



ΣΧΟΛΗ ΝΑΥΤΙΚΩΝ ΔΟΚΙΜΩΝ  
HELLENIC NAVAL ACADEMY [www.hna.gr](http://www.hna.gr)



6th International *Virtual*  
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# Designing a knowledge management system for Naval Materials Failures

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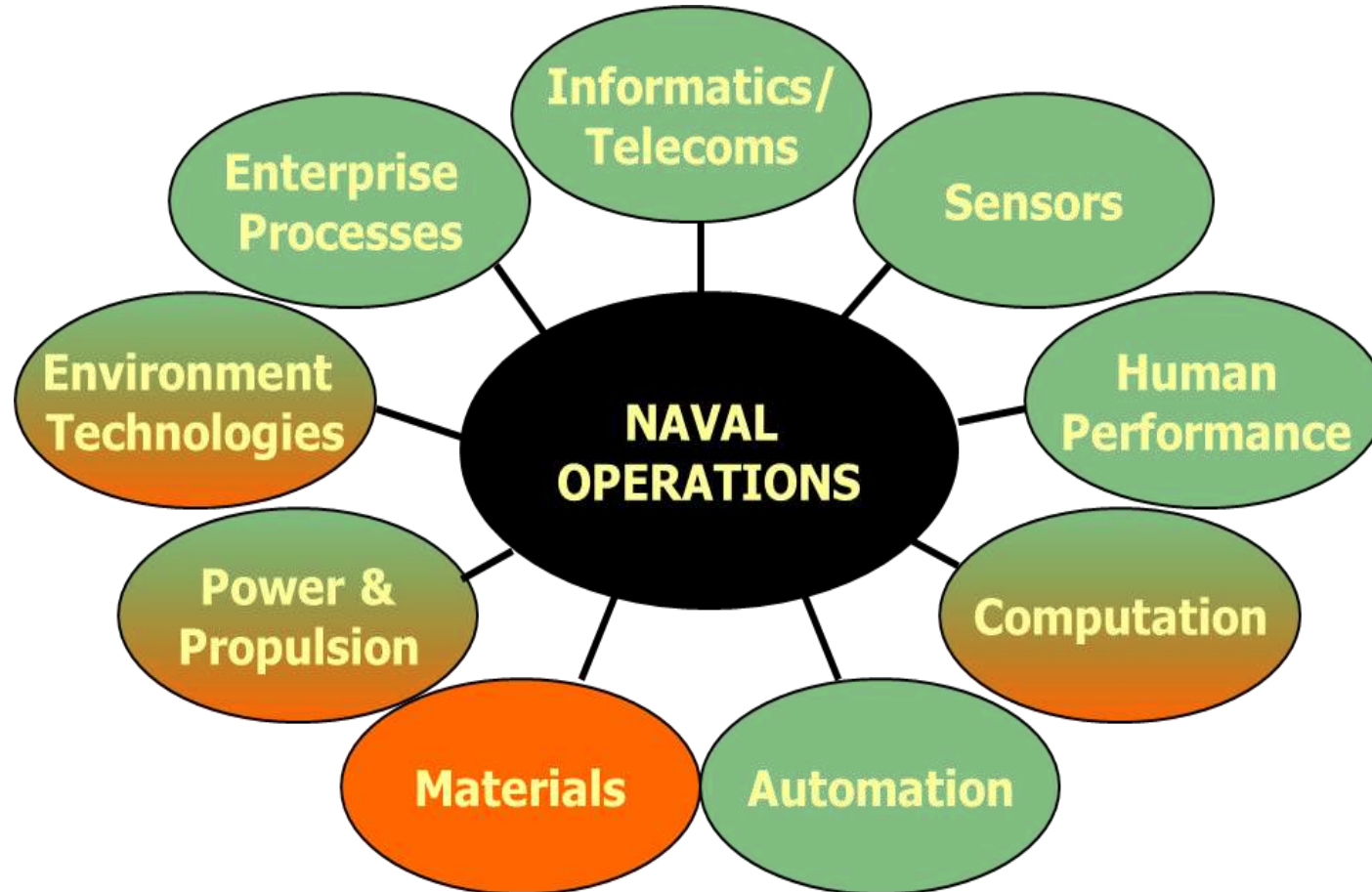
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**H.F.R.I.**  
Hellenic Foundation for  
Research & Innovation

