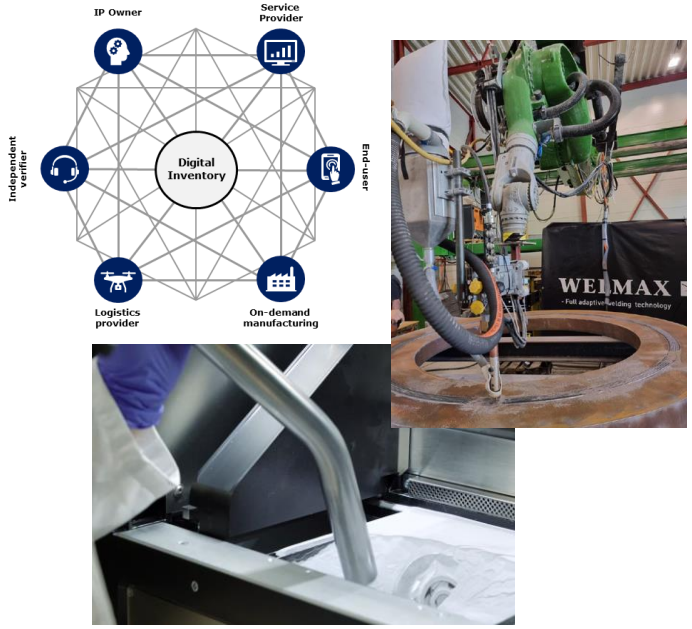
AM i Equinor

Robotek seminar 26.10.23

Tore Knudsen
AM implementation



Digital Supply Networks and Additive Manufacturing

On-Demand Manufacturing is the key

Cost

- Reduce physical inventories
- Reduce cost related to long lead times
- Reduce replacement projects
- Reduce maintenance cost
- Reduce production losses

Sustainability

- Reduce CO2 emissions
- Reduce waste
- Reduce transport
- Increase lifetime of equipment
- Use recycled scrap metal

Supply resilience

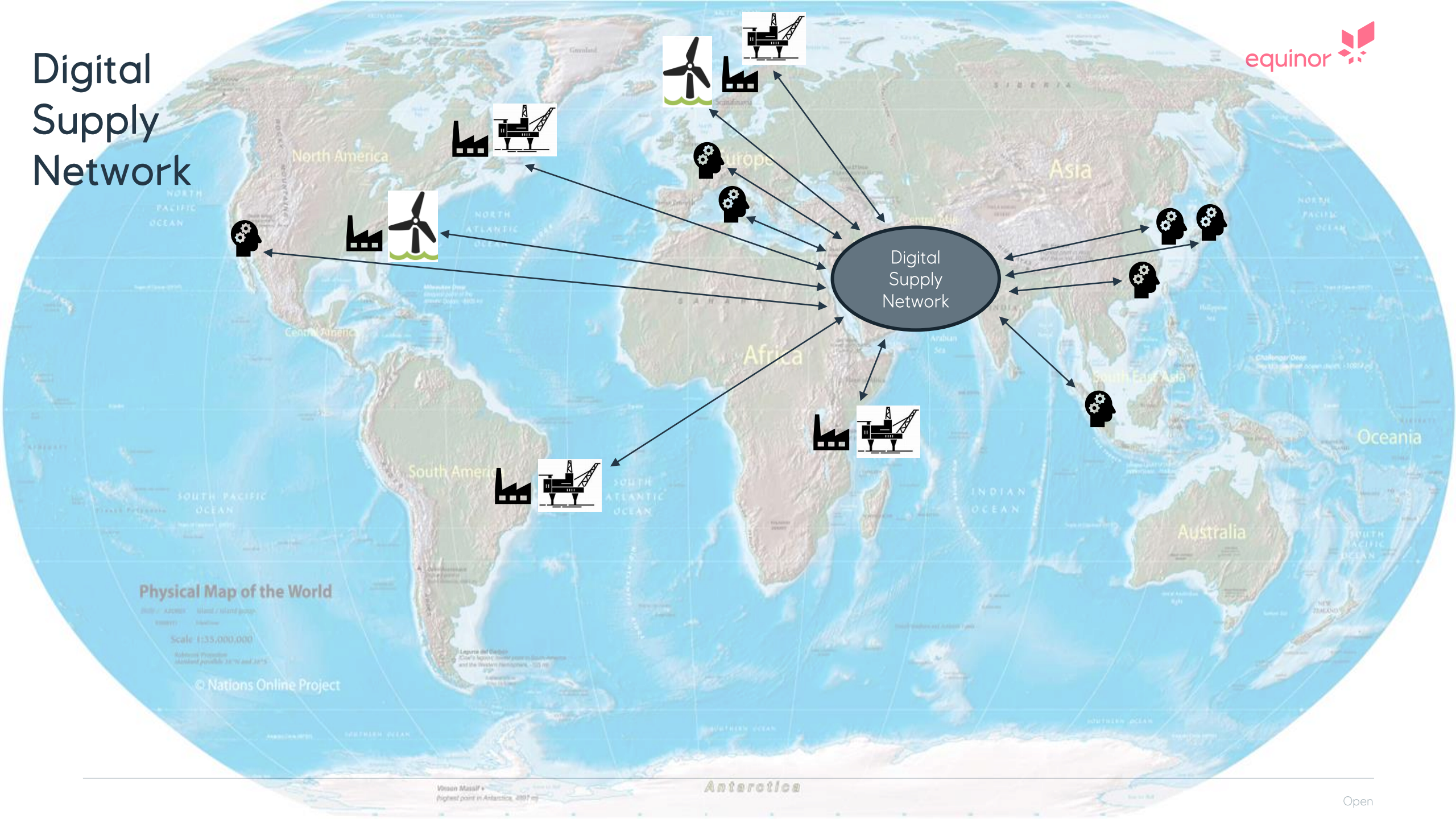
- Digital Inventory combined with local manufacturing and services
- Reduce delays
- Reduce need for crossing borders
- Use of local, recycled raw materials

