Reduced Inboard Wheel Bearing Size

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Research:

Riot Racing currently uses a wheel bearing configuration designed to withstand 10,890 maximum impact loading cycles for both front and rear wheel hubs, shown in Figures 8 and 10. A trait of dual-wheel bearing designs is that the outboard bearing experiences higher stress than the inboard bearing. The inboard bearing can therefore be reduced in size accordingly, as shown in Figures 9 and 11, substantially reducing cost while maintaining service life.

The inboard bearing should maintain an internal diameter of 35 mm (to avoid altering wheel hub design) and achieve a service life similar to that of the existing outboard bearing. The current bearings cost $69.57 each, and the design uses 8 total, resulting in a total cost of $556.56. Reducing the size of the inboard bearings would decrease the total cost by $79.83.

Previously, wheel bearings were selected to reduce unique part count. To optimize the total assembly cost, unique bearings were investigated. The change in bearing size merely requires smaller bearing bores to be machined in the trailing links and front uprights, and is compatible with the existing wheel hub designs. These differences will not prevent the components from being manufactured in-house and will maintain the current assembly weight.

Design:

The vehicle's rear suspension is a modified five-link system where the wheel bearings are housed within the trailing link, as shown in Figure 8. The proposed design reduces the size of the inboard wheel bearing. To accommodate this change, the machined bearing seat would shrink to match the outside diameter of the new bearing. Since the overall width of the trailing link would remain unchanged, the spacer between the bearings needs to be slightly longer to compensate for the lesser width of the new bearing (Figure 9).

Similar changes are required for the front suspension. Figure 10 shows the current front upright, where two identical inner and outer wheel bearings are used. Maintaining proper suspension geometry depends on the distance between the bearings, which is addressed with a smaller bearing seat in Figure 11.

Analysis:

Figure 12 presents a feasibility analysis comparing different bearing configurations, conducted using KISSsoft's system module and the ISO 16281 Modified Life calculation method. This method provides a more accurate assessment of bearing damage and fatigue life than the previously used ISO 281 method, improving the prediction of bearing performance under real-world conditions. The goal of the analysis was to identify a bearing configuration that could achieve a damage percentage close to, but below, 100% after 9,900 cycles with a factor of safety of 1.1 (equating to 10,890 cycles).

Achieving this balance ensures that the bearings meet performance targets without excessive overdesign and cost. Configuration A represents Riot Racing's current design, which meets the fatigue life goal for the outboard bearing. However, the low inboard bearing damage indicates it is not optimized, presenting an opportunity for cost and weight reduction. Configuration B is similar to Configuration A, as it meets the target lifespan for the outboard bearing, but could benefit from improvements to the inboard bearing's performance.

Configuration C stands out as the most balanced and cost-effective option, achieving the optimized fatigue life targets for both the inboard and outboard bearings. Configuration D, while more cost-effective, fails to meet the target lifespan for the outboard bearing, which could result in premature failure and increased maintenance costs. Therefore, Configuration C was selected.

2 - Analysis

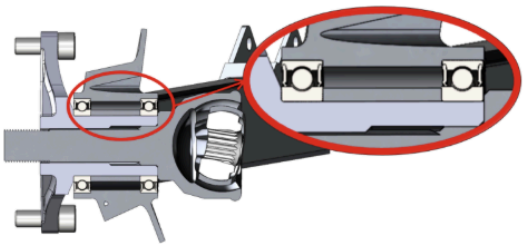


Figure 8: Current rear wheel bearing setup

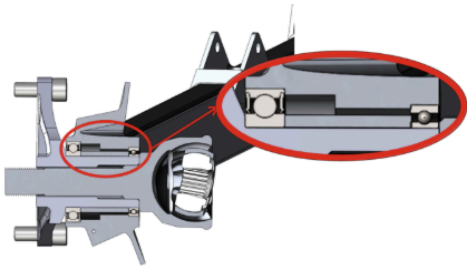


Figure 9: Proposed rear wheel bearing setup

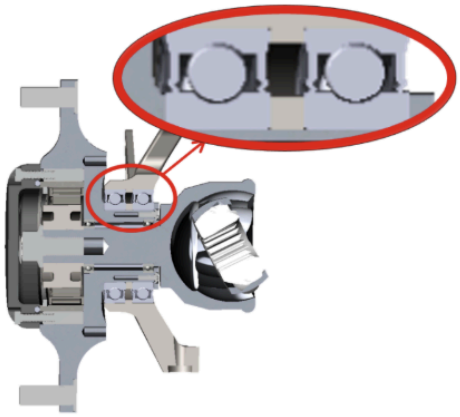


Figure 10: Current front wheel bearing setup

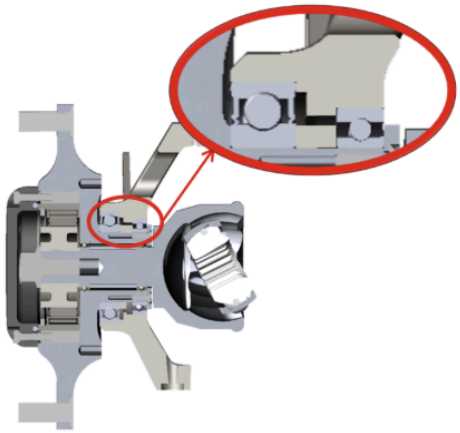
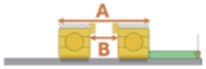
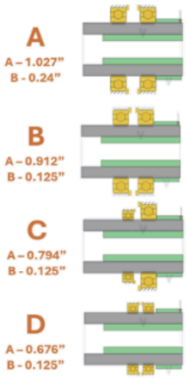


Figure 11: Proposed front wheel bearing setup

Hub Wheel Bearing Comparison





Design Comparison		A	B	C	D
Outboard	Survivable Cycles	16,632	18295	24,393	2550
	Damage [%] 10,890 Cycles	65.7	59.9	44.6	384.9
Inboard	Survivable Cycles	853,776	687,456	21,898	25,225
	Damage [%] 10,890 Cycles	1.3	1.6	49.9	46.1

Design Inputs	
Item	Value
Calculation Method	ISO 16281 Modified Life
Lubrication	Grease with very high contamination (ISO 4406)
Minimum Cycles	9900 (10,890 with FOS of 1.1)
Minimum Reliability [%]	99
RPM	462
Axial Force [lb]	1,721 (1,893 with FOS of 1.1)
Radial Force [lb]	5,300 (5,830 with FOS of 1.1)

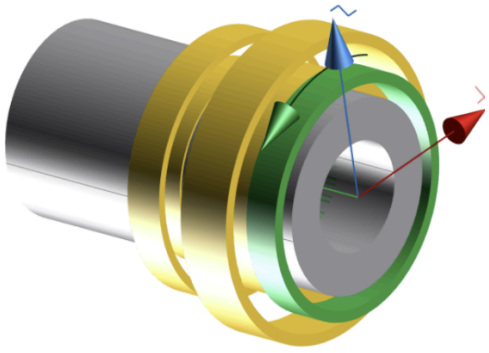


Figure 12: Feasibility analysis for bearing configuration selection and KISSsoft Bearing Calculation Setup 4