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HELLENIC NAVAL ACADEMY www.hna.gr

UNIVERSITY OF THE AEGEAN
SCHOOL OF ENGINEERING
DEPARTMENT OF PRODUCT AND SYSTEMS DESIGN ENGINEERING

NAVMAT Platform: Failure management of marine materials with artificial intelligence and machine learning tools

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H.F.R.I.
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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:

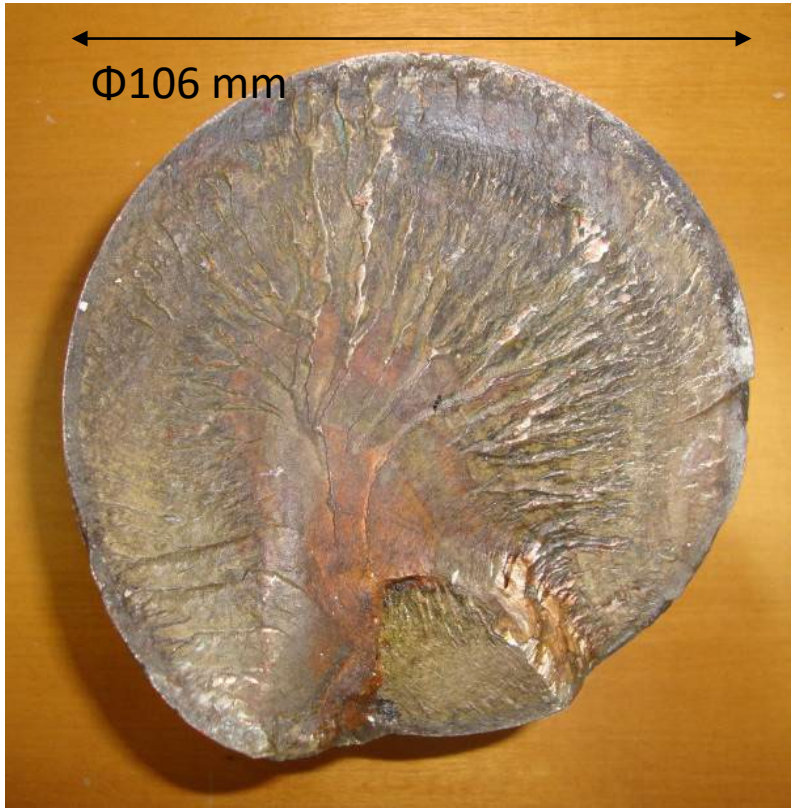
  poor design, manufacturing fault, installation error, maintenance negligence, process weakness …

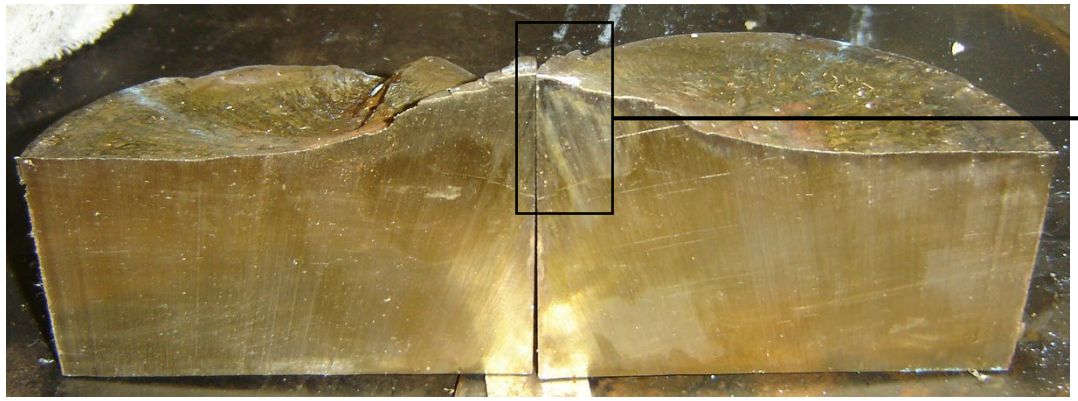
- “Force majeure”