Local value creation

- Manufacturing of mechanical parts close to end user
- Change from centralised mass production to local on-demand manufacturing
- The digital is global, the physical is local

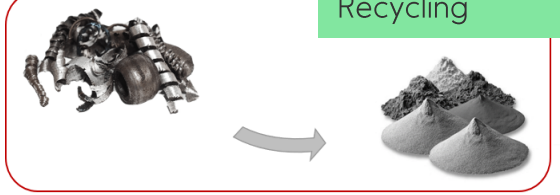
Supply Challenges

Digital Supply Network



Digital Inventory and sustainability

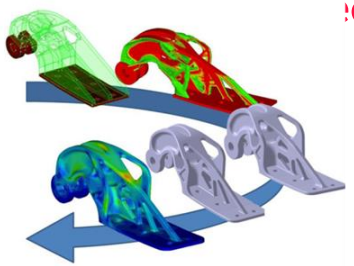
Recycling



Decommissioning

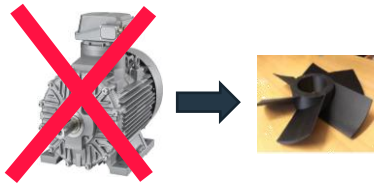
Raw material

Design



Manufacturing

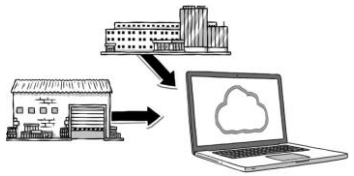
Operations and maintenance



Extended lifetime

Improved function

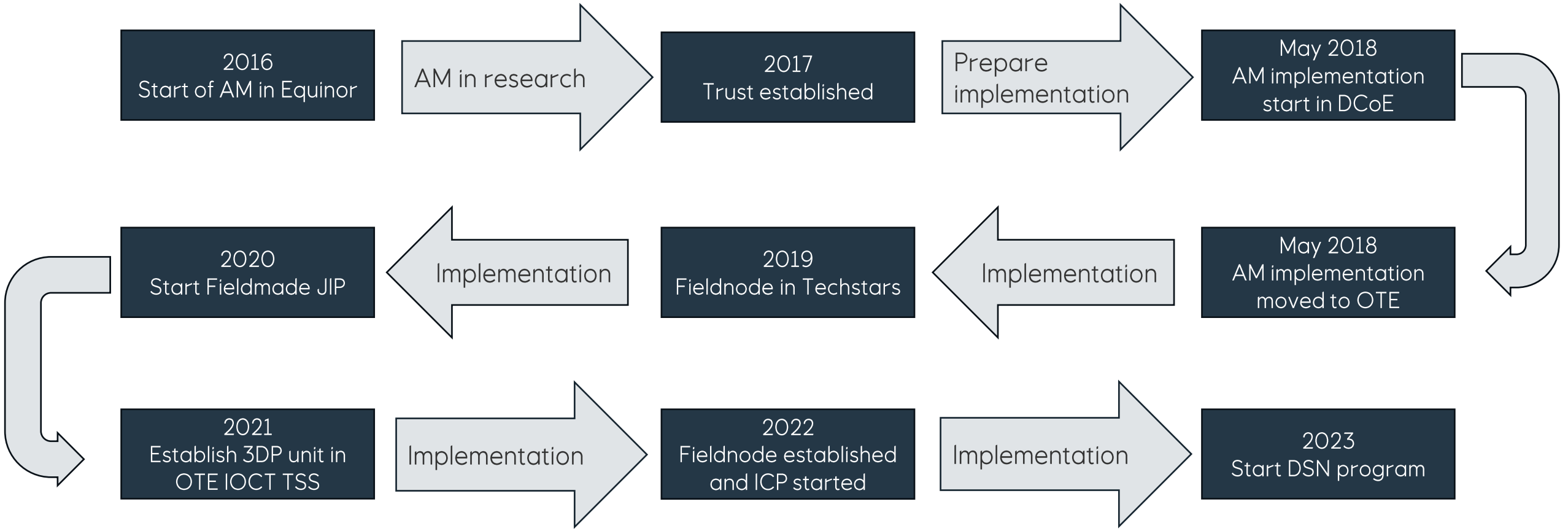
Digital Inventory



Reduced waste

ReducedTransport

AM and DI timeline



Digital Supply Networks and Additive Manufacturing

- What has been accomplished?

Cost

Value capture 2022: 4,5bn NOK

Johan Castberg 3D print microfactory:
339 cases in 11 months,
3000+ items printed

In addition:
300 completed cases
40 ongoing

Sustainability

3D print with recycled metal at Stord

Emergency stock of recycled metal powder

Pilot project with recycled polymer material

Supply resilience

Digital Inventory tested and verified

