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CURRENT STATE AND OPPORTUNITY

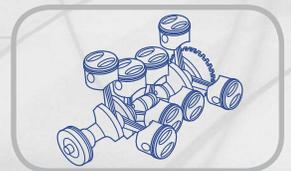
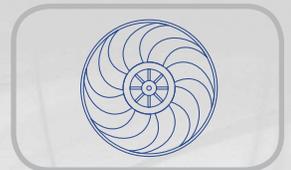
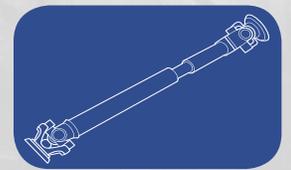
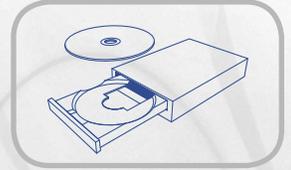
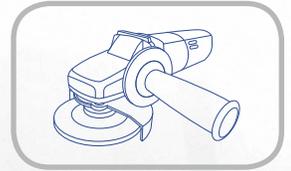
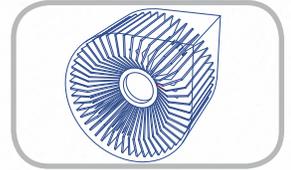
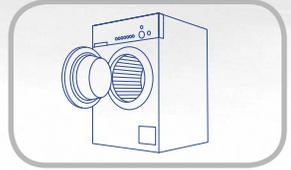
The XYO technology shows significant improvements in driveshaft performance during independent studies. Perpetual Industries wants to work with innovative manufacturers to optimize and implement the XYO balancer in their product.

Contact us to see how your product can beat the competition using XYO



XYO PROTOTYPE BALANCER AS APPLIED TO DRIVE SHAFTS Summary Report

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RESULT HIGHLIGHTS

The XYO technology reduces vibration by compensating for variable mass imbalance during operation of a drive shaft. Tests show that a **prototype XYO balancer** significantly reduces drive shaft vibration. Additional benefits of reducing vibration include:

- ▶ Lower manufacturing costs by eliminating conventional balancing
- ▶ Better transmission of power
- ▶ Reduced noise during operation
- ▶ Improved fuel efficiency
- ▶ Longer product life and reduced wear to adjoining components

Drive Shaft Vibration Decreased by 91%

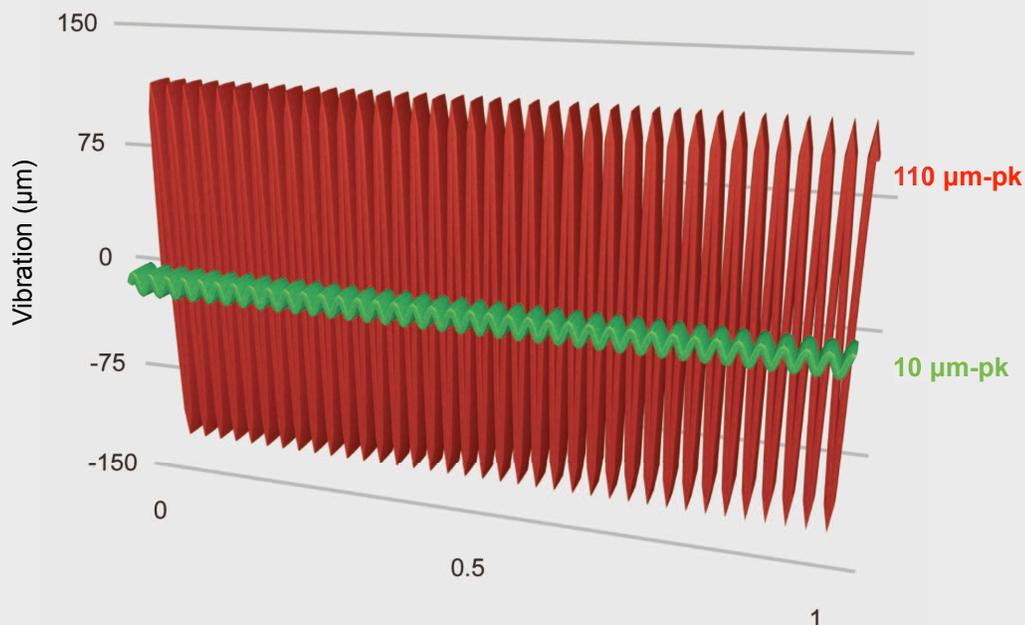


Figure 1. Impact of XYO on vibration of a drive shaft with a 6.86 oz.in mass imbalance, and is operating at at 2250 RPM

■ WITHOUT XYO ■ WITH XYO

Note:

- ▶ The results in this report are based on prototype XYO balancer designs. While the results shown are significantly positive, it is possible to exceed and improve upon these results with optimization.
- ▶ Perpetual Industries is looking for a capable partner that needs the competitive advantage that XYO can provide.



