SentientScience

sentientscience.com

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Research & Development
1000 Riverwalk Drive, Suite 375,
Idaho Falls, ID 83402

Laboratory Testing Facility
1201 Cumberland, LLC
West Lafayette, IN 47906

Company Summary

Founded in 2001, Sentient Science Corporation has grown into a leading technology platform in the field of component life prediction through materials science modeling and physics-based simulation. Sentient's core technology, DigitalClone® is a platform of operators, OEM suppliers and service providers connected through short and long-term life predictions, demand forecasting and prescriptive maintenance actions.

DigitalClone®

DigitalClone® is an award-winning software that predicts long-term failure rates through simulation of components under operational load. The software predicts early crack initiation and identifies wear and fatigue damage in the microstructure of critical components and major systems of helicopter drivetrains and industrial rotating mechanical equipment.

Reduce Design Costs by

30% - 40%

Accelerate Schedules by

50% - 75%

Reduce Operating Costs by

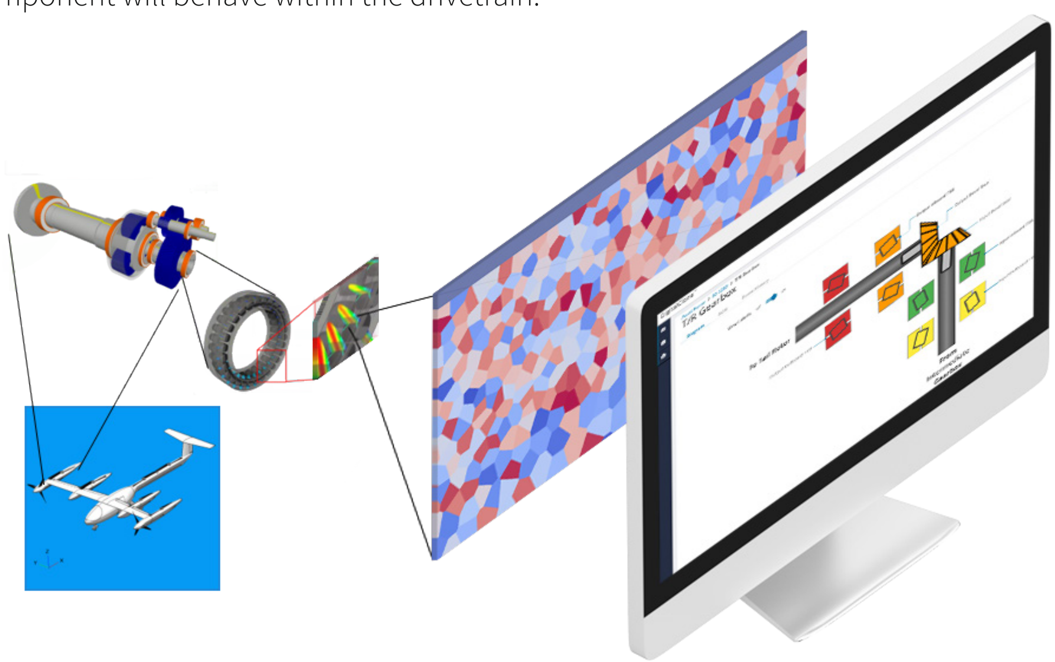
10% - 15%

DigitalClone®

DigitalClone was developed to support and facilitate an ecosystem of operators and suppliers in an emergent digital marketplace. Through demand forecasts generated by the component life predictions of deployed assets, the ecosystem encourages transactions based on lifecycle cost and optimized maintenance schedules to reduce the cost of operation, sometimes by as much as 13% of an asset's annual revenue.

The ecosystem encourages transactions based on life (Buy on Life®) through a scientific understanding of product lifecycle costs based on material performance under operational loads, and how the materials and manufacturing processes effect reliability and sustainability of aircraft drivetrain components.