Local, on-demand manufacturing tested and verified

Access to local, recycled raw materials at Stord

Local value creation

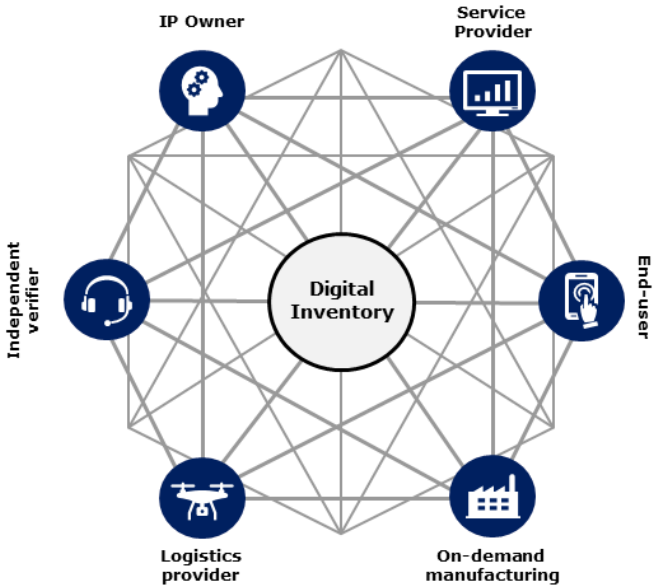
Two new 3D print factories in Northern Norway, Established in Hammerfest, est. ongoing in Mo

Digital Inventory software provider Fieldnode from Norway

Design-for-AM company Korall

Recycling company F3nice

Implementing Additive Manufacturing and Digital Inventories in Equinor



Digital Supply Network

Connection to Equinor systems

IT development and integration

Change the way we work

ICP Collaboration between operators

External arenas

Techstars Accelerator program

AM Implementation team

General implementation

Service unit supporting organisation

Competence within AM, welding and robotics

Supplier mapping and involvement

3D printing and 3D scanning service

Build competence and AM mindset

Digital Supply Network development – past present and future

08.2019 – 12.2019

Techstars Energy
- Support start-ups

FIELDMADE DIGITAL INVENTORY

equinor

A program that provides early-stage companies the education, resources and mentorship needed to rapidly scale growth

