

DESIGN DISCLOSURE DOCUMENT — ADDENDUM

Evolutiv Filament Construction System

Addendum to EFC-DISCLOSURE-2025-001: Extended Applications, New Primitives, and Manufacturing Pathway Clarification

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Supersedes / Extends: EFC-DISCLOSURE-2025-001 (07 March 2025)

Domain: Additive Manufacturing — Mechanical Construction Systems — Replacement Parts

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1. Purpose of This Addendum

This addendum extends and updates the original design disclosure EFC-DISCLOSURE-2025-001 dated 07 March 2025. It documents: (a) additional reduction to practice achieved between March 2025 and March 2026; (b) a new construction primitive P7 covering multi-axis combined radial and axial filament bearing configurations; (c) corrections and clarifications to primitive P2 regarding demonstrated multi-row configurations; (d) explicit extension of all primitives to injection-moulded housing manufacture; and (e) identification of non-standard replacement parts — specifically luggage and travelling bag wheel assemblies — as a primary commercial application domain.

2. Corrections and Clarifications to EFC-DISCLOSURE-2025-001

2.1 Primitive P2 — Multi-Row Configuration Range

The original disclosure stated 'two to four rows demonstrated' for the polygonal intermediate race bearing in multi-row configuration. This is corrected as follows: three toroidal filament rows constitute the standard production configuration as demonstrated in the caster wheel prototype. The maximum demonstrated and designed configuration is five rows for heavy-duty applications. The standard specification is therefore three rows (standard load) to five rows (heavy load), replacing the previously stated two to four row range.

Parameter	Original Disclosure	Corrected Specification
Standard row count	Not specified	Three rows
Maximum row count	Four rows demonstrated	Five rows (design maximum)
Demonstrated application	Four-row configuration	Three-row caster; five-row design validated

2.2 Primitive P4 — Thermal and Span Limitations

Empirical testing establishes the practical span range for pretensioned filament linear slides at 200–300mm for standard FDM-printed housings using nylon 1.75mm filament as the rail element. Beyond this range, differential thermal expansion between the nylon filament rail (thermal expansion coefficient approximately 80–90 $\mu\text{m}/\text{m}/^\circ\text{C}$) and the printed housing material creates preload variation sufficient to affect carriage clearance. Mitigation strategies under investigation include: adjustable end-cap tensioners; substitution of PETG filament as the rail element for reduced thermal coefficient; and carbon fibre rod as a non-filament rail element for precision applications requiring spans beyond 400mm. These limitations do not affect the bearing primitive P1 or P2.

3. New Construction Primitive

P7 — Multi-Axis Combined Radial and Axial Filament Bearing

Swivel and multi-directional load bearing primitive

A bearing configuration in which filament torus elements are arranged to simultaneously resist both radial and axial loads within a single printed housing assembly. The configuration employs a minimum of two radial filament torus elements and two axial filament torus elements, each inserted through independent tangential entry ports oriented appropriately to their load axis. This arrangement provides complete constraint against both radial displacement and axial separation without requiring separate bearing stages or metallic thrust elements.

The primitive is demonstrated in the swivel joint of the EFC caster wheel assembly, where the fork yoke rotates freely about the vertical axis relative to the mounting plate. Under load, the two axial torus elements carry the vertical (downward) force from the supported structure, while the two radial torus elements resist lateral forces arising from direction changes during rolling. The swivel motion is smooth and requires no lubrication.

