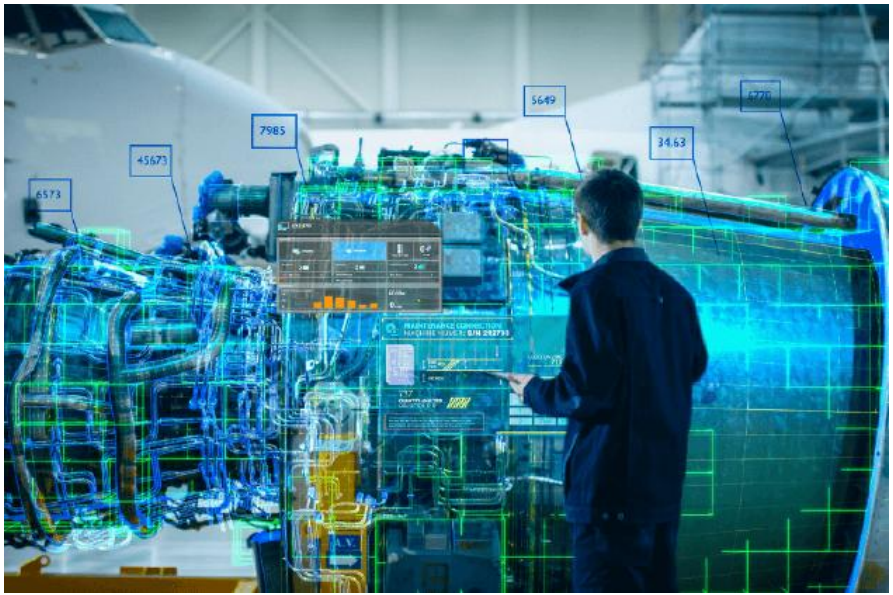
2. Professional Gig Worker Profile[2]
   - 54% have a 4-year college degree or higher.
   - Top fields for professionals include consulting and IT
   - 53% provide skilled services such as computer programming, IT, and business consulting[3]

3. An excellent source of educated pool of highly skilled workers to address the skills gap.

[1] ADP Research Institute. (2020). "Illuminating the Shadow Workforce: Insights into the Gig Workforce in Businesses
[2] MBO Partners. (2023). "State of Independence in America 2023."
[3] Upwork. (2022). "Freelance Forward 2022."
Ref: "JP-US-EU Project for Industrial Sustainability", Sudarsan Rachuri, PhD (US Dept of Energy), John Dyck, (CEO, CESMII), Ragu Athinarayanan (Professor, Purdue University), September 17, 2024

