AI for humans in manufacturing

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AIM-NET workshop, Brussels


VTT
OUR PURPOSE
We bring together people,
business, science and technology,
TO SOLVE THE WORLD'S
BIGGEST CHALLENGES,
creating sustainable growth,
jobs and wellbeing.

VTT – *beyond the obvious*

VTT is a visionary research, development and innovation partner for companies and society and one of the leading research organisations in Europe.

Our role is to promote the utilisation and commercialisation of research and technology in business and society. Through science and technology, we turn global challenges into sustainable solutions for business and society in a responsible way.

261 M€
turnover and other operating income

2,213
employees

43%
of the net turnover from abroad

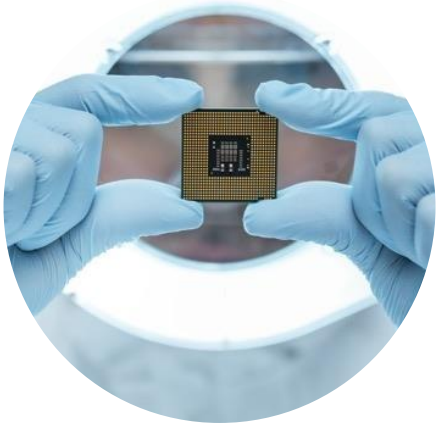
32%
a doctorate or a licentiate's degree

Establishment year
1942

Steered by Ministry of Economic Affairs and Employment

We create solutions in three business areas

Carbon neutral solutions



Digital technologies

Sustainable products and materials

Sustainable Products and Materials

Sustainable production: processes, technologies, materials and products from lab-to-pilot scale				
				
Industrial Chemistry	**Industrial Biotechnology and Food**	**Biomaterial Processing & Products**	**Knowledge Driven Design**	**Cognitive Production Industry**
Valuable chemicals, polymers and, fuel component from recycled streams and raw material feeds e.g. biomass, CO2, plastic and waste	Biotechnical production of high value chemicals and proteins. Biosynthetic materials and material components. Innovative food solutions	Novel bio-based materials and structures from biomaterial feeds e.g. biocomposites, biomass, fibre and cellulose	Design and production of new materials and components. Maximize lifetime value of assets.	Advanced manufacturing technologies. Data driven industries. Optimization of supply chains and maintenance. Robotics.

Context: Sustainable manufacturing impact targets by 2028

AIM-NET connection point

Focus areas	Responsible Manufacturing	Autonomous Production	Transformation of work	Agility in value chains
Key questions	1. What are the new business and operating models enabling responsible growth? 2. How to make sustainable manufacturing profitable? 3. What are the viable transformation paths to renewed manufacturing? 4. What are the new roles and business opportunities of manufacturing companies in responsible business and innovations? 5. How to proactively manage constant changes in manufacturing environment (resources, processes, stakeholders)?	1. How to redesign production for autonomous manufacturing? 2. How to utilize the key technology opportunities in autonomous manufacturing? 3. How to ensure safety in autonomous manufacturing operations? 4. How to make autonomous manufacturing flexible and resilient?	1. What are the new ways of working and new roles in the manufacturing industry in the future? 2. How can we enable optimal collaboration between humans and machines? 3. How do we enhance industry workers' and work communities' capabilities via augmentation and empowerment technologies?	1. How to develop and use data technologies and platforms for building transparent and agile value chains in manufacturing? 2. What is the role of open standards in data-sharing solutions in industry? 3. How to ensure cybersecurity in transparent value chain? 4. How can the value chains be made more resilient, safe and responsible?
Key technology areas	Additive manufacturing Extended reality Robotics Artificial Intelligence Data technologies			

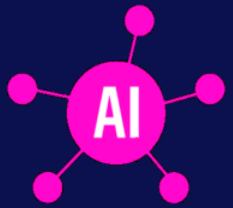
Case example #1: AI Foreman

Challenges in human resource planning

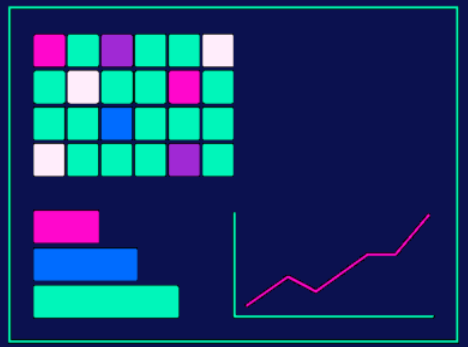
- In the industry, **demands for production capacity, flexibility, quality and reduced costs are continuously increasing** while the availability of skilled and motivated personnel is getting lower
- There is a need to **increase the optimisation of the production line**, while taking care of the personnel wellbeing and motivation
- **Advanced planning and scheduling (APS)** provides tools for simulating the production and creates better optimised plans and schedules for production
- However, the current APS tools **do not fully record the attributes of the personnel**; their competences, preferences as well as general wellbeing at work are not taken into account

