PEAK OF FLIGHT NEWSLETTER

Issue 613 / November 21st 2023

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In This Issue:

Model Rocket Helicopter Hub Design

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Model Rocket Helicopter Hub Design

By Michael Hatcher

Helicopter hub designs for model rockets present a fascinating and challenging aspect of model rocketry. These designs deploy folded helicopter blades at apogee, transitioning from a ballistic rocket to a gyro helicopter.

In preparing this article, I conducted an exhaustive search for all available documentation on model rocket helicopter design. The references at the end of this article serve as the source documents for this comprehensive analysis of alternative ways to build helicopter hubs, particularly for competition.

One research document and article, the Apogee Components *Peak of Flight* Newsletter Issue 375, Oct 7, 2014, written by Tim Van Milligan, stood out. Tim had asked me to write an article in 2023 on model rocket hub designs. After reading his 2014 article, I realized the challenge of adding new technology insights to the extensive research already accomplished and published by Tim and George Gassaway.

To progress, we sometimes need to understand our past. As others have said when trying to understand gravity, “we must stand on the shoulders of giants.” Therefore, I feel it is necessary to summarize the existing body of knowledge to identify potential areas for new research. Tim is particularly interested in publishing new ideas that his sophisticated readers cannot find using Google or AI search engines. For this reason, I will first generalize the common design features and then focus on design concepts that can enhance or extend the current knowledge.

The ultimate goal is the Traditional Helicopter Hub Design:

- Traditional helicopter hubs use a powered rotor to develop lift and thrust.
- The design of a traditional helicopter hub is often more complex, requiring precision assembly than a gyrocopter design.
- These hubs are designed to be part of a larger system, with multiple components working together for flight control.

In summary, while both types of hubs serve the purpose of controlling flight, their designs are significantly influenced by the specific requirements and constraints of their respective applications.

Model Rocket Helicopter (Gyrocopter) Hub Designs:

- Model rocket helicopters function more like gyrocopters, using an unpowered rotor in free autorotation to develop lift.
- The design approaches for model rocket helicopters can be categorized into external blades and internal blades.
  - **External Blades:** The blades are attached to and fold along an engine-diameter body. This design is widely used for National Association of Rocketry (NAR) competitions. It is easy to build but has high boost drag.
  - **Internal Blades:** The blades fold inside a body that is larger than the engine in diameter. This design must be used for Fédération Aéronautique Internationale (FAI) competitions. A piston ejects the blades, which are attached to a hub. The blade hub is attached to the booster body by a Kevlar cord and descends with the body dangling under it.

Common design features:

1. All heliroc blades we researched are either inside or outside the rocket body tube, mounted to deploy horizontally by a 90-degree hinge. Blades mounted inside are generally FAI derived 40mm body tube designs to reduce drag.

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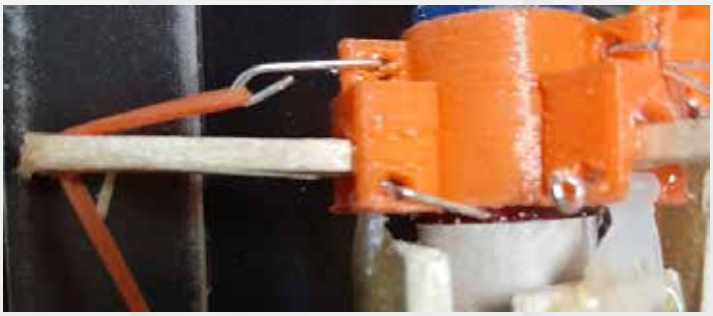
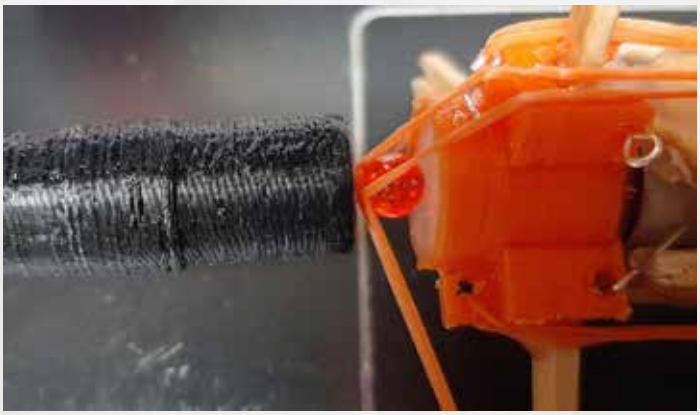
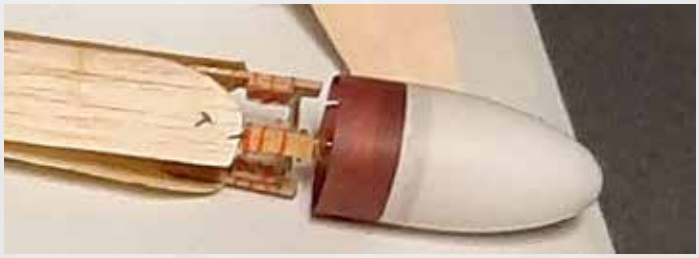
2. Blades are deployed by elastic bands. A variation is Bob Kaplow's Rotocrock use of 0.22-gauge Z bend torque wire under Klett hinges. Blades deployed by gravity are unreliable.



