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UNIVERSITY OF THE
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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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Failure consequences ...

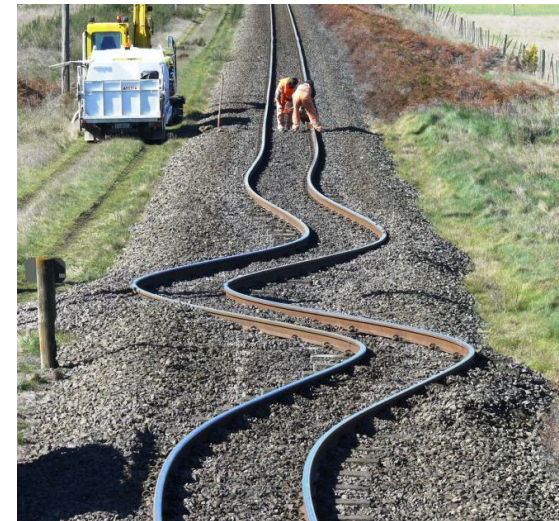


... of a component, a structure, a vehicle or a system –
in any technology depended sector, are assessed in terms of
economy, personnel safety, **environment**, **operations**



“Unforeseen” failure

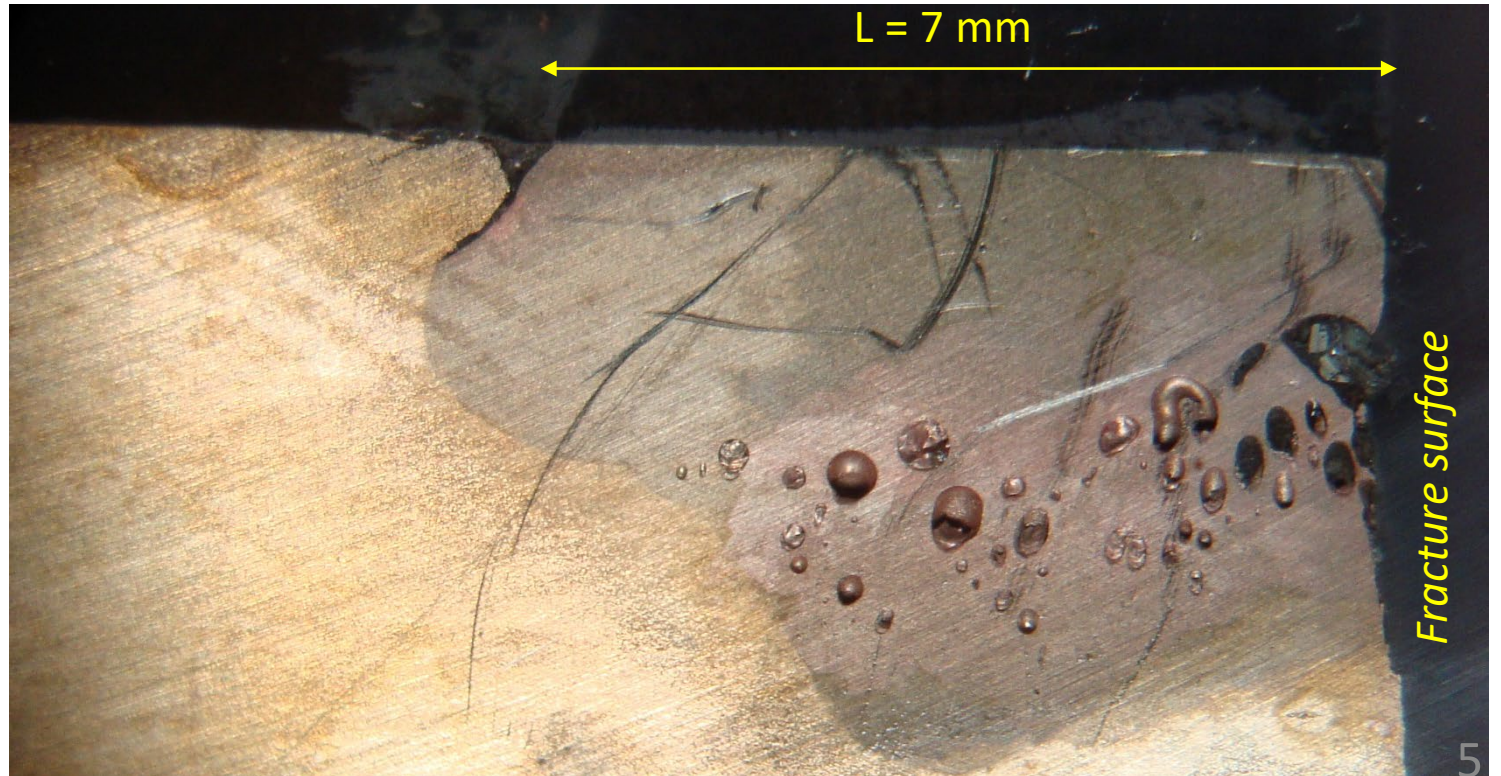
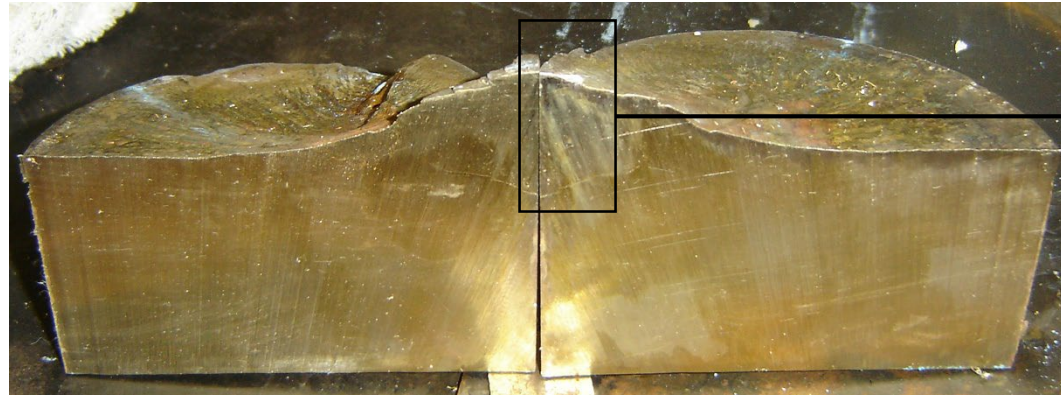
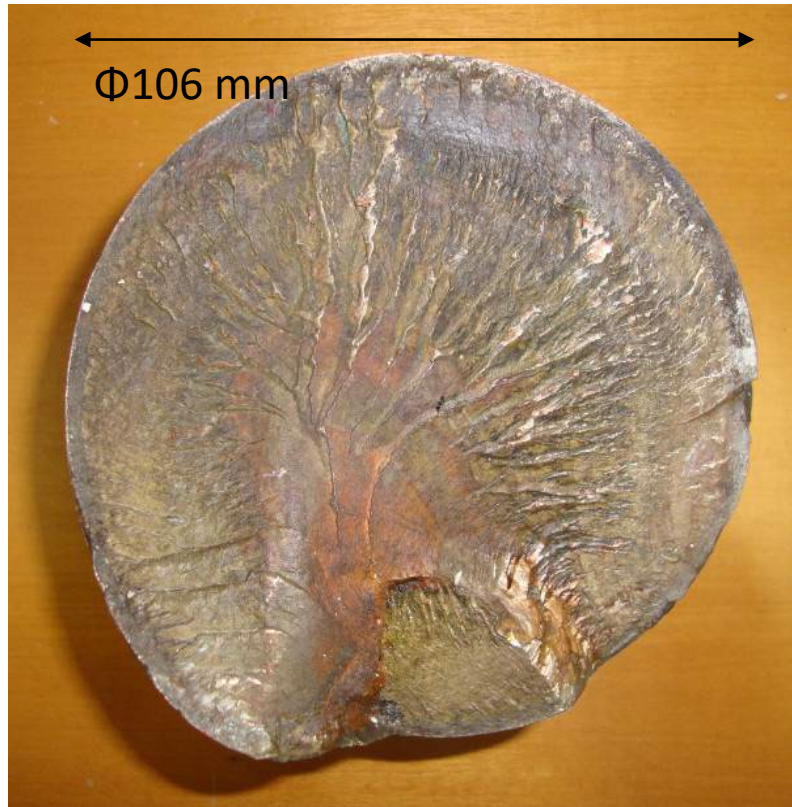
- Uncontrolled failure parameters:
poor design, manufacturing fault,
installation error, maintenance
negligence, process weakness ...
- “Force majeure”
meteorological, geological phenomena,
terrorism, etc.