Reboot IoT Factory

Vision of Digital Labor



AI Enhanced capacity planning, “AI Foreman”



Employee digital twin and well-being at work

Employee Digitalization Technologies

Ethics, user acceptance and legislation

AI Foreman: APS with strong personnel wellbeing focus

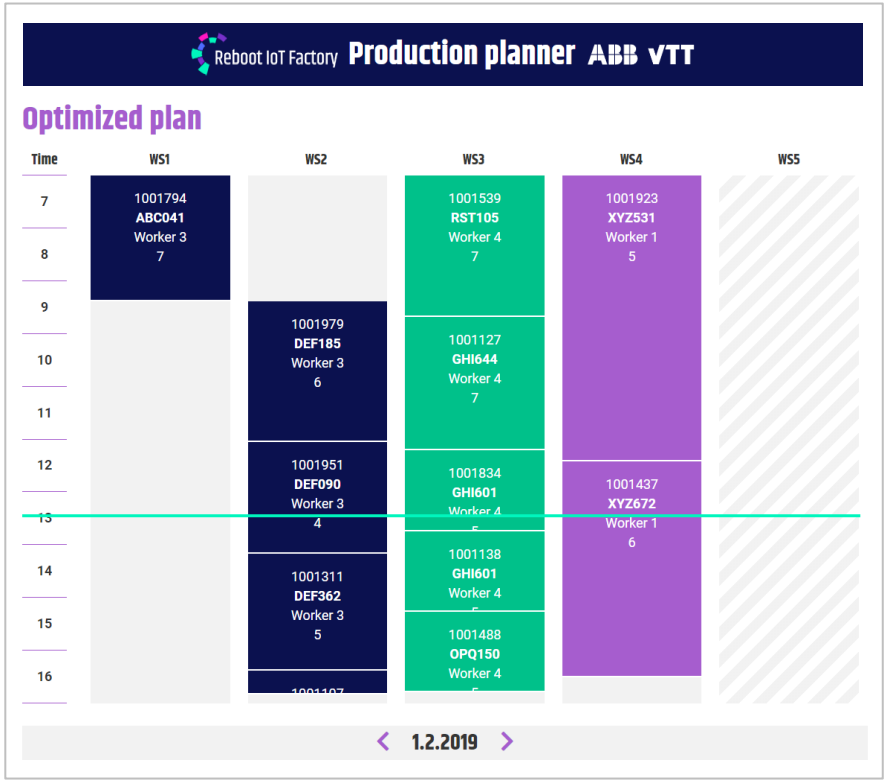
- Provides tools for aiding supervision of **daily manufacturing operations and managing large amounts of data**
- More efficient allocation of tasks and understanding of “hidden” activities
- Following work activities becomes more systematic
- Foreman (or employees) can allocate their time on more productive tasks, as an optimised production plan is made automatically
- Facilitates predicting production efficiency
- Leads to increased
  - Quality
  - Performance
  - Employee experience

AI Foreman – where it’s used

- In the Reboot IoT Factory project, multiple different **Production Planner proofs-of-concept were demonstrated in cooperation with ABB Factory** in Vaasa, leading to the current version of AI Foreman
- In addition to ABB, development to implement AI Foreman solution to Nokia Networks in Oulu is on-going

”VTT has done remarkable job in realising our vision of automated resourcing using AI Foreman concept developed in collaboration with Reboot IoT Factory ecosystem.”

Mikko Jukkanen, ABB Vaasa



Why AI Foreman?

- Much of the human foremen's time is used for planning the production, which can be a very complex task
  - Foreman views the production orders from customers
    - Number and types of products, deadline, takt times*…
  - Foreman prioritizes the manufacturing of products
  - Foreman allocates the employees
- Even though extensive data on production may well be available, information about employees is often "silent":
  - Availability
  - Qualifications or skill sets
  - Preferences

*takt time: total time taken for producing a single unit

Case example #2: InnoSale

ITEA InnoSale (2022-2025)

Increase the level of innovation for the industrial B2B sales processes

Context:

- B2B sales of **complex** products
- Products are **configured** for specific customer need
- A lot of **human knowledge and work** is required for the sales process

VTT is developing

- **NLP methods** for analysis of customer need based on historical data
- **Customer segmentation methods** to increase customer understanding

VTT is aiming at **demonstrating the feasibility** of the developed solutions as proof-of-concept implementations for selected use cases

data + AI -> performance experience

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Case example #3: Mad@Work

Why measuring stress is important?