3. Elastic bands connect to hooks or notches on the blades and on the body tube. The torque wire exception connects under plastic Klett hinges or standard DuBro nylon aileron hinge plates. Another exception is loops over a central pivot free spinning rod.



4. All blades are stopped at 90-degree horizontal deployment by a stop plate, tab, or pad. The stops can be attached to the rotor blades or blades stopped by the coupler tube.



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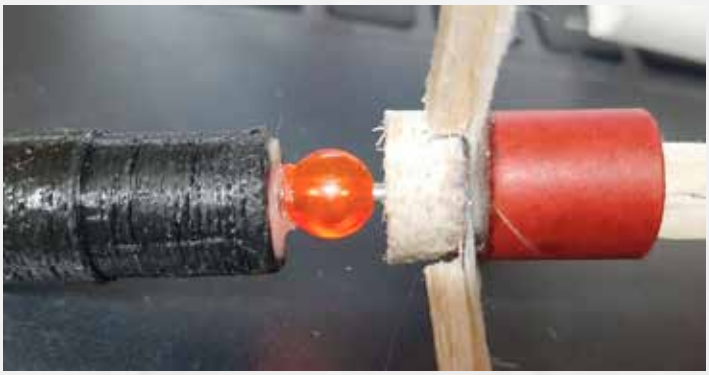
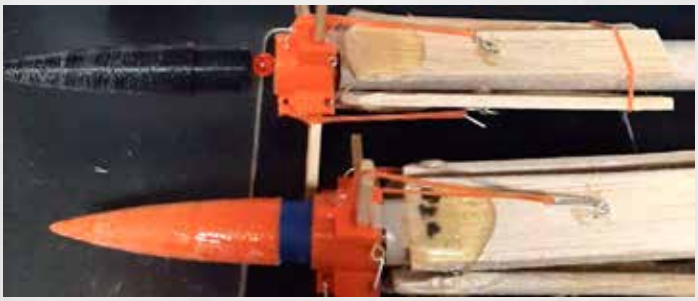
5. The basic hub connection involves a block attached to the rotor blade, which connects to a fixed hub plate attached to the nosecone or body tube. Variations include a free spinning hub sliding over a central rod or dowel with retaining bushings. Examples include the Art Rose Rosa Rock 12 and the first known example of a published free spinning nose cone, Trip Barber's 1976 MIT Spinner One, which used curved sections of body tube for the blades.



6. Blades deploy from the top of the rocket, folding downward or upward. Some outside blades use a 13mm body tube, while others use a 3.2mm wood or carbon fiber rod between the fin can and nose cone. An example is John Demarr's Whirl-a-While, which also uses a hollow, free spinning nosecone between launch lug bushings. FAI blades are usually attached to a free spinning nosecone hub, or fixed vacuum molded, Depron foam nosecone to fit a 40mm body tube.

7. All model rocket helicopters use some type of hinge. The technical advancements and recommendations in this article focus on improving the hinge design. Common hinge types include Klett plastic hinges, 0.22-gauge u-shaped wire, and DuBro Nylon Aileron hinges.

8. Blade Deployers commonly use rubber bands or Z bend Torque hinges. Free Spinning designs often use circular or triangular hubs on central wood or carbon fiber rods, drilled nose cones on central wood or carbon fiber rods with stop bushings, or small tubes with pin hooks and Klett hinges on central wood or carbon fiber rods.



