Open Universal Mounting Plate
DESIGN RATIONALE

Makers Making Change
A Neil Squire Program

Introduction

The Open Universal Mounting Plate is a simple mounting option for assistive devices that do not have integrated mounting hardware. This device uses hook and loop fastener strips to attach to an assistive device allowing it to be mounted with standard ¼”-20 mounts, like those found on readily available camera mounting accessories.

Research

Commercial Products

Device	Cost	Notes	Link
Quick Ready Mounting Plate 	$35	This device uses hook and loop fastener strips to secure an assistive device to a mounting plate. The mounting plate has an attached external ¼”-20 bolt to allow the device to be mounted.	https://www.ablenetinc.com/quick-ready-mounting-plate-for-assistive-technology/
Quick Release Plate 	$43	This device uses rails that match the geometry of another device to secure ¼ -20 threads to for mounting.	FALCAM F38 Quick Release Plate

DIY Designs

Device	Cost	Notes	Link
Camera Mount Kit 	~$26 for 12	Various bolt on adapters that allow you to add internal ¼”-20 threads to a device. Uses screws to mount to the device.	Camera Mount Adapters for the Logitech Adaptive Gaming Kit - Makers Making Change
Suction-Cup Switch Mount 	~$10	This mount attaches to AT with hook and loop fastener and uses a section cup for mounting. Must be mounted to smooth flat surfaces.	Suction-Cup Switch Mount - Makers Making Change

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Requirements

Goals

G01	Securely mount AT that doesn't have integrated mounts

Functional Requirements

F01	Must be compatible with standard AT mounts (1/4"-20 UNC)
F02	Must be able to hold the weight of small AT (XX g)
F03	Must allow approximately 5 mm of threads to be engaged for mounting. (Or standard number of thread engagement)

Non-functional Requirement

NF01	Multiple mounting plate size options
NF02	The device must be able to accommodate three lengths of ¼+-20 UNC tee nuts: 5/16", 7/16", and 9/16".

Constraints

C01	Easily printable with common maker printers
C02	No specialty tools for assembly
C03	Use easily available, off the shelf parts

Ideation

Threaded Mounting Connections

The mounting plate is intended to attach to a mounting system with a threaded connection. Mounting systems are available with either external threads or internal threads. DIY and camera mounting systems typically have an external thread, such as the magic arm (e.g., SmallRig Articulating Magic Arm). There are also AT-specific mounting systems that have an internal thread (e.g., the AbleNet One Mount).

Connection Type	Mounting System	Mounting Plate	Comments
Internal-External	Internal Thread	External Thread	No additional hardware required.
Internal-Internal	Internal Thread	Internal Thread	This could possibly be achieved with a male-to-male thread adapter. 
External-External	External Thread	External Thread	This can be achieved with a coupling nut. Coupling nuts are readily available and inexpensive. 
External-Internal	External Thread	Internal Thread	No additional hardware required.

Threaded Connection Mounting Option 1: Internal Threads

An internal threaded connection (i.e., female) provides the ability to connecting to a mounting system with an external (I.e., male) thread.

There are several ways that an internal threaded connection can be added to a 3D printed part:

1. 3D printed threads.
2. Tapped threads.
3. Integrated hardware
    a. Hex nut
    b. Tee nut
    c. Heat-set insert.

Threaded Connection Mounting Option 2: External Threads

An external threaded connection (I.e., male) provides the ability to connect to a mounting system with an internal (i.e., female) thread. A mounting knob is commonly used to fix this connection in a desired orientation.

Some ways external threaded connections can be added to a 3D printed part:

1. 3D printed threads (size and print orientation will be important for strength)
2. Hex Bolt

Threaded Connection Mounting Option 3: Combined Internal-External Threads

The third option is a design that provides both an internal and external threaded connection or the ability to easily swap between configurations.

Some ways external and internal threaded connections can be added to a 3D printed part:

1. Modular design that can be swapped out.
2. Use of a tee nut and hex bolt
    a. Internal threads: Only the tee nut is used.
    b. External threads: A hex bolt is threaded through the tee nut to expose external threads.

Types of Tee Nuts

Diagrams and measurements and 3D models of hardware taken from McMaster-Carr.

