EIROforum Workshop on Knowledge Management

EUROfusion Knowledge Management Strategy

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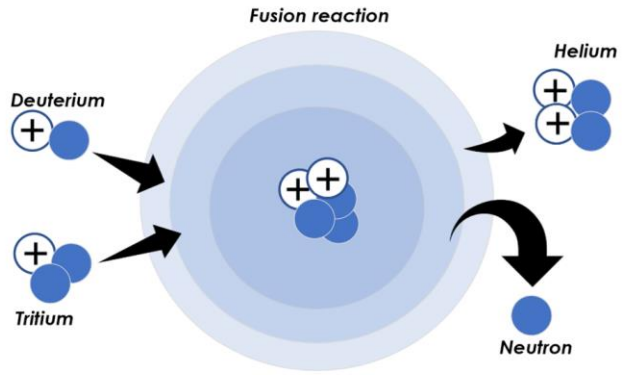
Nuclear Fusion Research

Fusion: sustainable, carbon-free energy source based on the reaction that powers the Sun.



Goal: Commercial fusion reactor to be part of the sustainable clean energy mix as continuous energy source. (2050+)

Next steps:

- **ITER** – International Experimental Fusion Reactor – test technology and plasma scenario
  (35 nations from 7 partners – EU, USA, Russia, India, China, South Korea and Japan)
- **DEMO** – Demonstration Power Plant – demonstrate power on the grid
- **Commercial fusion reactors**

The EUROfusion Consortium

EUROfusion integrates Research & Development in nuclear fusion in Europe funded by the European Commission.

26 + 3	Countries
28	Research Institutes (members)
167	Affiliated entities (universities, laboratories)
3	Associated partners (UK, Switzerland, Norway)
1000+	MSc and PhD students
5000+	Fusion scientists, engineers and support staff

Understanding the current situation

Public-sector in Europe:

- 5 medium-size experiments in Europe + a number of small devices
- 3 devices in design or construction-phase
- **JET** closed down in 2023 after 40 years of operation
  -> world's largest device, recent fusion world record
- **JT-60SA** started operation in Japan in 2023
  -> world's next largest device, EU-Japan collaboration

Private-sector:

- Strong private investment resulting in new private fusion companies
- Industry involvement in construction of large-scale projects

EUROfusion Human Resource Survey (2023) – Skill distribution and needs

Education Programmes Overview (2022, 2023) – availability and access to education

Operator roles and training overview – roles, roster, type and length of training, qualification

