DESIGN DISCLOSURE DOCUMENT

Evolutiv Filament Construction System

A System of Mechanical Construction Primitives Using Standard 1.75mm Filament

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1. Purpose and Legal Notice

This document constitutes a formal design disclosure establishing the date of conception, the identity of the originator, and the technical specificity of each construction primitive comprising the Evolutiv Filament Construction System (hereinafter "the System"). It is intended to serve as prior art documentation, to support intellectual property claims, and to accompany any public or commercial release of associated design files.

This disclosure does not constitute a patent application. It establishes the originator's priority of invention for each primitive described herein and provides sufficient technical detail to enable a person skilled in additive manufacturing to reproduce the described mechanisms.

2. System Overview

The Evolutiv Filament Construction System is a complete mechanical construction system for fused deposition modelling (FDM) printers. It enables the fabrication of functional machines — including rotary bearings, precision linear slides, permanent assembly joints, gear trains, and modular linear actuator axes — using standard 1.75mm diameter nylon or PLA filament as the sole functional mechanical element beyond the printed geometry itself.

The System is distinguished from prior printed mechanism work by the following characteristics taken in combination:

(1) The use of continuous filament torus geometry as a rolling/bearing element formed in situ within a split printed housing.
(2) Tangential filament entry geometry permitting torus formation without disassembly of bearing races.
(3) Filament-threaded tubular channels crossing housing parting planes to create permanent, tool-free, topology-locked assemblies.
(4) Pretensioned filament linear guide elements split half-diameter across fixed and moving components.
(5) Epicycloidal cam rack linear drive geometry for printed modular axes.
(6) UV-resin in-motion curing as a precision surface calibration process for printed sliding and rolling interfaces.

3. Construction Primitives — Technical Disclosure

P1 Tangential-Entry Filament Torus Bearing

Rotary motion primitive

A bearing assembly in which standard 1.75mm nylon or similar flexible filament is inserted through a tangential entry port machined into the outer race of a split printed housing. The filament traverses a circular channel of cross-sectional diameter equal to or marginally greater than 1.75mm, completing a full 360° torus path. The entry port is subsequently sealed with a printed press-fit plug or printed screw element, enclosing the filament torus permanently within the race geometry.

The torus acts as the rolling/sliding bearing element between the outer race (integral to the housing) and an inner race (shaft insert). The dimensional precision of commercially produced 1.75mm filament — manufactured to tolerances tighter than typical FDM feature resolution — provides the functional precision of the bearing without requiring post-machining of printed surfaces.

Minimum demonstrated size	OD 16mm × Height 5mm
Standard reference size	OD 25mm × Height 6mm × Bore 6mm
Filament diameter	1.75mm ±0.02mm (standard FDM feedstock)
Entry geometry	Tangential to bearing race circumference
Inner race geometry	Circular (standard) or polygonal (hexagonal variant)
Sealing method	Printed plug or threaded screw in entry port
Key novelty	Tangential in-situ torus formation within closed race; no race disassembly required

P2 Polygonal Intermediate Race Bearing

Heavy-duty rotary motion variant

A variant of Primitive P1 in which the intermediate race element between the filament torus and the bearing bore presents a polygonal (specifically hexagonal or octagonal) exterior profile rather than a circular profile. Under radial load, the polygon flats create defined linear contact zones between the race and the filament torus, increasing contact area progressively with load — a self-compensating geometry not achievable with circular races.

Multi-row configurations stack two or more axially separated filament tori within a single housing, each loaded through independent tangential entry ports, for increased axial load capacity. Demonstrated in castor wheel application with four-row filament stack.

Race profile	Hexagonal or octagonal intermediate element
Load behaviour	Progressive contact area increase under radial load
Multi-row capability	Two to four rows demonstrated; limited by housing height
Demonstrated application	Heavy-duty castor wheel, large-format axis bearings
Key novelty	Polygonal race geometry for adaptive load-contact distribution in filament bearings

P3 Tangential Filament Assembly Lock

Permanent topology-locked fastening primitive

A permanent fastening method in which one or more tubular channels are divided across the parting plane of a multi-part printed assembly, such that when the assembly is mated, the channels form continuous closed tubes. Filament is inserted through a tangential entry port that passes through the outer wall of the assembly into this channel network. Once inserted to full depth, the entry port is sealed. The filament torus or linear segment within the closed channel cannot exit without destroying the channel geometry.

The joint simultaneously provides: (a) alignment of mating surfaces; (b) resistance to separation perpendicular to the parting plane; (c) resistance to rotation about axes parallel to the parting plane; and (d) resistance to lateral shear. No adhesive, no threaded fastener, no heat insertion, and no external tooling are required.

Lock mechanism	Filament torus in topology-closed channel across parting plane
Disassembly	Impossible without destruction of housing geometry
Functions provided	Alignment, separation resistance, rotation resistance, shear resistance
Entry sealing	Printed plug, press-fit pin, or screw cap
Key novelty	Topology-based permanent fastening using filament; no adhesive or threaded element

P4 Pretensioned Filament Linear Slide

Linear motion primitive

A linear motion guide in which filament rails are divided half-diameter across the interface between a fixed rail body and a sliding carriage. The filament is inserted with pretension applied at one or both termination points, eliminating clearance at the rail-carriage interface. Two or more parallel rails constrain all rotational degrees of freedom, providing fully constrained linear motion. Clearance between filament and channel wall is set at 0.01–0.05mm through combined dimensional design and UV resin finishing (see Primitive P6).