Steel Tee Nuts for Wood (4 – Pronged)

Zinc-Plated Steel

Black-Oxide Steel

Thread Size	Installed Lg.	Barrel Dia.	Barrel Lg.	Flange Dia.	Flange Thick.	Drill Bit Size	For Max. Hole Dia.	Pkg. Qty.		Pkg.
Steel										
1/4"-20	0.36"	0.305"	5/16"	3/4"	0.047"	5/16"	5/16"	100	90975A307	$15.43
1/4"-20	0.36"	0.305"	5/16"	1 1/4"	0.047"	5/16"	5/16"	25	90975A308	11.11
1/4"-20	0.485"	0.305"	7/16"	3/4"	0.047"	5/16"	5/16"	100	90975A309	14.40
1/4"-20	0.61"	0.305"	9/16"	3/4"	0.047"	5/16"	5/16"	50	90975A311	8.17
1/4"-20	0.61"	0.305"	9/16"	1 1/4"	0.047"	5/16"	5/16"	25	90975A312	13.84
Zinc-Plated Steel										
1/4"-20	0.36"	0.305"	5/16"	3/4"	0.047"	5/16"	5/16"	100	90975A025	16.30
1/4"-20	0.36"	0.305"	5/16"	1 1/4"	0.047"	5/16"	5/16"	50	90975A060	21.76
1/4"-20	0.485"	0.305"	7/16"	3/4"	0.047"	5/16"	5/16"	100	90975A027	16.53
1/4"-20	0.61"	0.305"	9/16"	3/4"	0.047"	5/16"	5/16"	100	90975A029	17.00
1/4"-20	0.61"	0.305"	9/16"	1 1/4"	0.047"	5/16"	5/16"	25	90975A063	15.28
Black-Oxide Steel										
1/4"-20	0.36"	0.305"	5/16"	3/4"	0.047"	5/16"	5/16"	50	90975A321	11.95
1/4"-20	0.36"	0.305"	5/16"	1 1/4"	0.047"	5/16"	5/16"	10	90975A322	7.93
1/4"-20	0.485"	0.305"	7/16"	3/4"	0.047"	5/16"	5/16"	50	90975A323	12.41
1/4"-20	0.61"	0.305"	9/16"	3/4"	0.047"	5/16"	5/16"	25	90975A324	7.70
1/4"-20	0.61"	0.305"	9/16"	1 1/4"	0.047"	5/16"	5/16"	10	90975A325	8.57

Split-Resistant Tee Nuts for Hard Wood (3 – Pronged)