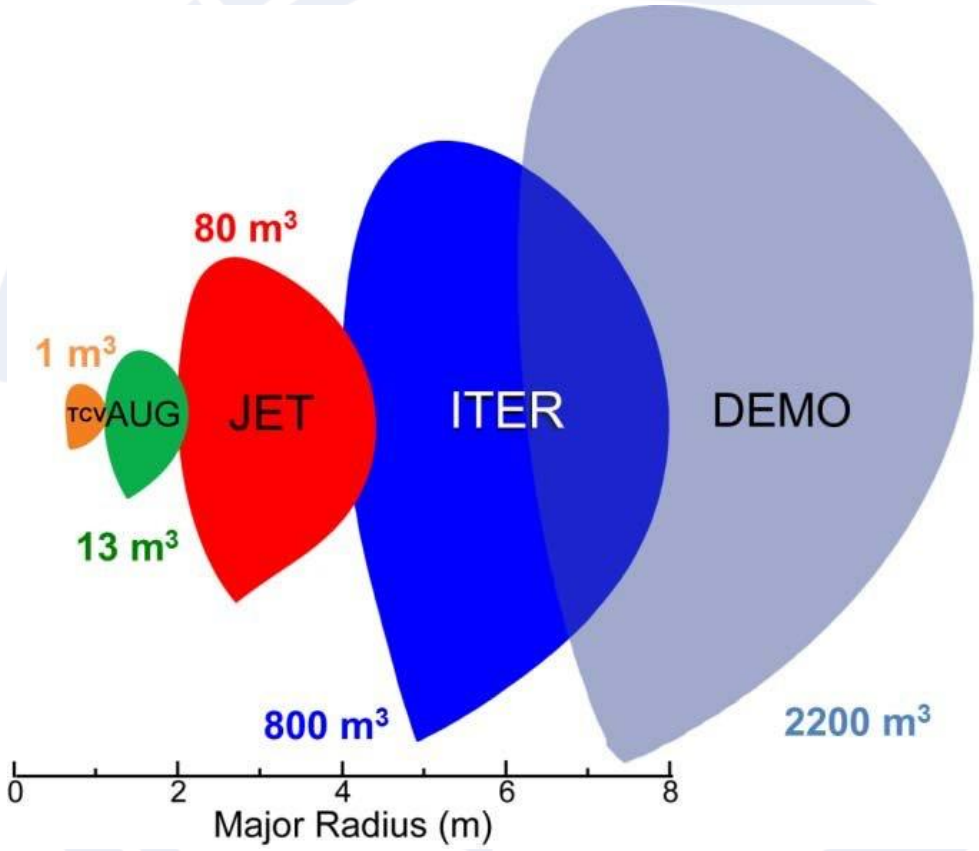
Challenges

- **Distributed teams** across Europe, strong international collaborations, retiring experts following closure of JET
- **Multi-cultural** international projects with in-kind contributions, transfer knowledge to new project & Japan

- **Nonlinear rise of complexity of operations with the size** of the device

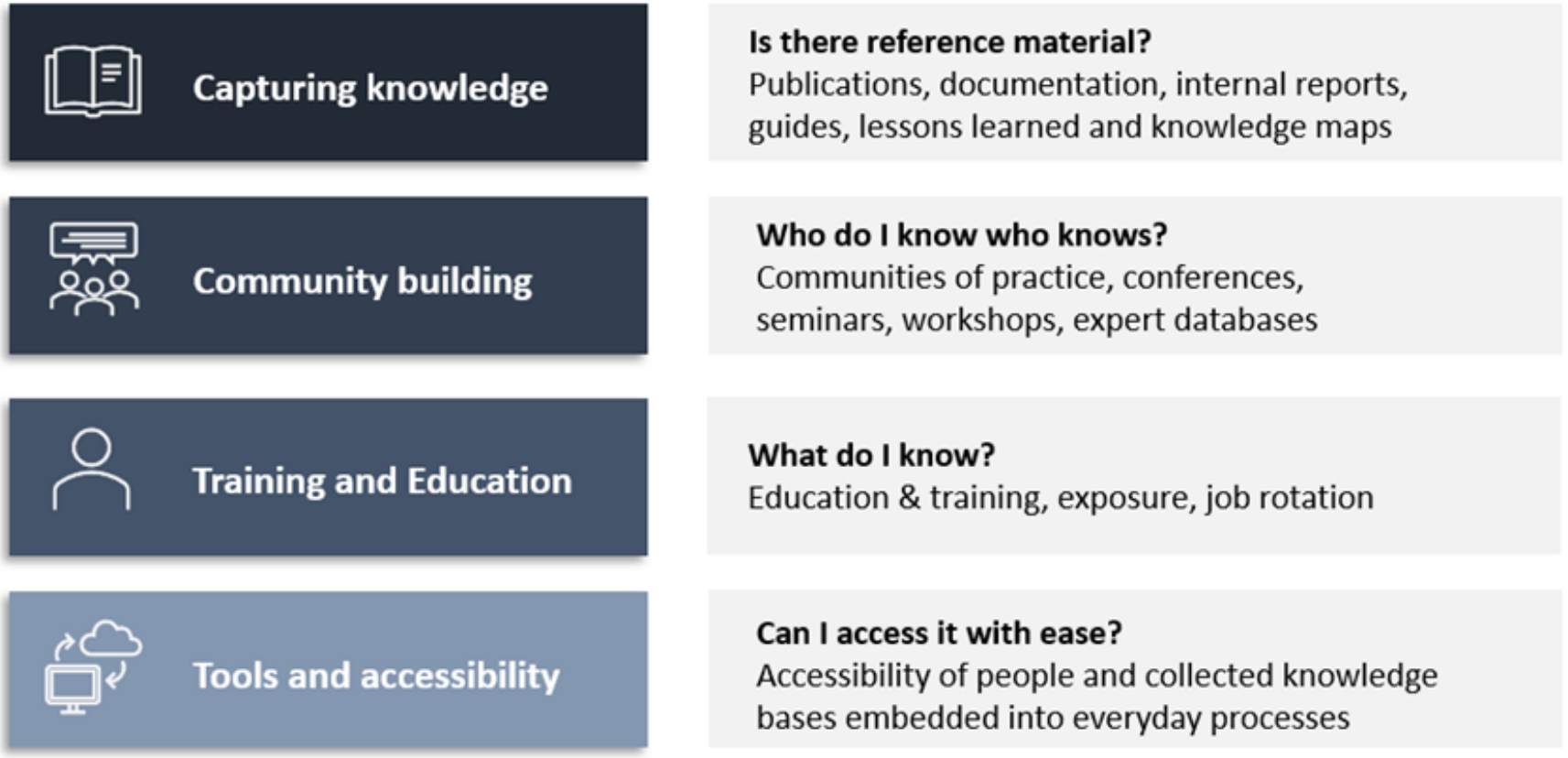
- **Long time scales (decades)** leading to generational gap between design, construction and operation.

