

THE FATIGUE BENCHMARK REPOSITORY ACTION: OBJECTIVES AND ITS RELEVANCE TO FATIGUE COMMUNITY

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FABER CA23109 Chair

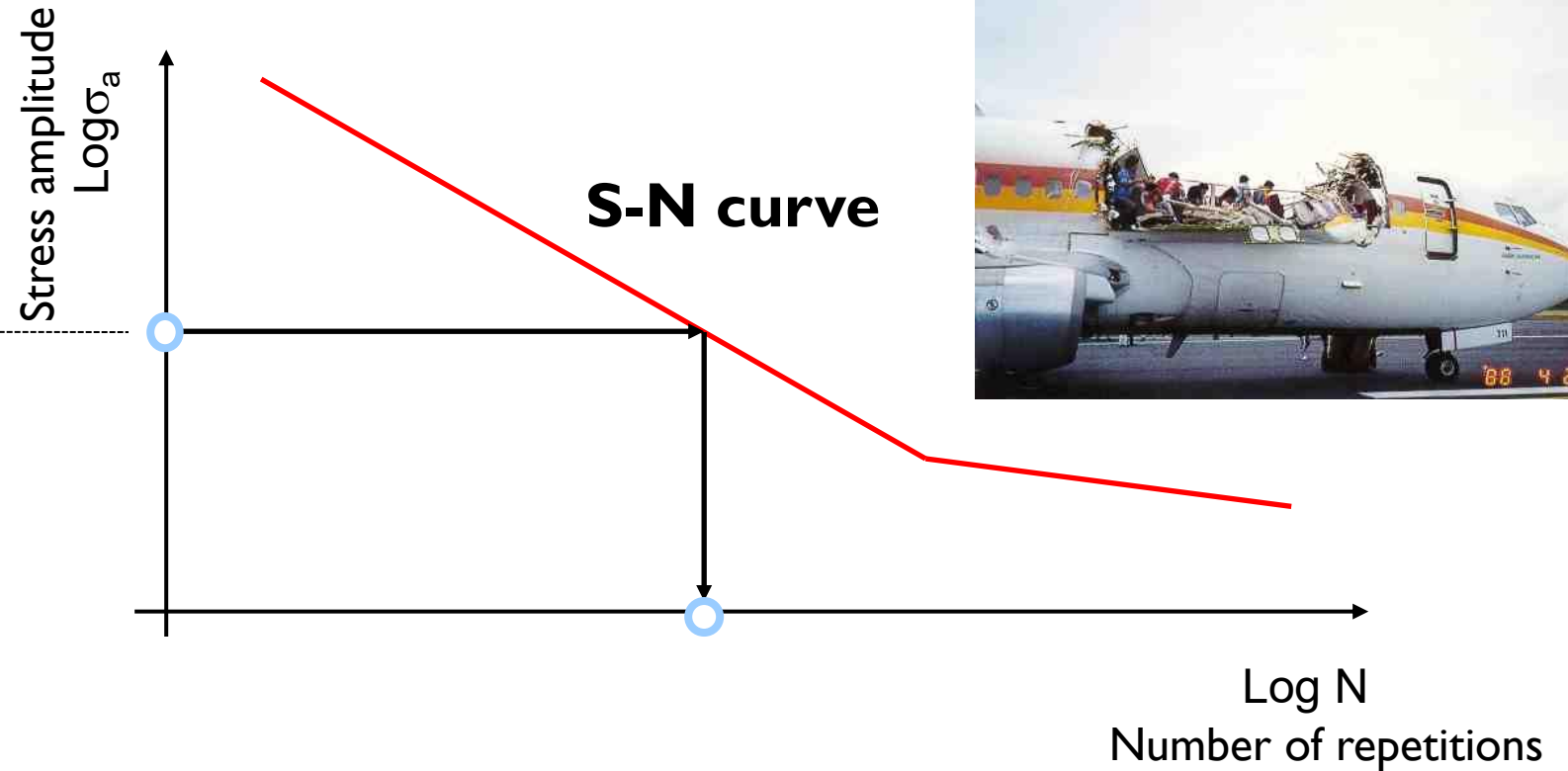
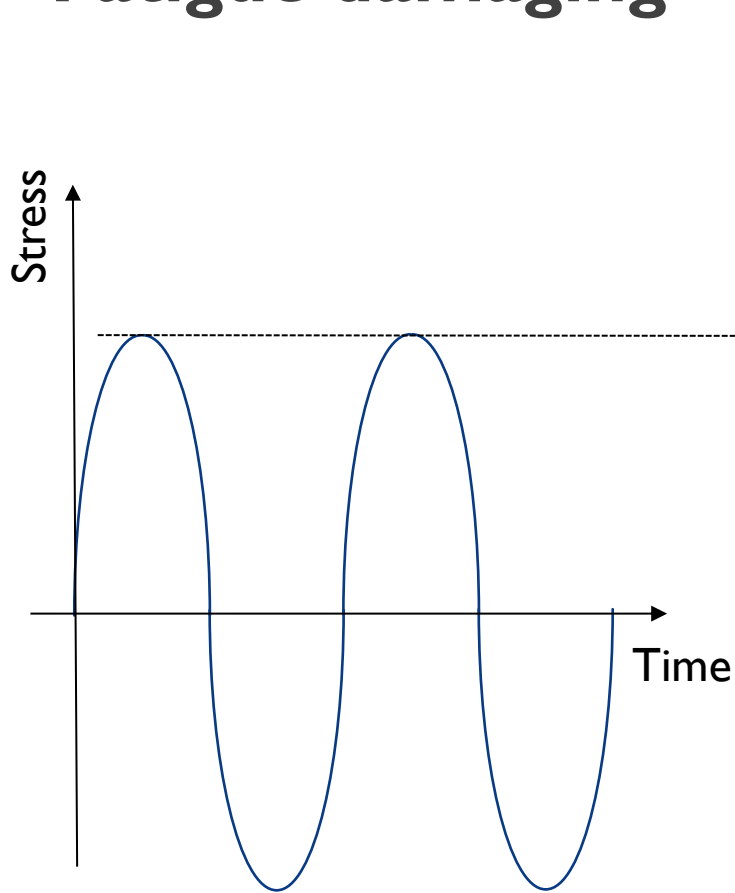