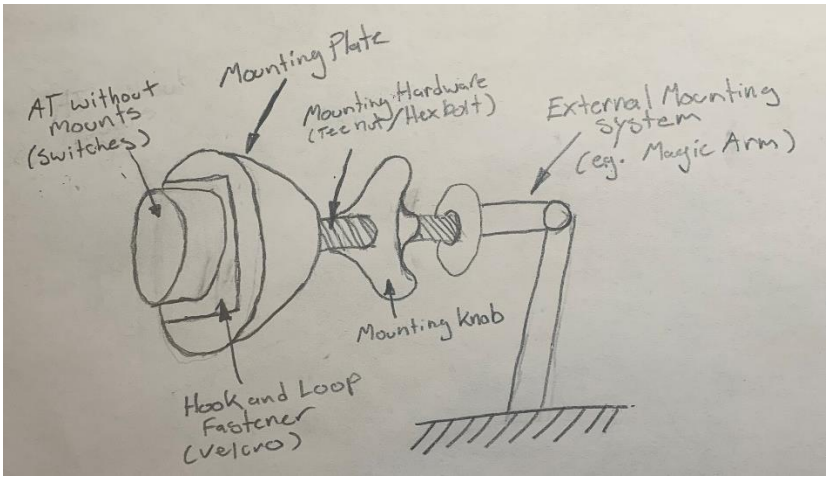
Thread Size	Installed Lg.	Barrel Dia.	Barrel Lg.	Flange Dia.	Flange Thick.	Drill Bit Size	For Max. Hole Dia.	Pkg. Qty.		Pkg.
Steel										
1/4"-20	0.235"	0.305"	3/16"	3/4"	0.047"	5/16"	5/16"	50	90975A235	$12.70
1/4"-20	0.36"	0.305"	5/16"	3/4"	0.047"	5/16"	5/16"	50	90975A237	9.60
1/4"-20	0.397"	0.305"	1/4"	3/4"	0.047"	5/16"	5/16"	50	90975A236	10.96
1/4"-20	0.422"	0.305"	3/8"	3/4"	0.047"	5/16"	5/16"	50	90975A238	11.40
1/4"-20	0.485"	0.305"	7/16"	3/4"	0.047"	5/16"	5/16"	50	90975A239	10.23
1/4"-20	0.61"	0.305"	9/16"	3/4"	0.047"	5/16"	5/16"	50	90975A240	9.66
Zinc-Plated Steel										
1/4"-20	0.235"	0.305"	3/16"	3/4"	0.047"	5/16"	5/16"	50	90975A064	12.80
1/4"-20	0.297"	0.305"	1/4"	3/4"	0.047"	5/16"	5/16"	50	90975A232	13.00
1/4"-20	0.36"	0.305"	5/16"	3/4"	0.047"	5/16"	5/16"	100	90975A053	16.58
1/4"-20	0.422"	0.305"	3/8"	3/4"	0.047"	5/16"	5/16"	50	90975A055	10.71
1/4"-20	0.485"	0.305"	7/16"	3/4"	0.047"	5/16"	5/16"	50	90975A233	11.20
1/4"-20	0.61"	0.305"	9/16"	3/4"	0.047"	5/16"	5/16"	50	90975A057	9.18
Black-Oxide Steel										
1/4"-20	0.235"	0.305"	3/16"	3/4"	0.047"	5/16"	5/16"	25	90975A218	10.56
1/4"-20	0.297"	0.305"	1/4"	3/4"	0.047"	5/16"	5/16"	25	90975A219	10.50
1/4"-20	0.36"	0.305"	5/16"	3/4"	0.047"	5/16"	5/16"	50	90975A220	17.61
1/4"-20	0.61"	0.305"	9/16"	3/4"	0.047"	5/16"	5/16"	25	90975A223	10.53

Twist-Resistant Tee Nut for Softwood

Thread Size	Installed Lg.	Barrel Dia.	Barrel Lg.	Flange Dia.	Flange Thick.	Drill Bit Size	For Max. Hole Dia.	Pkg. Qty.		Pkg.
Zinc-Plated Steel										
1/4"-20	0.3"	0.305"	1/4"	3/4"	0.047"	5/16"	5/16"	25	90975A360	$10.86
1/4"-20	0.36"	0.305"	5/16"	3/4"	0.047"	5/16"	5/16"	100	90975A153	18.43
1/4"-20	0.485"	0.305"	7/16"	3/4"	0.047"	5/16"	5/16"	100	90975A158	19.75
1/4"-20	0.61"	0.305"	9/16"	3/4"	0.047"	5/16"	5/16"	25	90975A337	12.10

Conceptual Design

Initial Concept



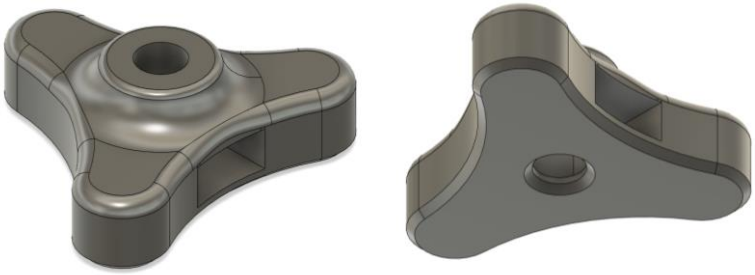
Hexagon Mounting Plate (External ¼”-20 Threads)

Notes: This design attaches a ¼”-20 hex bolt to a mounting plate. To increase the adaptability of this design, a ¼”-20 T-nut could be added so internal threads can also be used for mounting.

Mounting Knob with ¼” – 20 nut recess.

Notes: Can only apply force in one direction. A captive nut would allow this knob to apply force in both directions depending on the use.