The article will later discuss improvements and steps required to enhance the free spinning hub design. To improve current and former designs, it is important to understand how the designs have evolved.

The design evolution of the helicopter duration event includes significant contributions from Trip Barber, Tim Van Milligan, and George Gassaway.

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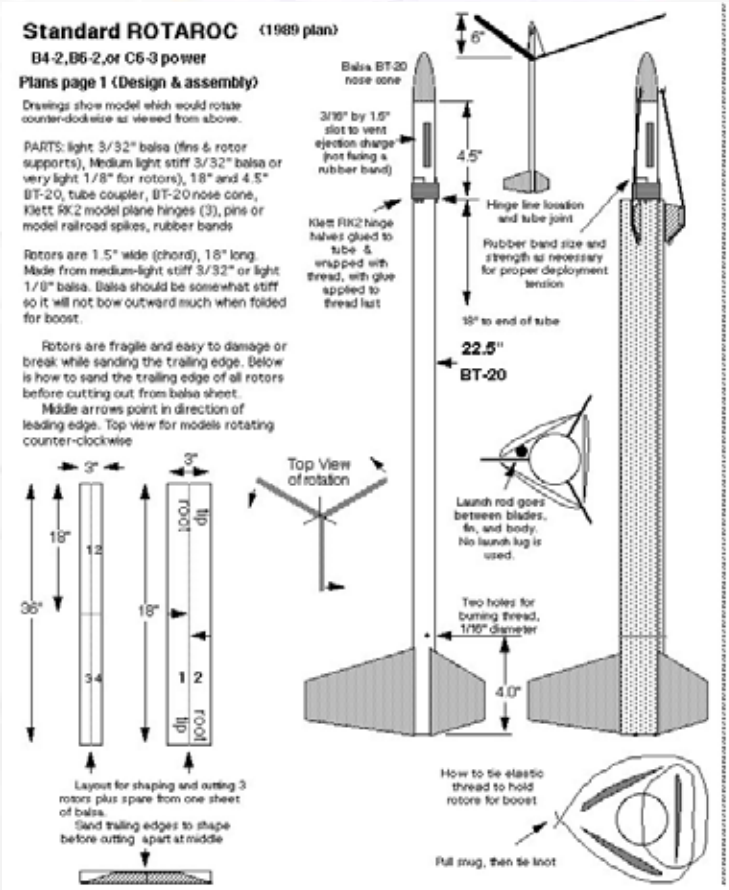

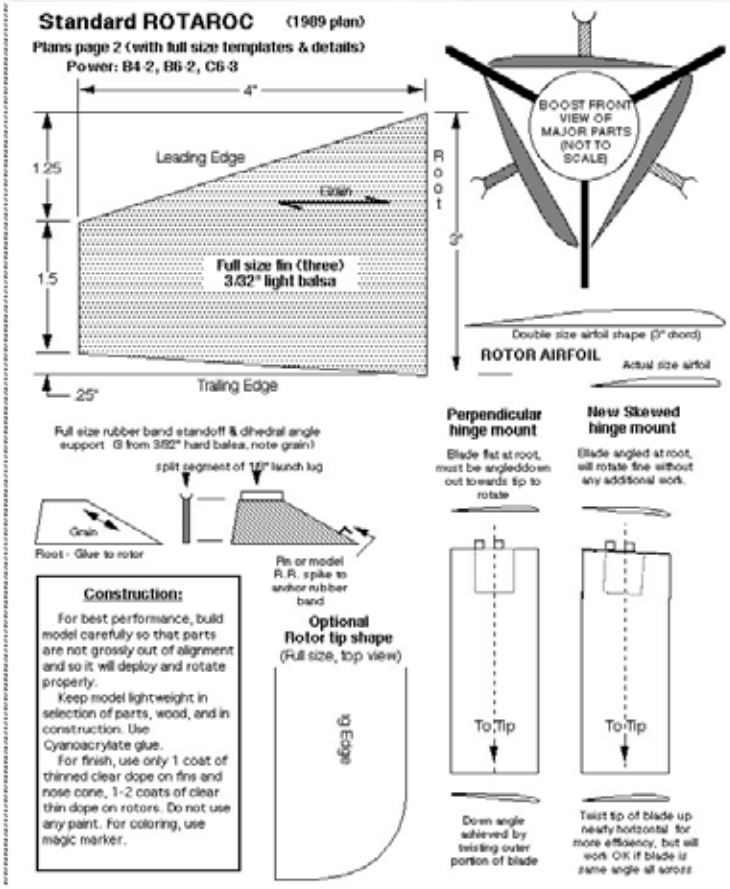

George Gassaway's RotaRoc

Each brought unique elements to heliroc design, from the use of free spinning hollow nose cone hubs and cloth tape hinges to the introduction of mini-rotoroc designs and the use of Klett hinges wrapped with thread and glued to the fixed body tube.

