Virtual Lifetime Evaluation: Accelerating Development and Reducing Validation Costs

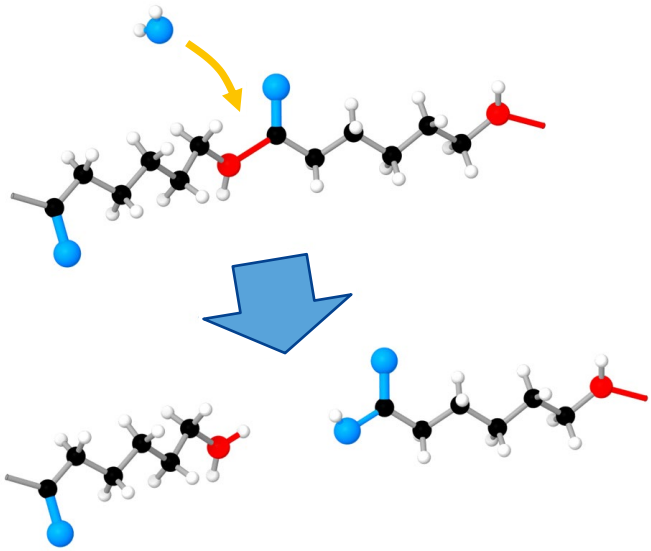
Predicting polymer aging: boosting product safety, reliability and speed to market

Chemical degradation of polymers inevitably reduces material performance over time.

As lifetime expectations grow, traditional testing becomes increasingly costly and time-consuming.

Our scientific approach to predict long-term degradation enables safer, more reliable products – delivered faster and more cost-effectively.

It's a key enabler for validating long-life applications that would otherwise be impractical to test conventionally.



This is what you will love!

- **Enhanced Product Reliability:**
  Understand and predict how polymers age under real-world conditions – ensuring long-term performance and safety.
- **Simulation-Driven Design:**
  Replace costly, time-consuming physical tests with advanced simulation models for faster development cycles.
- **Accelerated Aging Insights:**
  Testing above normal service temperatures accelerates long-term predictions, saving time and costs.
- **Adapt to Harsh Environments:**
  Identify and mitigate the effects of heat, oxygen, water, UV light and chemicals on polymer degradation.
- **Supports Sustainability:**
  Extend product life and reduce waste and CO_2 emissions through better material durability.
- **Competitive Advantage:**
  Offer customers longer-lasting, more reliable and cost-efficient polymer-based solutions.
- **Enabler of long-term validation:**
  Facilitate developments which would be impractical to validate through conventional testing.

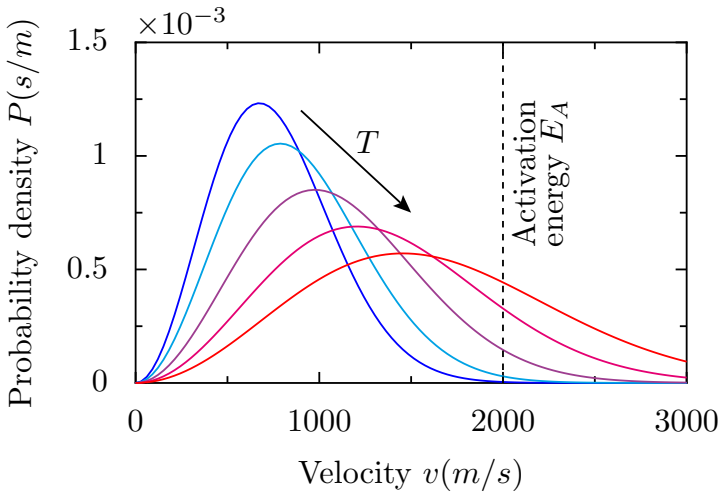
Simulating years of polymer aging in minutes – background

Where you will benefit from it:

- Applicable to any polymer that must retain function over time – across automotive, industrial, and consumer sectors.
- Especially effective for polymers exposed to heat and media, where aging is accelerated and traditional testing is slow.

How it works:

- Chemical degradation occurs when molecules gain enough energy to overcome an activation energy barrier.
- The Maxwell-Boltzmann distribution describes how many molecules have this energy at a given temperature.
- Higher temperatures increase the fraction of reactive molecules, accelerating aging.
- By testing at elevated temperatures, we simulate long-term aging in a shorter time.
- Using kinetic models, we calculate how long it would take to reach the same degradation at real service temperatures.
- This enables accurate lifetime predictions without lengthy real-time testing.



