Product Name: **Zor Deca Mechanical Mug Holder**

ZOR *represents strength.* ***DECA*** *represents the 10th iteration.*

Assembly & Setup Instructions

Download the Zor Deca assembly manual and build guide: jayruslabs.com/zor-deca-manual

1. Component Identification & Parts List

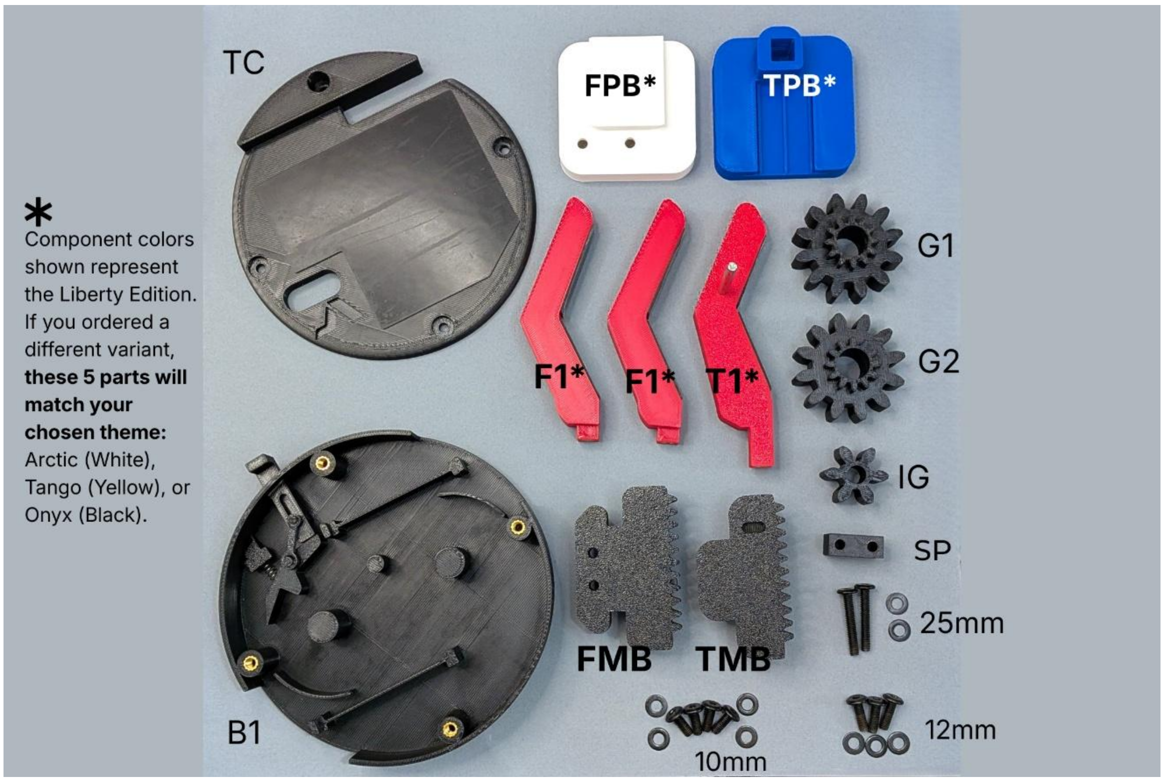

Figure 1: Zor Deca Parts Identification

Part ID	Component Name	Qty	Part Type	Visual & Practical Description
TC	Top Cover	1	Printed	Circular cover with 4 mounting holes and a rubber pad to add grip.
B1	Base	1	Printed	Main circular base housing the gear pins, track walls, and mounting holes.
FPB	Palm Block – Fingers	1	Printed	Sliding connector block featuring 2 alignment pockets and a male dovetail joint.
TPB	Palm Block – Thumb	1	Printed	Sliding connector block featuring 1 alignment pocket and a female dovetail track.

F1	Claw-Shaped Fingers	2	Printed	Narrow mechanical fingers with a rear connecting post.
T1	Claw-Shaped Thumb with Metal Pin	1	Printed / Hardware	Thumb shaped wide finger featuring a rear connecting post and an embedded steel pin.
G1	Gear 1	3	Printed	Large main gear paired with a smaller stacked gear on top.
G2	Gear 2	3	Printed	Large main gear paired with a smaller stacked gear on top.
IG	Idler Gear	3	Printed	Small helper gear used to reverse the direction of rotation.
FMB	Moving Block – Fingers	3	Printed	Wide block featuring gear teeth along the edge, 2 mounting holes and lower guide walls.
TMB	Moving Block – Thumb	3	Printed	Narrow block featuring gear teeth along the edge, an alignment slot and lower guide walls.
SP	Spacer	3	Printed	Spacer block with 2 alignment holes.
25mm	25mm Screws	2	Hardware	25mm machine screws paired with flat washers.
12mm	12mm Screws	3	Hardware	12mm machine screws paired with flat washers.
10mm	10mm Screws	4	Hardware	10mm machine screws paired with flat washers.