31. Gig Workers in U.S. Manufacturing 2/2

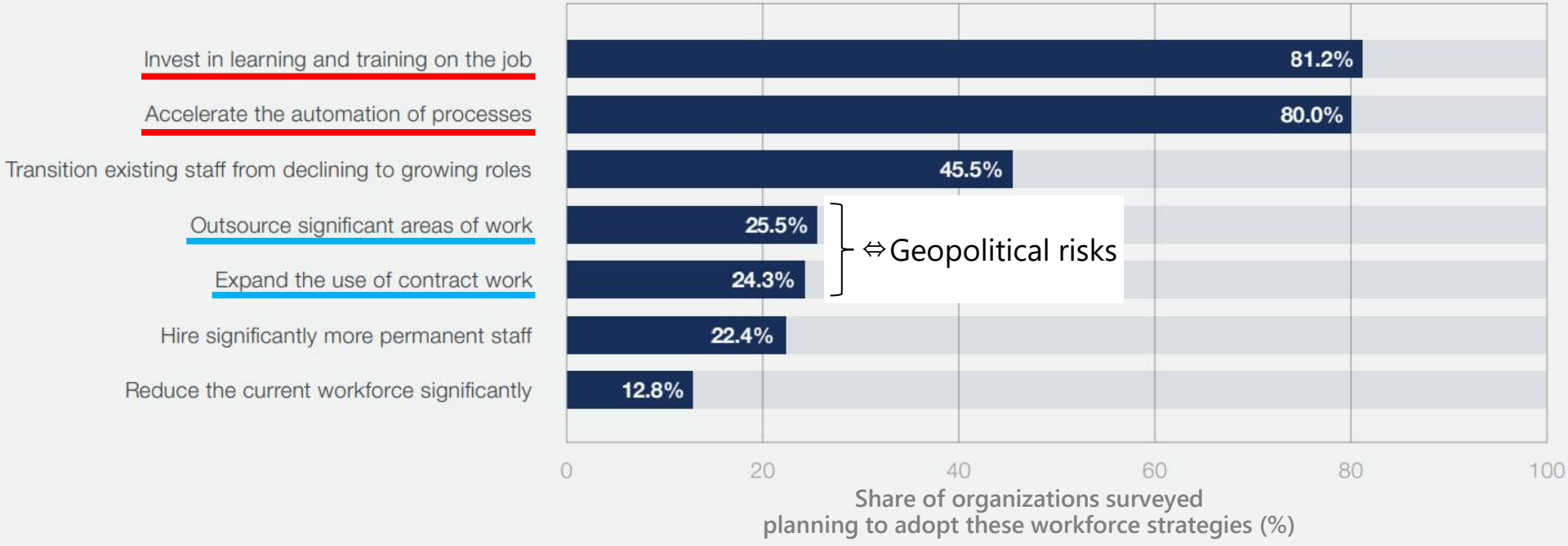
4. Technology, connectivity and advances in digital platforms are making it easier to integrate gig workers into manufacturing.
5. In 2021, 11-15% of all manufacturing workers in the U.S. were employed on a temporary or contract basis[4]. This percentage is projected to reach 20% by 2025[5].
6. 38% of manufacturers are implementing flexible work models to attract and retain workers[5].
   Types of Gig work in Manufacturing[6]:
   •17% in engineering or technical roles,
   •51% in production and assembly,
   •4.7% in maintenance/repair and
   •12.4% in other roles
   (e.g logistics, quality control)



[4] American Staffing Association. (2022). "Staffing Industry Statistics for Manufacturing Sector."
[5] Deloitte and The Manufacturing Institute. (2021). "2021 Deloitte and The Manufacturing Institute Manufacturing Talent study."
[6] U.S. Bureau of Labor Statistics. (2022). "Occupational Employment and Wages in Manufacturing."

32. Workforce strategies, 2023-2027

Future of Jobs, World Economic Forum, May 2023



- They consider geopolitical risks and suggests that countries are investing in education and automation within their own countries, rather than outsourcing to other countries.
- Is this really the case in each country including the status of Gig work?

Ref: https://www3.weforum.org/docs/WEF_Future_of_Jobs_2023.pdf

Session 4.

Policies and concepts for automation of work and digitalization/sharing/utilization of skills/know-how

34. Past project of Human-Machine-Interaction (2018-2019)

We discussed each society's condition, workstyle, and policies of future image of Human-Machine Interaction