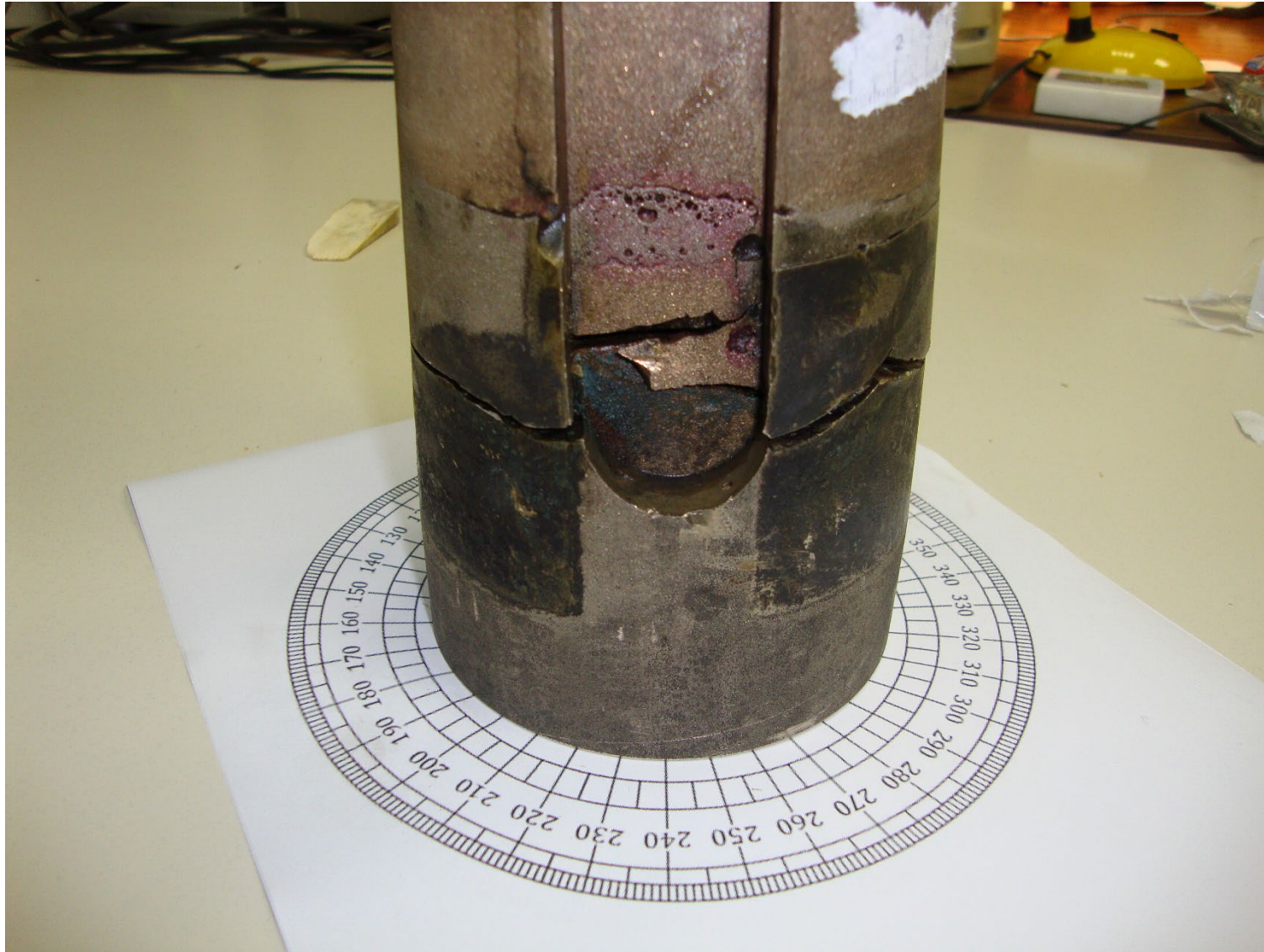
Materials failure – a knowledge process



Example: July 2015, Boat shaft No 1 failure