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# Definition of terms and focus



Technology Drivers for the Naval Forces,  
Technology for the US Navy & Marine Corps, 2000-2035

# Failure consequences ...

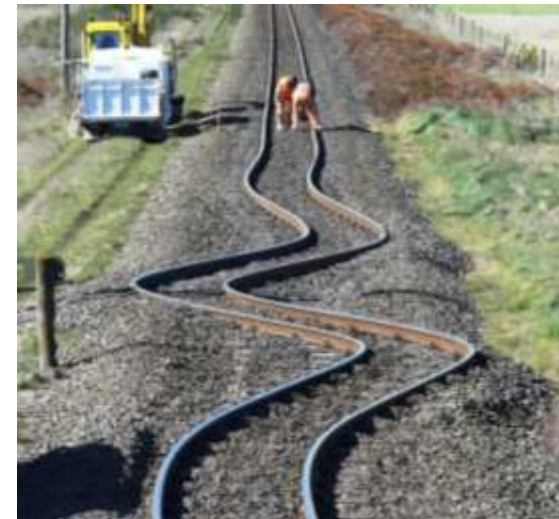


... of a component, a structure, a vehicle or a system –  
in any technology depended sector, are assessed in terms of  
**economy**, personnel safety, **environment**, **operations**



# “Unforeseen” failure

- Uncontrolled failure parameters:  
poor design, manufacturing fault,  
installation error, maintenance  
negligence, process weakness ...
- “Force majeure”  
meteorological, geological phenomena,  
terrorism, etc.