Tim Van Milligan's return to the design of helicopter duration events at NARAM53 in 2011 led to the publication of an exhaustive design comparison article in the *Peak of Flight* Newsletter Issue #375 Oct 7, 2014. He identified significant technological changes since 2000, while noting that hubs had changed very little. These changes included:

1. Curved and mandrel-shaped balsa blades.
2. Thinner layers of wood for the hub.
3. DuBro nylon hinges sandwiched between two hub layers.
4. Blades bonded to a square post and then to the DuBro hinge using epoxy.
5. The post was extended to create a dihedral blade stop, eliminating the need for additional tab stops, but was structurally weak and could debond.
6. Limit strings were attached to the underside of the blade, to limit the dihedral angle when deployed.

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Tim's major improvements to the hub design included:

1. Using a leased CNC laser to cut sandwiched, hexagonal plywood hubs with slots cut for the hinges, ensuring they were perpendicular.
2. Adding a CF rod and aluminum tube to create a free-spinning hub, attached to a lightweight nose cone.
3. CNC laser cutting lightweight extension posts and blade attachments.

These improvements were implemented to create the Gyro Chaser, the successor to the original Apogee Heliroc design. The Gyro Chaser by Apogee is a highly efficient competition style rocket for the helicopter duration event using 18mm diameter motors. It has been optimized to fly higher into the sky due to both its lightweight components and low drag aerodynamic shape, and to descend slower to the ground because of its unique curved blades and free-spinning rotor hub.

Apogee Heliroc

The original Apogee HeliRoc uses a fixed nosecone, with notches cut into the nosecone used for rubber band deployment attachment. Balsa rotor stops are attached to the balsa rectangular shaped airfoil blades. The rotor blades are attached to the body tube using thread wrapped Du-bro standard nylon aileron hinges. Another model is the Rotary Revolution kit by Apogee. The project's goal originally started when the designer tried to create an easy-to-assemble helicopter hub that could be competitive at the FAI fly-offs. The new helicopter hub used in these models simplifies the assembly process, making it easier for beginners to get involved in this exciting aspect of model rocketry. Alternative commercial hub designs include the Semroc Heliroctor, a commercial version of the Gassaway RotoRoc, and the ESTES Helicopter rocket.

Semroc Heliroctor: This is a commercial version of the Gassaway RotoRoc. Its hub design is distinguished by pinhooks on the nosecone and blades for rubber band deployment, Klett hinges wrapped with thread and epoxied to a fixed body tube. The blade stops are attached to the blades. Other features are rectangular airfoil shaped blades, with slots cut to align the blades to the rocket fins.

ESTES Helicopter rocket: This model rocket helicopter design is similar to the Gassaway design, except the rotor hub uses rubber band deployment glued directly into the body tube like the Barber Spinner One and attached to balsa tabs on the rotor blades. The blades are attached to a flat balsa hinge tab glued to the body tube.

To gain insight into what possible technology improvements could be made to existing hub designs, we first assess the possible limitations of the Helicopter Duration event rules. The rules for the helicopter duration event include:

1. Helicopter Duration comprises eleven events open to any single-stage model rocket that uses autorotation as the sole means of recovery. The purpose of this competition is to achieve the longest flight duration using an auto-rotating recovery system.

2. Each entry must be decelerated during descent by its auto-rotating recovery device. The resulting autorotation must be around the vertical axis. An entry that descends nose first or flips over during descent is permitted.

3. Recovery devices employing flexible (e.g., plastic film or cloth) surfaces are prohibited. Entries using a recovery system that is designed to act (or that acts) in a manner like a parachute, a rigid inverted bowl, or similar technique.

4. FAI Gyrocopter (S9) models must be contained in a body that is at least 500 millimeters long, and that is at least 40 mm in diameter for at least half of its length.

The main design restriction of the helicopter duration event is the requirement for autorotation. This means it cannot be powered with a brushless drone motor and ESC design.