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WHAT MAKES MACHINES FAIL

■ Fatigue damaging



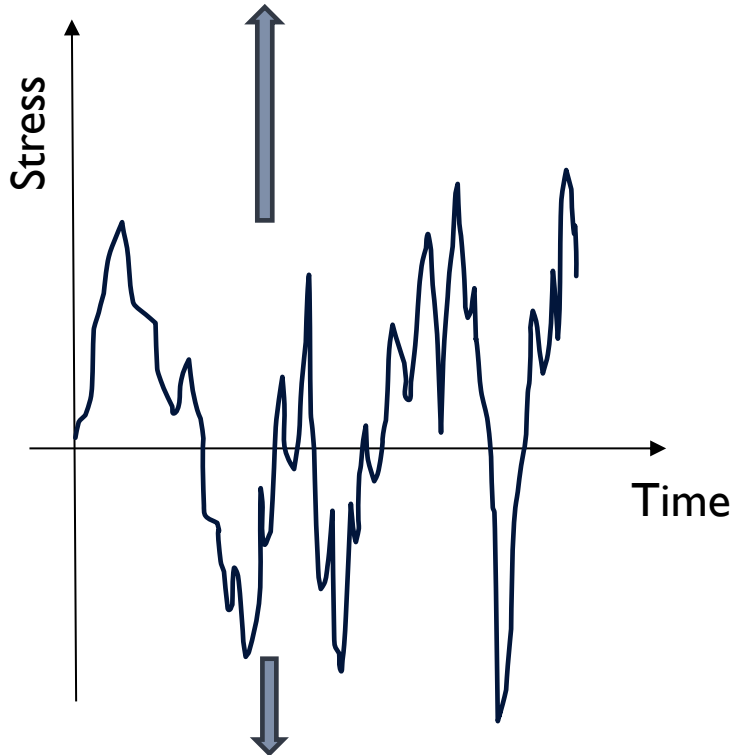
35496 flight hours
89680 landings
19 years in service