Understanding material fatigue to enhance product reliability and maximize material utilization

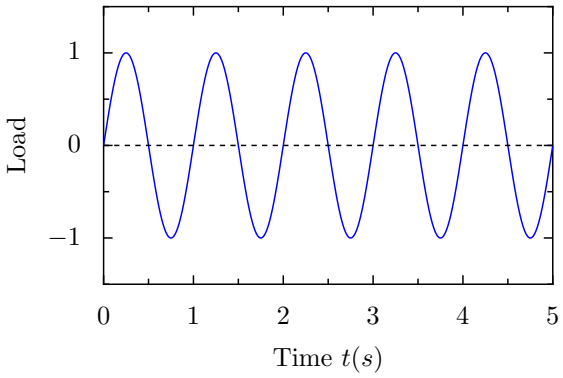
Imagine bending a paper clip back and forth a few times, eventually it will snap.

This illustrates the fundamental concept of material fatigue.

It is the progressive weakening of a material caused by repeated loading and unloading cycles.

Over time, even small stresses can lead to the formation of micro-cracks, which grow and eventually cause failure.

Fatigue is a critical factor in product durability, especially in components exposed to vibrations, pressure fluctuations, or other mechanical loads.



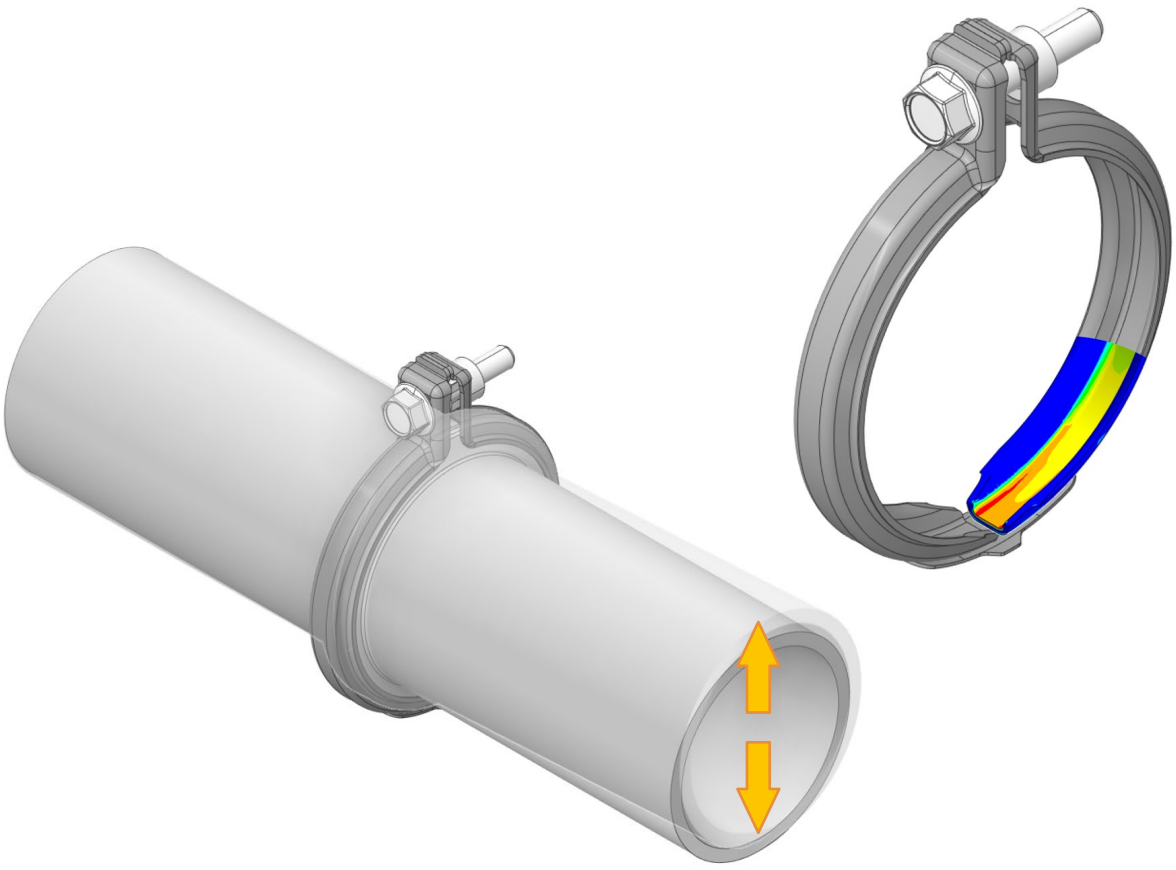
This is what you will love!