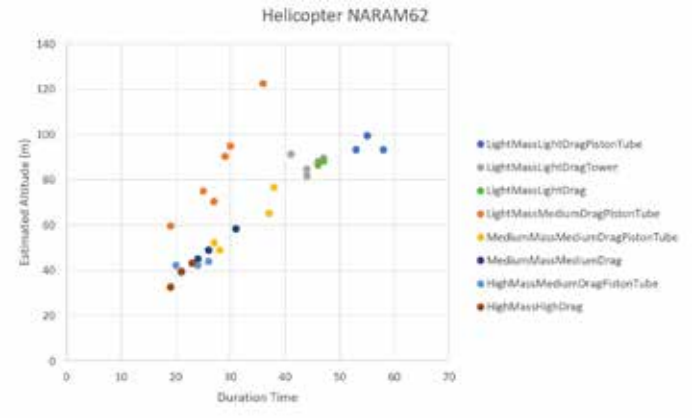
Some potential improvements to hub design based on the rules:

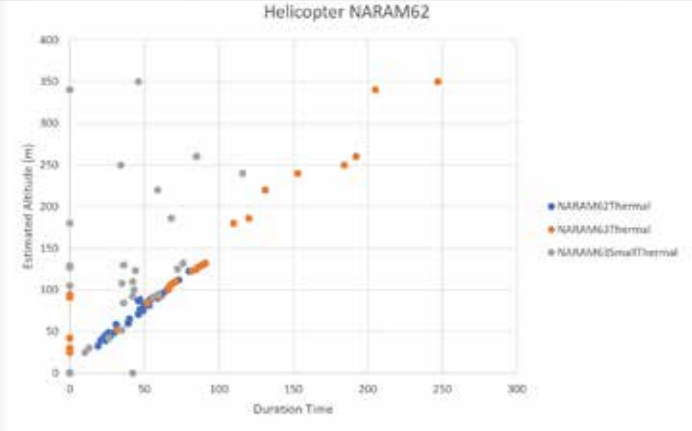
The contest rules, subject to interpretation, may not prohibit the use of a kicker spring or elastic band to start the autorotation event faster than letting gravity start it.

Advanced blade angle control: None of the designs we researched had any type of variable blade pitch control. An exceptional research paper written by Tim Van Milligan for NARAM 33 calculating blade aerodynamics and descent rate, established a descent rate blade angle maximizing CL3/CD2 at 8 degrees pitch, analyzing varying blade angle from -4 to 24 degrees.

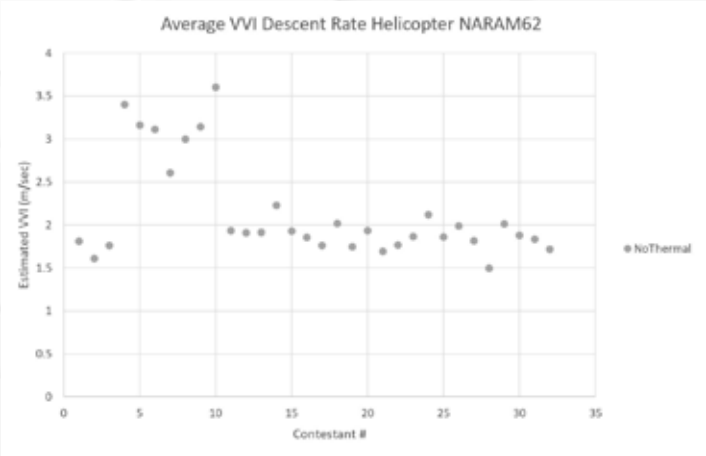
Using angle of attack research: Angle of attack research was conducted for NARAM29 by Tim Barklage, March 1988.

Optimizing descent rate: This author conducted yet unpublished research for NARAM62 helicopter descent rates, assessing thermal impact using NAR precontest published event qualifying data. The range of descent rates is calculated by dividing maximum altitude by maximum time to achieve an estimate of the average VVI sensed vertical velocity.





With this research knowledge, we can understand improvement of the hub design must improve the non-thermal descent rate or VVI sensing technology of the helicopter.