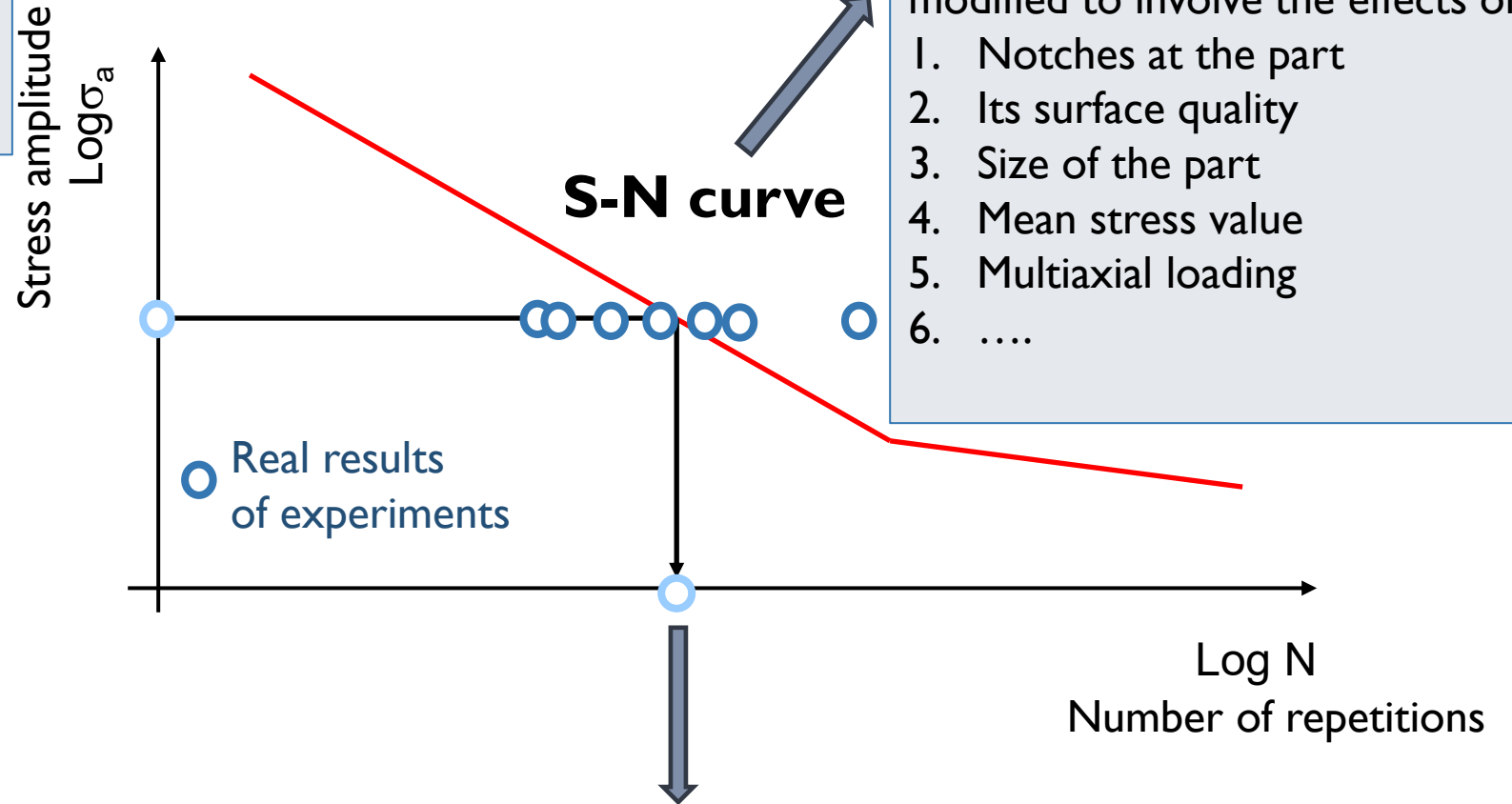
Quite simple, is not it?

