



*Virtual Twin™ Simulators  
A New Era in Life Cycle Mgt*

*Gorham PMA Conference  
San Diego, CA  
March 31, 2011  
Carl D. Kolts*

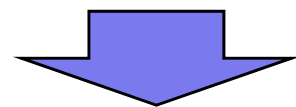
# *Life Cycle Management*

***Every component is designed and manufactured with an application for use in mind.***

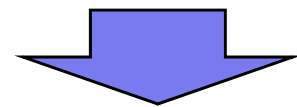
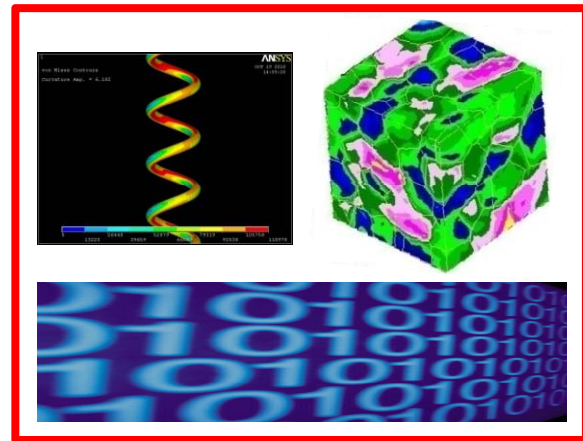
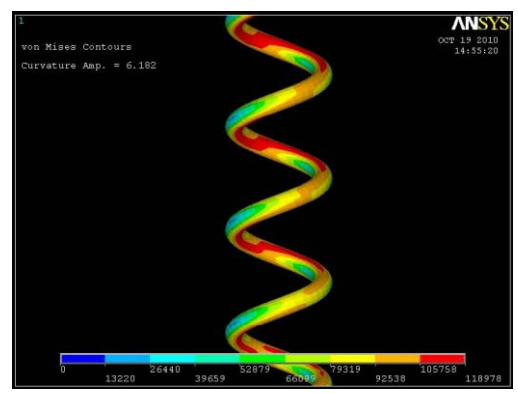


***That application involves an expected level of reliability, performance, and life.***

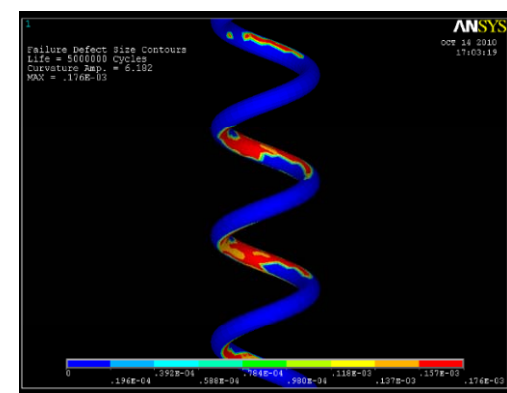
*Everything fails... now a computational means exists to manage it - VLM*



**Design & Stress**



**Probability of Failure & Why**



## *What's New Since Last Year*

### ➤ ***The Technology - Virtual Life Management™ advances***

- ✓ **Cloud Computing - increasing processing speed**
- ✓ **Web Application – self directed client access**

