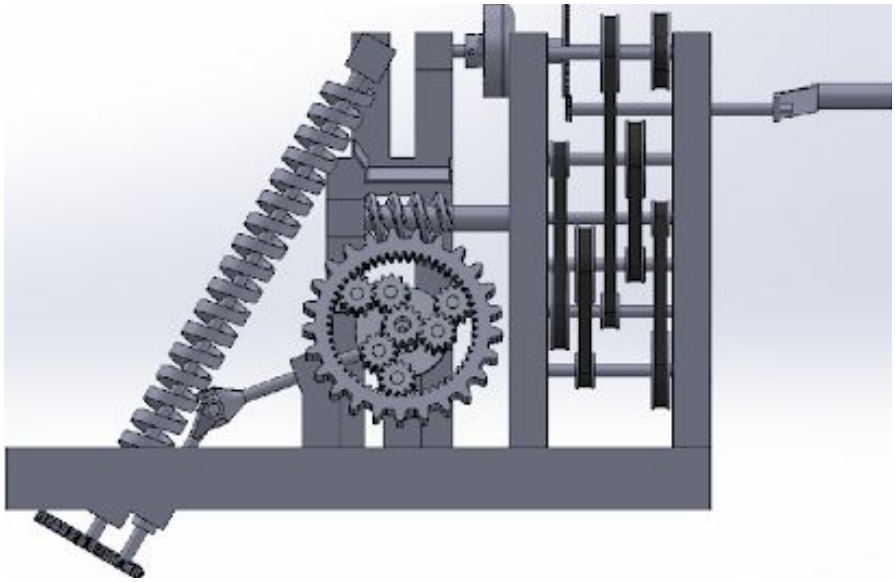
Art Combined with Engineering

Presents

ARTIMEDES



OPERATIONS MANUAL

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1. Overview

Artimedes is a kinetic sculpture created by the senior capstone team, Art Combined with Engineering. This sculpture implements timing belts, pulleys, gears, an Archimedes screw, and fluid flow. This document will detail how to operate the kinetic sculpture and the proper maintenance of the sculpture.

2. Operation

The sculpture requires a wind via hand crank from the user. The hand crank is connected to the timing belt system which drives the rest of the sculpture. The sculpture will only operate while the user continues to wind the hand crank.

3. Maintenance

This sculpture does not require much maintenance. The only parts susceptible to failure is the timing belts. Extra timing belts were purchased for such failure. Three different lengths of belt were used for the system. If these belts are to break, use Figure 3.1 and Table 3.1 to determine the belt needed.

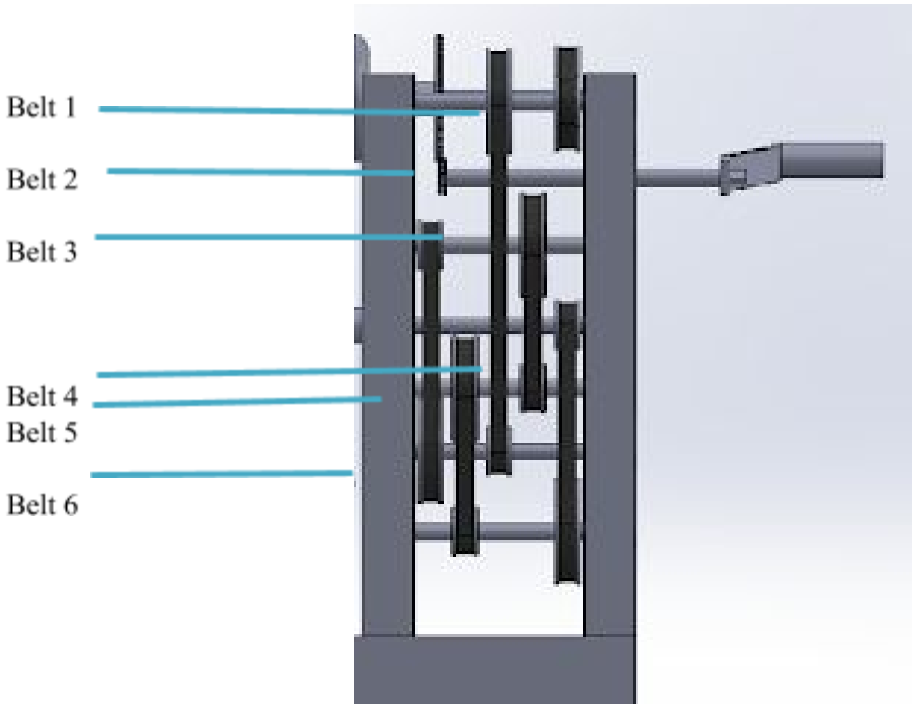

Figure 3.1: Timing Belts

Table 3.1: Timing Belt Specifications

Belt Number	*Belt Length (in)*	*Part Number*	*Purchased From:*
1	18.7	187L050NG	Automation Direct
2	27.0	270L050NG	Automation Direct
3	15.0	150L050NG	Automation Direct
4	18.7	187L050NG	Automation Direct
5	15.0	150L050NG	Automation Direct
6	18.7	187L050NG	Automation Direct

With these specifications, the timing belts can easily be replaced, if needed.