04.2020 – 04.2022

Digital Inventory
- Develop platform

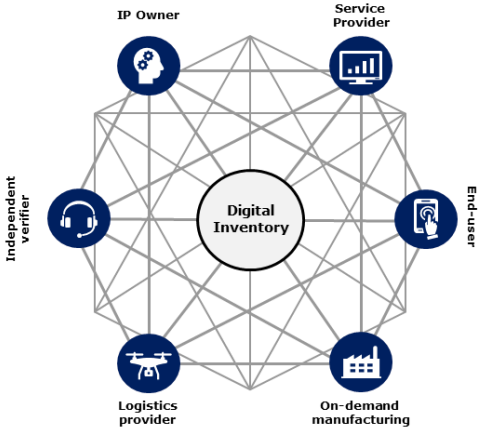
FIELDMADE

equinor

SIEMENS energy

TotalEnergies

Launch of "Fieldnode" 1.may 2022



Fieldnode

05.2022 - 08.2024

Global implementation of DI
- Commercial models and content

equinor

bp

TotalEnergies

Woodside Energy

ConocoPhillips

vår energi

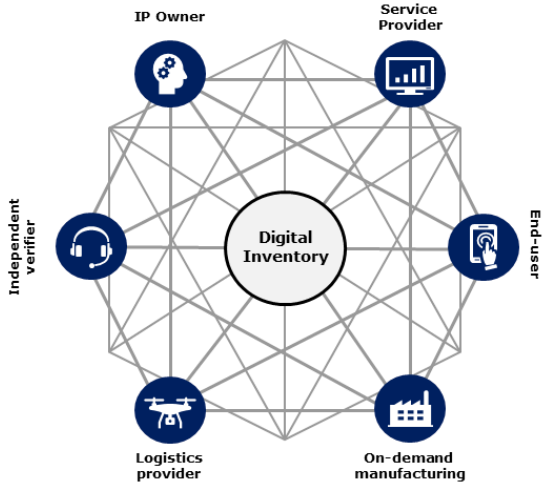
ExxonMobil

Fieldnode

DSN = Digital Supply Network

The Digital Inventory Industry Collaboration Project (ICP)
May 2022 – September 2024

Ambition: Global Implementation of Digital Inventory in the Energy Industry



Partners

Equinor (Chair)
TotalEnergies
Shell
ConocoPhillips
Vår Energi
Woodside
BP
Exxon Mobil
Fieldnode (Facilitator)

Work Packages

WP1 – Project Management (Fieldnode)
WP2 – Contracts, pilots & ecosystem scaling
WP3 – User driven SW development
WP4 – SW platform integration
WP5 – Commercial models
WP6 - Ecosystem strategy
WP7 – Dissemination and PR relations
WP8 – QA/QC Digital assurance

ICP roadmap

01.06.2022

ICP1.0 - POC

- Develop and test OEM centric model
- Develop and test Flex model
- QA/QC and audit routines

OEM centric and Flex model

31.12.2024

ICP2.0 – Global Implementation

- End user forum
- Sharing implementation experience

Distributor model

31.12.2026

ICP3.0 - Consolidation

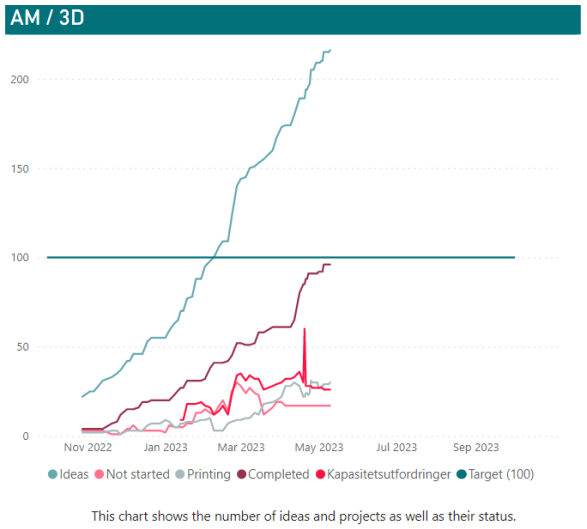
Reference group of end-users

Reference group of OEMs

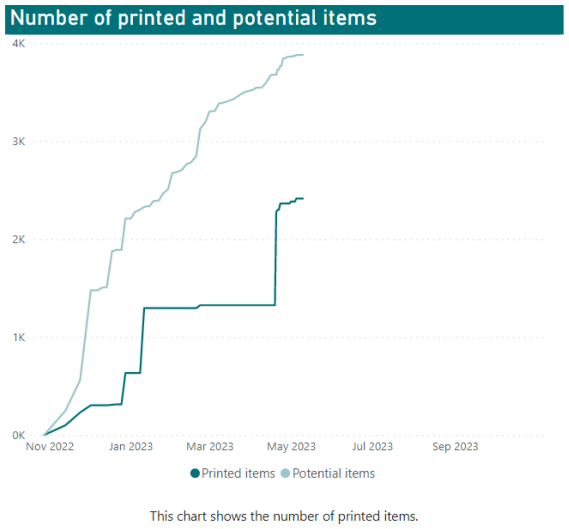
3D print microfactory during commissioning phase Johan Castberg

Goal for 1 year was 100 cases identifed

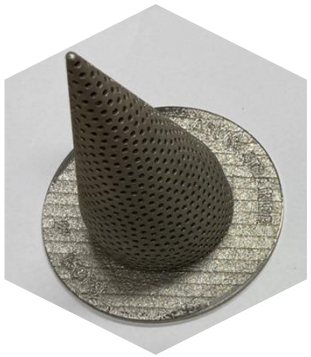
In 11 months: **339 cases** identified
>3000 printed components



This chart shows the number of ideas and projects as well as their status.