Published Sep.2019

Prof. Kagermann

Dr. Nonaka

acatech NATIONAL ACADEMY OF SCIENCE AND ENGINEERING

HITACHI Inspire the Next

PLATTFORM INDUSTRIE 4.0

ロボット革命イニシアティブ協議会 Robot Revolution & Industrial IoT Initiative

UNIVERSITÄT AUGSBURG UNIVERSITY

TECHNISCHE UNIVERSITÄT DARMSTADT

東京大学 THE UNIVERSITY OF TOKYO

明治大学 MEIJI UNIVERSITY

FAU FRIEDRICH-ALEXANDER UNIVERSITÄT ERLANGEN-NÜRNBERG

Fraunhofer IAO

MITSUBISHI ELECTRIC

German Research Center for Artificial Intelligence

FESTO

RIETI

IPA Information-technology Promotion Agency, Japan

infineon

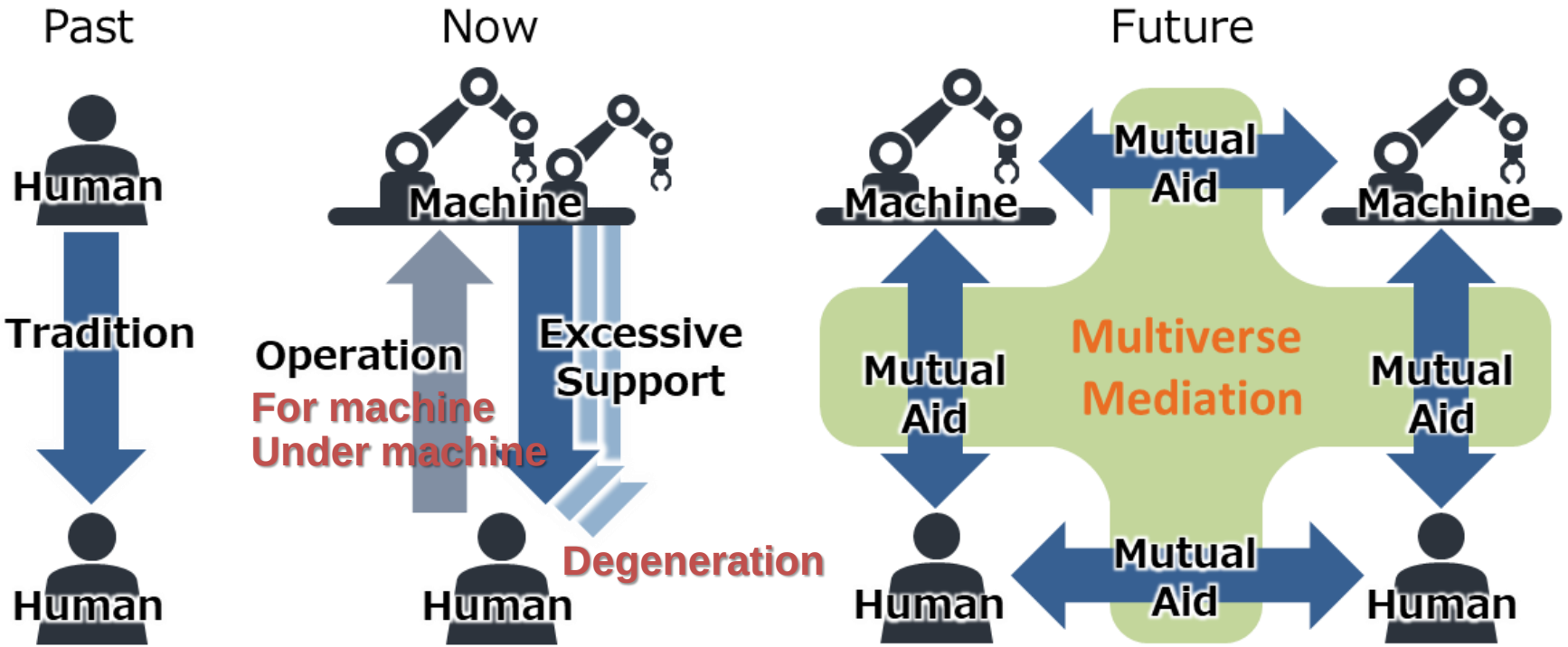
SAP

AIST

Ref: https://en.acatech.de/publication/revitalizing-human-machine-interaction-for-the-advancement-of-society-perspectives-from-germany-and-japan/

35. Key message of the past project

"Through digitalization, machines and humans will not only be able to help each other physically but will also be able to help each other with explicit and tacit knowledge."