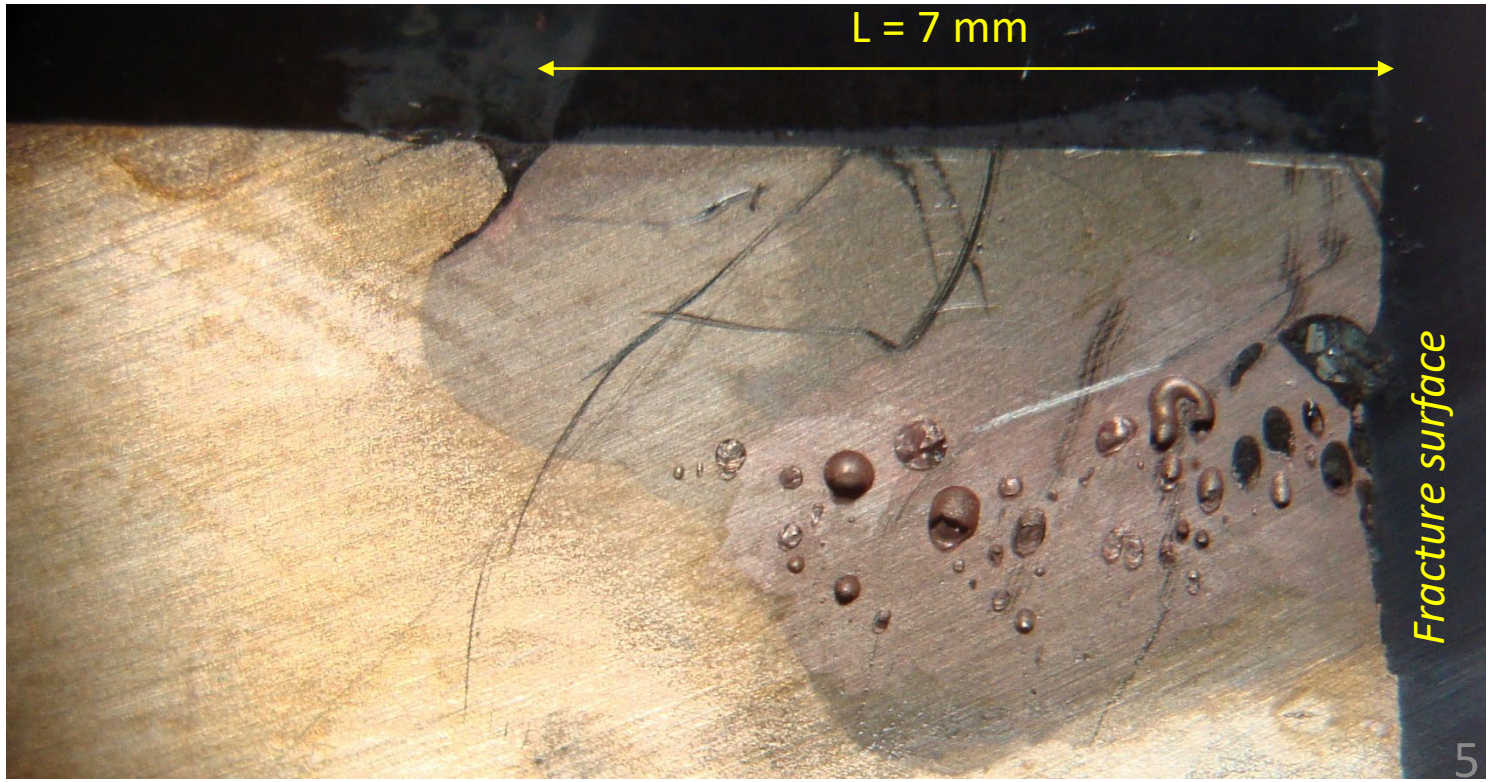
  meteorological, geological phenomena, terrorism, etc.