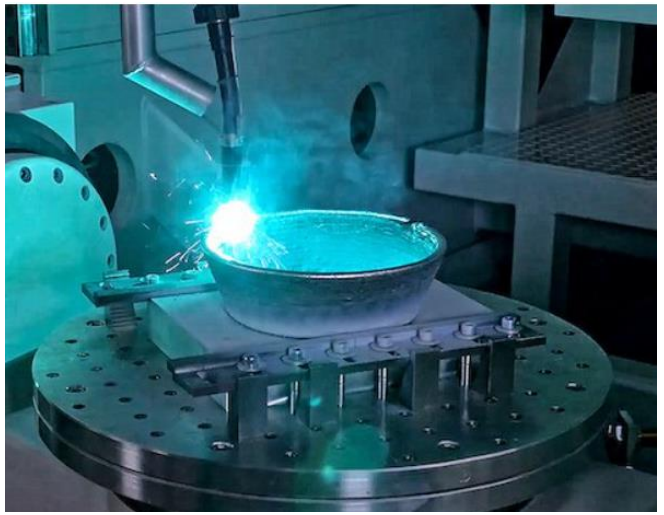
This chart shows the number of printed items.



Building the ecosystem

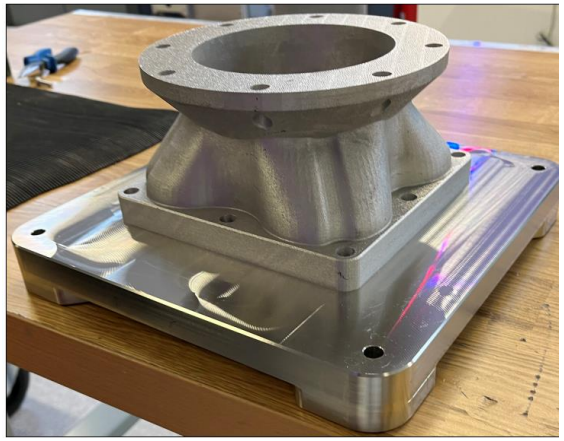
- **AM North AS**
  - Hammerfest
  - Polarbase - ProBarents – GSG AS
  - PBF – Powder Bed Fusion

- **Industrial AM AS**
  - Mo i Rana
  - Testpartner - Momek Robotics – Kunnskapsparken Helgeland
  - WAAM – WireArc AdditiveManufacturing



Noen eksempler på saker som er gjennomført i Equinor

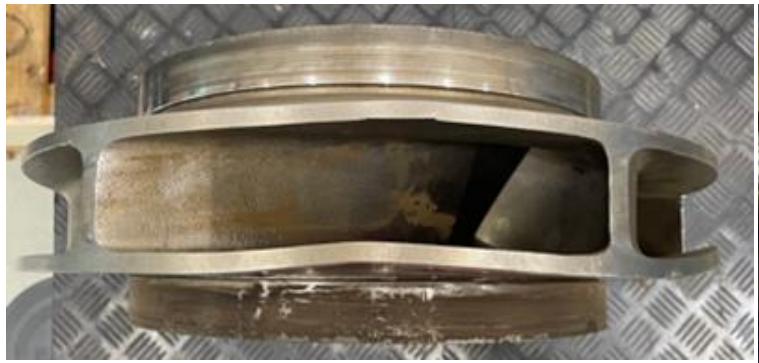
Kjølevannsadaptor Kollsnes

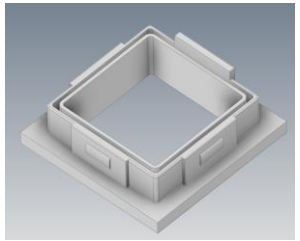


Ledetid redusert fra 70 dager+ - til 8 dager fra skanning til installasjon!