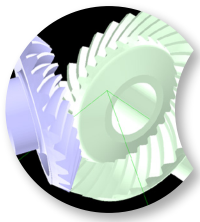
Sentient's technology includes advanced gear and bearing analysis modules that detail time-varying drivetrain models to predict steady state and transient loading events on the components. The non-linear, time varying nature of the algorithms provide insight into performance complexities generally not available in commercially available drivetrain analysis tools. The technology leverages materials science, tribology, multibody dynamics and data analytics to provide a component life prediction, or long-term forecast, of how each component will behave within the drivetrain.



Using DigitalClone, complex system-level drivetrain models, can compare up to six sub-component variations with up to 3 different sub-component upgrade options to evaluate the optimal bill of materials configuration to improve the sustainability of the system. The computational models can be parameterized for large-scale batch simulation and data extraction using Sentient's extensive materials and component library.

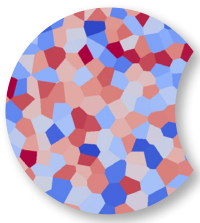
DigitalClone® Technology

Sentient Science uses a proprietary materials science-based computational approach to provide accurate life prognostics for each major system and critical components in rotorcraft systems. The software builds digital models of complex rotating systems and simulating the contact fatigue and bending fatigue damage over time.



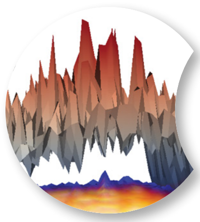
1. Macro-level loading Analysis

Macro-level loads are determined using a combination of finite element and multi-body dynamics modeling. System loads are translated to determine high stress regions of the component. The analysis accounts for load intensity, contact pressures, relative velocities, and curvatures.



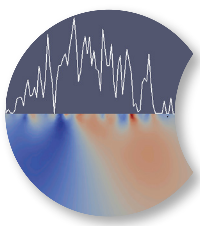
2. Build Material Microstructure Models

DigitalClone software models the microstructure of the component based on a detailed material characterization. The model accounts for material characteristics and manufacturing process such as heat treatments, coatings, and surface finishing.



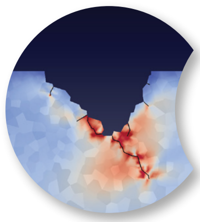
3. Build Surface Traction Models

A mixed Elastohydrodynamic Lubrication (EHL) model is used to understand the tractions and stresses on material surfaces. Detailed analysis of surface roughness and microasperity interactions ensure full consideration of the impacts that micro-level surface tractions can have on surface distress and fatigue cracking of critical components.



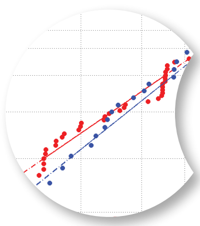
4. Material Microstructure Response

A finite-element solver determines the stresses acting on individual grains in reaction to the applied surface traction. Bulk stresses and surface tractions are applied to determine material microstructure responses to damage accumulation and crack nucleation/propagation. Surface shear stresses are modeled to analyze asperity interaction and surface roughness.



5. Calculate Time to Failure

A failure mode is determined as an outcome of the loading conditions (applied loading, surface tractions and internal loads). The software determines probability of component failure due to fatigue, pitting, subsurface initiated spalling, through-cracking, fretting fatigue, or bending fatigue.



6. Generate Response Surfaces

DigitalClone generates a response surface to evaluate the life impact of changes to grain size, lubrication, material properties, material cleanliness, additives, or viscosity. Customers use this to evaluate design trade-offs and to accelerate optimization efforts.