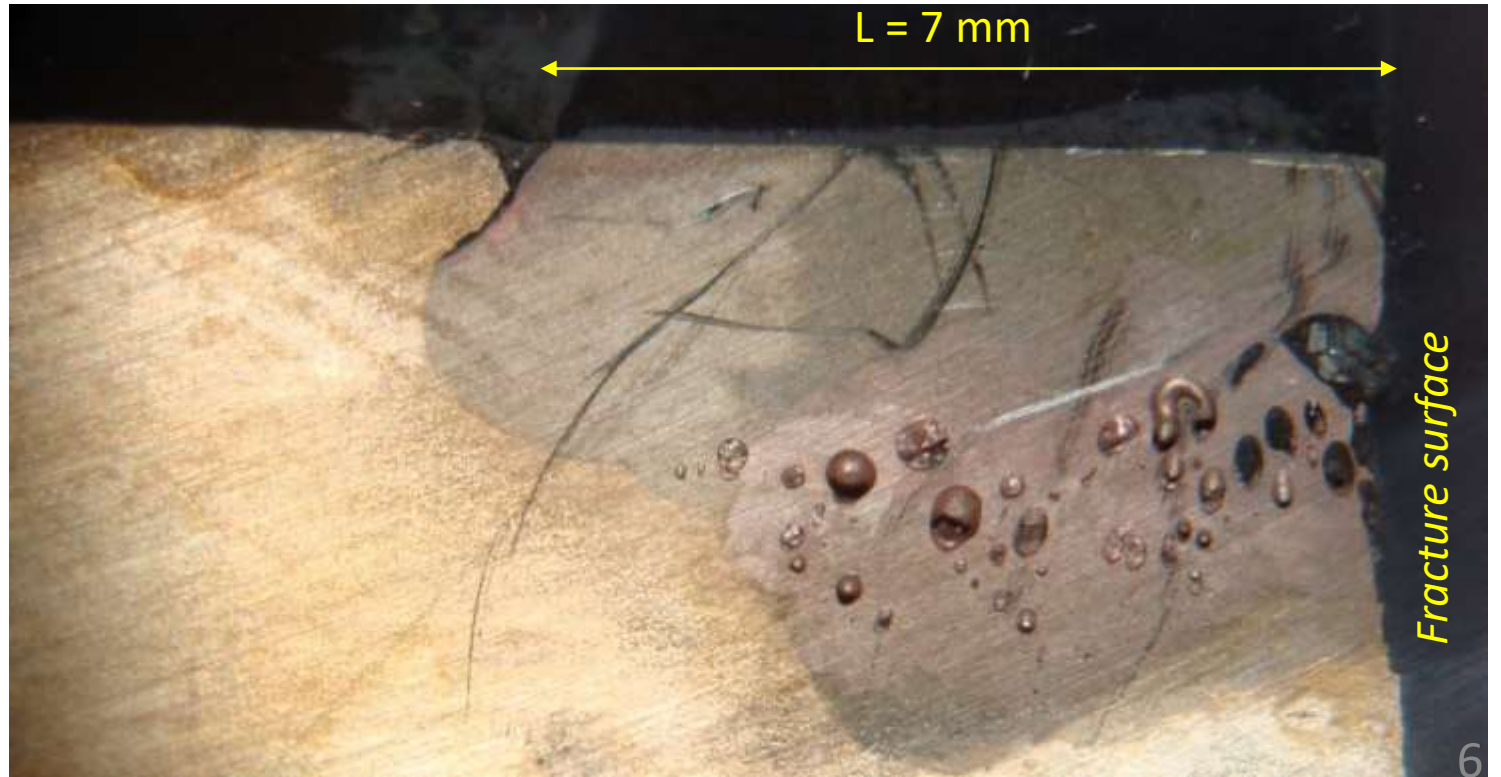
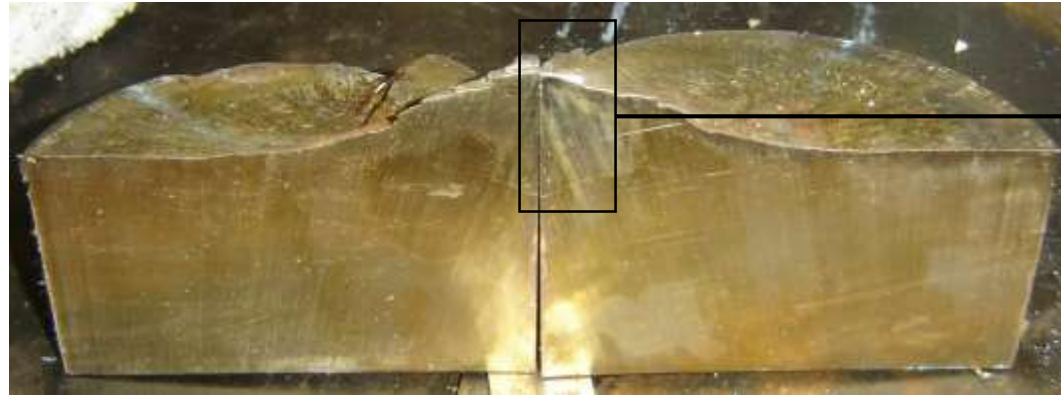