INTRODUCTION

The primary cause of drive shaft vibration is mass imbalance due to manufacturing tolerances, defects, uneven welding, among others. During normal operation, erosion or build-up of debris (Figure 2) can also contribute to the mass imbalance leading to violent vibration.

TEST OBJECTIVE

The purpose of this test was to evaluate the ability of the XYO balancer technology to automatically balance an automotive drive shaft (Figure 2).

TEST OVERVIEW

A test rig was built in order to evaluate the performance of the XYO technology (Figure 3).

Stub shafts were connected to each end of the main shaft universal joints. The stub shafts were supported by two bearings mounted to a rigid plate.

The driveshaft's rotational velocity was measured by an optical key-phasor. Four velocity transducers were used to measure vibration at the differential end and the driven end.

Two prototype XYO balancers were mounted, one at each end of the driveshaft. One XYO balancer was mounted on the slip yoke at the driven end as shown in Figure 5. The other XYO balancer was mounted on the 4" shaft close to the yoke located at the differential end.

Mass imbalances of 6.86oz-in and 9.14oz-in were applied at either end of the driveshaft and tested with and without the prototype XYO balancers; the test conditions were as follows:

- ▶ No mass imbalance
- ▶ 6.86oz-in at differential end
- ▶ 9.14oz-in at driven end
- ▶ 6.86oz-in at differential end & 9.14oz-in at driven end

Vibration measurements were taken from 1500RPM to 2250RPM to show the benefits of the XYO balancer over a large operating range of the driveshaft.



Figure 2. An automotive drive shaft showing signs of erosion and wear

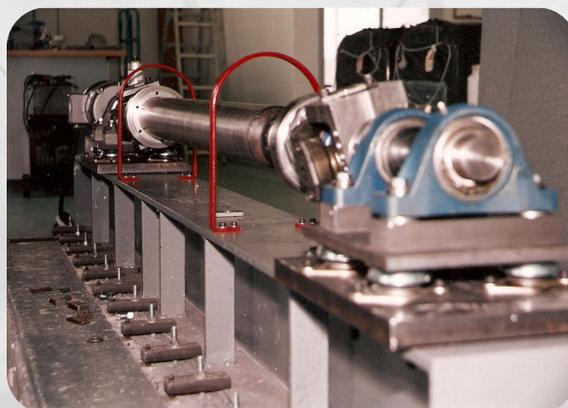


Figure 3. Drive shaft test rig

Prototype XYO balancer

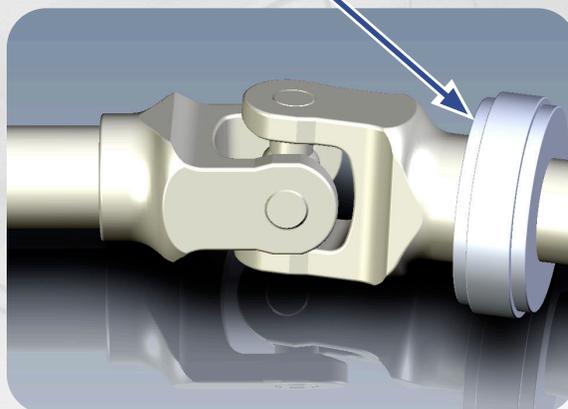


Figure 5. XYO balancer installation location



TEST RESULTS

Results were measured in the vertical axis at the differential end from 1500RPM to 2250RPM, which was the actual operating speed range of the drive shaft. Figures 6 to 9 show the significant impact that the XYO balancer had on the vibration of a drive shaft. Vibration values are compared at Tables 1, at 2250RPM; this was the nominal drive speed during operation.

Vibration Decreased 50% (No imbalance)

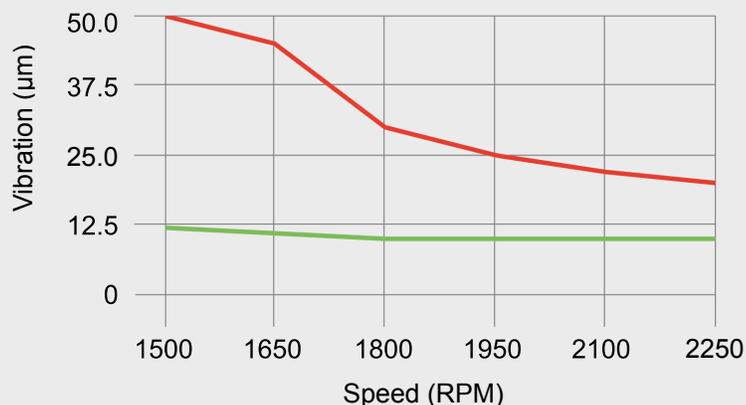


Figure 6. Impact of XYO on vibration of shaft with no imposed imbalance

■ WITHOUT XYO ■ WITH XYO

Vibration Decreased 91% (6.86 oz-in imbalance)