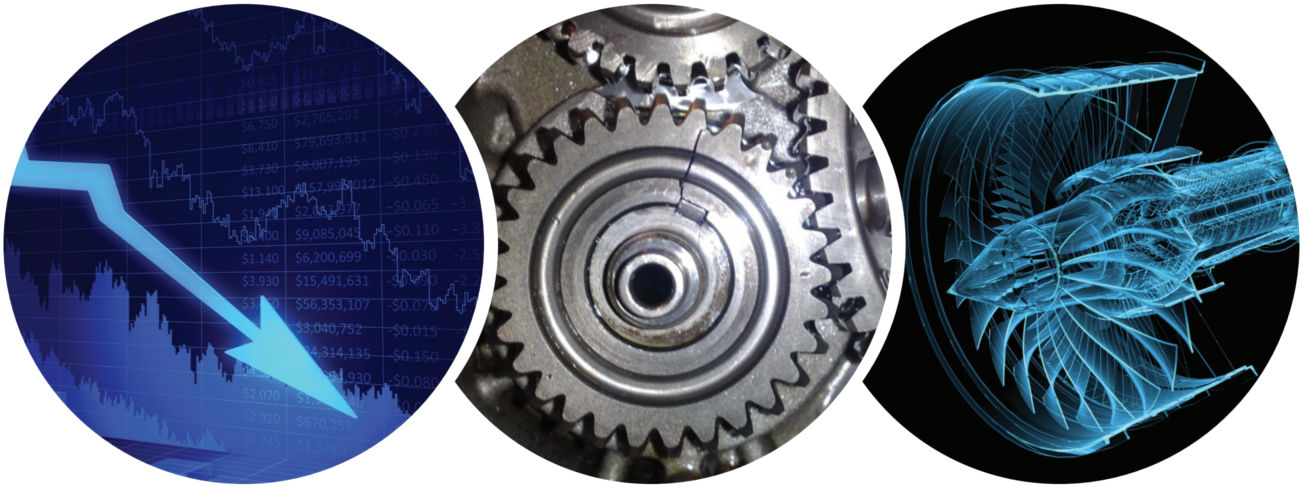
Failure Modes Detected Within DigitalClone Platform

- Micropitting Fatigue
- Bending Fatigue
- Fretting Wear
- Wear – Polymers
- Wear – Metal
- Coating Degradation
- Spalling Fatigue
- Fretting Fatigue
- Composite Delamination
- White Layer Etching
- Corrosion Fatigue

Sentient Science is in partnership with Amazon Web Services with direct collaboration and support on tasks related to cloud infrastructure, high performance computing and data protection and security.

Sentient also has a partnership with the University at Buffalo's high computing center to simulate computational test runs on their industrial cluster of 8,000 microprocessors to expedite performance analysis at higher speed and throughput. Sentient's laboratory team analyzes on average 10 components per week and has a throughput rate of ~2 weeks.

Practical Application of Software



Reduce Cost

- Lower inventory carrying cost
- Enhance HUMS with DigitalClone life Predictions
- Improve maintenance predictability
- Reduce cost - 40%

Reduce Risk

- Life product before high-cost physical test phase
- Ensure new designs meet pre-qualification standards
- Identify and optimize design performance
- Accelerate design schedules 50% - 75%

Reduce Uncertainty

- Test different design thresholds
- Digitally evaluate new design concepts
- 3rd party validations for new products

Materials Lab

The materials laboratory includes 800-sq. ft. test rig facilities used for physical testing, and a 1,200-sq. ft. electronics and general research laboratory, plus a 400-sq. ft. fabrication workshop, housing specialized test equipment and computer hardware.