May 2017: Boat shaft No 2 failure



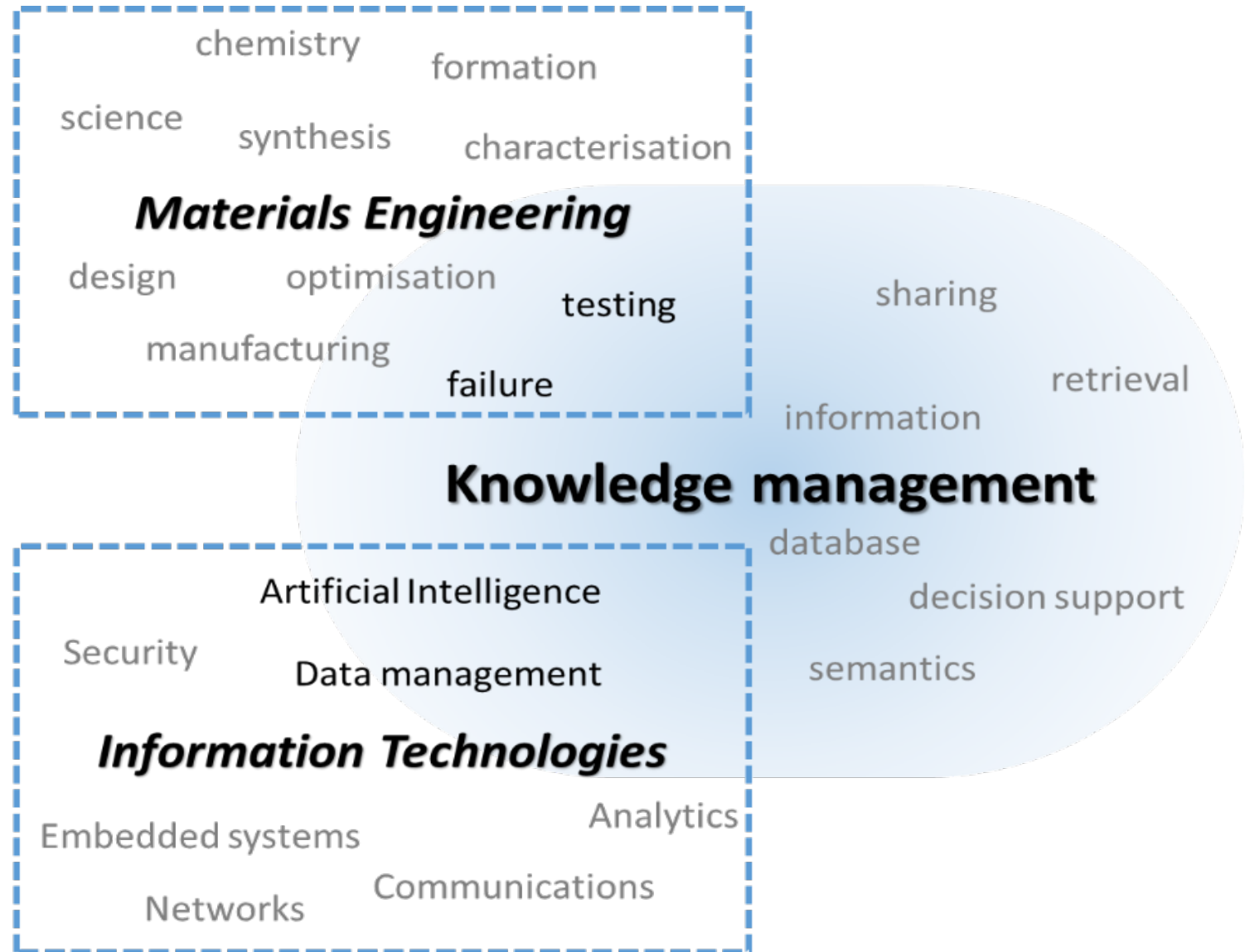
Issues to address

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*.