In any one year … one in six workers is likely to be suffering from a mental health condition. *(The Deloitte Centre for Health Solutions, 2017)*

- Work everywhere is increasingly about knowledge, driven by digitalization; incidentally mental health has become a major occupational health issue
  - **Up to 50 % of all lost working days are linked to stress**
  - Already in 2015 c. 25 % of EU workers faced stress on a regular or continuous basis
- For the employer, it's about investing in your key asset – the workforce
  - Healthy and hale workforce is more productive than a stressed one
  - Replacing an experienced worker is expensive
- To manage it – you need to measure it
  - This is already reality for physical ergonomics, but not for cognitive ergonomics
  - **Assessing cognitive ergonomics with data-driven technology** needs to be translated into practical, privacy-safe and ethical tools that can measure stress and identify stressors in the work conditions.

What is needed in practice?

- Employees need a way to monitor their stress exposure and means to support their wellbeing
  - Measurement must adapt to the individual, as stress responses and thresholds are personal, and vary widely from one individual to another.
  - Stress and stressors need to be identified and the information visualized
  - Based on the information, tailored services / support actions can be identified / suggested
- Human Resource management needs objective (data-driven) visibility and ability to evaluate the impact of corrective actions
  - Continuous (but fully anonymous) overview of the stress load and key stress-inducing factors, in the different parts of the organization
  - Continuous and sufficiently frequent update on the situation, to allow visibility into impact or lack thereof when actions are taken

Mad@Work –project:
Stress management with science

- Solutions for **mental well-being at work**

1) **means to measure (dis)comfort**, both physical & mental
2) **tools for awareness and support** for the well-being at individual, team and organisational level

To build a better, productive conditions for knowledge work.

Portugal

Spain

Austria

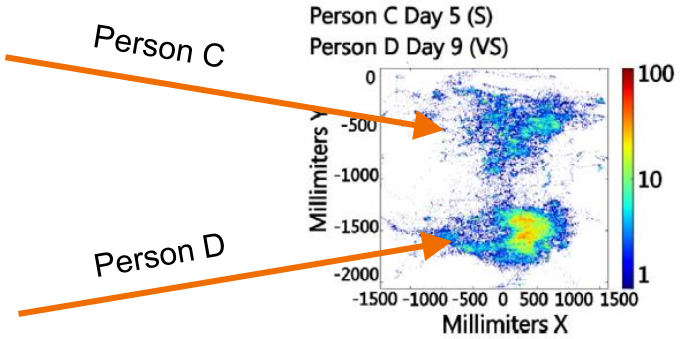
Republic of Korea

Individuality of stress is a challenge

- Stress is a subjective experience and there is no absolute scale for measuring it
- Individual characteristics, such as age, personality and stress management skills, influence stress manifestation
- The best detection accuracy is achieved by identifying individual stress-indicative features from the sensor data and modeling the stress at the individual level

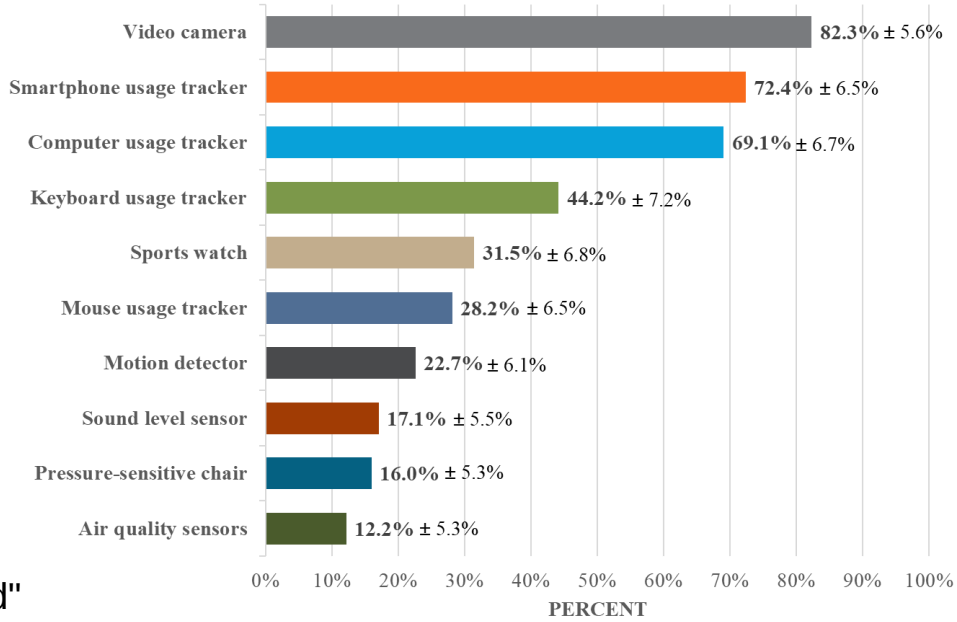
Behavioural changes: Physical movements at the workstation