Materials failure – a knowledge process

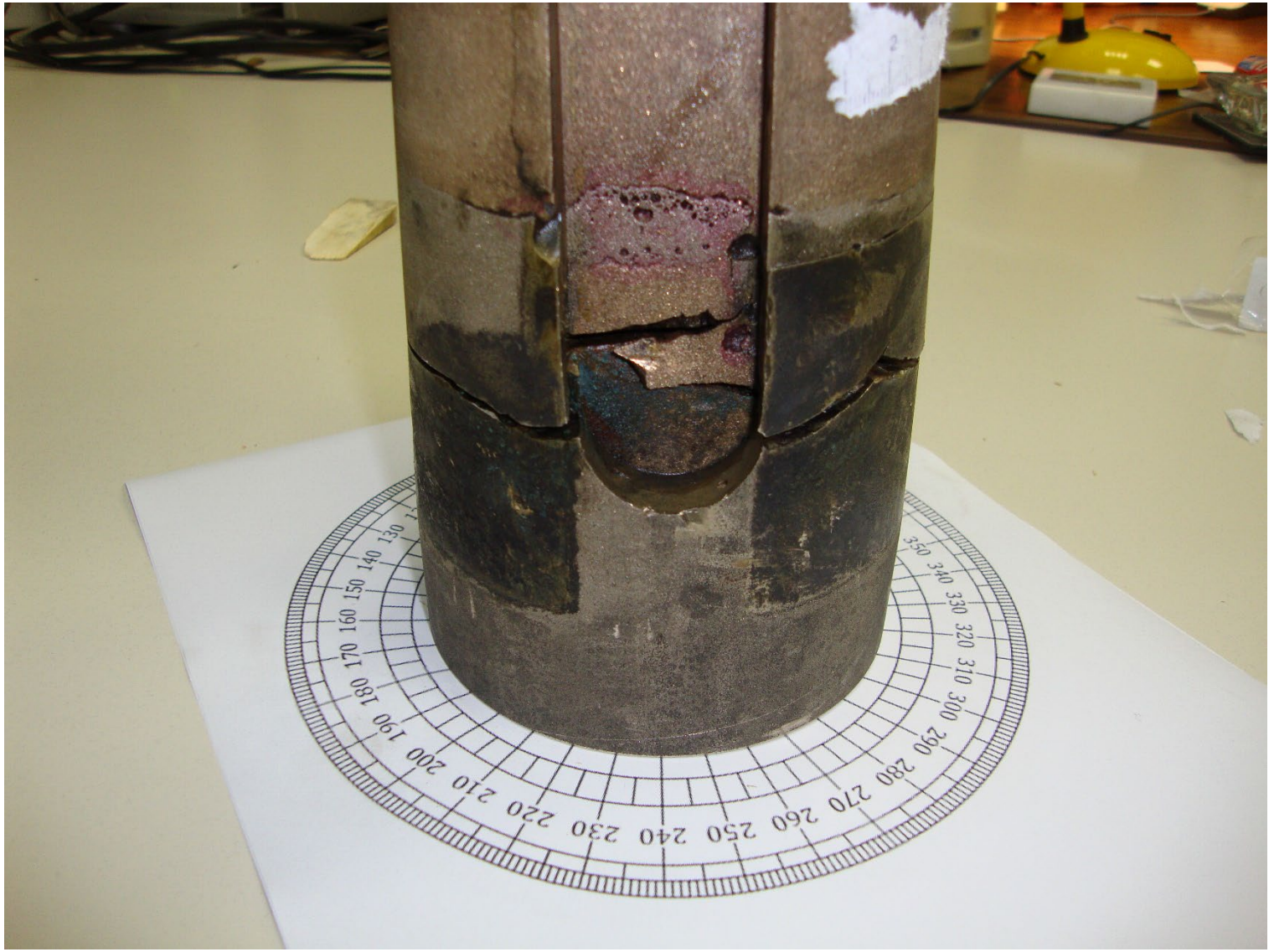
Example: July 2015, Boat shaft No 1 failure