# Materials failure – a knowledge process





# Example: July 2015, Boat shaft No 1 failure





# May 2017: Boat shaft No 2 failure



# Issues to address

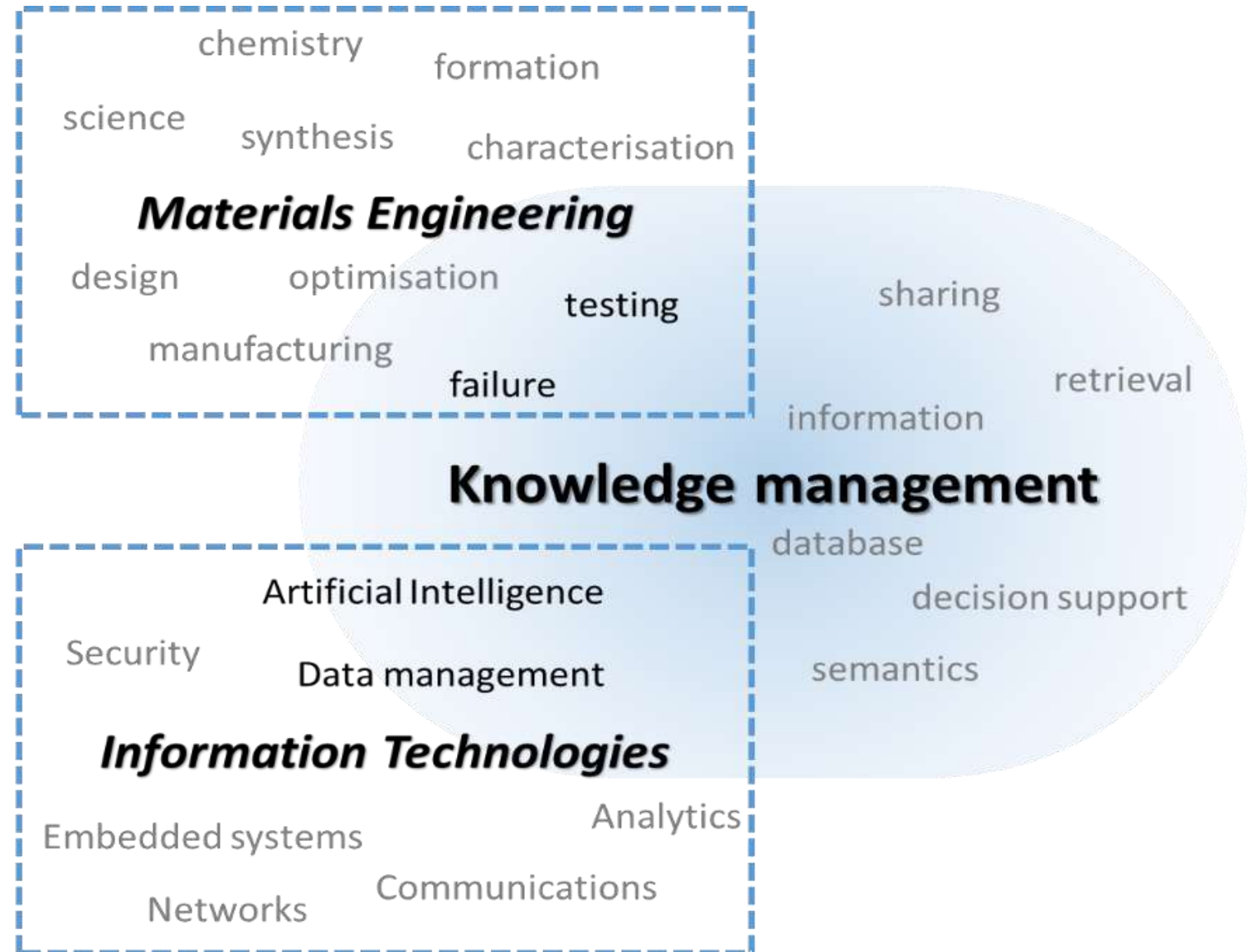
Disruptions in the flow of knowledge (knowledge gap) due to:

- *broad geographic distribution of platforms and units (as in a fleet)*
- *frequent transfer and reallocation of staff (career model)*
- *early retirement schemes due to the character of some professions*
- *information from various sources (data, images, reports, opinions)*
- *recording and indexing of an incident*



# The NAVMAT project concept

NAVMAT attempts an interdisciplinary approach by integrating *Materials Engineering* and *Informatics* under the *Management of Knowledge*.