- Stress may manifest itself as changes in physical movements and postures
- Around 80% stress detection accuracy on a daily level has been achieved using coarse motions data (passive infrared sensors) and machine learning
- Around 95% stress detection accuracy on a monthly level has been achieved using movements data (depth cameras) and machine learning



Attitudes toward different measurement methods

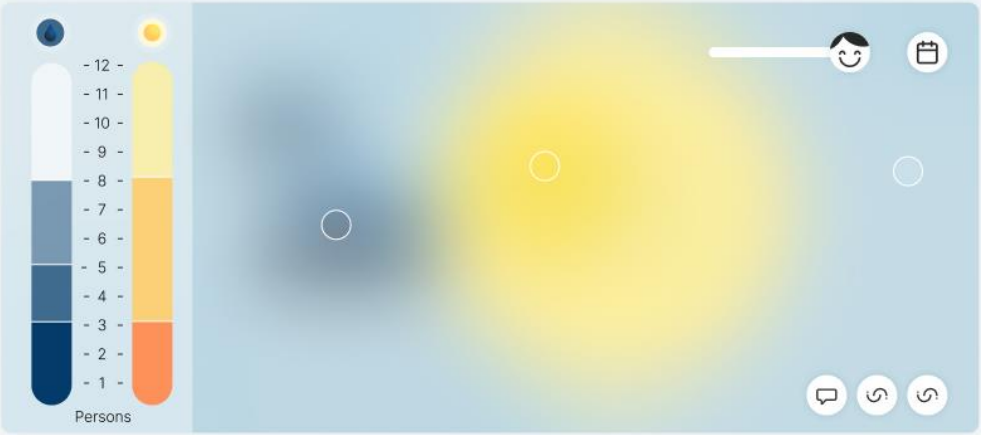
- In general, European knowledge workers (N = 200) expressed interest in receiving information about their own work stress levels and using unobtrusive stress monitoring methods
- "Wearable electronics don't work for me, but I wouldn’t mind if the heart rate (in fact, heart rate variability) was measured with radar“
- "The privacy of the video camera is suspicious“
- "Measurement ok, if they do not require measures from the person being measured"



Perceived privacy-sensitivity of measurement methods

2021

Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec



Highlights

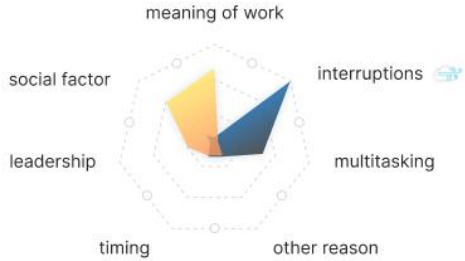
Over half of the days were **mostly positive or calm**