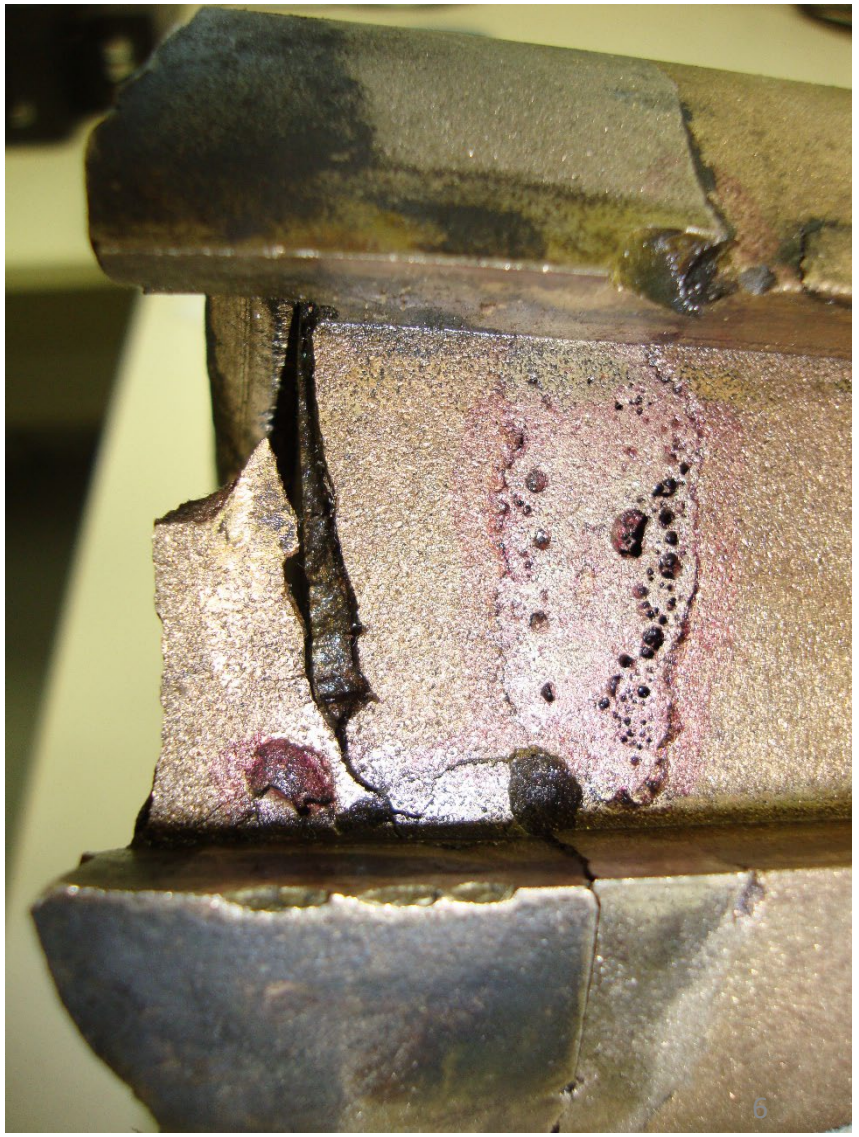






May 2017: Boat shaft No 2 failure





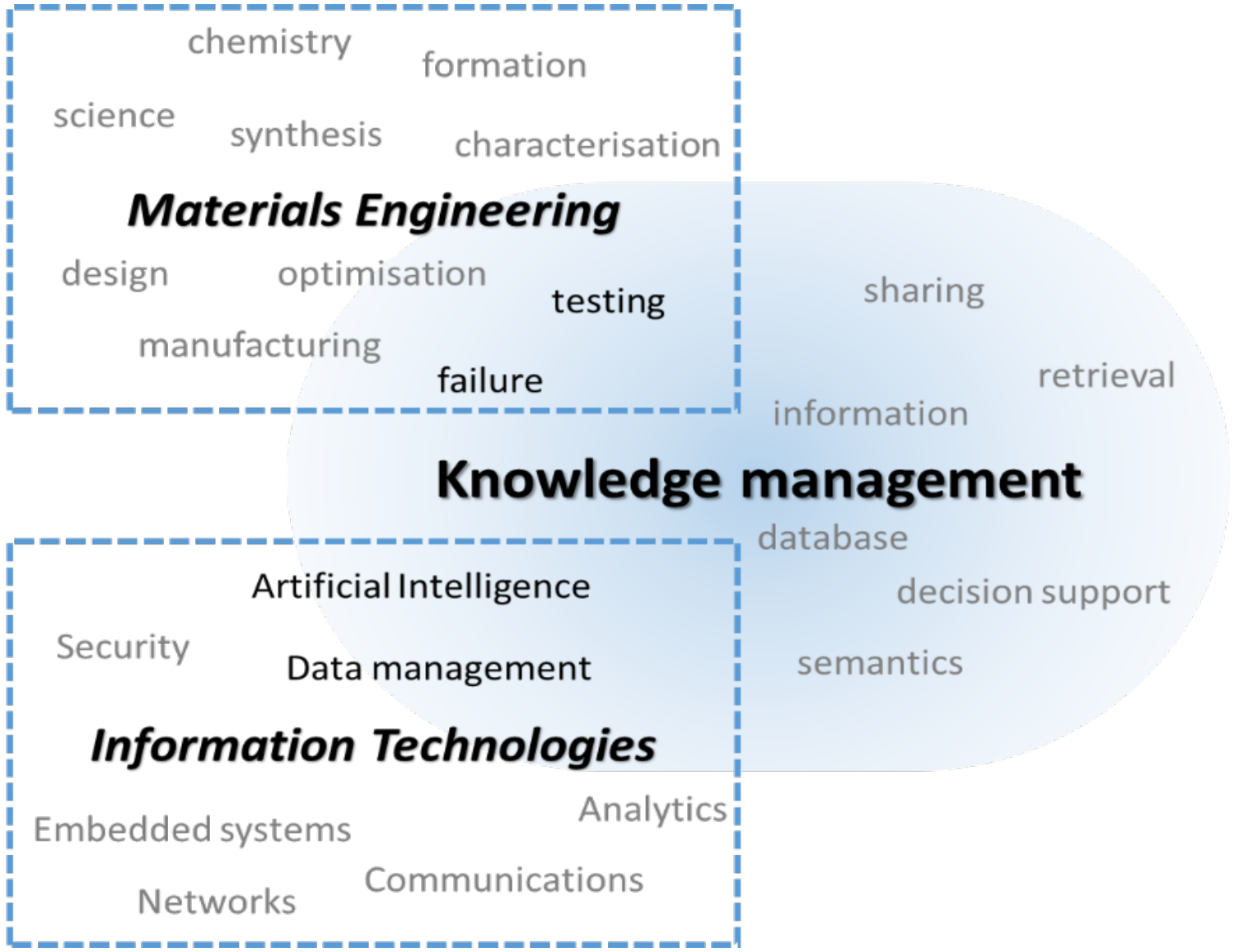
Issues to address

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