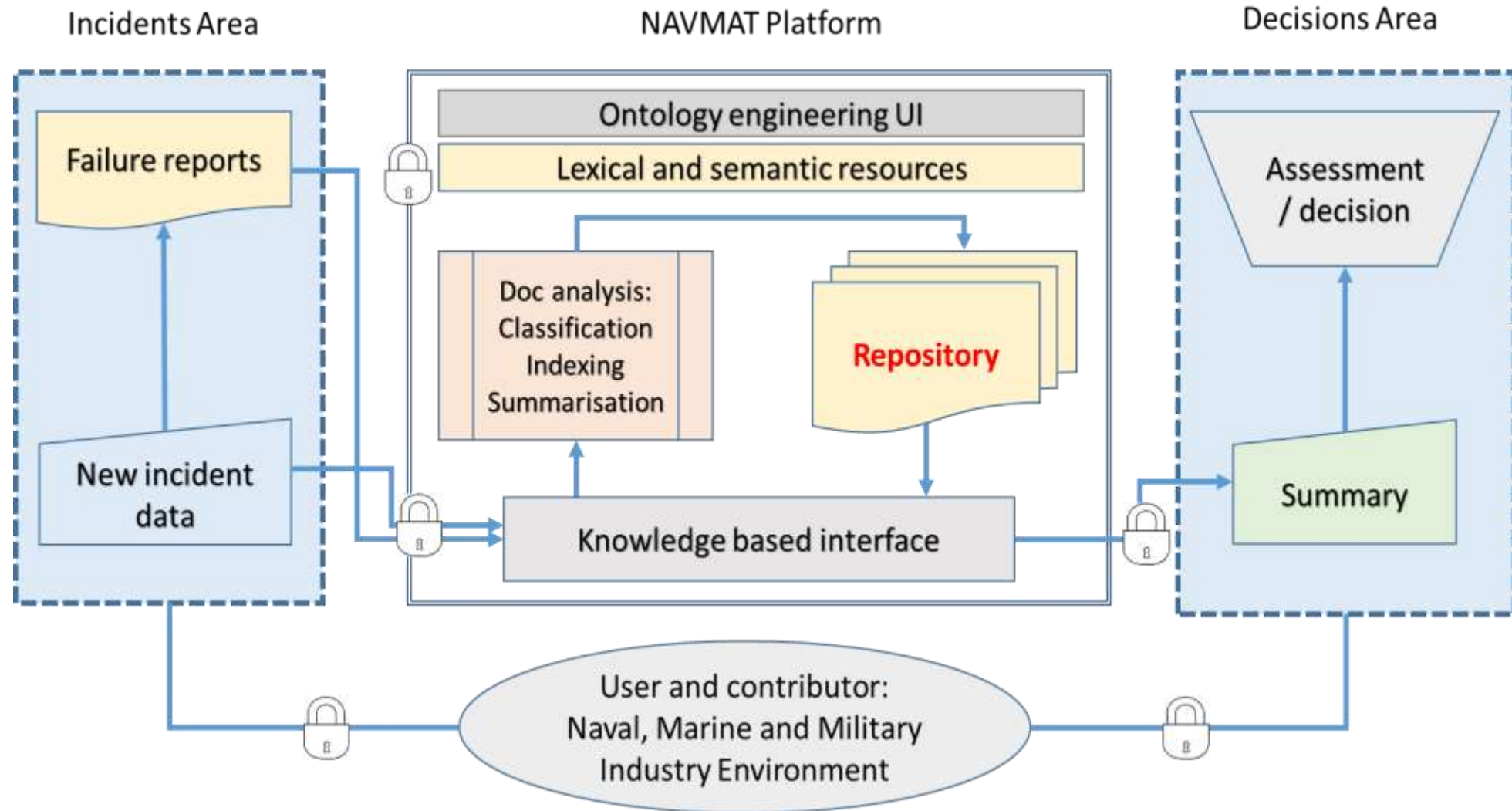


# The project definition



- NAVMAT is a knowledge based system dedicated to effective recording, efficient indexing, easy and accurate retrieval of information, history of maintenance, concerning every failure incident of marine materials, components and systems in a Naval environment
- Based on materials failure ontology, utilising artificial intelligence algorithms and modern approaches in data handling
- Aims at the optimisation of naval materials failure management and the support of decision making in Maintenance and Repair Operations (MRO), materials supplies and staff training

# Business flow





# Indicative system ontology

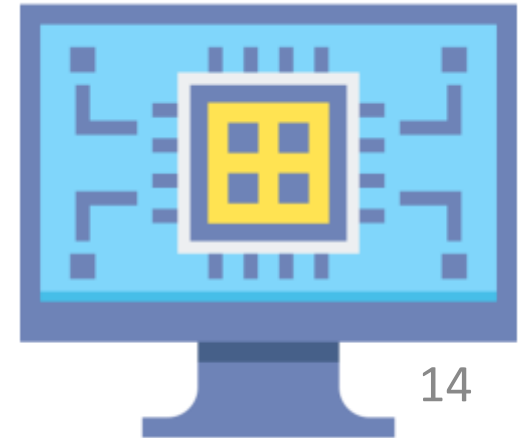
Materials	Components	Diagnostics	Failure type	Reason
<b>Metallic</b> <b>Steels</b> <b>Coppers</b> <b>Aluminium</b> ... <b>Ceramics ...</b> <b>Composites</b> .... ....	Shaft Gear Gearbox Bolt Plate Flange Bearings ...	XRF Ultrasound Magnetic testing Tensile testing Hardness testing ...  FEA analysis ...	Fracture, brittle/ductile torsional fatigue crack creep deformation Plastic deform ...	Installation Maintenance Design fault ... Material selection Specification fault Misuse ...