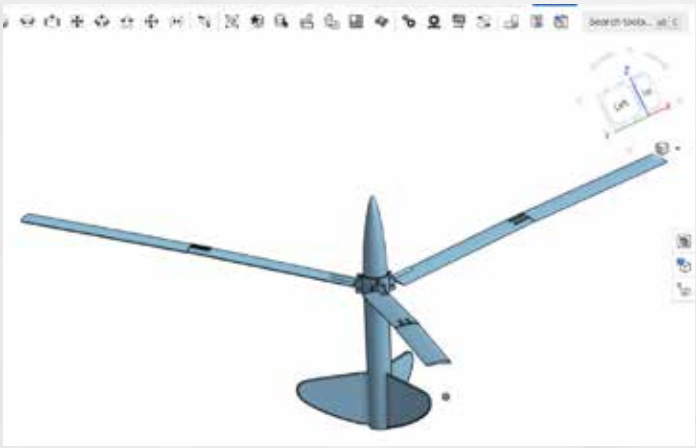
One possible improvement is adjustable blade pitch, manual or servo controlled. The first known design of a fixed pitch blade used balsa wedges under the Klett hinges to fix the blade angle of attack used in the Pinkas, Wickart Midwest Weedwhacker NARAM44 2002. Enhancing this design to permit variable manually set pitch options only requires the use of a rotating central carbon graphite rod inserted into the blade axis and a mounting hole in a free spinning hub which uses a set screw to fix the blade angle. Such a design would permit testing by drop test, to find the optimum pitch angle for a given mass and blade design. Blade designs tested by Allison Van Milligan could be used for blade curvature analysis, airfoil shape and pitch angle testing.

Using a light mass servo is also not prohibited by the rules. A single servo could control pitch angle or blade deployment. Multiple servos could control each blade using helicopter hub linkages. The ultimate state of the art for blade control is to use a swashplate and two servos to control pitch and roll angles, permitting optimization of VVI descent rates monitored by a flight computer, and to control for stability and lift inside thermals, again optimizing the flight computer for maximum VVI ascent rate or minimum VVI descent rate.

How we build this advanced minimum viable prototype (MVP) proof of concept model rocket helicopter:

Step 1: Design your helicopter in OnShape or AutoDesk 360 so you can use 3D printing or CNC laser cutting technology to speed build times.

Step 2: We cloned our existing fully autonomous model rocket flight controller system design to test different alternative or lighter materials used in the blades and hub mount and add the possible use of lightweight servos in a PLA 3D printed hub mechanism. This design was altered in the original Onshape and Autodesk Fusion 360 hub and rotor design model. The Onshape models are free to download if you have an account.



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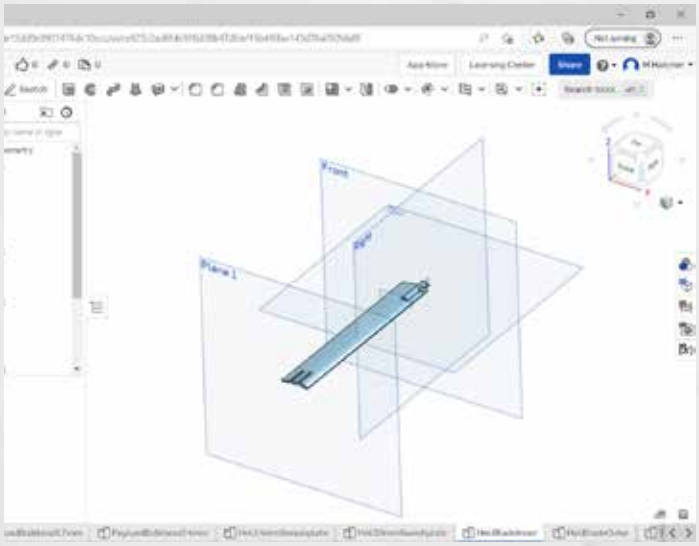
HeliFalcon I Design Goals (Duration Gyro):

