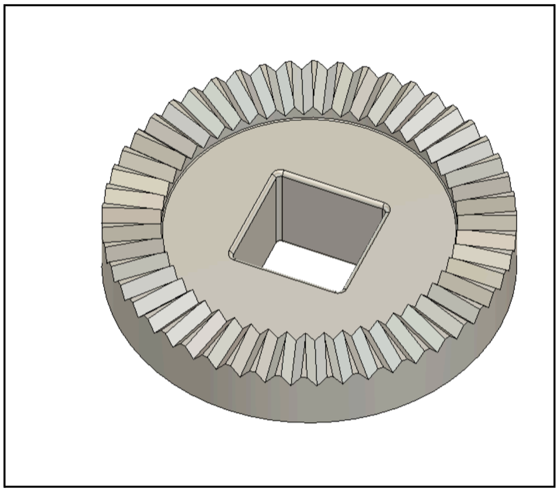
DESIGN ITERATIVE ANALYSIS

Case Study: $25,000 Annual Failure Cost Reduced Through Smarter Material Selection



Client Snapshot

Application	Adjustable Fixture Assembly
Problem Type	Repeated Part Failure
Annual Cost Impact	$25,000+
Service Provided	Mechanical Failure Analysis

Executive Summary

A medical service provider was spending approximately **$25,000 per year** replacing repeatedly failing components inside an adjustable fixture assembly.

The source of failure was traced to **cast aluminum inserts** that fractured under normal tightening loads. While the original design functioned in theory, it created recurring replacement costs, downtime risk, and ongoing operational frustration.

Design Iterative Analysis evaluated the failure mode, identified the weak link, and recommended a more durable replacement strategy using machined billet components.

Result:

A relatively small engineering decision had the potential to eliminate a five-figure annual expense.

The Business Problem

The fixture assembly relied on two cast aluminum inserts mating with steel brackets through a toothed locking geometry used for anglular adjustment.

This design introduced three expensive problems:

1. Recurring Breakage

The aluminum inserts consistently failed in service.

2. Replacement Costs

New parts had to be continually purchased and stocked.

3. Operational Disruption

Failures created unnecessary maintenance events and preventable interruptions. The time technicians lost replacing the inserts, delays, and operational friction contribute to the overall cost of these part failures.

The issue was not one catastrophic failure.

It was **death by repetition**.

Root Cause Findings

Mechanical analysis identified localized stress concentration at the sharp tooth geometry of the cast inserts.

The parts were vulnerable at approximately **21 in-lbs of rotational load** — a level easily reached with standard hand tools. This matches the problematic experience of using these inserts

In practical terms:

- Normal use could damage the part
- Casting variability increased inconsistency
- The design had little margin for real-world handling

Visual Analysis

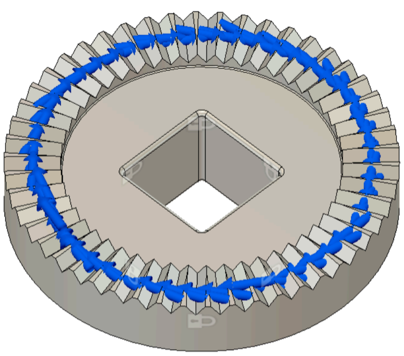
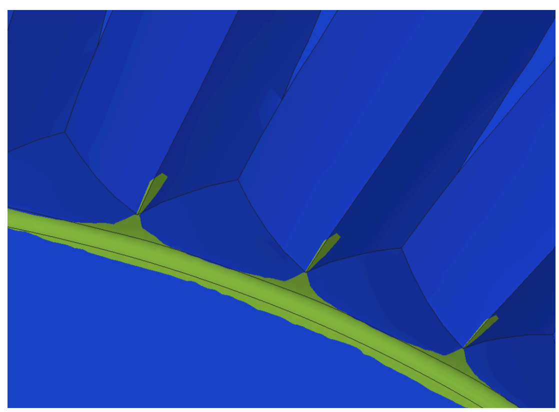
Image #1 Load Case	Image #2 Source of Failure
	

Image 1 highlights the torsion load that the teeth experienced under load. Image 2 highlights how the load increased at the sharp corners of teeth. This is where the parts repeatedly failed under normal operations. This load aggravated material imperfections and created fractures that lead to complete failures

Results Delivered

Our recommendation is that a superior material be selected that would provide increased strength and also a different process that aids in providing a stronger design, such as machining the inserts out of a billet material. This would provide a stronger design at an economical cost. A table has been provided to showcase what different materials could be machined and the most attractive aspect of each of these materials. Please see the provided table to make simple and effective decisions.

Table 1: Material Selection Table

Material	Key Feature	Increased Strength Over Cast Aluminum	Cost Comparison to Cast Aluminum (50 units)
Carbon Steel	Low Cost	2.8	1.3-1.8x
316 Stainless Steel	Corrosion Resistance	2.4	1.8-2.8x
Titanium	Strength + Corrosion Resistance	4.2	5-8x
Inconel	Heat Resistance + Strength + Corrosion Resistance	5.0	10-15x

The original design prioritized manufacturing convenience. Changing the material prioritizes **lifecycle cost** to remove this recurring cost and reduce the operating cost of the business. A small number of units with adequate strength would have a higher individual cost compared to the cast aluminum units, but they would be adequately strong to handle the desired loads.

If the desire is to have the lowest cost over the longest time frame and highest number of units, then we recommend that the insert should be redesigned to accommodate a better orientation system.

If a part keeps failing, costing money, or slowing production - every month it continues is money that you never get back. The longer recurring problems persist, the more expensive they are.

Design Iterative Analysis helps find the issue and correct it before another cycle of avoidable cost.