- **Commercialisation** of fusion research requires training more early and mid-career experts, higher movement between institutes, private sector and industry
- Culture change from academic research to industry

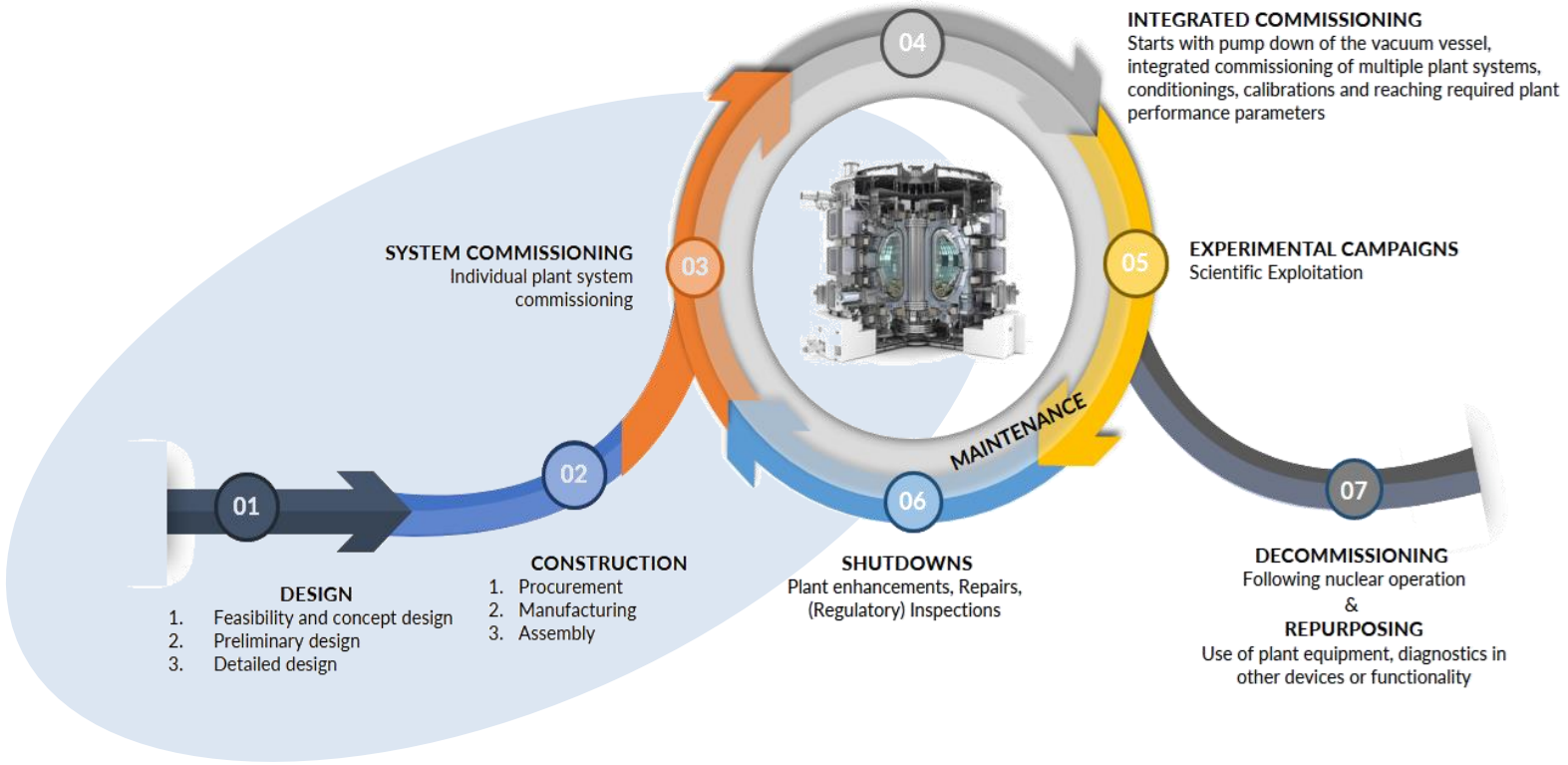


The EUROfusion Knowledge Management Framework

THE EUROFUSION KNOWLEDGE MANAGEMENT MODEL



More focus on engineering and operations needed



Operational complexity of devices increases with their size.