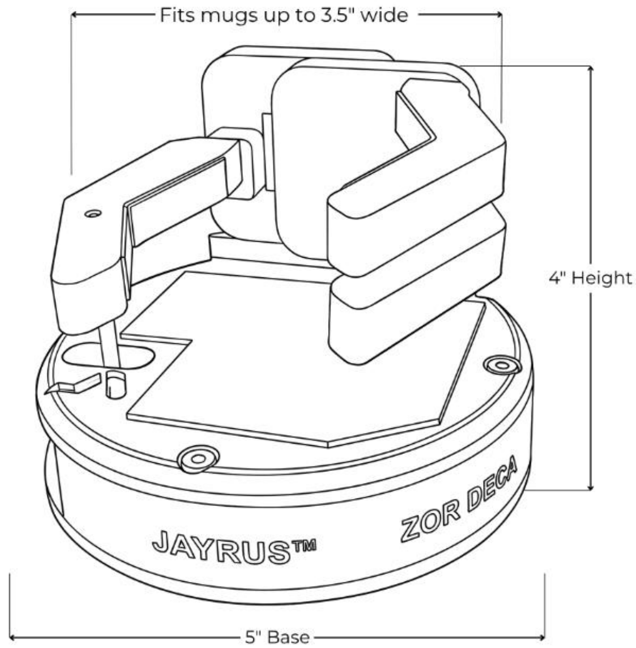

Figure 2: Zor Deca Technical Drawing

Pre-Assembled Sub-Modules

- **Base Locking Module:** The Structural Base (B1) comes with the internal locking pawl, compression spring, release button, and the thicker 1/16-inch rubber pad pre-installed.
- **Mug Contact Liners:** The Top Cover (TC), Claw-Shaped Fingers (F1), and Thumb Gripper (T1) come with the 1/32-inch rubber pads pre-installed.

Note on Product Architecture & Classroom Safety:

The internal locking mechanics and all rubber grip pads come pre-assembled in the base and components. This intentional design choice protects the small internal components from being lost or damaged in a classroom setting and allows students to focus their assembly time on the mechanics of the product.

2. Combined STEM Concepts + Component Mapping Table

STEM Division	STEM Concept	Part IDs	How the Parts Demonstrate the Concept
Engineering	**Kinetic Energy Conversion** Linear → Rotational → Linear	FMB, TMB, FPB, TPB, G1, G2, IG	Demonstrates how motion changes forms. Pushing or pulling the main blocks (FMB/TMB) drives the palm blocks linearly. Their teeth spin the gear train (G1/G2/IG), which instantly drives the opposite side in reverse. It shows how linear motion turns into rotational motion and back into linear motion.
Engineering	**Gear Trains & Motion Transfer**	G1, G2, IG, B1	Shows how motion transfers between components. By placing the idler gear (IG) between G1 and G2 inside the base, it creates a 3-gear train that reverses rotation. This allows the finger and thumb sides to open and close in perfect synchronization.
Engineering	**Guided Linear Motion**	FMB, TMB, FPB, TPB, B1	Shows how rotating parts can drive sliding parts. When gears G1 and G2 spin, they push against the straight rows of teeth on the palm blocks (acting like a rack-and-pinion setup). This transforms the rotational spinning into straight-line sliding along the track walls.
Engineering	**Constrained Motion** (Straight-Line Travel)	FMB, TMB, FPB, TPB, B1	Demonstrates how to lock movement in a single direction. The moving blocks have lower guide walls that straddle the raised tracks/walls in the base (B1). It keeps the parts moving perfectly straight and prevents them from twisting or drifting sideways.
Engineering	**Kinematic Joints**	FPB, TPB, FMB, TMB, T1, G1, G2, IG	Teaches students how different types of physical connections work together in a single machine. It combines sliding joints (dovetails), rotational joints (gears spinning on shafts) and a pin-in-slot tracker (T1's metal pin sitting in the oval slot in TMB).
Engineering	**Dovetail Mechanics**	FPB, TPB	Demonstrates a classic woodworking and engineering joint. The male dovetail on FPB slides smoothly inside the female dovetail slot on TPB.