WHY IS FATIGUE ESTIMATION COMPLICATED?

1. What is the stress amplitude?
2. How can I turn this record to cycles to define the amplitude?
3. There are more cycles of other sizes, how to treat them?



1. How I get to this record of the process?
2. Does it represent „general“ machine of this type?



Though it is originally material characteristics, it must be modified to involve the effects of:

1. Notches at the part
2. Its surface quality
3. Size of the part
4. Mean stress value
5. Multiaxial loading
6.

1. The S-N curve shows „typical“ behaviour
2. In 50% of cases, the break comes sooner
3. How to make the service safe?

FATIGUE ESTIMATION MODELS

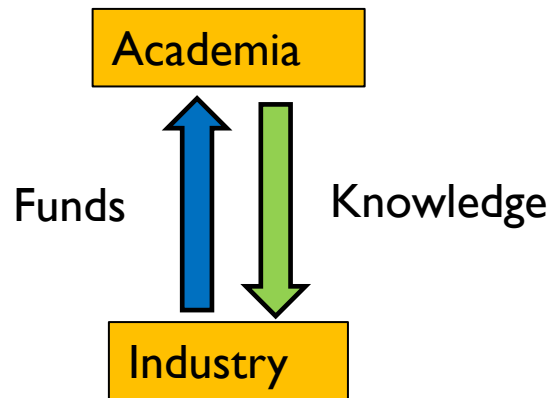
- Fatigue emerged as an engineering domain to study at the second end of 19th century
- They are purely empirical
- Fatigue damaging can be described as a weakest-link mechanism
 - Under further repeated loading, any minor partial damage can cause the whole structure to collapse
- Multiple concurrent mechanisms, effects and issues are preventing to find a general theory
- Experiments and experimental data to support or validate models are extremely costly

FATIGUE SOLVERS

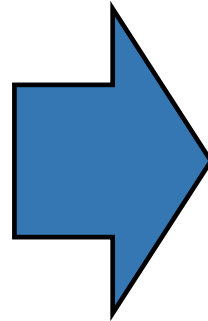
- Emerged at the 80's of the 20th century
- Implemented the current status quo of the fatigue analysis
- They focus on automation of existing empirical knowledge
- Thanks to that they provide a stable output less subject to human factor
- Dependency on current users and their habits prevents frequent updates and improvements
- They cannot provide a universal solution
- Their use includes warranty denial
 - The only person responsible for the results of the analysis using the software is its user

STAKEHOLDERS

1960:

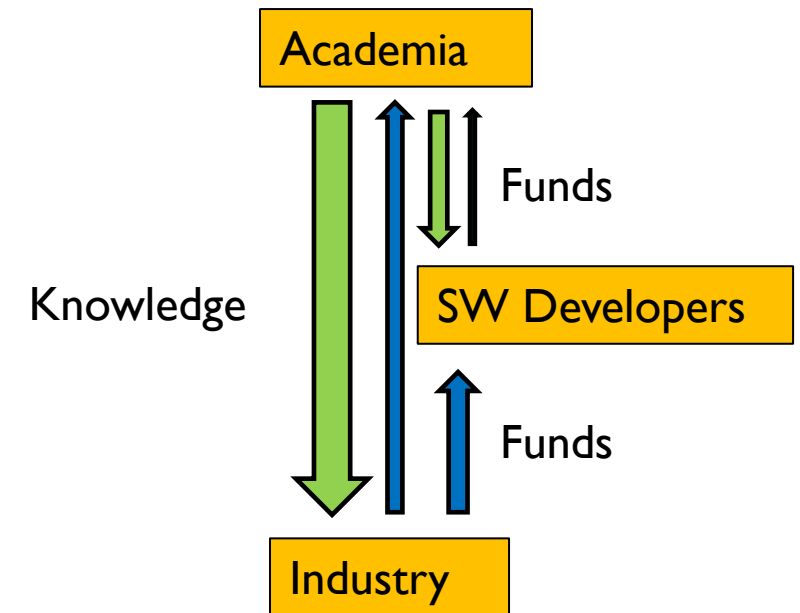


**Free market
competition**



Computerization

2020:



“... The users don’t really want to do their own research anymore. They expect nCode etc to "build-in" any new concept. Unfortunately this has stifled research by others. The major fatigue research labs in N. America are dying off....”