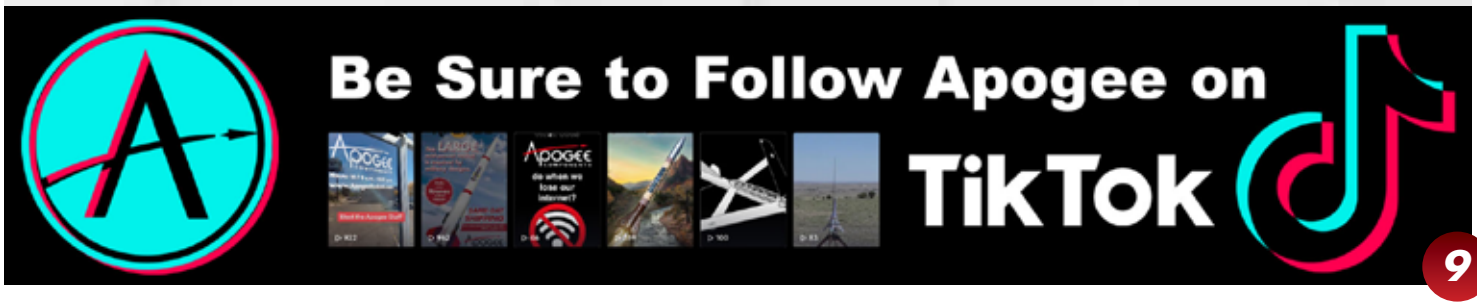
- HeliFalcon Length: (0.27 m)
- Nose Cone 0.072 m, 0.018 m
- Tube 1 (0.2013 m)
- Fin Assembly Root 0.045 m, Length 0.0589 (elliptical)
- Mass Empty: (0.088 kg)
- Tube Diameter (Max): (0.019 m)
- Measured ID (0.0.018 m)
- Measured OD (0.019 m)
- Fin Count: 3, Fin Thickness 0.002m
- Motor Size: BT-20 19mm B4-2, B6-2, B6-4, C6-3, C6-5
- Motor Size: BT-5 14mm 1/2A3-4T, A10-3T
- Recovery System: Nose Cone helicopter
- Launch Pad Type: Fly-away-Rail.
- CP Location: (19.68 cm) from the tip of the nose cone
- CG Location (5.85 cm) from rear station
- Expected Altitude 500 ft (162 m)

Step 3: Build a prototype HeliFalcon

- Model & Scale Blade details (use 3 Blades)
- Check Balsa Material Strength (C-Grain 0.108g/m2 (6.99lb/ft2)
- Model Fins in OnShape .STL
- Export the model to .dxf 2D file format for import into CNC routing or CNC laser cutting tool Import the .dxf file into RDWorksV8, convert to Export the model to .dxf 2D file format for import into CNC routing or CNC laser cutting tool.gcode CNC router, CNC laser cutting output file on MicroSD card.
- Cut Balsa with CNC laser cutter and RDWorks .dxf and Gerber .gcode files.
- For 3D PLA/ABS/PETG FDS printing: Export the Onshape or Fusion360 model to 3D .stl stereolithography file format for import into a 3D slicer tool. Use Cura, ideaMaker or similar 3D slicing tool. Export to .gcode on Micro SD card for 3D printer.

HeliFalcon Blade Design: Folding and Extended Blade design





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Step 4: 3D FDS or SLA print PLA/ABS/PETG print blades and fins or CNC laser cut from balsa. If you don't have a CNC laser cutter, use a sharp hobby knife.

- Cut blades to shape and then curve them.
- cut shape to 30mm wide x 340mm long typical blade.
- create curvature to provide lift.
- rotor tip has most lift and drag due to velocity.

Square blades ready for shaping and curving.

Alternative is to sand airfoil shapes using Dremel sander.

Step 5: Steps To curve the blades:

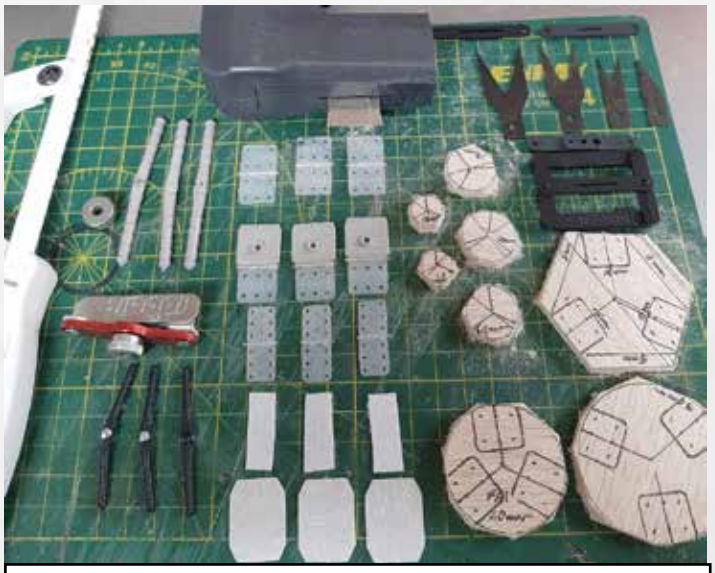
- Wet with Windex
- Use rubber band/plastic/tape to roll around 40mm mandrel for airfoil.
- 1" PVC pipe can be used for mandrel
- Allow it to dry.