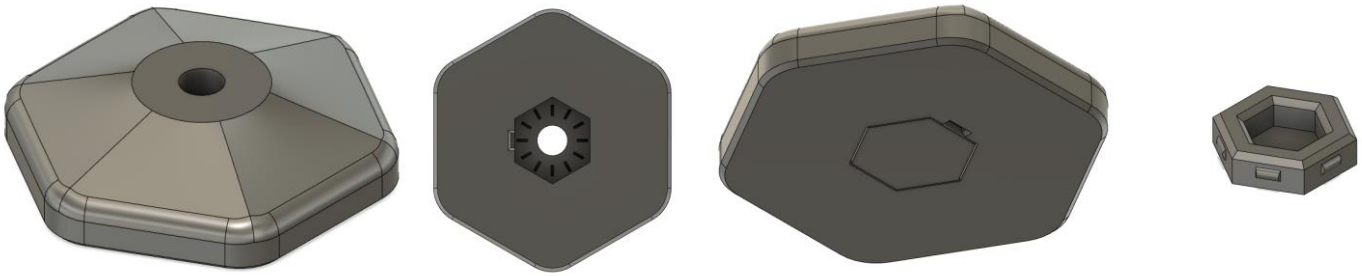
Mounting Knob with captured ¼" – 20 nuts.



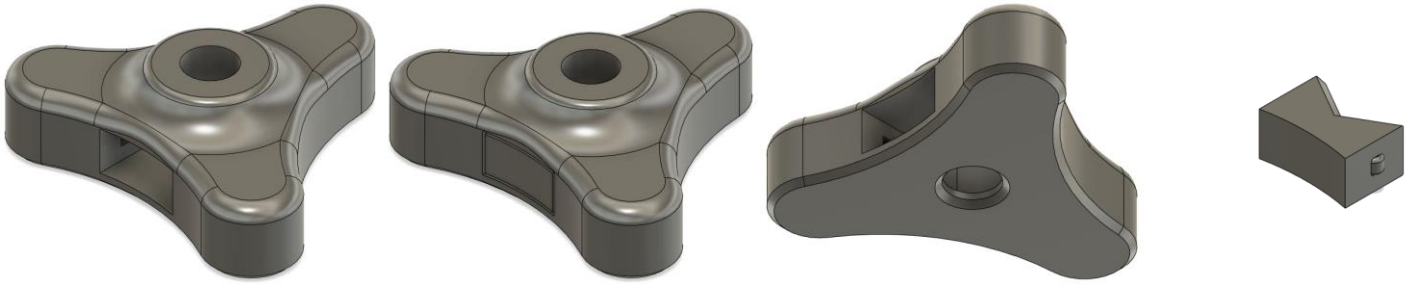
Notes: Sacrificial bridges used to make this printable without supports but a cover should be added to keep the bolt hole from interfering with the user.