Andre eksempler

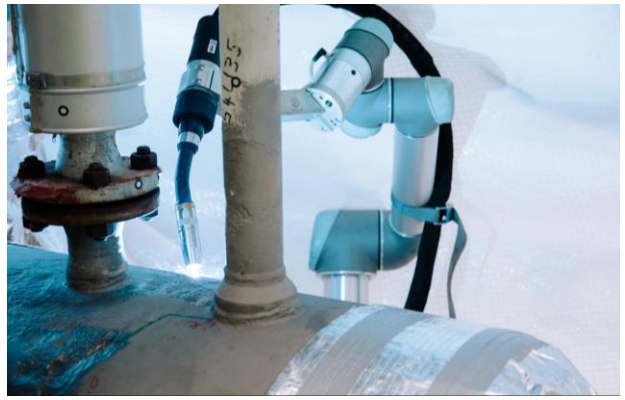
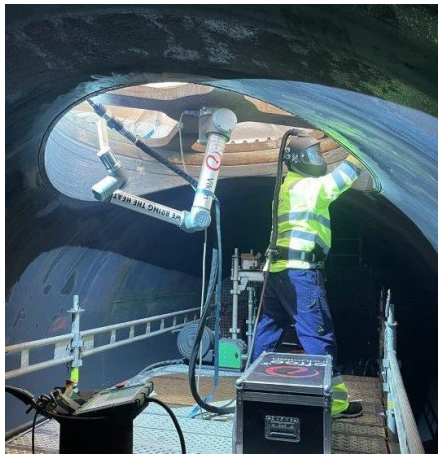
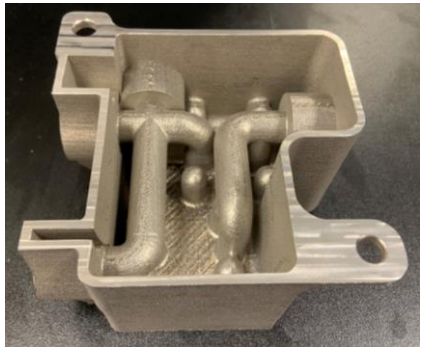
Nye deler....
Eller reparasjon....

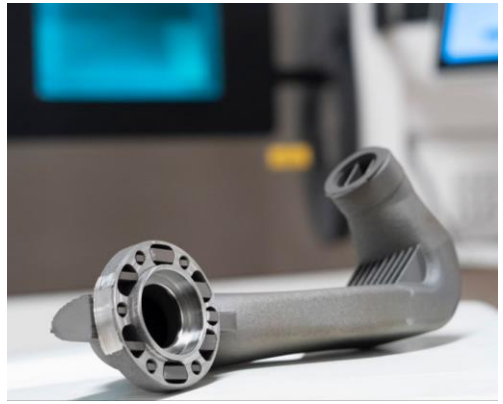




Noen eksempler

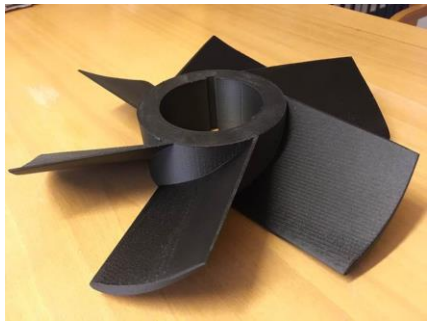
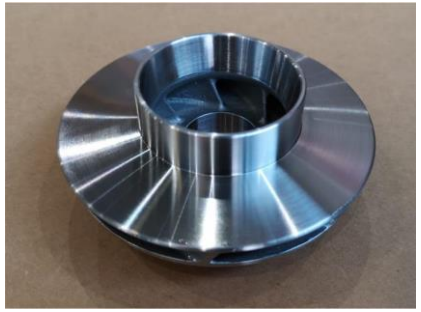