# Failure ontology



# How does Artificial Intelligence (AI) contribute?

- Allows the system to **take advantage of expert know-how**
  - **Concepts** of the domain (**components and materials failure modes**)
  - **Different ways to express** the same concept (**yield, plastic deformation**)
  - **Relations** between concepts (e.g. X=**pitting** is a type of Y=**corrosion**)
- Suggests identifying tags (meta-data) for an input case/document to facilitate indexing
- Helps identify most appropriate documents for a given query
  - Information retrieval to identify related documents
  - Allow efficient retrieval, allowing scalability





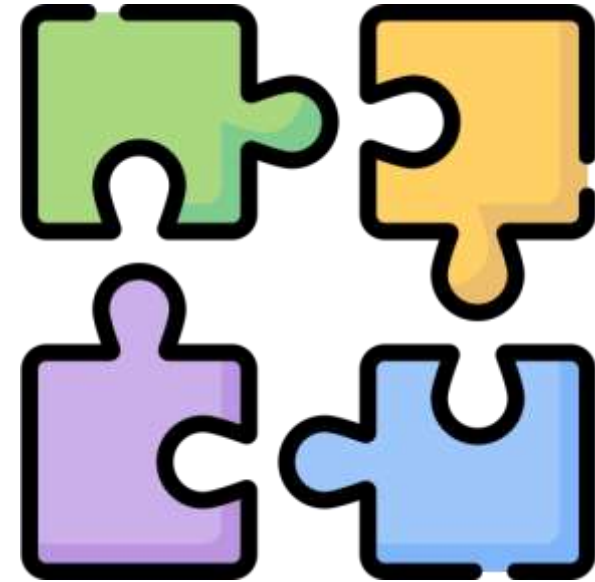
# Typical workflows

- “Something happened (**failure incident**) and I want to **report it /contribute**”
  - ☐ Allow the user to **easily record** the incident
  - ☐ Support the expert by **suggesting tags** for the incident
- “Something happened and I want to **see what others did** in similar cases”
  - ☐ Allows the user to **form a query**
  - ☐ Allows the user to browse **related incidents**
  - ☐ Facilitates easy **retrieval of related documentation**



# Features and potential

- Multi-lingual
- Scalable
  - Various sources of incidents of failure
  - Various sources of documentation
  - Many users
- Adaptive / personalized
  - Varying levels of access
  - Learning from user actions