Prototyping

Parametric Mounting Plate with Mounting Knob

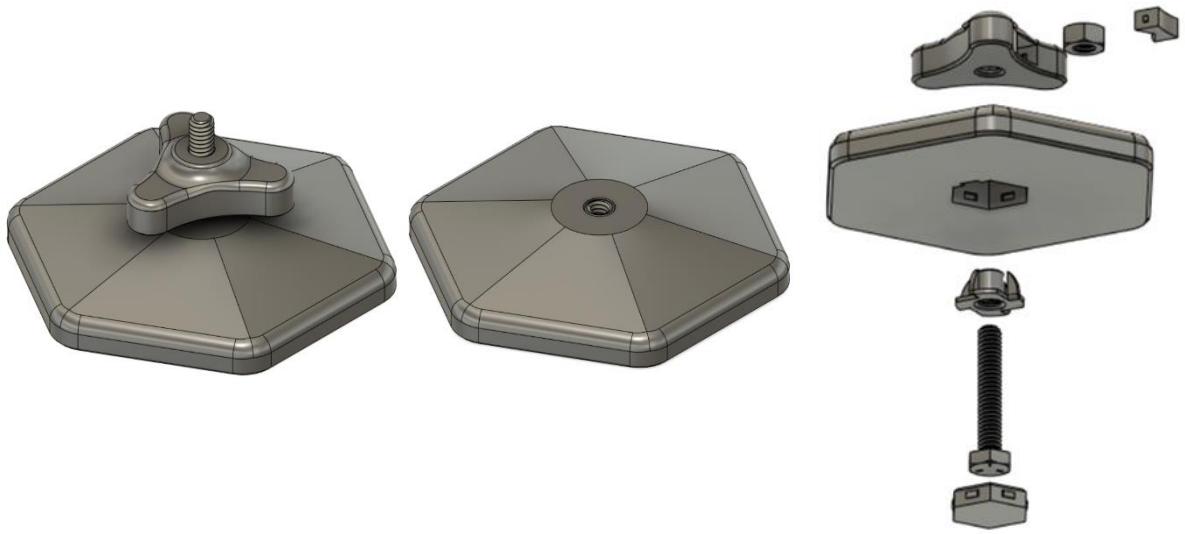


This prototype has increased thickness allowing room for a tee nut and a hex bolt to be installed and hidden via a snap fit cover. If the user wishes to use internal threads for mounting, the hex bolt can be removed and only the tee nut used. If external threads are required, the hex bolt can be threaded through the tee nut from the bottom. The cover is used to cover the internal hardware and keep the hex bolt from rotating inside when used. The cover can be popped out via a small screwdriver.



When using the external threads of the hex bolt, it is common to use a mounting knob to secure the device in the desired orientation.

Prototype Assembly



Detailed Design

Design Decisions

Mounting Plate Size Options

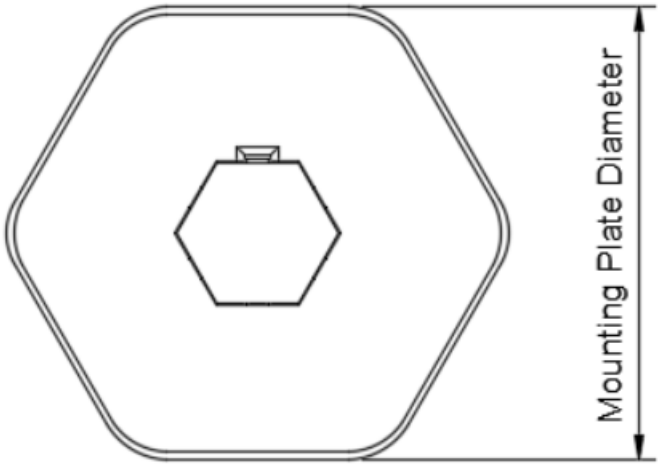
The sizes and shapes of MCC switches without integrated mounts will be considered to determine appropriate mounting plate sizes.

Existing MCC Switches	Dimensions of Base (mm)	Shape	Integrated ¼”-20 Mounts
Interact Switch	85 x 85	Round	N
Raindrop	30 x 20	Rectangular	N
Light Touch	50 x 20	Rectangular	N
MCC 60	60 x 60	Round	Y
Solderless Uni Body	50 x 20	Rectangular	N
Round Touch 60	60 x 60	Round	N
Low Profile Switch	65 x 65	Square	N

Mounting Plate Size Selection

Three sizes were selected: 45 mm, 65 mm, and 85 mm.

Plate Size	Consideration
Small – 45 mm	• Smaller than commercial alternative • Allows one or two smaller switches to be mounted
Medium – 65 mm	• Comparable size to commercial universal mounts • Allows up to three raindrop / light touch switches to me mounted side by side. • Ideal for mid-sized switches
Large – 85 mm	• Larger than commercial alternative • Can mount the larger MCC switches (Interact switch) • Enough room for various layouts of multiple small switches



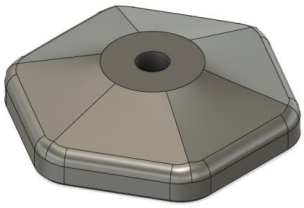
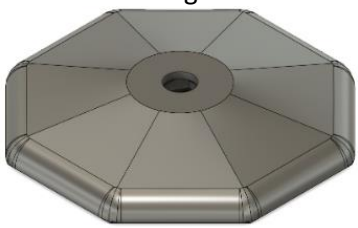
Threaded Connection Type (Internal/External)

There are three options for threaded connection on the mount: internal, external, and combined internal/external.

Threaded Connection Selection

The prototype was designed to provide both internal (tee nut) and external (hex bolt) mounting options. To reduce complexity and material cost, **only internal threads (tee nut) will be integrated.** Internal threads for mounting are a more common method of mounting that MMC uses. This reduces the thickness of the plate, resulting in reduced print time, and eliminates the need for the mounting knob.