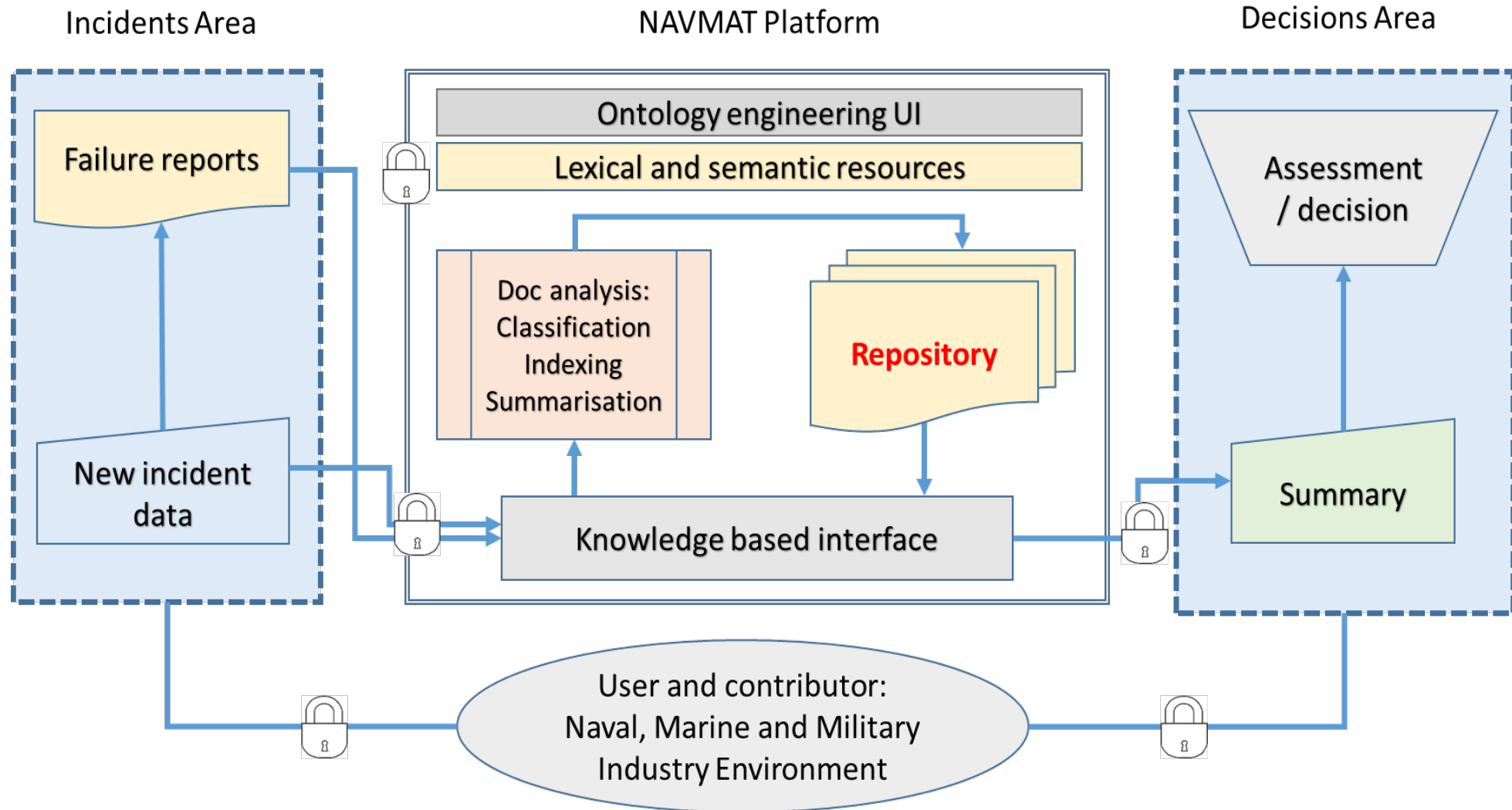


The project definition



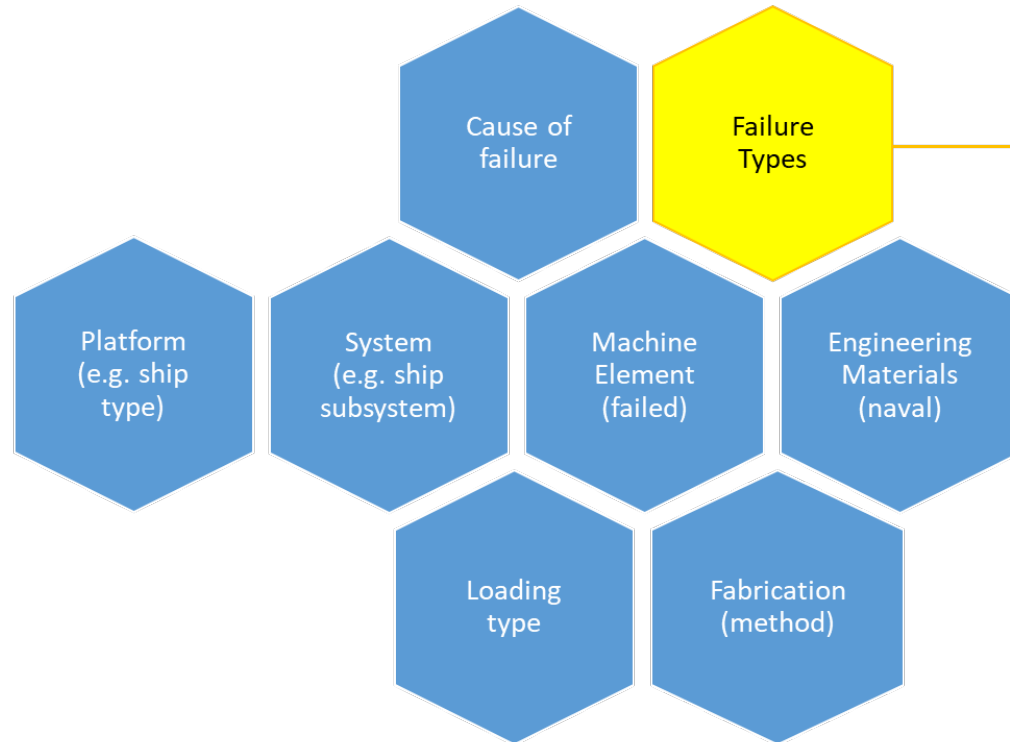
- NAVMAT is a knowledge based system dedicated to effective recording, efficient indexing, easy and accurate retrieval of information, history of maintenance, concerning every failure incident of marine materials, components and systems in a Naval environment
- Based on materials failure ontology, utilising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