From personal e-mail communication with Al Conle (retired from Ford), 2009

WARRANTY DISCLAIMERS VS ADVERTISEMENT

- „MSC Fatigue enables durability engineers *to quickly and accurately predict* how long products will last *under any combination* of time-dependent or frequency-dependent loading conditions.“
MSCsoftware.com (2018). MSC Fatigue: FE Based Durability Solution. [online] Available at: <http://www.mscsoftware.com/product/msc-fatigue> [Accessed 30 Aug. 2018]

- “Do I need to be a fatigue expert?
No, you can leave that to us. There are factors which cannot be ignored if results are to be trusted. However, because fe-safe is technically advanced, it is configured to take into account many variables which will affect the accuracy of your results automatically.”
3ds.com. (2018). FE-SAFE – SIMULIATM 3D Software – Dassault Systèmes®. [online] Available at: <https://www.3ds.com/products-services/simulia/products/fe-safe/> [Accessed 30 Aug. 2018].

The goal today - Search for an intelligent system: The same (wo)man builds the virtual CAD model, meshes it, adds boundary conditions and runs the FE-analysis, which (s)he then uses for the subsequent fatigue analysis. The computer (program) assists to these actions and prevents any potential errors.

THE DEADLOCK

Industry

- Rarely funds academic fatigue research directly due to uncertain outcome.
- Prefers to invest in fatigue solvers.

Fatigue solver developers

- Use the outcome of academic research without any compensation.
- Prevent direct comparison of their products through EULAs that prohibit benchmarking.
- Their marketing emphasizes ease of use, often suggesting that no prior expertise in fatigue analysis is required.

Academia

- Sees little incentive to engage with industry or fatigue software developers.
- Researchers rely on government grants, which necessitate ambitious, forward-looking objectives rather than immediate practical applications.

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Can we afford to rely on outdated, decades-old calculation models simply because they are automated?

At what point does this lack of progress become a liability rather than a convenience?

THE WAY OUT

Industry: Demand Transparency and Validation

- Not to accept the black-box scenario
- Demand independent benchmarking studies
- Provide access to verified fatigue data
- Define industry-wide validation protocols