			The angled shape allows smooth sliding while physically locking the parts together so they cannot pull apart under pressure.
Engineering	**Pawl-and-Ratchet Locking**	B1, G1, G2	Teaches the principle of a one-way mechanical lock. The tooth on the locking pawl drops cleanly into gear teeth to act as a physical stop and hold the grip tight. An internal spring pushes against the pawl to keep it locked and to prevent reverse motion. When the user presses the release button, it forces the opposite side of the pawl against the spring, pivoting the locking tooth safely out of the way to release the mechanism.
Engineering	**Mechanical Advantage**	G1, G2, IG	Shows how component sizes affect force and movement. By utilizing calculated gear diameters and tooth spacing inside the base, the kit allows a small input movement from the user to smoothly drive the sliding blocks forward to grip an object.
Engineering	**Multi-Component Synchronization**	G1, G2, IG, FMB, TMB, FPB, TPB	Demonstrates system coordination. The central gear core handles the timing for both sides of the mechanism simultaneously, ensuring that the fingers and thumb move at the exact same pace to clamp the mug evenly on its center point.
Engineering	**Modular Product Architecture**	F1, T1, FPB, TPB, FMB, TMB	Shows how complex products are broken down into simpler sub-assemblies. Separate sub-modules (fingers, sliding blocks and gear racks) connect using standardized pegs and joints to build a functional mechanical consumer product.
Engineering	**Iterative Prototyping**	All Parts	Teaches the reality of product development. The current design is a direct result of testing and refining earlier versions. Factors like plastic shrinkage, surface friction, and ease of sliding all had to be managed. Modifications also included hardware adjustments to ensure every piece fits together properly.
Physics	**Potential Energy & Tension**	B1, G1, G2	Demonstrates spring force and stored energy. In its default state, the internal spring inside the base (B1) applies continuous tension that forces the locking pawl down into the teeth of the main gears (G1/G2) and keeps the system locked. When a user

			manually presses the release button, the force is overridden by compressing the spring, which temporarily stores elastic potential energy until the button is released and the spring snaps the pawl back into its default locking position.
Physics	**Rotational Torque**	G1, G2, IG	Shows how rotational force travels. The twisting force (torque) applied to one gear is physically transferred through the interlocking faces of the gear teeth and distributes power across multiple spinning centers.
Physics	**Load Paths & Force Distribution**	B1, FPB, TPB, FMB, TMB	Demonstrates how structural parts handle weight and pressure. When a mug is clamped, the physical squeezing forces travel out of the fingers, through the palm and moving blocks and are absorbed by the thick structural walls of the base (B1).
Physics	**Friction & Material Gripping**	F1, T1, TC	Illustrates how surface materials affect grip. While the fingers (F1/T1) supply the physical holding force against the sides of the mug, the Top Cover's (TC) rubber pad introduces a high-friction surface that prevents the mug from sliding vertically.
Physics	**Friction & Material Optimization**	Pre-Attached Rubber Pads, Included Grease Packet	Illustrates how surface materials and thicknesses are chosen to manage friction. A thicker 1/16-inch rubber pad is used on the bottom of the base to grip the desk and stop the holder from skidding under weight. Meanwhile, thinner 1/32-inch rubber pads are used on the fingers to give them a high-friction grip on the mug without adding bulk. Additionally, the included grease packet teaches students how lubricants reduce mechanical resistance; applying it to the gear bases, dovetail ribs and rack teeth ensures the raw 3D-printed layer lines glide smoothly without binding.
Physics	**Center of Gravity & Stability Limits**	B1, Object Weight	Teaches the physics of balance and tipping points. The broad design of the base (B1) ensures a low center of gravity for standard mugs. However, if a vessel exceeds 5.5 inches in height, the center of gravity shifts upward and makes the system "top-heavy." This warns students how height and weight

			distribution directly impact the stability and balance of a mechanical structure.
Technology	**Digital CAD Modeling to Physical Reality**	All Parts	Every component in this kit serves as a lesson in 3D design. Students see how dimensions, spacing and shapes created in computer software translate into real-world physical objects.
Technology	**3D Printing & Additive Manufacturing**	All Printed Parts	The kit serves as a live case study for 3D printing. Because it is built layer-by-layer, it shows students how complex internal shapes (e.g. sliding dovetail slots and internal tracks) can be easily manufactured without needing to cut or glue separate pieces together.
Mathematics	**Tolerances & Clearances**	FPB, TPB, FMB, TMB, G1, G2, IG	Teaches the math behind engineering tolerances. Students explore clearance fits, showing how to leave just enough gaps so sliding blocks and spinning gears move freely without binding. This is contrasted with interference fits, which require a peg to be slightly tighter than a hole so parts stay aligned during assembly (e.g., the thumb's metal pin sitting tightly in the TMB slot).
Mathematics	**Dimensional Measurement & Audit**	All Parts	Acts as a hands-on math artifact. Students can use standard measuring tools (like rulers or calipers) to measure physical features like block widths or track gaps. This teaches them how to compare real-world objects against 2D blueprints and understand how physical parts can vary slightly from their digital designs.

Appendix A: Internal Mechanism & Component Alignment

The internal layout below illustrates the physical gear train mesh, track walls and pre-assembled locking system. It shows the fingers (F1), moving block (FMB), and palm block (FPB) seated inside the base, with the unattached thumb (T1) and thumb moving block (TMB) positioned just above it. The straight teeth on the moving blocks drive the gears, while the spring-loaded pawl (housed in the upper-left quadrant) locks directly into the main gears to secure the mechanism.

Figure 3: Top-down view of the internal mechanism

Procurement Note:

For school district procurement, formal quotes or to discuss flexible pricing options for under-resourced programs, please reach out to us at support@jayruslabs.com or visit the **Contact Us** page on our website www.jayruslabs.com