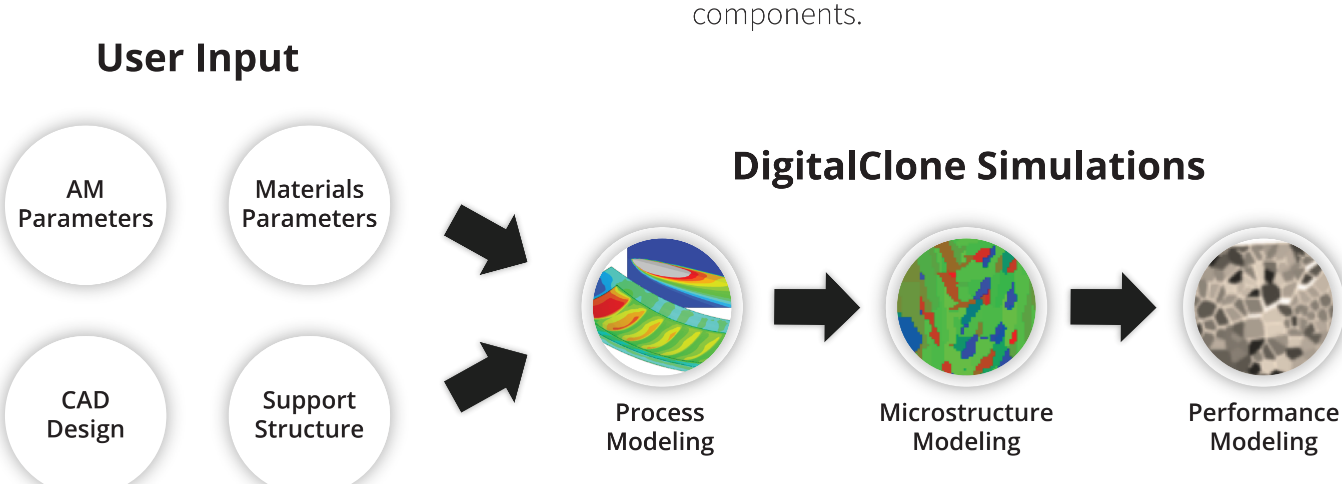
Additive Manufacturing

The Application

DigitalClone software is being developed to include component life prediction and lifecycle cost assessment to Additive Manufacturing. The technology provides analysis that goes well beyond the conventional methods of the past, allowing users to virtually test different material combinations for engineering applications.

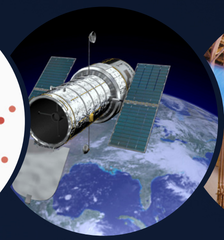
The Benefit

The use of conventional FEM approaches is insufficient for AM materials and components, which have life expectancies that are heavily influenced by stresses at the microstructure-level. This limitation has been a major obstacle for additive manufacturing and design of new components using AM processes, and is an example of how Sentient's DigitalClone technology can provide American manufacturers with a competitive advantage by vastly reducing the development cycle required to bring new products to market, while greatly increasing product testing. All of these factors contribute to drastically lower unit costs for discrete components.



Company History






2001
Sentient Science founded

2002-09
$25 Million in funding from DOD & DOE

2010
DigitalClone® technology validated by NASA

2010-14
Validation against physical testing with world's largest commercial companies

2011
Joined the White House's Advance Manufacturing Partnership - Material Genome Initiative

2013
DigitalClone® Live launced

2017
10% of the worlds fleet under contract

Government Awards

55 SBIR / STTR PROGRAMS

$30 MILLION GOVERNMENT FUNDING

2001 – 2010
DEVELOPMENT OF CORE CAPABILITIES

2010 – PRESENT
ENHANCEMENTS TO CORE TECHNOLOGY CAPABILITIES

Awards and Recognition

2014
Tibbetts Award Winner

https://www.sbir.gov/sites/default/files/tibbetts_2014_book_web_version.pdf

2016
Bloomberg New Energy Pioneer

http://www.bizjournals.com/buffalo/news/2016/04/04/buffalo-based-sentient-science-wins-prestigious.html

2016
Wind Energy Update, Best Technological Innovation of the Year:

http://www.windenergyupdate.com/operations-maintenance-usa/awards.php

2016
Featured in NASA Spinoff

https://www.nasa.gov/offices/oct/feature/digital-clone-testing-aims-to-maximize-machine-efficiency

2017
Frost & Sullivan Innovation in Wind Prognostics

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