### ➤ ***The Product – Virtual Twin Simulators in use***

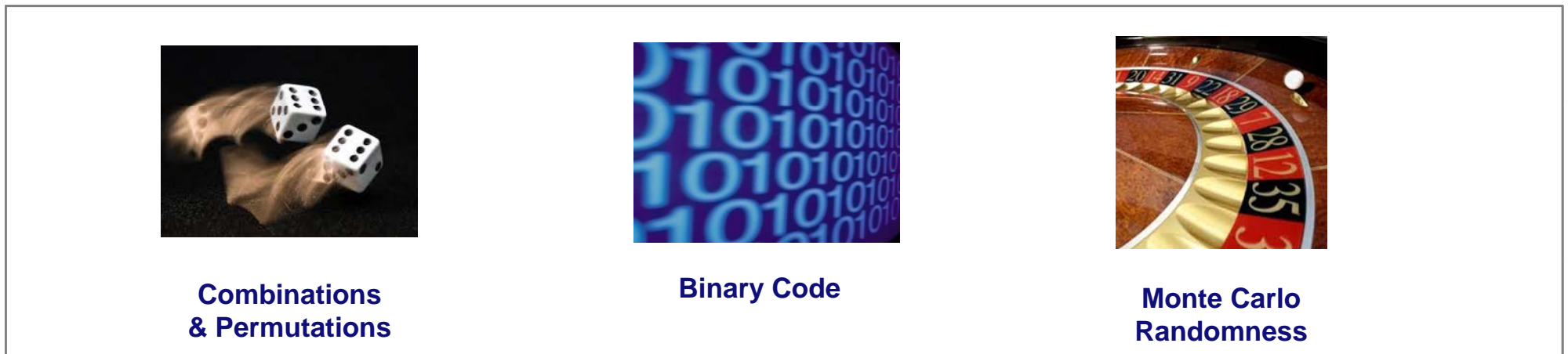
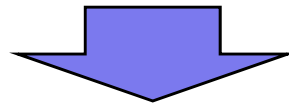
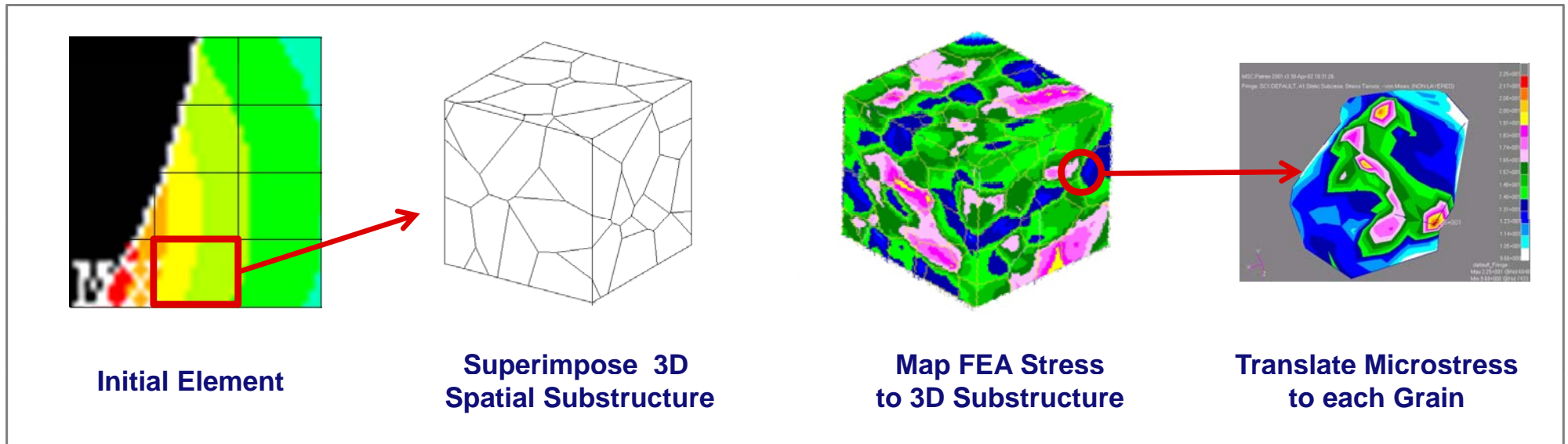
- ✓ **Commercial Aviation - Life Cycle Mgt**
- ✓ **Medical Devices – Accelerating Development**
- ✓ **Construction Products - Manufacturing Productivity**
- ✓ **Off Highway Vehicles – Weight & Cost Reduction**
- ✓ **Automotive – Material Processing Improvements**
- ✓ **Electronics – Product Reliability**

