Cleaned Technical Analysis: Injection Molding Issues in Office Chair Star Base

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Introduction

The star-shaped base is a critical structural component of modern office chairs, typically manufactured using injection molding processes with engineering thermoplastics such as nylon (PA6 or PA66) reinforced with glass fibers. This report presents a comprehensive analysis of common defects observed during the injection molding process for this part, focusing on root cause identification and practical mitigation strategies.

Common Defects Observed

The following defects are frequently encountered during production:

No.	Defect Type	Description
1	Warpage	Distortion or bending of the base after ejection due to uneven shrinkage
2	Sink Marks	Surface depressions, particularly around thick sections or rib intersections
3	Weld Lines	Visible lines where melt fronts meet, often at the center hub area
4	Short Shot	Incomplete filling of the mold cavity, especially in outer arms
5	Flash	Excess material escaping from parting lines or vents
6	Internal Voids	Air pockets trapped within thick walls

7	High Residual Stress	Leading to premature failure under load or environmental exposure

Root Cause Analysis

Material-Related Factors

- Use of hygroscopic resins without proper drying leads to splay marks and reduced mechanical strength.
- Inconsistent glass fiber distribution affects anisotropic shrinkage behavior.
- Poor thermal stability of regrind material impacts flow properties.

Mold Design Issues

- Non-uniform wall thickness causing differential cooling rates.
- Suboptimal gate location leading to long flow paths and high shear.
- Insufficient venting resulting in air traps and incomplete filling.
- Lack of conformal cooling channels increases cycle time and warpage risk.

Processing Parameters

- Melt temperature too low reduces flowability and increases viscosity.
- Injection speed too slow allows premature freezing before full cavity fill.
- Holding pressure insufficient to compensate for volumetric shrinkage.
- Cooling time inadequate for large mass parts, contributing to ejection deformation.

Part Geometry Challenges

- The star base features radial symmetry with five or six long arms extending from a central hub.
- Thick-to-thin transitions at junctions promote sink marks.
- Large flat surfaces prone to vacuum formation during cooling.

Process Optimization Strategies

Strategy Category	Recommended Actions
1. Mold Modifications	Implement uniform wall thickness (target: 4–5 mm); add ribs instead of increasing wall thickness; optimize gate type (e.g., submarine or pin gate) and position near thickest section; install conformal cooling circuits
2. Material Handling	Ensure resin drying at recommended conditions (e.g., 80°C for 4 hours for PA6-GF30); limit regrind ratio to ⩽20%; use consistent pellet size and colorant dispersion
3. Parameter Tuning	Increase melt temperature within material limits; apply multi-stage injection profile; optimize packing pressure and duration; extend cooling time based on part ejection temperature

4. Post-Molding Controls	Utilize fixtures during cooling to maintain dimensional accuracy; perform annealing if high residual stress is detected
5. Quality Monitoring	Integrate in-line vision systems for weld line detection; use pressure sensors for cavity monitoring; conduct regular CMM inspections

Simulation and Validation

Moldflow analysis is highly recommended to predict:

- Filling patterns and potential short shots
- Weld line locations and strength prediction
- Clamp force requirements
- Warpage magnitude and direction

Simulation should be validated through:

- First article inspection reports (FAIR)
- Dimensional measurement plans (DMP)
- Mechanical testing (load testing to simulate chair usage)

Conclusion

Successful manufacturing of office chair star bases requires an integrated approach combining optimized mold design, precise process control, appropriate material selection, and robust quality assurance protocols. Addressing

injection molding challenges proactively can significantly reduce scrap rates, improve product reliability, and lower overall production costs.