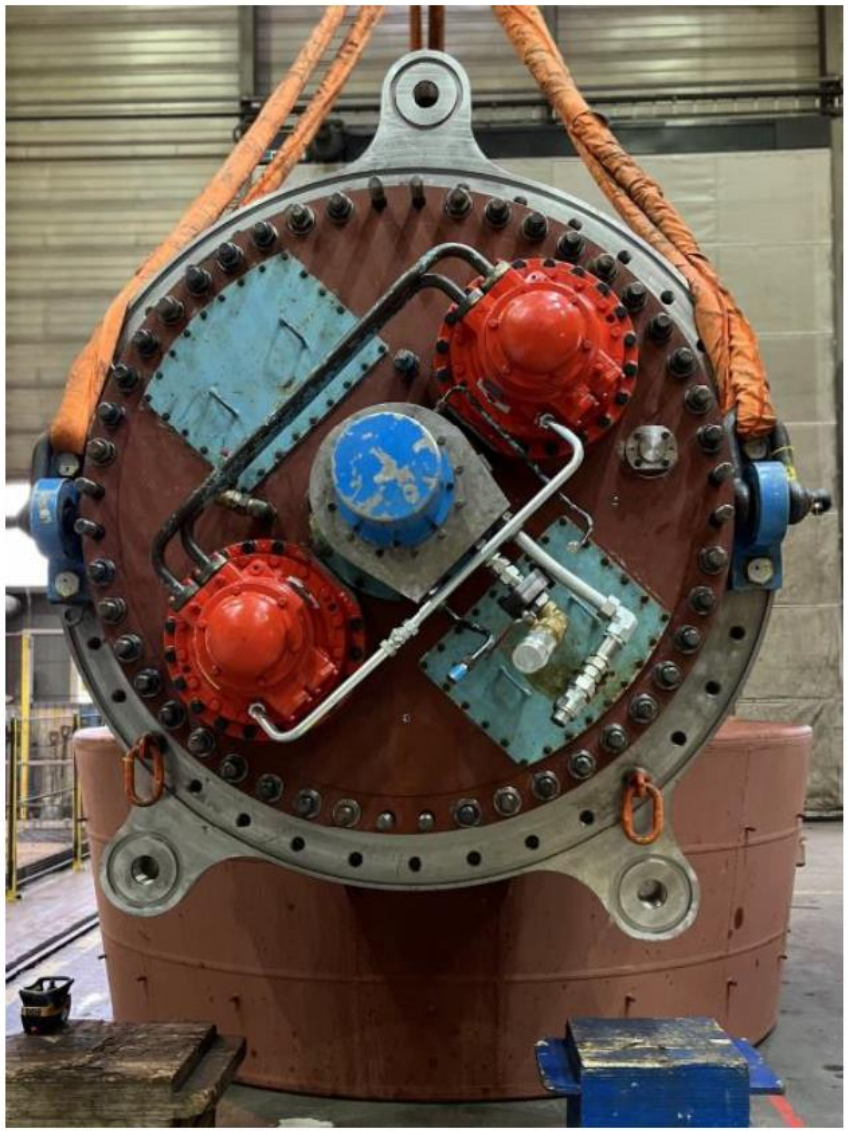






Flens montert på KAmewa thruster



Thomas Liabø, On - site repair

Kort sagt; Det er mye som skjer – og mye som skal skje framover ☺

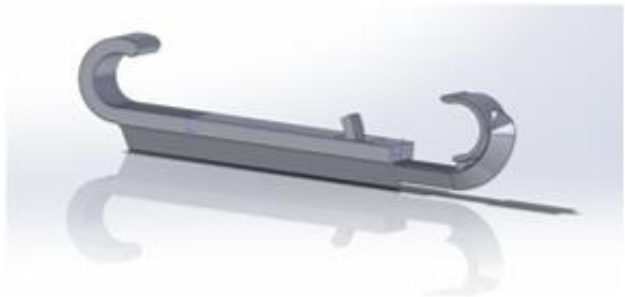
Takk for oppmerksomheten

Tore Knudsen
Head of AM Implementation

Extras

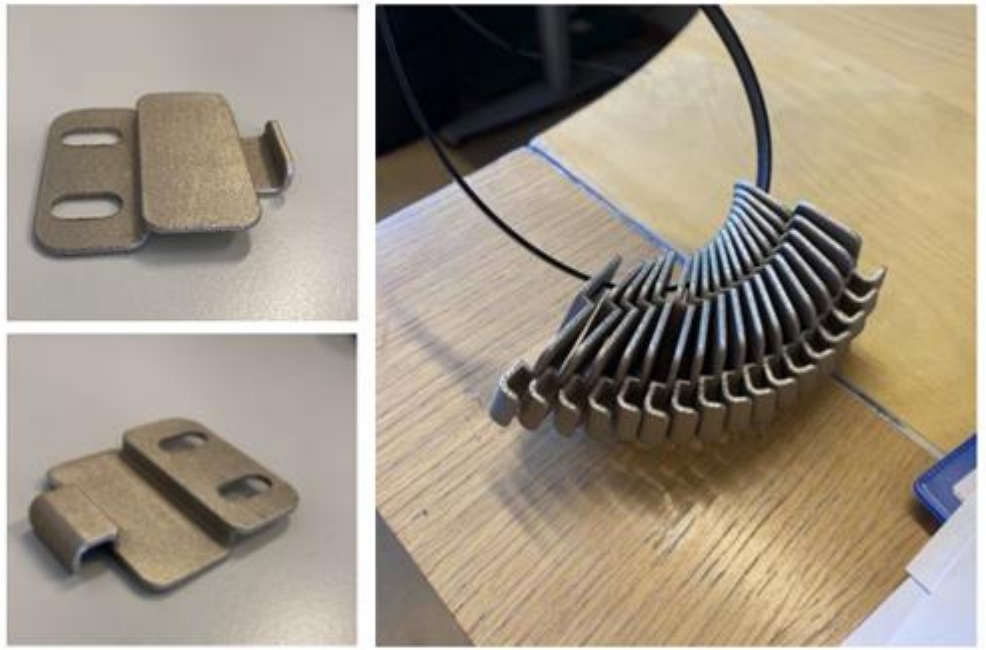
TOOL TO IMPROVE FILTER CHANGE

- **What?** Tool to ease SRU filter maintenance. Holds pipes secure during installation and maintenance
- **Why?** 3D printing allows custom solution to be designed that fits the different systems in the SRU.
- **Learning:** Enables us to implement improvements of our workflow in an easy way. Easy to adapt to other usecases in maintenance work
- **Saving/effect:** Reduces POB with 2, as time to install filters is reduced. (1900 filters)
- **Material:** Nylon