## *Virtual Twin Simulators*

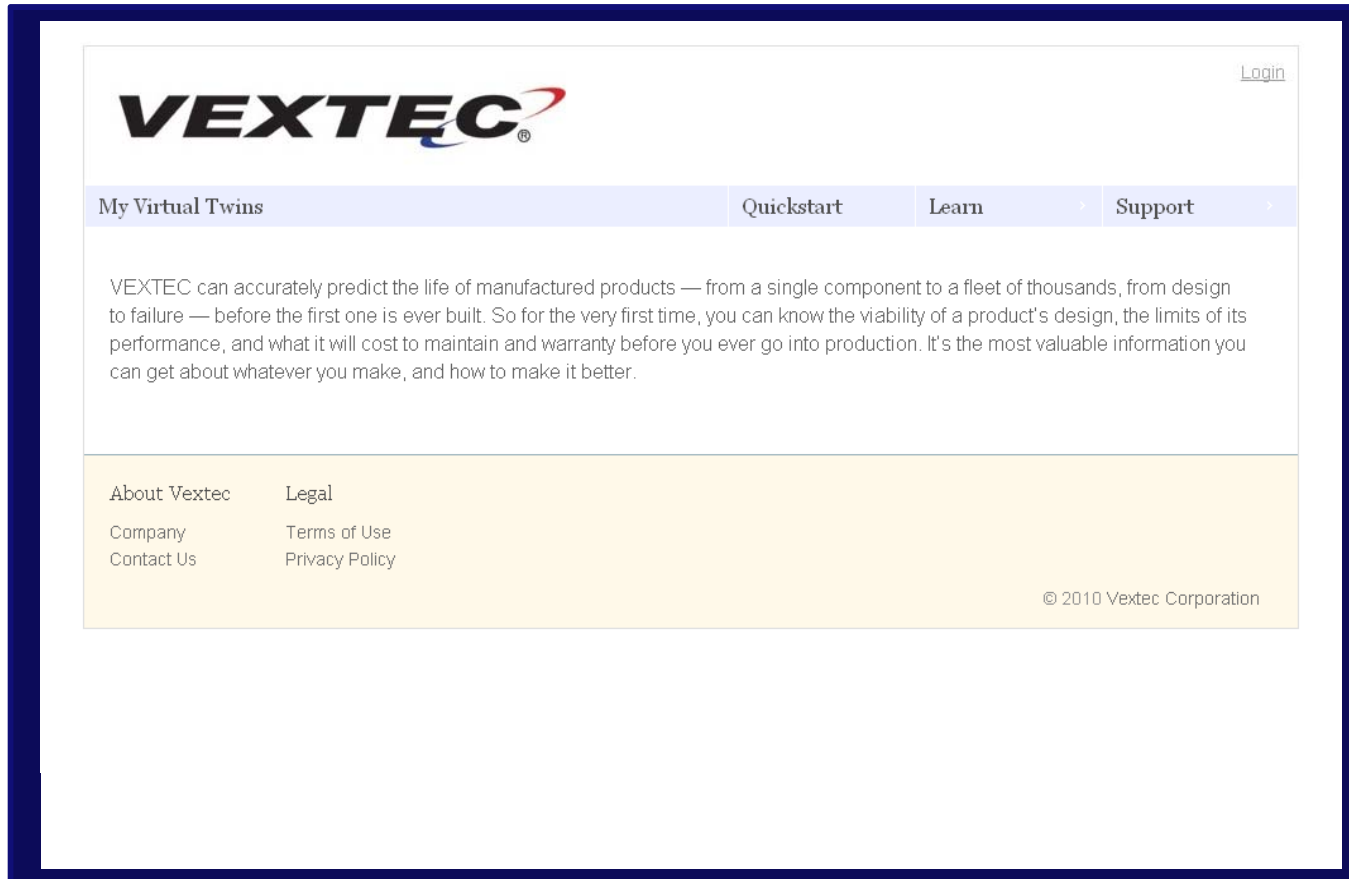
*Component renditions used to predict fleet reliability and lifetime cost, even before they're built.*



# VEXTEC Intellectual Property



# *Virtual Twins are accessed via the Internet*



The screenshot shows the VEXTEC website interface. At the top left is the VEXTEC logo. In the top right corner, there is a [Login](#) link. Below the logo is a navigation menu with four items: "My Virtual Twins", "Quickstart", "Learn", and "Support". The "My Virtual Twins" item is highlighted with a blue background. Below the navigation menu is a main content area with the following text: "VEXTEC can accurately predict the life of manufactured products — from a single component to a fleet of thousands, from design to failure — before the first one is ever built. So for the very first time, you can know the viability of a product's design, the limits of its performance, and what it will cost to maintain and warranty before you ever go into production. It's the most valuable information you can get about whatever you make, and how to make it better." Below this text is a footer area with a light yellow background. On the left side of the footer, there are four links: "About Vextec", "Company", "Contact Us", and "Legal". On the right side of the footer, there are two links: "Terms of Use" and "Privacy Policy". In the bottom right corner of the footer, there is a copyright notice: "© 2010 Vextec Corporation".