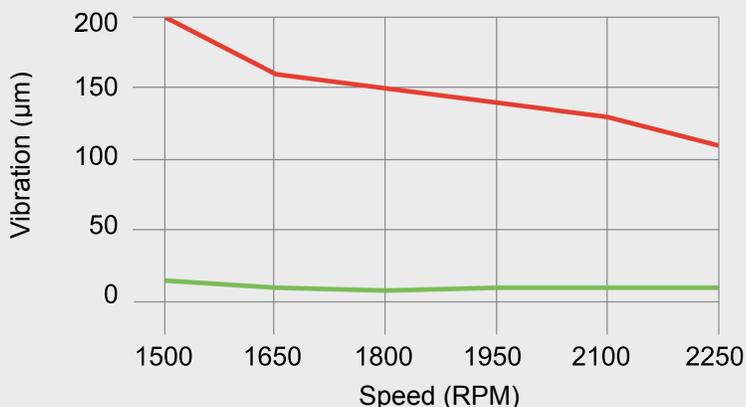


Figure 7. Impact of XYO on vibration of shaft with 6.86 oz-in imbalance at differential end



TEST RESULTS (Continued)

Vibration Decreased 71%
(9.14 oz-in imbalance)

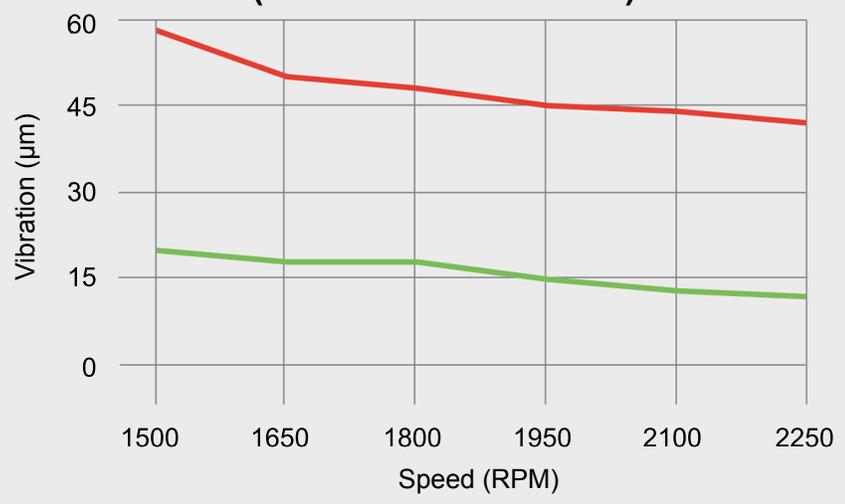


Figure 8. Impact of XYO on vibration of shaft with 9.14 oz-in imbalance at driven end

■ WITHOUT XYO ■ WITH XYO

Vibration Decreased 87%
(9.14 oz-in and 6.86 oz-in imbalance)



Figure 9. Impact of XYO on vibration of shaft with 6.86 oz-in imbalance at differential end and 9.14 oz-in imbalance at driven end



TEST RESULTS (Continued)

Table 1. Summary of vibration results for drive shafts at 2250RPM

MASS IMBALANCE (oz-in)	VIBRATION AT 2250 RMP (μm)		IMPROVEMENT (μm)
	WITHOUT XYO	WITH XYO	
No imposed imbalance	20	10	10 (50%)
6.86 at differential end	110	10	100 (91%)
9.14 at driven end	42	12	30 (71%)
6.86 at differential end & 9.14 at driven end	135	18	117 (87%)

The XYO technology shows tremendous improvements in vibration (91%) of driveshafts. The prototype XYO balancers consistently reduced vibration of the driveshaft over a range of operating speeds and mass imbalance conditions; this demonstrates the versatility of the XYO technology.

Manufacturers of motorized components can see significant performance improvements in their products if they choose to implement the XYO technology. XYO can create a strong market advantage for innovative companies by providing their customers with better performing and more durable products that outlast the competition.

FINDINGS AND CONCLUSIONS

Two prototype XYO balancers were successfully applied to driveshafts. The significant (91%) reduction in vibration was observed and can lead to these additional benefits:

- ▶ Reduced manufacturing costs as conventional methods of balancing drive shafts can be replaced
- ▶ Reduced mechanical wear on components such as bearings and universal joints
- ▶ Increased product reliability
- ▶ Eliminated need to rebalance driveshafts as the XYO balancer will automatically and continuously do so
- ▶ Increased energy efficiency and better power transmission

Perpetual Industries wants to work with a capable and innovative driveshaft manufacturer to optimize and implement the XYO technology and provide a strong competitive advantage in the market.

Impact of XYO:

- ▶ **Vibration decreased 91%**
- ▶ **Lower manufacturing costs**
- ▶ **Reduced mechanical wear**
- ▶ **Increased power transmission**
- ▶ **Improved fuel consumption**