August was more stressful than July

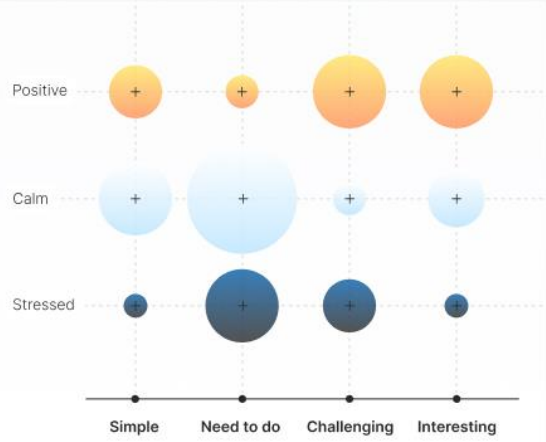
Fridays were mostly calm

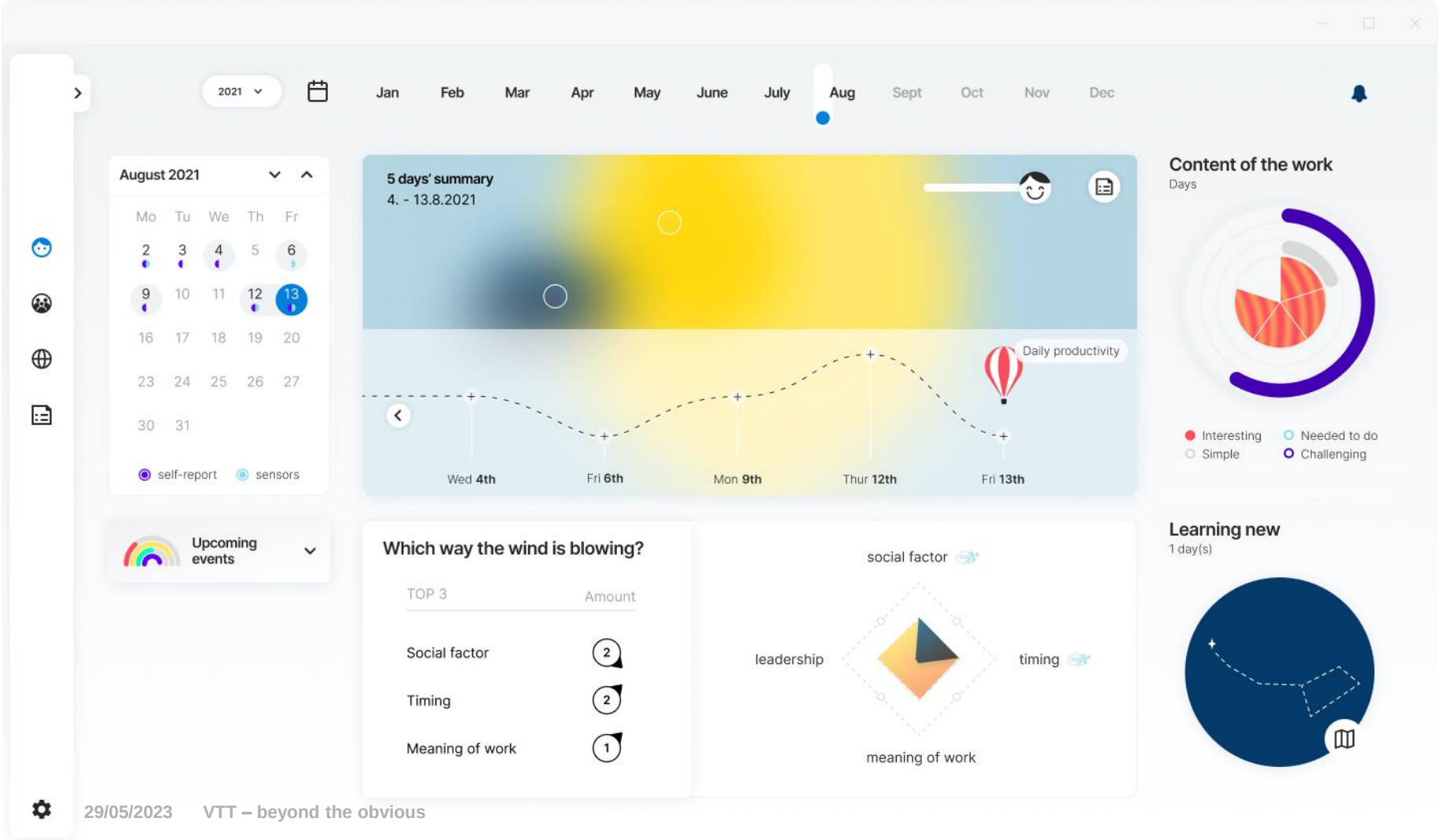
Which way the wind is blowing?

TOP 3	Amount
Social factor	17
Interruptions	15
Meaning of work	14



Content of the work




2021
Jan
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Mar
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May
June
July
Aug
Sept
Oct
Nov
Dec
August 2021
Mo Tu We Th Fr
2 3 4 5 6
9 10 11 12 13
16 17 18 19 20
23 24 25 26 27
30 31
self-report
sensors
5 days' summary
4. - 13.8.2021
Daily productivity
Wed 4th
Fri 6th
Mon 9th
Thur 12th
Fri 13th
Content of the work
Days
Interesting
Needed to do
Simple
Challenging
Upcoming events
Which way the wind is blowing?
TOP 3
Amount
Social factor 2
Timing 2
Meaning of work 1
social factor
leadership
timing
meaning of work
Learning new
1 day(s)

beyond

the obvious

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