# Dedicated & Secure Client Home Page

The screenshot shows a web browser window displaying the VEXTEC client home page. The page layout includes a header with the VEXTEC logo and a 'Login' link. Below the header is a navigation bar with tabs for 'My Virtual Twins', 'Quickstart', 'Learn', and 'Support'. The main content area contains a paragraph describing VEXTEC's capabilities in predicting product life. A sidebar on the left provides links for 'About Vextec', 'Company', 'Contact Us', 'Legal', 'Terms of Use', and 'Privacy Policy'. The browser window shows the URL 'https://demomds.vextec.com/demo/client/SimulationListSimulations.aspx' and a table of 'Durability Simulators'.

Part Name	Part No	Simulator Name	Description
Lead Wire	Lead Wire	Lead Wire Simulator	Durability analysis of lead wire



# Virtual Twin GUI utilizes Google Analytics

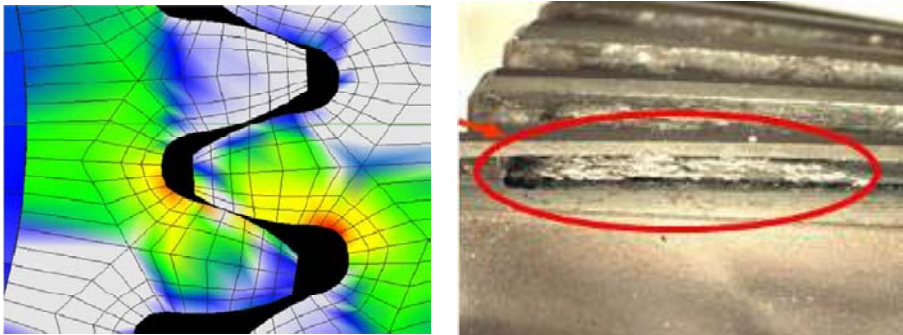
The screenshot displays the VEXTEC Virtual Twin Analyzer web application. The top navigation bar includes 'My Virtual Twins', 'Quickstart', 'Learn', and 'Support'. A main text block describes the software's capability to predict product life from design to failure. Below this, a table lists 'Durability Simulators' with columns for Part Name, Part No, Simulator Name, and Description. The table contains one entry: 'Lead Wire' with 'Lead Wire Simulator' and 'Durability analysis of lead wire'.

Two graphs are shown at the bottom:

- FOD v4 Histogram:** A dual-axis chart showing 'Frequency' (left y-axis, 0-200) and 'Cumulative PoF %' (right y-axis, 0.00-150.00) against 'Cycle of Failure' (x-axis, 0-4.8 k). The histogram bars are blue, and a red curve represents the cumulative probability of failure.
- Estimated Implant Loading:** A line graph showing 'Estimated Implant Loading' (y-axis) versus 'Heartbeat (cycles) to Failure' (x-axis). It features several curves labeled 'B' (Current Design), 'M1, M2, M3' (Material & Processing Changes), and a shaded green area labeled 'Design Space'.

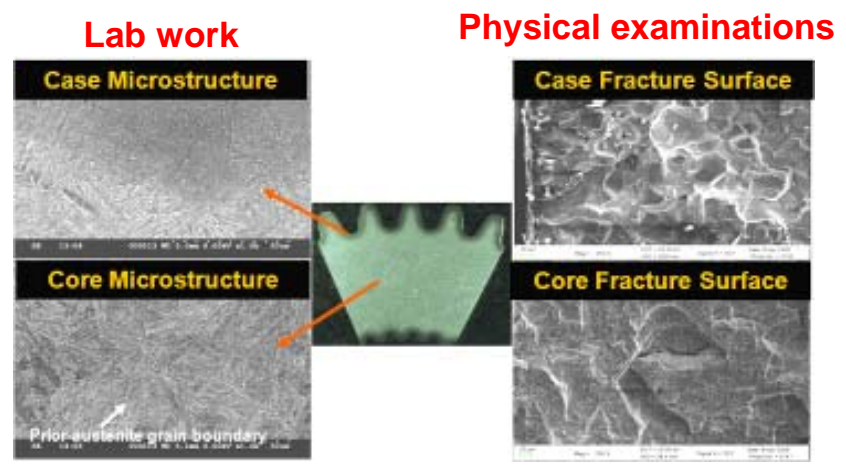
# Problem Resolution & Corrective Action Assessment