- **Improved Product Reliability:**
  Fatigue modeling ensures components withstand real-world cyclic loads, reducing the risk of unexpected failures.
- **Design Optimization:**
  Identify fatigue-critical areas early and refine geometry or material usage to enhance performance and reduce weight.
- **Fewer Physical Tests:**
  Reduce reliance on costly and time-consuming fatigue testing by validating concepts virtually.
- **Faster Iteration Cycles:**
  Integrate fatigue analysis into the design loop to accelerate development and decision-making.
- **Sustainable Solutions:**
  Optimized designs use less material without compromising strength, contributing to lower CO_2 emissions and greener products.

Fatigue analysis – potential benefits and applications

Where you will benefit from it:

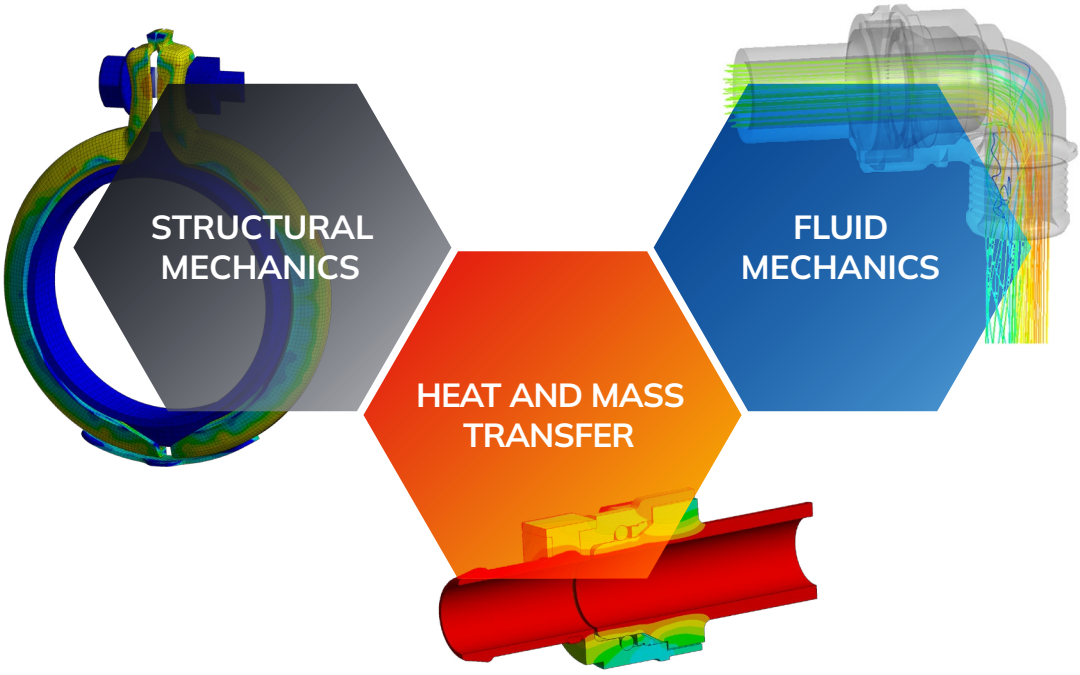
- **Product and Tool Optimization:**
  Evaluate components under cyclic loading to identify fatigue-critical areas and optimize design for durability and efficiency.
- **Accelerated Testing:**
  Use increased load amplitudes to shorten test durations and accurately translate results to real-world service conditions.
- **Test Profile Analysis and Optimization:**
  Analyze validation test plans to pinpoint which load stages cause the most damage to enable smarter, more targeted test planning.



In a nutshell:
why simulation makes a difference for your development cycle

- Reduced development time and cost
- Better design decisions earlier in the process
- Support for validation, virtual testing, and homologation

Discover more of our extensive simulation capabilities:



Do you have questions or require a personal consultation?
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Or visit our website for more information about our solutions: www.normagroup.com

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