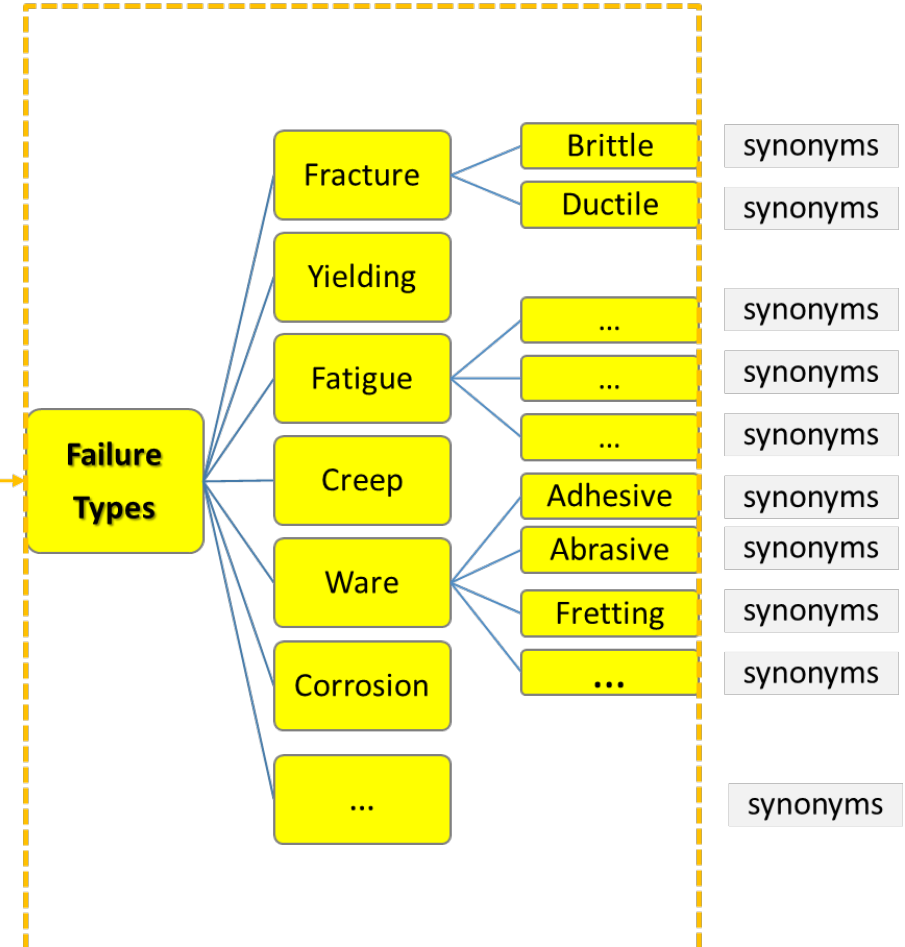
Indicative system ontology

Naval Materials Failure Ontology Tables



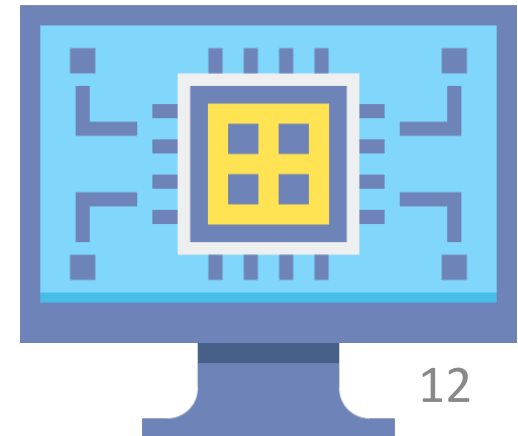
7. Failure mode

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



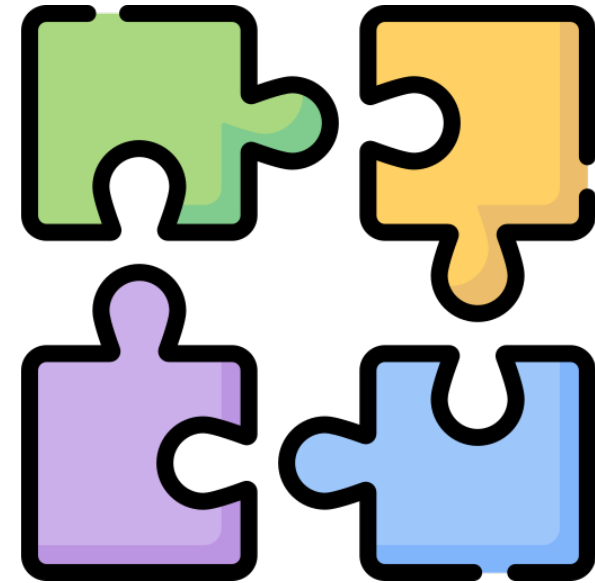
Typical workflows

- “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



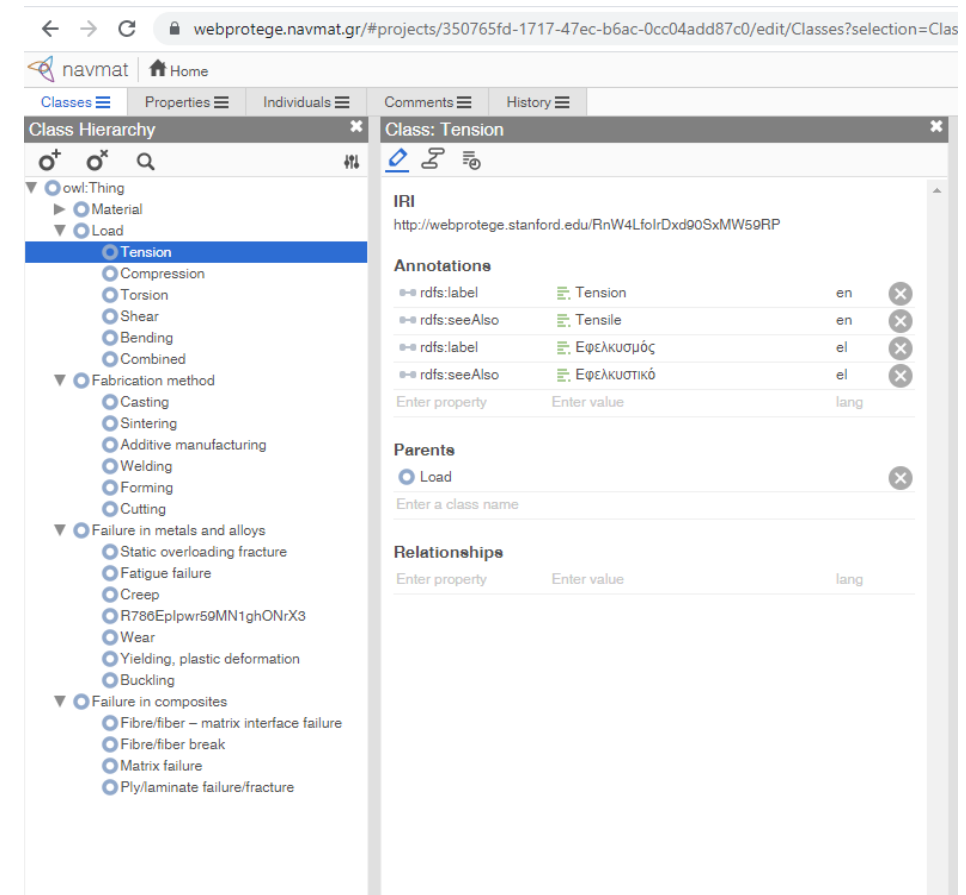
WebProtégé ontology management system

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.)

The screenshot shows the NAVMAT website interface. At the top, there is a search bar with the text 'Enter terms then hit Search...' and a magnifying glass icon. Below the search bar, the NAVMAT logo is displayed, with the tagline 'Knowledge based System for Naval Materials failures'. To the right of the logo, there are navigation links for 'HOME', 'OBJECTIVES', and 'CONTACT'. The main content area is titled 'OBJECTIVES' and contains a paragraph describing the system's purpose: 'The proposed work is intended to develop a knowledge based system for the support of decision making and knowledge management of Naval Materials (NAVMAT) failures. The objective is to establish a new process in which the scientific and technical staff involved in fleet operations and maintenance will share in an effective and efficient way, feed, access and assess information from various sources (data, images, reports, opinions), all associated with failure of materials, components and systems operating primarily in a marine environment.' Below this paragraph, it states 'In particular, the objectives of NAVMAT are:' followed by a bulleted list of five objectives: 1. To erase disruptions in the flow of knowledge (due to the high mobility of personnel and the distribution of knowhow across a fleet). 2. To improve the management of knowledge of critical components failures. 3. To support the decision making in maintenance and supply of marine platform operations. 4. To train and further educate the technical and scientific personnel of the host Organisation. 5. To evaluate the currently available but distributed know-how for benefit of operational readiness. 6. To adopt and explore the potential of semantic web for enriching information and knowledge beyond the Organisation environment (access to public failure incidents information and open access publications).

At the bottom of the screenshot, there is a footer with logos for H.F.R.I. (Hellenic Foundation for Research & Innovation), ΣΧΟΛΗ ΝΑΥΤΙΚΩΝ ΔΟΚΙΜΩΝ (HELLENIC NAVAL ACADEMY), and DEMOKRITOS (NATIONAL CENTRE FOR SCIENTIFIC RESEARCH). Below the logos, there is a copyright notice: '© NAVMAT Knowledge based System for Naval Materials failures' and a small upward-pointing arrow icon.

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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