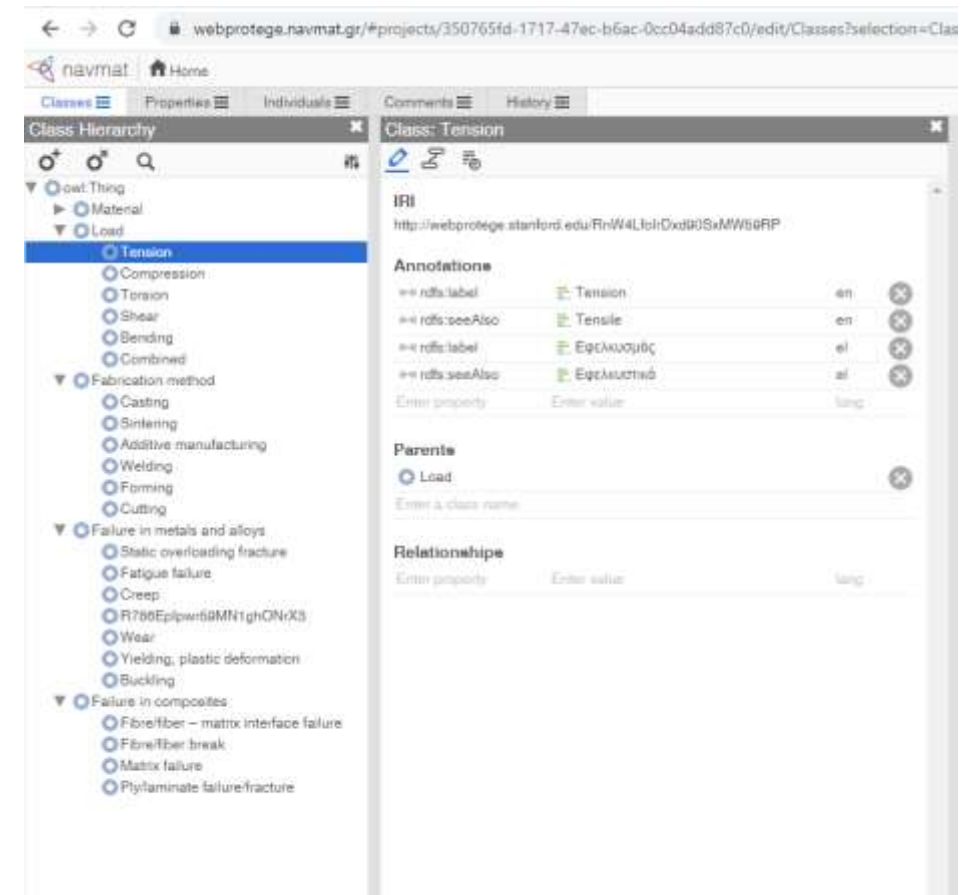
# WebProtégé ontology management system

Protégé is a free, open-source ontology editor and framework for building intelligent systems

Some of its features:

- Support for editing ontologies
- Full change tracking and revision history
- Collaboration tools
- Multiple file formats supported for upload and download of ontologies (RDF/XML, Turtle, OWL/XML, OBO, and others)

More at <https://webprotege.stanford.edu>





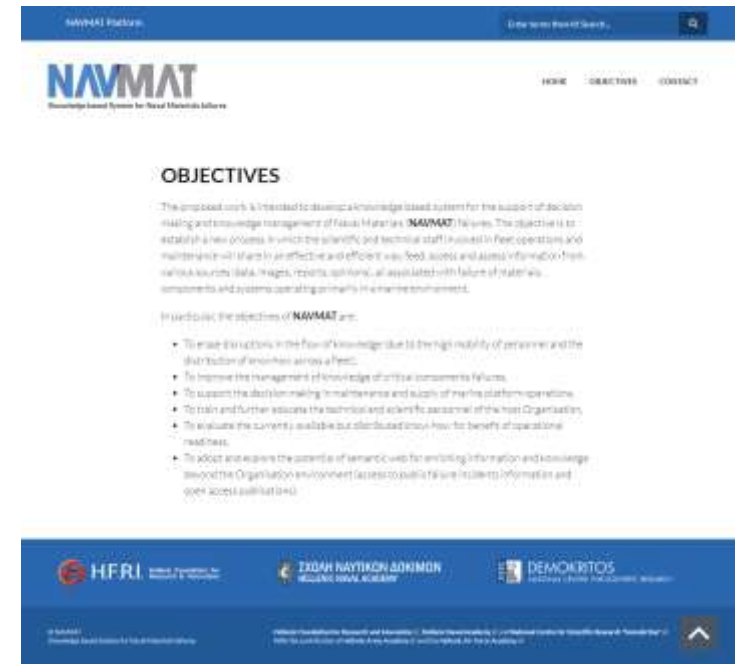
# app.navmat.gr

## The knowledge-based interface:

- one or more thin clients (Web/mobile app)
- use of security mechanisms (https, login, etc.)

## Indicative workflows include:

- CRUD (create/read/update/delete) operations on reports / incidents / documents;
- requests suggestions from the Document analysis component, concerning main concepts in the text;
- enrichment of inserted documents through the Document analysis component;
- storage of the enriched document into the repository;
- efficient searching (based on ontology) for previous
  - related incidents,
  - related resources (publications, videos, etc.)



# Expected outcomes

- Development of a failure of materials and components knowledge management system
- Strengthening Research and Innovation capabilities of partners
- Building and upgrading infrastructure
- Contributing to Research and Innovation integration and networking
- Diffusing Innovation to products, services and processes
- Introducing innovation in the organisational culture

# Thanks and Acknowledgements



*You* for your attendance

*The Hellenic Foundation for Research and Innovation* for its support

## and invite you

to contribute

to participate

to expand

the NAVMAT community and network

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