4. Disassembly

To get to the sculpture, first, the plexiglass above the placard must be removed with a screwdriver. Then, the hand crank will need to be unbolted from the ratchet drive gear shaft. The two set screws holding the shaft in place will need to be removed and the shaft will need to be pushed towards the inside of the sculpture. The other shafts can be removed by using an Allen wrench to unscrew the set screws in the pulleys. The other shafts can be loosened and removed just like the ratchet drive gear shaft. The worm gear is attached to a shaft with set screws, so an Allen wrench is needed for that as well. Once the shafts and worm gear are disconnected, the ring gear which encases the planetary gear set can slip off easily. The planet gear holder with the planet gears can be removed by pulling them away from the sun gear. In order to remove the sun gear you would need to use an Allen wrench to hold the bolt inside the center of the sun gear from turning as you use a wrench to remove the nut located behind the sun gear. The bevel gear, U-Joint, as well as the two gears located below the Archimedes screw are all easily removed with a phillips screwdriver. Finally in order to remove the Archimedes screw you need to slide the entire assembly upward until the shaft slides out of the bottom bearing. At this point would would want to slide the bottom of the archimedes screw to the left and simultaneously down and out of the top bearing.

5. Bill of Materials

Figure 5.1 below showcases the Bill of Materials for the entire project. The BOM showcases where the team bought the materials, the material number, and the price.

Figure 5.1: Bill of Materials

Budget From NAU EGR Department	***$2,000.00***					
Budget From Green Fund	***$525.00***					
Total Expenses	***$2,493.26***					
Budget Left	***$31.74***					

						Status
	Prototype		*$190.01*	*Total*		*Completed*
		3-D Printer Filament	*$152.46*	*Amazon*		*Purchased*
		Super Glue	*$11.57*	*Amazon/Walmart*		*Purchased*
		Steel Rod	*$2.41*	*Home Depot*		*Purchased*
		Rope	*$2.70*	*Home Depot*		*Purchased*
		Speed Control	*$8.62*	*Amazon*		*Purchased*
		Batteries	*$8.86*	*Amazon*		*Purchased*
		Battery Connectors	*$3.39*	*Amazon*		*Purchased*
	Foundry		*$102.59*	*Total*		*Scraped*
		Pearlite	*$36.97*	*Home Depot*		*Purchased*
		Concrete	*$9.97*	*Home Depot*		*Purchased*
		Trash Can	*$21.77*	*Home Depot*		*Purchased*
		Home Depot Bucket	*$10.62*	*Home Depot*		*Purchased*
		PVC Pipe	*$3.90*	*Home Depot*		*Purchased*
		PVC Coupler	*$4.34*	*Home Depot*		*Purchased*
		Eye Bolts	*$5.25*	*Home Depot*		*Purchased*
		Trowel	*$9.77*	*Home Depot*		*Purchased*
	2nd Foundry		*$111.32*	*Total*		*Completed*
		Home Depot Bucket	*$7.12*	*Home Depot*		*Purchased*
		PVC Coupler	*$2.32*	*Home Depot*		*Purchased*

		Plastic Drop Cloth	*$2.19*	*Home Depot*		*Purchased*
		Steel Wool	*$8.71*	*Home Depot*		*Purchased*
		U-Bolt	*$3.42*	*Home Depot*		*Purchased*
		Sand	*$6.48*	*Home Depot*		*Purchased*
		Plaster of Paris	*$54.88*	*Home Depot*		*Purchased*
		Metal Trash Can	*$26.20*	*Ace Hardware*		*Purchased*
	Casting Process		*$402.60*	*Total*		*Failed*
		Crucible	*$48.50*	*Amazon*		*Purchased*
		Tongs	*$23.38*	*Manufactured By The Team (Material Purchased From Havasu Iron and Steel)*		*Manufactured*
		Casting Sand	*$52.95*	*Amazon*		*Purchased*
		Casting Mold	*$4.49*	*Home Depot*		*Purchased*
		Propane Torch	*$27.68*	*Amazon*		*Purchased*
		Propane x2	*$107.53*	*Home Depot*		*Purchased*
		Propane Refill	*$24.99*	*Various*		*Purchased*
		Face Shield	*$8.69*	*Harbor Freight*		*Purchased*
		Leather Gloves	*$10.89*	*Harbor Freight*		*Purchased*
		Slag Spoon	*$6.98*	*Amazon*		*Purchased*
		Easy Seperate Powder	*$15.95*	*Amazon*		*Purchased*
		Ingot Mold	*$23.96*	*Amazon*		*Purchased*
		Storage Bin For Casting Sand	*$9.24*	*Home Depot*		*Purchased*
		Mixer For Casting Sand	*$15.22*	*Home Depot*		*Purchased*
		Sand For Casting	*$8.65*	*Home Depot*		*Purchased*