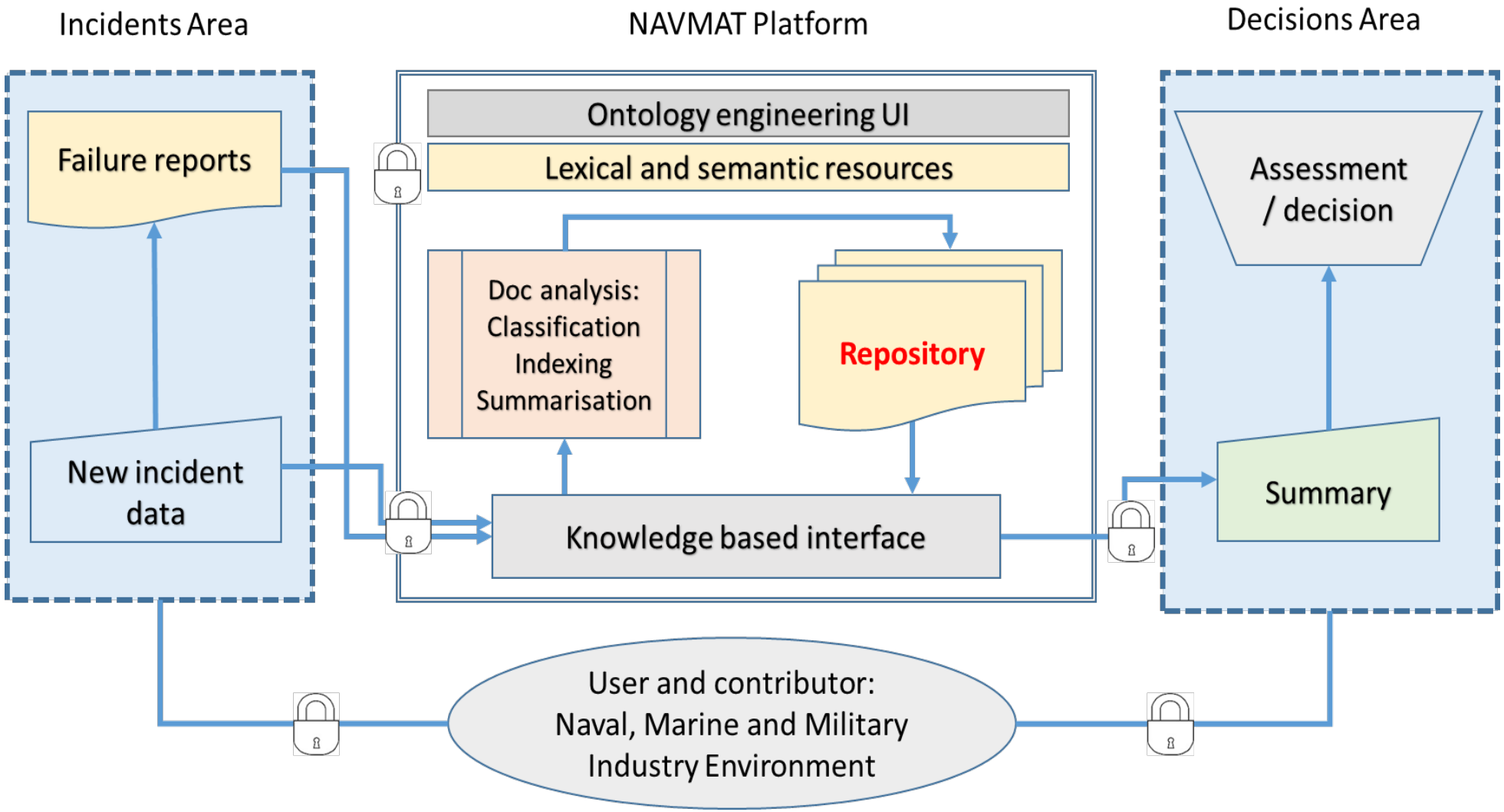
NAVMAT attempts an interdisciplinary approach by integrating *Materials Engineering* and *Informatics* under the *Management of Knowledge*.