## 1. The OEM Issue

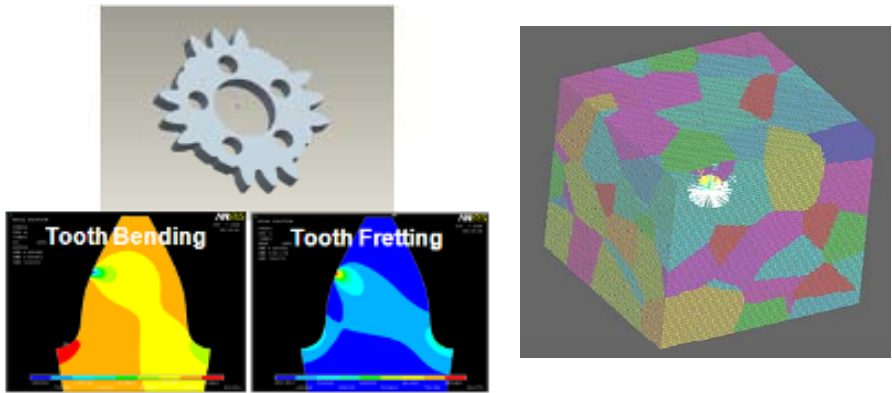


Overload missions or lubrication break down lead to premature field failures and impacts fleet readiness