COVER FOR CABLES AROUND TURRET

- **What?** Cover to hold cables secured around the turret. Part was urgent to keep progress in the installation work. Part was delivered within 14 hours of ordering.
- **Why?** Alternative solution was to have parts manufactured by conventional manufacturing. This would have taken several weeks.
- **Learning:** 3D printing on-site is a great option for on demand manufacturing of non existing parts
- **Saving/effect:** Ensured progess in turret campaign
- **Material:** 316L



DENSIQ PRESSURE GASKET TOOL

- **What?** A tool which was needed to increase safety during assembly of gaskets.
- **Why?** Short leadtime. Easy part to design and print fast
- **Learning:** 3D printing on-site has the potential for making smarter and safer tools and equipment

Saving/effect: Prevents gaskets dropped on the floor during assembly, (need to be replaced)
reduced the risk of injures of personnel

- **Material:** Polymer

MODULE ATTACHMENTS FOR HAKI SCAFFOLDING

- **What?** A tool to hold in place various hoses/equipment
- **Why?** Easy part to design and print with customized geometry
- **Learning:** 3D printing on-site enables us to get customzied solutions for specific problems

Saving/effect: Reduces waste by avoiding use of tape and strips. Creates a more organized environment

Material: Polymer

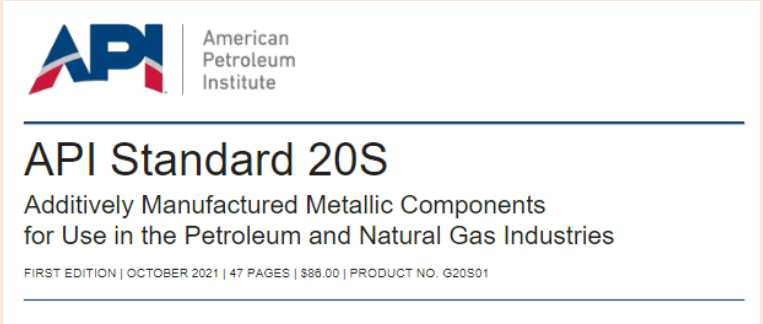
From scrap metal to a 3D-printet and mounted part at Johan Castberg

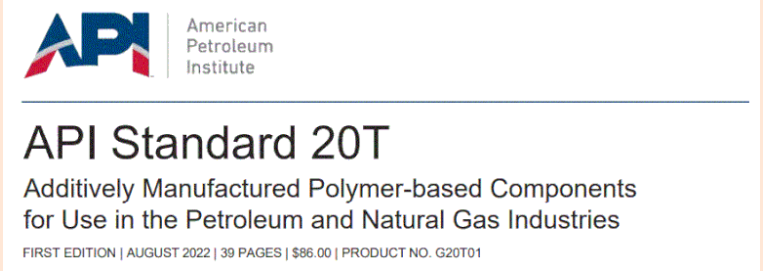
https://youtu.be/6M4guRV1QG8

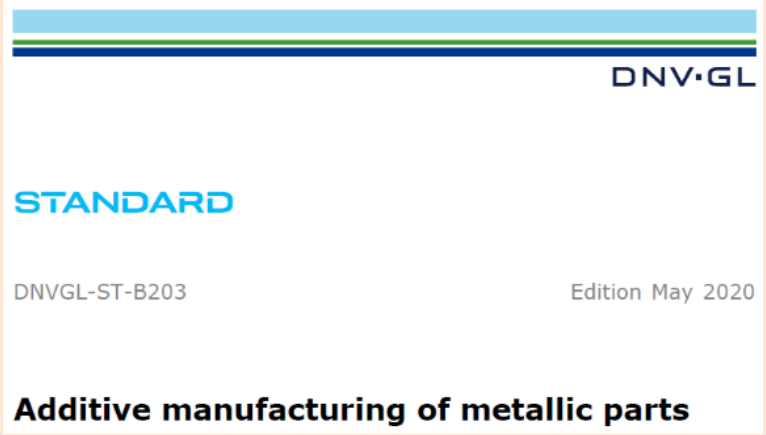
Material Quality & Standardisation

DNV-ST-B203 & API 20S/T – O&G application specific metal / polymer AM standards

- Quality management of additive manufacturing and additively manufactured metal parts
- Test, inspection and QA/QC protocols for qualification, certification and production







What is Additive Manufacturing?

Additive manufacturing is **the process of creating an object by building it one layer at a time**. It is the opposite of subtractive manufacturing, in which an object is created by cutting away at a solid block of material until the final product is complete.

Materials: Polymers, metals, sand, glass, concrete, human cells
Quality (Metal): Better than casted parts, equal to forged.

"Complexity is free"