Mounting Plate Shape

Shape Considered	Notes
Circular 	• Like other mounting plate options. • No sharp corners. • Matches shape of circular assistive switches
Hexagon 	• Differs from existing mounting options. • Flat edges give better grip for mounting. • Edges can be rounded to reduce sharpness.
Octagon 	• Similar advantages to the hexagon in style and grip.

Mounting Plate Shape Selection: Hexagon Plate

We will continue with the hexagon shaped plate used in the prototype device.

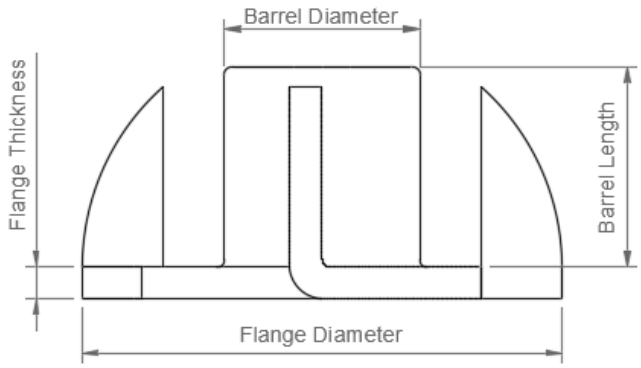
The tee nut mount and cover without a mounting plate will be offered for designers that wish to create their own plate size and shape.

Tee Nut Sizes

Ideally, there will be alternate versions of this device to match the size and style of T-Nuts that the builder has on hand. Due to the vast number of different sizes, only 3-4 of the most common types will be focused on and a parametric Fusion 360 model will be available for builders to match any size of hardware.

Tee Nut Size Selection

The design will accommodate a limited set of the most commonly available tee nut sizes.



Tee Nut Option	Specification	Barrel Diameter [mm] (in)	Barrel Length [mm] (in)	Flange Thickness [mm] (in)	Flange Diameter [mm] (in)	# of Prongs
1	5/16” x ¼"-20 UNC	7.75 (0.305)	7.94 (5/16)	1.194 (0.047)	19.05 (3/4)	3, 4, 6
2	7/16” x ¼"-20 UNC	7.75 (0.305)	11.11 (7/16)	1.194 (0.047)	19.05 (3/4)	3, 4, 6
3	9/16” x ¼"-20 UNC	7.75 (0.305)	14.29 (9/16)	1.194 (0.047)	19.05 (3/4)	3, 4, 6

Standard Configurations

A set of standard configurations will be released as individual print files to make it easier to print the device for the desired mounting plate size and tee nut hardware. The print files released will be constrained to 3 different plate widths that will accept 3 of the most commonly available sizes of tee nuts.

Name	Mounting Plate Size	Shape	Tee Nut
OUP-45-H-5	45 mm	Hexagon	5/16”
OUP-45-H-7	45 mm	Hexagon	7/16”
OUP-45-H-9	45 mm	Hexagon	9/16”
OUP-65-H-5	65 mm	Hexagon	5/16”

OUP-65-H-7	65 mm	Hexagon	7/16”
OUP-65-H-9	65 mm	Hexagon	9/16”
OUP-85-H-5	85 mm	Hexagon	5/16”
OUP-85-H-7	85 mm	Hexagon	7/16”
OUP-85-H-9	85 mm	Hexagon	9/16”

Device Name

- Open Universal Mount
- Open Quick Mount
- Universal AT Mount
- Hexagon Universal Mounting Plate
- Hexagon Quick Mount
- Universal Hexagon Mount
- Open Universal Mounting Plate

Testing

Print Test

The Tee Nut Mount (without mounting plate) was tested on another printer.

- Tee Nut Installation
    - Some difficulty installing tee nut due to sacrificial bridge.
    - Successfully installed.
- Hardware Cover Installation
    - Found that the cover could be installed too deep and sit crooked.
    - Didn’t have this issue once the tee nut was installed.
- Overall Notes
    - No major concerns.

Snap Fit Cover Durability

The hardware cover can be removed to expose the tee nut used for mounting. The durability of this part is less of a concern now that only internal threads are offered and there is no need to replace the mounting hardware for external threads.

Opportunities for Improvement

1. Provide the option for external mounting threads.
2. Modular Tee Nut mount that can connect to any of the plate sizes.