- On JET, we had ~50 operator roles with ~500 staff.
- Training takes few months to a year with the exception of a few roles that can take 4-10 years.
- Training is often on the job, shadowing an experienced operator.

Delays due to commissioning and operations can take weeks, months to years to recover.

- Sharing experience and lessons learned, training can reduce operational delays and training times.

Capturing knowledge

- **ITER Engineering Design Handbook** - project launched this year in collaboration with ITER to capture design decisions and engineering considerations.
- **Textbook on tokamak operations –** follows the joint operations course, in collaboration with IAEA.

- **Publication on Operations** – Since 2021, we have a special issue in a refereed journal focusing on capturing commissioning and operational experience.
- **MSc and PhD thesis repository** on our publication pinboard

- **Pilot video capture project** - Interviews (need to be expert driven, better to capture exchange), screen capture to demonstrate tools, capture processes e.g. calibrations.

- **JET Operational Delay Logs** (captures any delay above 5-10 minutes in the control room) – review at weekly coordination meeting, campaign report, 20-year analysis

  -> allows identification of frequent minor delays, guide maintenance/improvement actions

- **Detailed commissioning procedures** with embedded logging of the commissioning experience and results as it happens.

Communities of practice

First communities of practice in Operations for the heating systems in 2022.

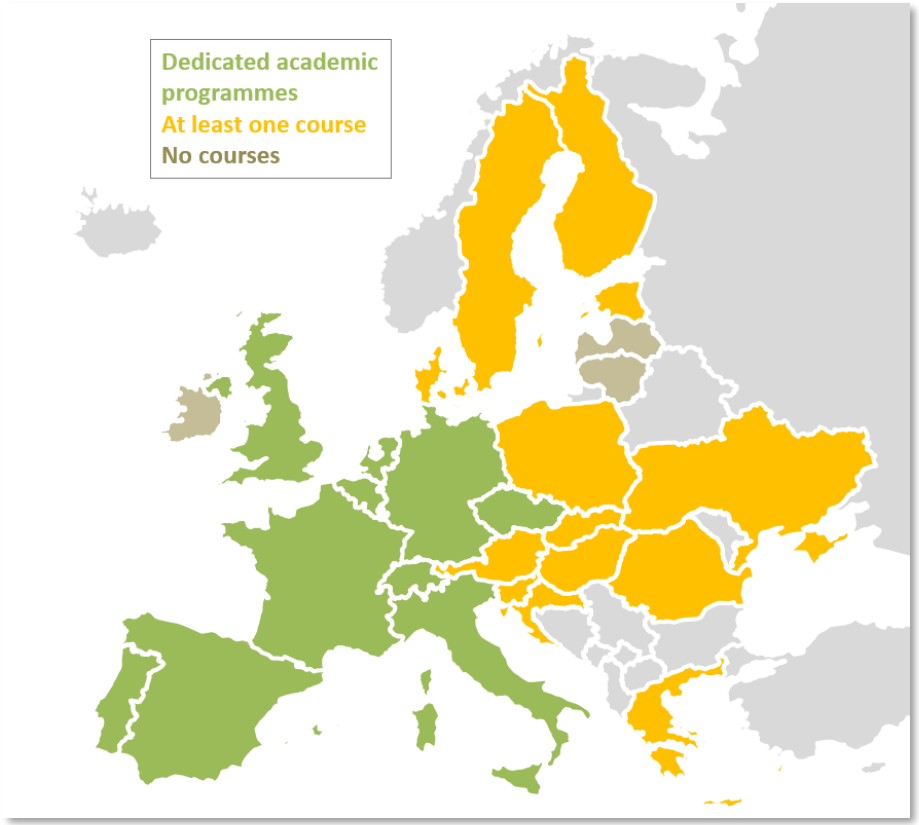
- We have 10-20 teams across Europe + guest collaborators.
- **Panel:** 1 representative per team + 2 early career representatives
  - Set up dates, topics and agenda
  - Organises their local teams

- **Activities:** online seminars with 50% discussion time, joint training courses, expert registry, resource database, share working with suppliers.

- Online events, all experts at all levels are invited to participate (technicians, physicist, engineers). No travel.
- Driven by the community, current needs, recent innovations.
- Informal, practical, discussion of difficulties and challenges, details not shared at conferences.
- Recording with transcript, presentations slides, training material available on a SharePoint Site. -> Teams chat function to be tested this year.
- Identified and opened collaboration opportunities across teams. Shared spare components.