Fatigue solver developers

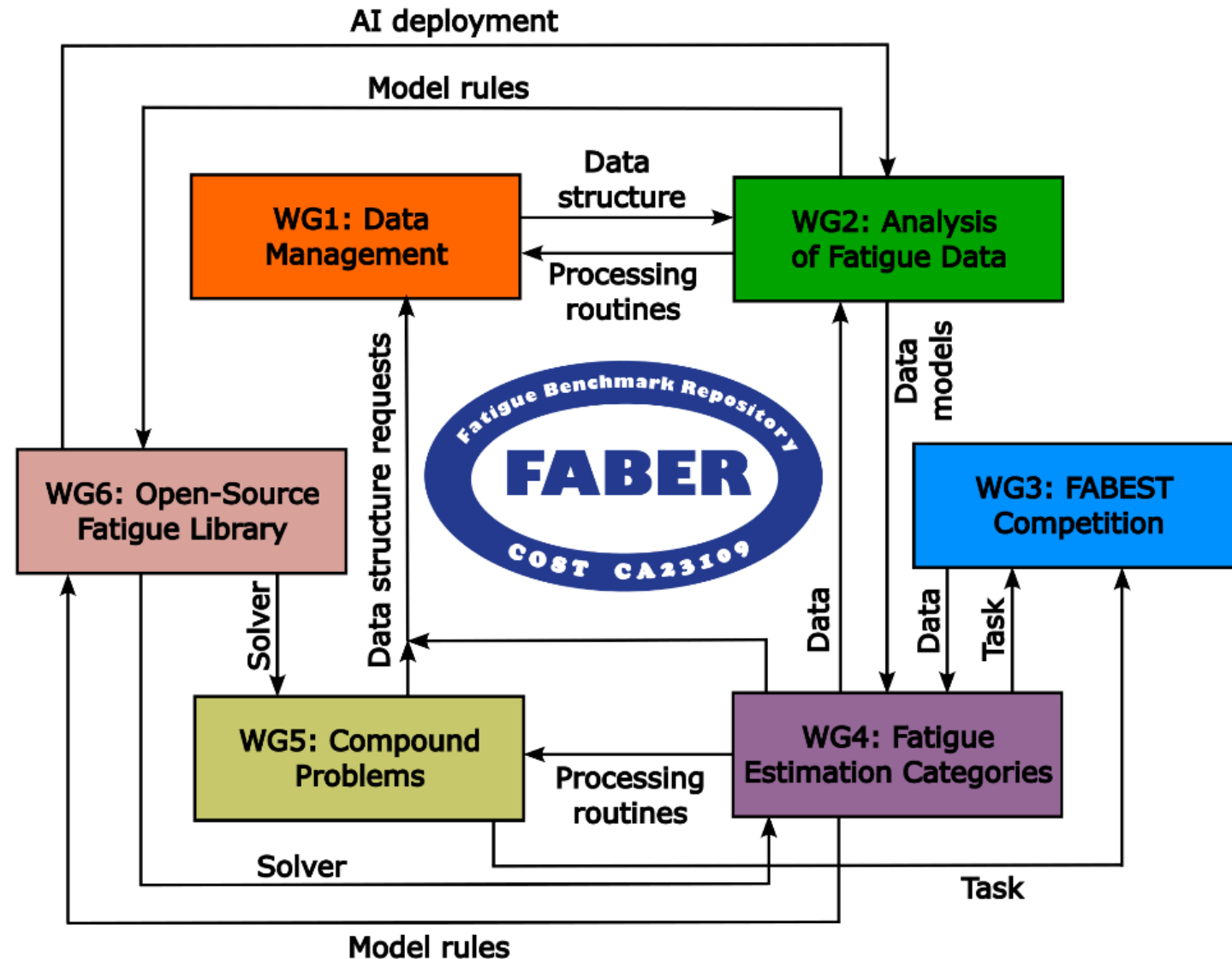
- Acknowledge the responsibility not only for automation but also for ensuring accuracy
- Support open-access benchmarking initiatives
- Provide the users with a clear understanding of their software's limitations

Academia

- Recognize the importance of validating and refining existing fatigue models
- Creating standardized, publicly available fatigue datasets for validation
- Collaborate with industry and SW developers in testing of real-world applications

FABER = FATIGUE BENCHMARK REPOSITORY

- Funded by COST for the period of 2024-2028
 - Funds networking costs, but no research or development
- Distributes the demanding tasks to more cooperating people/institutions
 - > 320 members (September 2026)
- Focuses on High-Cycle Fatigue
- **Is open to all newcomers**



MAJOR OUTPUTS

- Benchmarks for fatigue evaluations in these categories

- High-cycle fatigue

- Mean stress effect
 - Notch effect
 - Multiaxial loading
 - Surface quality effect
 - Damage accumulation
 - Anisotropy of material

- Low-cycle fatigue

Database of fatigue experiments

FABEST competition for the best fatigue prediction

FatPy open-source fatigue library

CALL TO ACTION

Academia

- [Join us](#) to redefine the quality of fatigue life estimation

Industry: Invest in Reliable Fatigue Estimation

- [Fund](#) targeted research and development within FABER.
- [Provide access](#) to proprietary fatigue datasets.
- [Participate in FABER](#) to help define benchmark requirements that reflect real-world challenges.

Fatigue solver developers

- [Integrate](#) FABER benchmarks [into validation](#) pipelines.
- [Allow](#) independent [benchmarking](#) of your tools.
- [Collaborate](#) with academia and industry to refine existing fatigue models and ensure their accuracy.

Your Benefits



- Contacts
- Research topics
- Base data for research



- Understanding the limits of used SW
- Confidence in your fatigue estimates
- Reduced risk of unexpected failures



- Credibility of your products
- Trust of your users
- Base for further enhancements
- Validation outsourced for free

2024-2028

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