Parameter	Specification
Radial torus elements	Two minimum (standard configuration)
Axial torus elements	Two minimum (standard configuration)
Entry geometry	Tangential, independent ports per torus axis
Load axes constrained	Radial (lateral) and axial (thrust) simultaneously
Lubrication required	None
Demonstrated application	Swivel caster wheel joint — 25kg sustained load target per caster
Scalability	Row count scalable independently per axis for higher loads
Key novelty	Combined radial/axial filament torus bearing in single printed housing; no meta element

4. Extension to Injection-Moulded Housing Manufacture

The original disclosure describes primitives P1 through P6 exclusively in the context of FDM additive manufacture. This addendum explicitly extends the scope of all primitives, including P7, to housings produced by injection moulding. The functional principles of each primitive — tangential filament entry, torus formation within closed race geometry, topology-locked fastening, pretensioned rail elements, epicycloidal cam profiles, and UV resin surface calibration — are independent of the manufacturing process used to produce the housing geometry.

Injection-moulded housings incorporating EFC primitive geometry present the following commercial advantages over FDM-printed equivalents: significantly reduced unit cost at volume; improved dimensional consistency of race and channel geometry; broader material selection including polypropylene, acetal, PEEK, and food-grade variants; and surface finish compatible with direct use without UV resin calibration in standard-tolerance applications. The filament torus bearing element itself remains unchanged — standard 1.75mm nylon or equivalent filament is inserted post-moulding through the same tangential entry geometry.

The originator explicitly reserves IP claims over injection-moulded implementations of all primitives P1 through P7 under the same licensing terms as FDM implementations stated in EFC-DISCLOSURE-2025-001 Section 5.

5. Non-Standard Replacement Parts Application Domain

5.1 Luggage and Travelling Bag Wheel Assemblies

A primary commercial application domain identified subsequent to the original disclosure is the manufacture of replacement wheel assemblies for luggage and travelling bags. This domain is characterised by: extreme fragmentation of wheel geometry across manufacturers with no industry standardisation; unavailability of replacement parts through normal retail channels; high emotional and financial motivation for repair rather than replacement of the bag; and wheel geometry fully within the capability of EFC primitives P1, P2, and P7.

The parametric nature of the EFC system permits generation of replacement wheel geometry matching any original part from a small number of dimensional inputs — wheel diameter, width, axle bore, and mounting interface. Printed or injection-moulded housings combined with filament torus bearings provide equivalent or superior load capacity and rolling smoothness to original equipment wheels. No lubrication is required, and the torus bearing element is field-replaceable without disassembly tooling.

5.2 Industrial Guide and Track Wheel Assemblies

A secondary replacement parts domain is non-standard industrial guide wheels — including V-slot profile wheels for aluminium extrusion systems, conveyor idler wheels, sliding gate runner wheels, and measuring or encoder wheels — where original equipment manufacturer parts carry long lead times, high prices, or have been discontinued. The EFC parametric system addresses this domain with particular advantage in the elimination of the pressed-in metallic bearing insert common to conventional V-slot wheels: the EFC filament torus bearing provides radial load capacity from a bore diameter of 10mm or greater without requiring a precision-ground shaft, and with bending stiffness substantially greater than conventional 5mm shaft designs at equivalent outer dimensions.

6. Updated Evidence of Reduction to Practice

Primitive	New Evidence (March 2025 – March 2026)
P1 / P2	Caster wheel assembly — 50mm diameter x 25mm width wheel; three-row standard configuration; fixed and variants
P7	Swivel caster joint — two radial + two axial filament torus configuration; smooth rotation under load confirmed
P4	Span testing confirming 200–300mm practical range; thermal expansion characterisation initiated
P5	Stepper motor integration demonstrated with NEMA 17; modular rack section joining confirmed in extended assembly
P1–P7 (Inj. Mould)	Design geometry confirmed compatible with injection moulding parting line analysis; no undercuts in standard housing

7. Declaration

I, Mark Culaj, declare that the additions, corrections, and extensions described in this addendum are accurate to the best of my knowledge, that all new primitives and applications described herein were conceived and reduced to practice by me independently, and that this document together with EFC-DISCLOSURE-2025-001 constitutes the complete prior art record for the Evolutiv Filament Construction System as of the date stated below.

Signature  Date: 14 March 2026

Mark Culaj — Evolutiv AI SH.A, Pristina, Kosovo