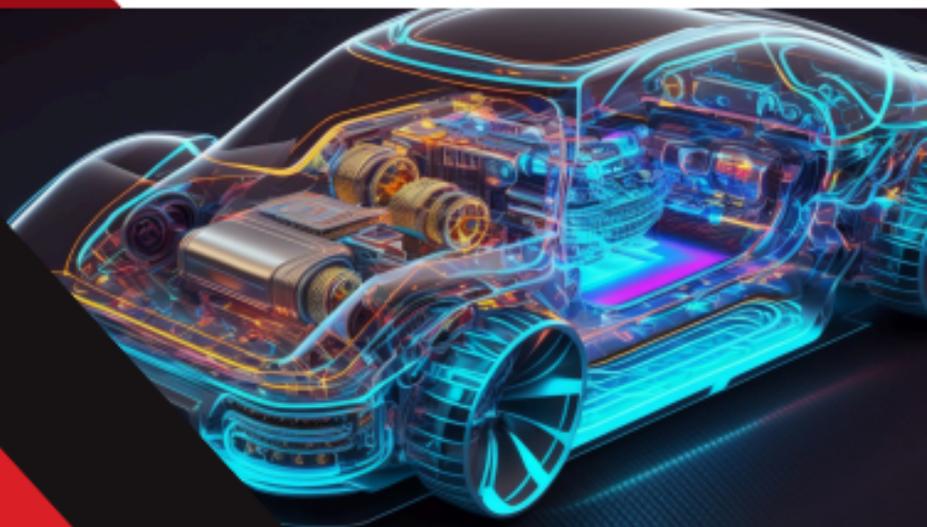


CASE STUDY:  
**RE-SHORED PRODUCTION AND ENGINEERING  
OPTIMIZATION OF A PEEK BEARING-  
ASSEMBLY COMPONENT FOR AN ELECTRIC  
MOTOR DIAGNOSTIC TEST SYSTEM**



## RE-SHORED PRODUCTION AND ENGINEERING OPTIMIZATION OF A PEEK BEARING-ASSEMBLY COMPONENT FOR AN ELECTRIC MOTOR DIAGNOSTIC TEST SYSTEM



### Abstract

A bearing-assembly component manufactured from PEEK required complete redesign and process optimization after field failures emerged during operation of an electric motor diagnostic test stand. The component, originally produced in high volumes overseas, experienced thermal-induced deformation following a revision to the end-product architecture. Supply chain instability during the post-COVID global disruption further accelerated the need for a domestic engineering and manufacturing solution. This case study details the engineering investigation, design-for-manufacture (DFM) collaboration, machining strategy development, and integrated subassembly production approach from KL Engineering, Inc., which restored reliability and stabilized the customer's test stand performance.

## Background

The component examined here is a PEEK precision part used in a bearing assembly for an electric motor diagnostic test stand that performs 100 percent inspection of production output. The part was initially a legacy design produced overseas in a different polymer and supplied to the customer for many years.

During the post-COVID recovery period, the customer experienced severe supply chain interruptions that restricted access to the legacy supplier. Concurrently, product-level design changes in the customer's motor assembly altered the thermal loading profile within the diagnostic stand. These modifications introduced localized heat generation in regions where it had not previously existed, resulting in repeated failures of the legacy component.

The customer initiated a resourcing effort and engaged our engineering and manufacturing team to support a material transition to PEEK, redesign the geometry to meet new functional requirements, and establish a reliable domestic supply chain that ensured consistent integration into a multi-component subassembly.



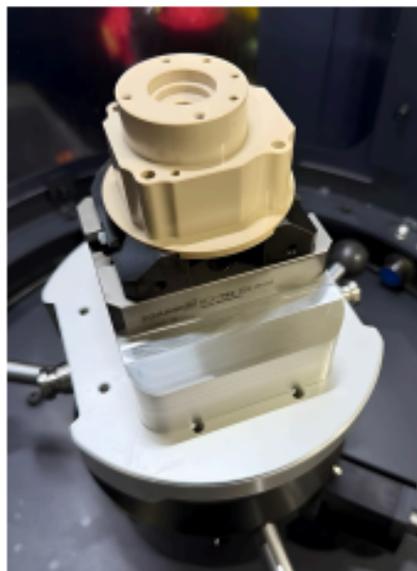
## Engineering Challenges

### Thermal-Driven Failure Mechanisms

Field failures were traced to thermally induced distortion and dimensional instability within the original polymer structure. Increased heat flux in a confined region of the assembly created progressive deformation that compromised bearing fits and functional alignment.

### Geometric Revision Requirements

The customer's engineering team owned responsibility for the formal design changes; however, due to the interdependent nature of the component interfaces, our team participated closely in early design reviews. The goal was to ensure dimensional robustness without introducing secondary issues that might degrade diagnostic accuracy or create downstream reliability risks in customer production lines.



### Material-Specific Machining Complexity

PEEK machining inherently introduces internal stresses during the stock removal process. The part contains several tight-tolerance bearing fits and critical alignment surfaces, which required a staged machining approach. Direct, full-featured machining led to unacceptable warp and dimensional drift. Instead, controlled intermediate stress-relief steps were introduced to allow the material to stabilize before final machining operations.

### Multi-Component Subassembly Integration

The PEEK component is only one element of a larger subassembly containing seven to eight mating components, including bearings, shafts, and mechanical interfaces. The customer required a single responsible source for the entire integrated assembly. The isolated procurement of individual components previously required the customer to manage tolerance stack-ups and integration challenges. A consolidated manufacturing and assembly solution would eliminate this burden.

## Engineering and Manufacturing Approach

### Collaborative DFM Process

Our team performed iterative DFM reviews with the customer's design engineers. Feedback focused on the manufacturability of the proposed geometry, cost implications, tooling access, and the stability of tight tolerance features, ensuring that the revised design supported reliable machining, minimized waste, and maintained functional alignment criteria at the system level.

### Five-Axis Machining with Multi-Stage Stress Relief

The final process utilized a two-operation, five-axis machining workflow. Key features were sequenced to allow internal stresses in PEEK to relax progressively. Machining intervals were separated by controlled thermal stabilization steps to ensure the material reached its natural equilibrium state before final precision finishing.

### Complete Subassembly Build

Our manufacturing system assumed responsibility for producing all components within the bearing-assembly module. This ensured:

- Full control of tolerance stack-ups
- Verification of interface fit during assembly
- Compliance to functional performance metrics at the subassembly level
- Elimination of integration risks previously experienced by the customer

The assembled module is shipped directly to the customer's facility for final installation into their diagnostic test stands.



## Results and Customer Impact

The project delivered several key outcomes:

- Rapid recovery from global supply chain disruption: Domestic production restored part availability during a critical period of instability.
- Elimination of thermal-induced failures: PEEK material selection, geometric revisions, and controlled machining strategies produced a dimensionally stable component under the new thermal load conditions.
- Reduced integration risk: Subassembly-level responsibility transferred tolerance management and fit-up verification entirely to our team.
- Sustained long-term support: The component and its associated subassembly continue to be produced reliably several years after the initial engagement.

## Conclusion

The successful redesign, requalification, and integration of this PEEK bearing-assembly component demonstrate the value of combining materials expertise, precision machining capabilities, and system-level engineering oversight. Through collaborative DFM engagement and control of the entire subassembly, performance failures were eliminated, production reliability was restored, and the customer achieved a stable, domestic supply solution that supported uninterrupted operation of critical diagnostic test stands.