The project definition

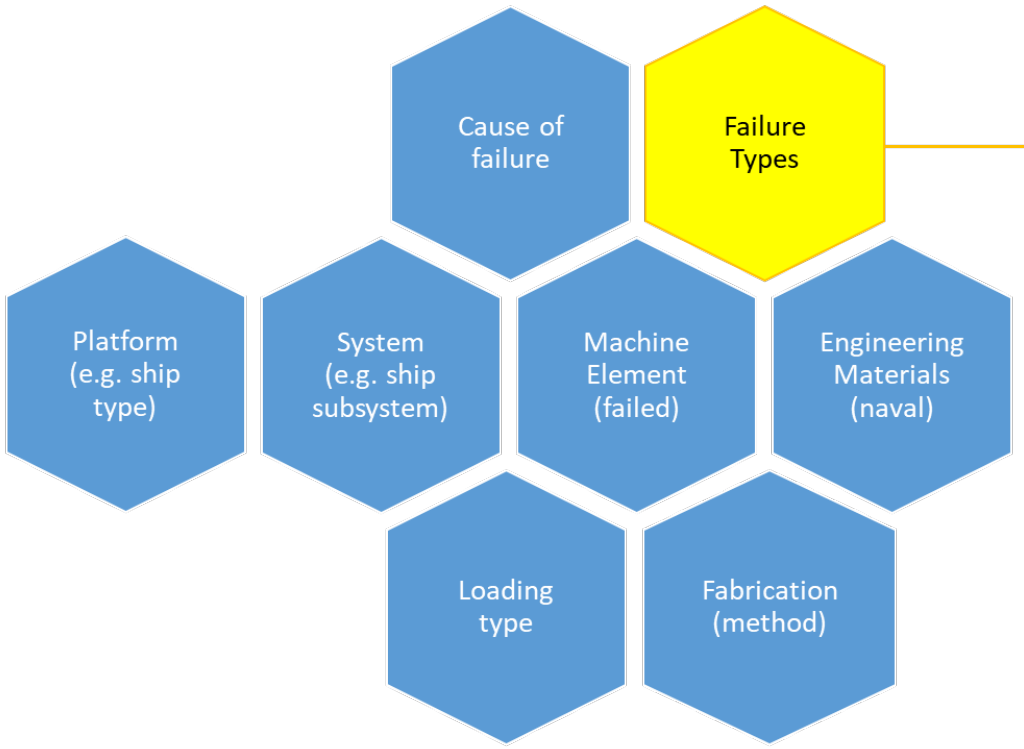
- NAVMAT is a knowledge based system dedicated to effective recording, efficient indexing, easy and accurate retrieval of information, history of maintenance, concerning every failure incident of marine materials, components and systems in a Naval environment
- Based on **materials failure ontology**, 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