## 2. Material Configuration



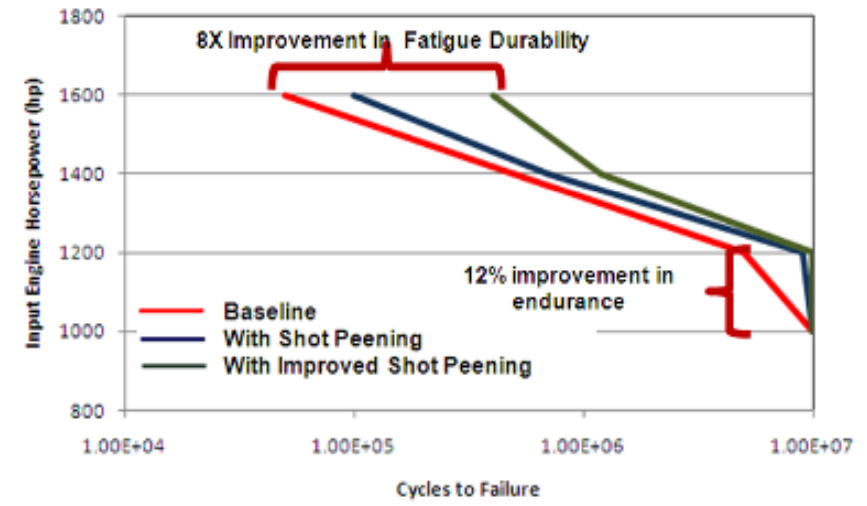
## 3. Design Configuration



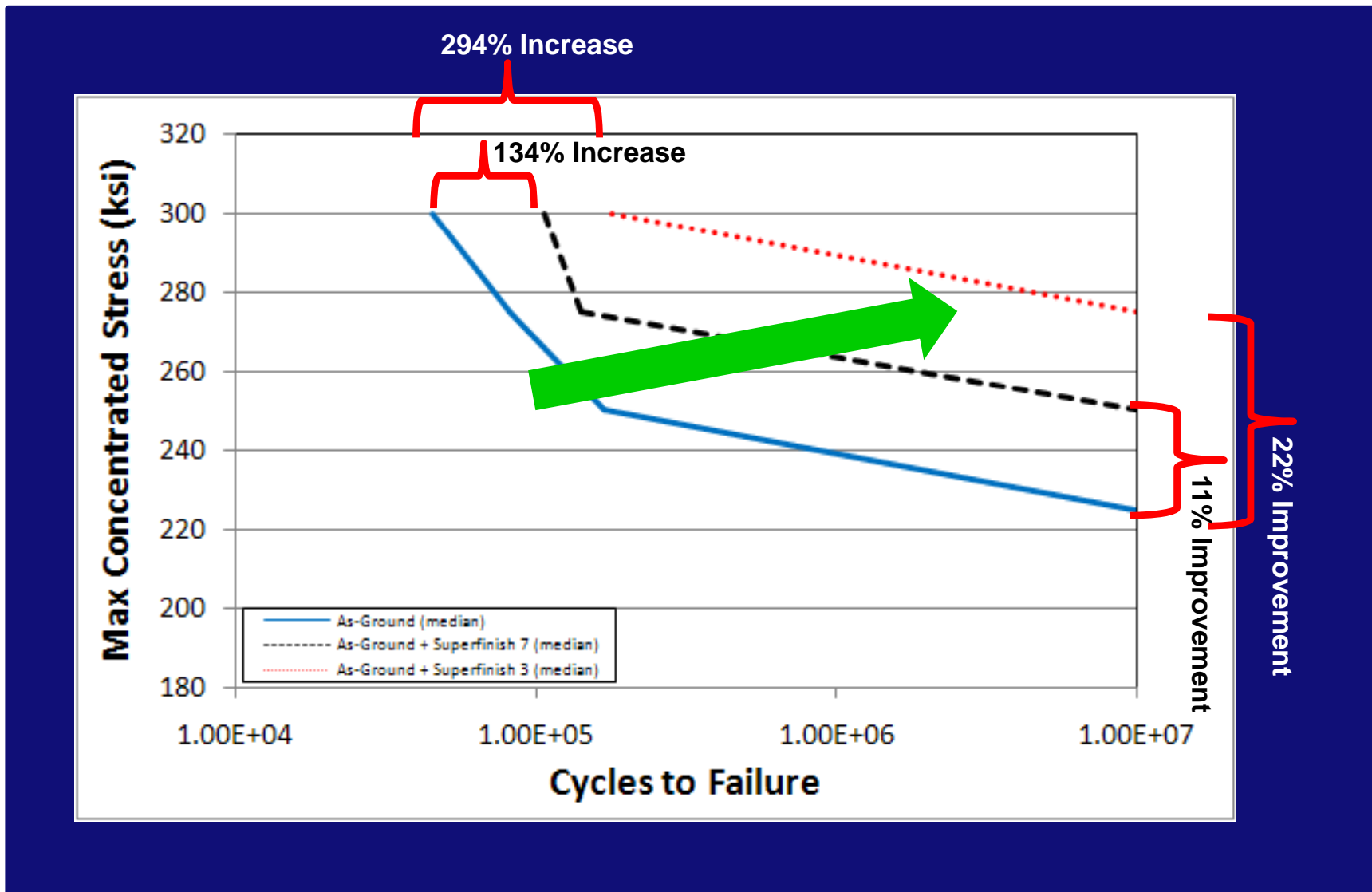
Contact and Bending stress

Damage buildup in material grains

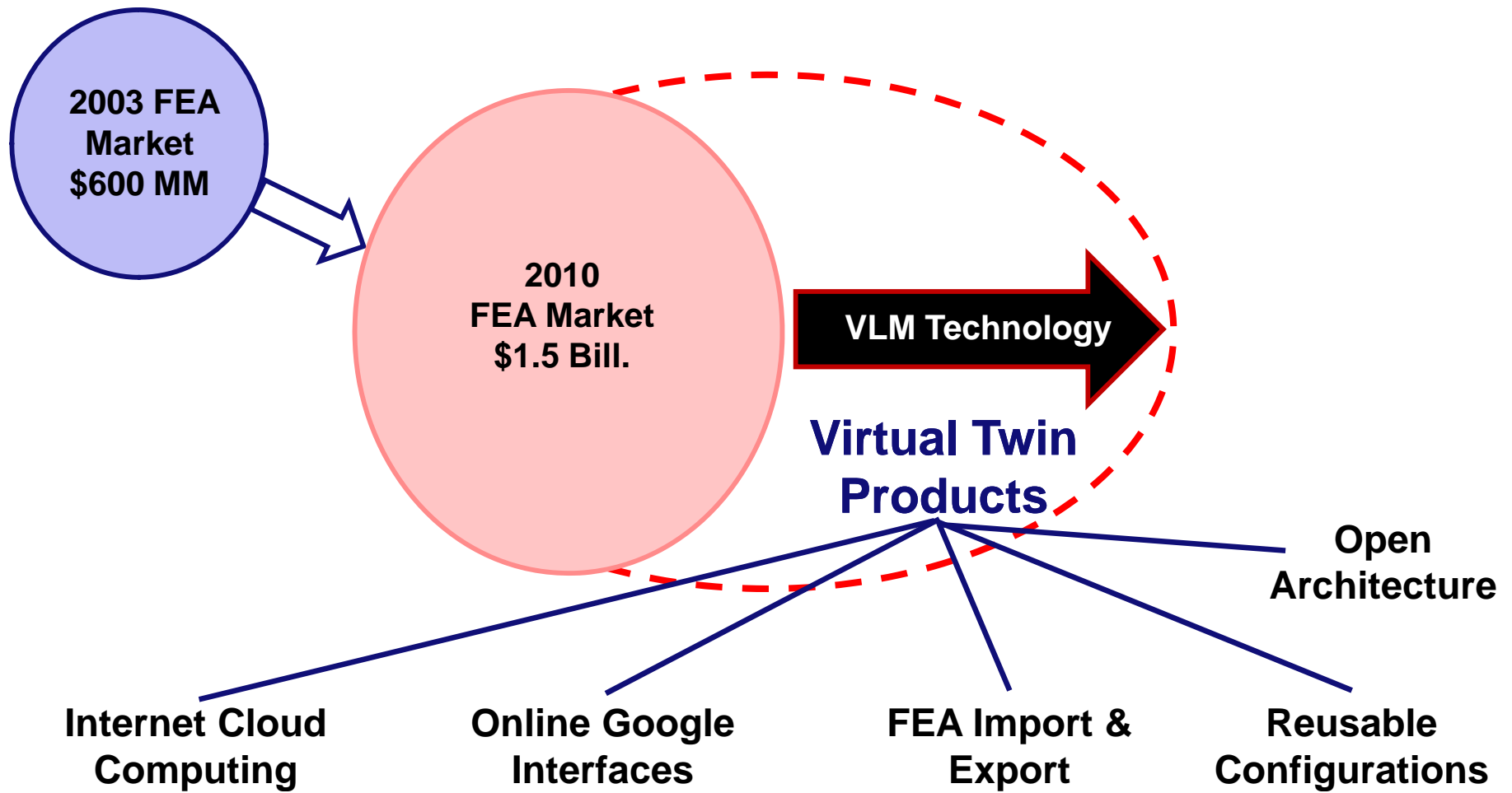
## 4. Simulator Conclusions



# Product Improvement - Gear Surface Finish



# *A New Era in Life Cycle Management*



## *Virtual Twins for Trade Studies*

### *Design Variables*

**FEA Stress Profiles**  
**Operating Conditions**  
(complex missions)  
**Operating Environment**  
**Geometry**

### *Material Variables*

**Materials**  
**Material Processing**  
**Damage Mechanisms**  
(cyclic fatigue)  
(contact & fretting fatigue)  
(corrosion or erosion)

***Capturing all the inherent variability, combinations and permutations of these that can occur at any given time***

## *Virtual Twin Simulators*

***Predict wearout – when, where, & how***

***Virtually evaluate variables simultaneously***



***Understand reliability as service conditions change***

***Reduce physical testing & prototyping***

***Extend component life***

***Improve maintenance & service programs***

The logo for VEXTEC, featuring the word "VEXTEC" in a bold, black, sans-serif font. A stylized red and blue swoosh or orbital line curves around the top right of the letter "C".

**VEXTEC**

*Thanks!*