36. Multigenerational workers adapting to Human-Machine Interaction in U.S. Manufacturing

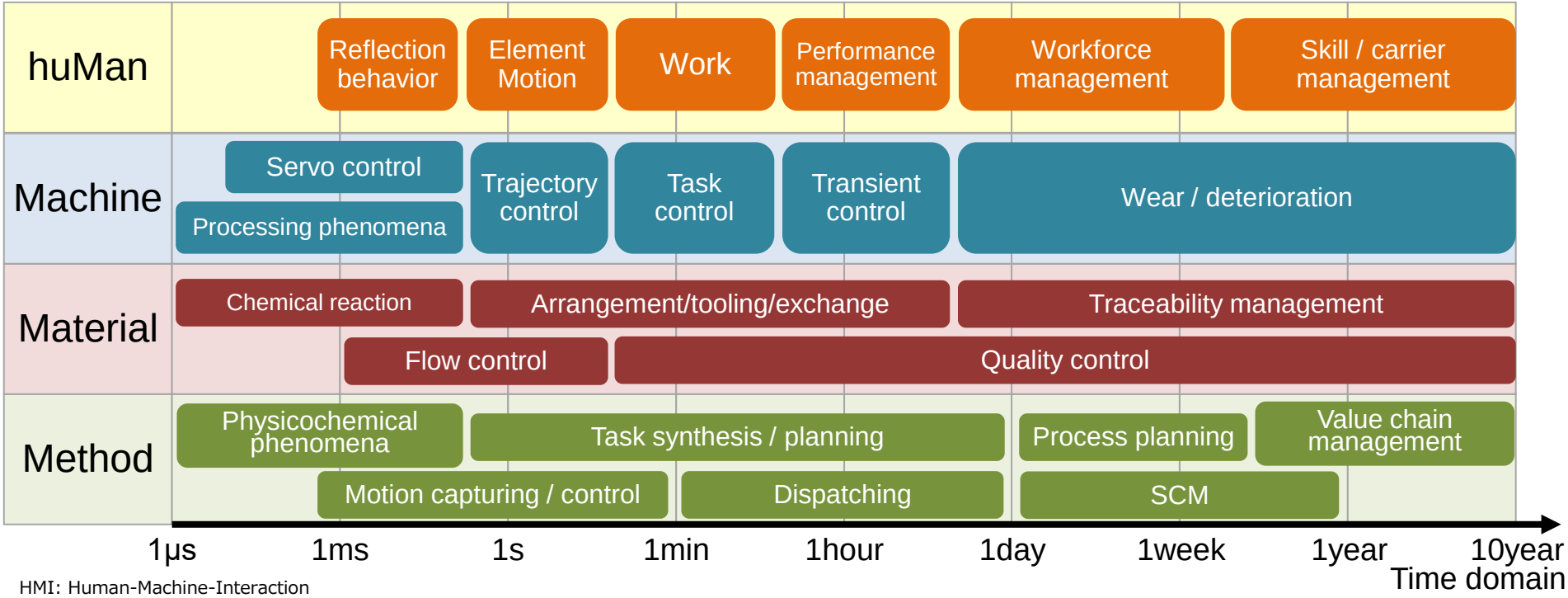
Collaborative Robots:
Their adoption in manufacturing has been growing rapidly due to their versatility and ability to enhance productivity while accommodating diverse multigenerational workforce needs.

1. **Baby Boomers (born 1946-1964):** 70% report increased job satisfaction due to reduced physical strain[1]
2. **Generation X (born 1965-1980):** 80% report improved work-life balance due to cobots taking on repetitive tasks[2]
3. **Millennials (born 1981-1996):** 90% express enthusiasm for working with cobots[3]
4. **Generation Z (born 1997-2012):** 95% expect to work with cobots as a standard part of manufacturing jobs[4]

[1] AARP. (2023). "Older Workers and Collaborative Robots in Manufacturing."
[2] Manufacturing Institute. (2023). "Generation X Perspectives on Cobot Integration."
[3] Deloitte. (2023). "Millennial Workforce in Automated Manufacturing: 2023 Survey."
[4] National Association of Manufacturers. (2023). "Gen Z Expectations in Modern Manufacturing."
Ref: "JP-US-EU Project for Industrial Sustainability", Sudarsan Rachuri, PhD (US Dept of Energy), John Dyck, (CEO, CESMII), Ragu Athinarayanan (Professor, Purdue University), September 17, 2024