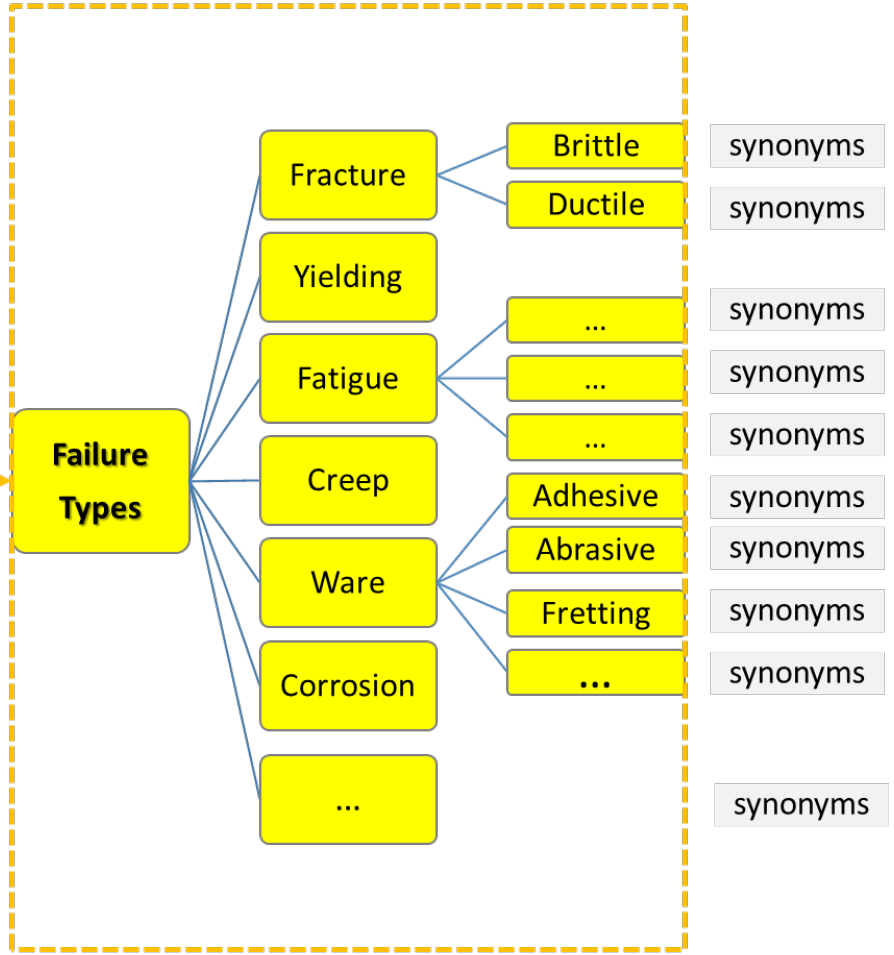
Indicative system ontology

Naval Materials Failure Ontology Tables



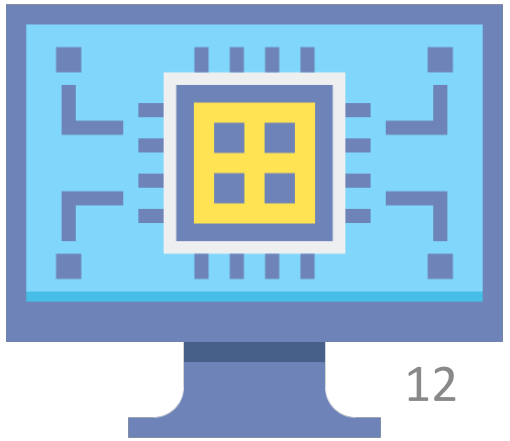
7. Failure mode

Indicative Table Taxonomy (2 levels)



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



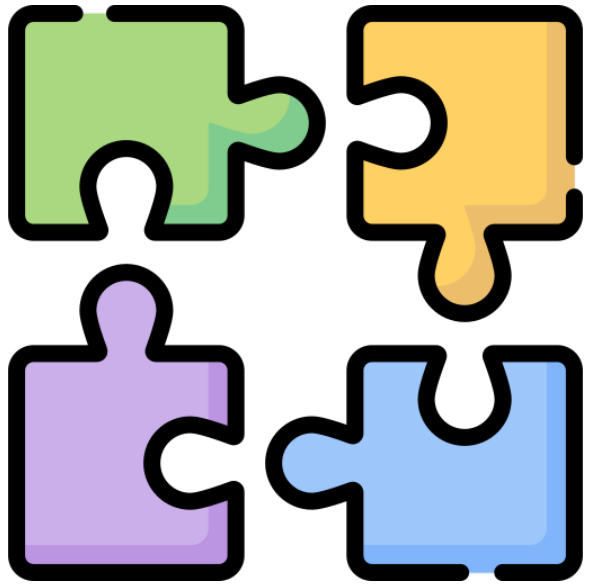
Typical workflows

- “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 (and language independent !)
- Scalable
  - Various sources of incidents of failure
  - Various sources of documentation
  - Many users
- Adaptive / personalized
  - Varying levels of access
  - Learning from user actions