Education & Training - The Fusion Online Learning Platform

The Education programmes overview indicated the lack of availability and access to courses dedicated to fusion across Europe. ➔ The EUROfusion online learning platform will host academic courses accessible across Europe



The type of training material and implementation steps planned are:

1. **Past courses:** make recorded courses accessible on-demand from universities that are happy to share.
2. **Remote academic lectures:** selected lecturers to repeat existing courses online and live through the new learning platform.
3. Create a **database of practical exercises** with tips and full solutions to be used by lecturers and students.
4. **On-demand online courses:** create on-demand online courses updating the format of the courses with short, recorded videos and exercises along the best practices of academic online courses.
5. **Support the development of new courses and in-depth niche training material** in scarce and important competency areas.

Integrated knowledge management approach – an example

EUROfusion Operations Network

P2. Create a community of practice
- Organized through a panel with 1 representative from each European team + early career representatives
- Recorded, regular online seminars open to all European experts
- Focus on current, community needs

P3. Training courses
- Develop training courses based on the joint experience

P1. Capture knowledge into written form and videos
- Publish on commissioning/operational experience – lessons learned, best practices, improve physics/engineering understanding
- Video capture of processes and practices
- Manuals and textbook

P4. Create expert registry and knowledge base
- List of experts with their competence, interest and contact
- List of publications, internal reports, commissioning/operational procedures

P4. Tools to make access to knowledge base easier
- Develop AI-enhanced tools to embed knowledge base into everyday processes and training.

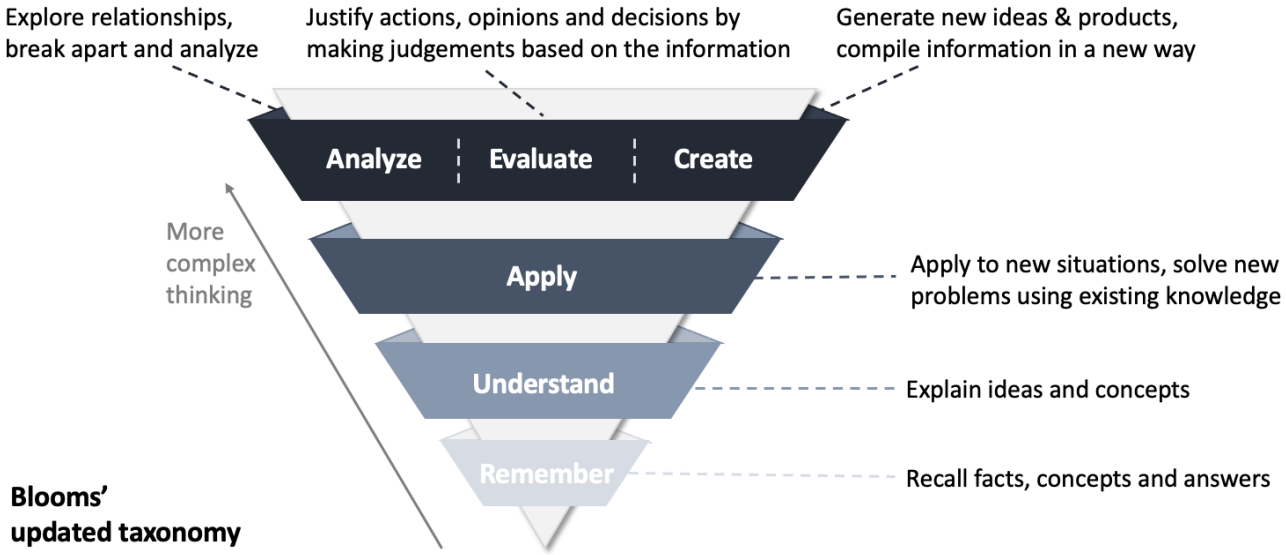
Inclusive design

Universal Design for Learning – create material and events that already incorporates diverse needs, learning capabilities, abilities and preferences.

- **Language barriers** – operations is always in the local language, use of English varies in the technical staff
- **Cultural differences** – differences on how discussions and work is approached (see culture maps)

- **Abilities**
  color blindness, use of color, figures
- **Learning preferences**
  combine text, video, activities

- **Immersive learning**
  include more interactive elements, project work, capstone projects



Interested to learn from EIROforum Members

Capturing lessons learned and reason behind decisions for:

- Design
- Construction
- Commissioning, day-to-day operations and maintenance

How to synthetize and integrate this know-how into new projects, new staff?

Training of Operators:

- How do you train operators?
- What educational materials do you have? How do you create training, write manuals/publications?
- Do you use written manuals or video? Use shadowing, on-demand or live training courses?

Bridging the generational gap:

- How to bridge decades / generations of staff from design to construction to commissioning, operation and maintenance of old equipment.

Access knowledge basis:

- AI advanced search and other tools