37. Current is mainly physical collaboration, not help each other with explicit and tacit knowledge.

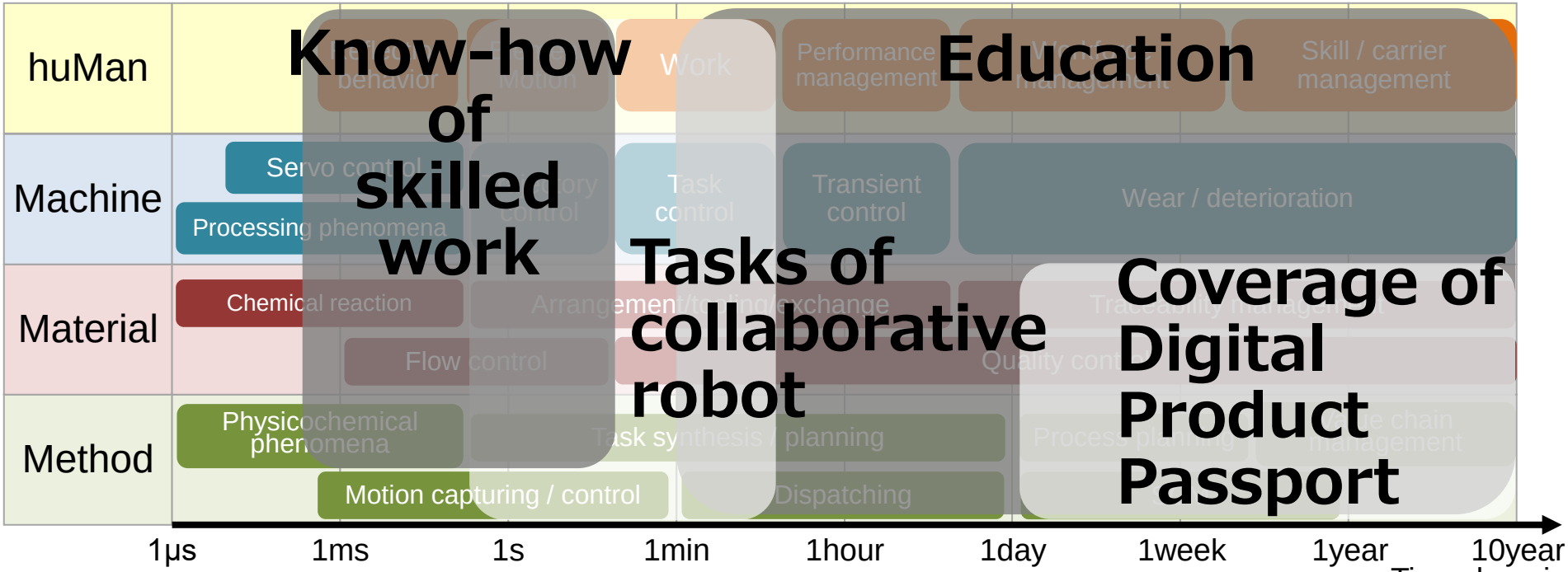
Behavior and knowledge of human and machine span a wide range of time periods, from microseconds to decades. Still no single system that covers all the time domains.



HMI: Human-Machine-Interaction
ELSI: Ethical, Legal, and Social Issues

A unified approach to enhance Industrial Sustainability by leveraging the mutual explicit and tacit knowledge between humans and machines

What kind of data and knowledge can and should be shared need to be discussed in terms of both technical capabilities and social rule-making



HMI: Human-Machine-Interaction
ELSI: Ethical, Legal, and Social Issues

Wrap-up

40. Summary

1. The growth rate of labor productivity in the manufacturing industry is slowing due to factors such as geopolitical risks that have led to stagnant trade openness, low wages compared to other industries making it difficult to attract skilled personnel, and issues with technology transfer due to a declining birthrate and aging population.
2. Jobs using digital technology are replacing traditional jobs, and STEM education and lifelong learning for young people are becoming increasingly important.
3. Automation should replace low-value-added jobs with machines, while digitalization should encourage the sharing and utilization of knowledge to sustainably unleash human creativity as an activity in the data economy.

This discussion did not address planetary boundary issues such as microplastics or climate change. We will deepen the discussion and incorporate these issues into the Discussion Paper scheduled for next spring.

STEM: Science, Technology, Engineering and Mathematics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