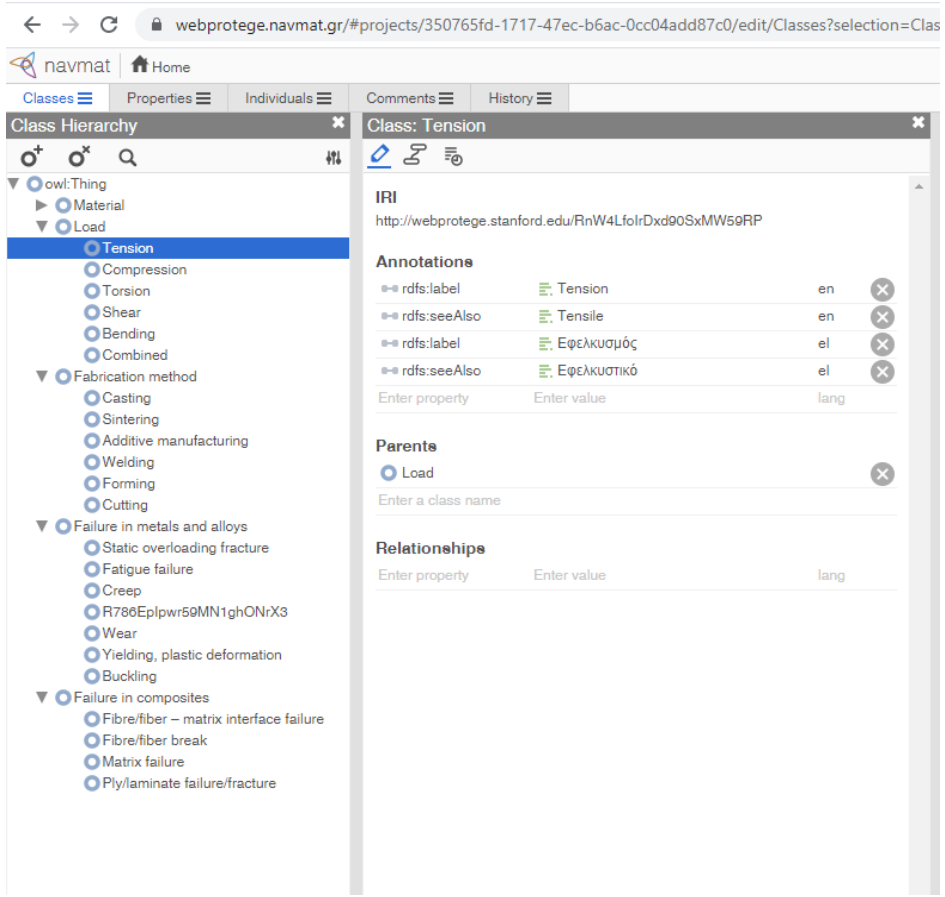
WebProtégé ontology management system

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



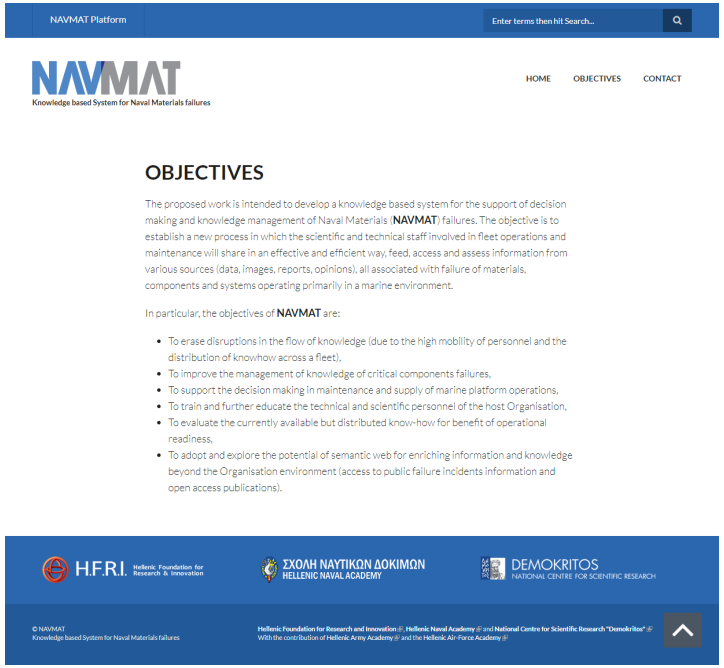
app.navmat.gr

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

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and invite you

to contribute

to participate

to expand

the NAVMAT community and network

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