		Sand				
		Cat Litter For Casting Sand	*$13.50*	*Walmart*		*Purchased*
	Can Collection		*$21.94*	*Total*		*Completed*
		Cardboard Boxes	*$7.25*	*Home Depot*		*Purchased*
		Trash Bags	*$6.01*	*Home Depot*		*Purchased*
		Tape	*$8.68*	*Home Depot*		*Purchased*
	Machining		*$325.24*	*Total*		*Completed*
		Foam Board For Practice	*$25.06*	*McMaster-Carr*		*Purchased*
		12"x12"x1.25" Aluminum	*$118.60*	*McMaster-Carr*		*Purchased*
		8"x8"x1.75" Aluminum	*$103.16*	*McMaster-Carr*		*Purchased*
		1.75"x1.75"x24" Aluminum	*$50.68*	*McMaster-Carr*		*Purchased*
		2.25"x2.25"x6" Aluminum	*$27.74*	*McMaster-Carr*		*Purchased*
		Shipping	*$0.00*			*No Shipping Charges*
	Full-Scale Model		*$1,281.76*	*Total*		*Completed*
		Planet Gears	*$0.00*	*To be Machined From Purchased Aluminum*		*Completed*
		Planet Gear Holder	*$0.00*	*To be Machined From Purchased Aluminum*		*Completed*
		Ring Gear	*$0.00*	*To be Machined From Purchased Aluminum*		*Completed*

		Worm Gear	*$0.00*	*To be Machined From Purchased Aluminum*		*Completed*
		Sun Gear	*$0.00*	*To be Machined From Purchased Aluminum*		*Completed*
		Connecting Rod	*$0.00*	*To be Machined From Purchased Aluminum*		*Completed*
		Connecting Gear	*$0.00*	*To be Machined From Purchased Aluminum*		*Completed*
		U-Joint	*$0.00*	*To be Machined From Purchased Aluminum*		*Completed*
		Archimedes Screw	*$44.30*	*To Be Manufactured from Steel*		*Completed*
		Timing Pulleys	*$350.50*	*Automation Direct*		*Purchased*
		Ratchet and Parts	*$27.23*	*Tractor Supply*		*Completed*
		Rods to Hold Gears	*$24.18*	*McMaster-Carr*		*Purchased*
		Timing Belts	*$63.25*	*Automation Direct*		*Purchased*
		Steel for Stand	*$103.38*	*Havasu Iron and Steel*		*Completed*
		Plexiglass	*$228.20*	*Home Depot*		*Completed*
		Engraved Plaque	*$0.00*	*To be CNC'd by Us*		*Completed*
		Plaque Board	*$27.31*	*Woodworkers Source*		*Purchased*
		Assorted Bearings	*$55.52*	*Amazon*		*Purchased*
		Caster Wheels	*$24.78*	*Amazon*		*Purchased*
		Various Fasteners	*$31.60*	*Ace and Home Depot*		*Purchased*
		Counter Weight	*$86.43*	*McMaster-Carr*		*Purchased*
		3-D Printer Filament	*$21.78*	*Amazon*		*Purchased*

		Spray Paint	***$57.18***	***Home Depot***		***Completed***
		Paint for Plaque	***$0.00***	***Home Depot***		***Completed***
		Plywood	***$16.60***	***Home Depot***		***Completed***
		Silicon	***$7.14***	***Home Depot***		***Completed***
		Stain	***$5.41***	***Home Depot***		***Completed***
		Rods for Aluminum Ingots	***$10.63***	***Home Depot***		***Completed***
		Glue	***$25.21***	***Home Depot***		***Completed***
		Sand Paper	***$31.58***	***Amazon***		***Purchased***
		Paint Thinner	***$5.41***	***Home Depot***		***Purchased***
		Rags	***$19.50***	***Home Depot***		***Purchased***
		Paracord for Weight	***$2.70***	***Home Depot***		***Purchased***
		Tube for weight	***$11.94***	***Home Depot***		***Purchased***