Demonstrated as the slide mechanism of a functional Vernier caliper with measured repeatability exceeding that of commercial low-end metal instruments. The pretension mechanism compensates for thermal expansion and material creep, maintaining consistent contact geometry over operational life.

Rail geometry	Filament split half-diameter across fixed/moving interface
Pretension method	End termination with controlled axial load
Operating clearance	0.01–0.05mm (design) refined by UV resin finish process
Minimum rail count	Two (full rotational constraint)
Demonstrated precision	Vernier caliper — precision exceeding low-end commercial metal instruments
Key novelty	Half-diameter split pretensioned rail; pretension compensation for creep and thermal drift

P5 Epicycloidal Cam Rack Linear Drive

Linear drive primitive for modular axes

A linear drive system for printed actuator axes in which the rack element presents a continuous epicycloidal (sinusoidal wave) profile rather than discrete gear teeth. A circular cam follower mounted on the drive shaft of a stepper motor engages the wave rack through rolling cam contact. This geometry is inherently tolerant of FDM-produced dimensional variance: the rolling contact point self-locates on the wave profile under load without requiring the tooth-to-tooth mesh precision of conventional gear racks.

The rail body incorporating the rack profile is printed in modular sections that join end-to-end, enabling axis construction to any practical length without reprinting. The filament linear slide system (Primitive P4) provides the bearing function for the carriage running on the rack rail. The combined assembly constitutes a complete single-axis linear actuator requiring no purchased mechanical components other than the stepper motor.

Drive profile	Epicycloidal (continuous sinusoidal wave) surface
Follower geometry	Circular cam on motor shaft or intermediate stage
FDM tolerance tolerance	High — rolling cam contact self-locates on wave profile
Modularity	End-join sections; any length without reprinting
Motor compatibility	NEMA 17, NEMA 23 (mount geometry parametric)
Demonstrated performance	Repeatability and speed suitable for desktop CNC and FDM printer axes
Key novelty	Epicycloidal rack + rolling cam follower; modular section joining; integration with filament slide bearings

P6 In-Motion UV Resin Precision Surface Calibration

Precision finishing process

A finishing process for printed sliding and rolling interfaces in which UV-curing resin is applied to the functional contact surfaces while the mating parts are in continuous relative motion. Continuous UV illumination is simultaneously applied. The resin flows under surface tension and capillary action into surface voids and dimensional deviation zones, filling them while the parts move at controlled speed. Curing occurs in the exact functional geometry — the loaded, moving configuration — rather than in the static assembly geometry.

The result is a surface calibrated to the operating relationship between the specific mating parts, compensating for FDM surface roughness, waviness, and dimensional deviation simultaneously. Parts processed by this method exhibit surface finish and dimensional conformance comparable to lightly machined metal components. The process is applicable to both linear slide interfaces (Primitive P4) and bearing races (Primitive P1).

Resin type	UV-curable low-viscosity resin (wavelength 365–405nm)
Application method	Applied during continuous relative motion of mating surfaces
Curing condition	Continuous UV illumination during motion
Result geometry	Cured in functional operating geometry, not static assembly geometry
Applicable interfaces	Linear slides, bearing races, cam follower surfaces
Key novelty	In-motion curing for functional geometry calibration; surface precision achieved through process rather than print resolution

4. Evidence of Reduction to Practice

The following physical prototypes have been constructed and photographed, demonstrating reduction to practice of the described primitives. Photographs are dated by device metadata and available upon request.

Torus bearing (P1)	Multiple units, OD 16mm to castor scale; thermal testing at speed — minimal warming confirmed
Hex race bearing (P2)	Castor wheel unit, four-row configuration, disassembled for component documentation
Assembly lock (P3)	Demonstrated in motor housing and axis end-stop assemblies

Linear slide (P4)	Functional Vernier caliper; two-rail and three-rail precision guide assemblies
Epicycloidal rack axis (P5)	300mm+ modular axis with NEMA 17 stepper; repeatability and speed tested
UV resin finishing (P6)	Applied to linear slide and bearing interfaces; surface documented

5. Scope of Disclosure and Licensing Intent

This disclosure covers the six primitives described in Section 3 and their combinations as described in Sections 3 and 4. It does not cover general printed bearing concepts, general printed linear slides, or epicycloidal gear geometry in isolation — only the specific implementations, combinations, and process inventions described herein.

The originator intends to publish demonstration STL files under Creative Commons CC BY-SA 4.0. Parametric source files and commercial design libraries incorporating these primitives are offered under separate commercial license through shop.evolutiv.ai. The originator reserves the right to license these primitives to manufacturers, software platforms, and filament producers under separate commercial terms.

6. Declaration

I, Mark Culaj, declare that I am the originator of the construction primitives described in this document, that they were conceived and reduced to practice by me independently, and that this document accurately represents the technical content of my inventions to the best of my knowledge.

Signature
Mark Culaj — Evolutiv AI SH.A

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