Step 6: Selecting a Hinge Design

To build upon Tim's significant enhancements to the hub design, we took the following steps:

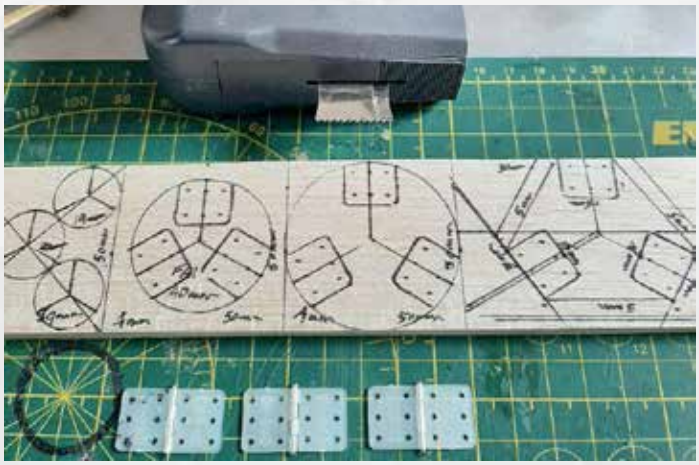
1. **Hub and Hinge Designs:** We created markings for 50mm wide hubs using 4mm thick balsa. With the remaining balsa, we crafted circular and hexagonal hub designs in sizes of 14mm, 19mm, and FAI 40mm. The circular design is simpler to mark, while the hexagonal design is easier to cut with a hacksaw, especially if a CNC laser cutter is unavailable. We used a Dremel sander to smooth the cut edges.

2. **Hinge Options:** We explored various ways to improve the current hub design. Selecting appropriate hinges can lead to superior performance and weight savings. We used Hobart or Dubro alignment guides to enhance the precision of our hub and hinge mounts.



Dubro Aileron hinge circular and hexagonal hubs, FG backed.

3. **Marking Hub and Hinge Designs:** We eliminated the need for two hub sandwiches and a CNC laser cut hinge channel by using a commercial aileron hinge electric slot cutting tool for DuBro hinges and opting for lighter 4mm balsa. Manual hinge slot cutters with alignment guides work but expand the balsa and take more time. We cut hinge slots into a CNC laser cut hexagonal rotor hub design, secured the hinges into the slot with epoxy, and then reinforced it with FG epoxy. If needed for additional strength, 2mm Cap Screws can be drilled into the hinge plastic holes, backed by the FG epoxy and 2mm nylon lock washers. When using CA glue to set the hinges, the hinge can be inserted quickly and accurately in one push.



4. **Nylon Pin Hinge Upgrade:** To further enhance the hinge, we used a pin hinge design. This allowed for a simple drilling of a hole in the blade post block and a hole in the hub using a Hobart hole alignment jig, with 1/8 and 3/16 drill bits. This design enables changing the angle of attack and lift variables. A significant performance improvement is the ability to set a fixed 8-degree pitch angle into the rotor blades, which is not possible with flat hinges and flat blade extension posts.

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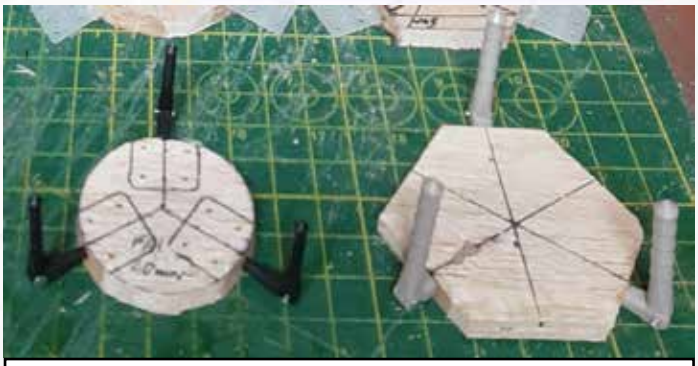
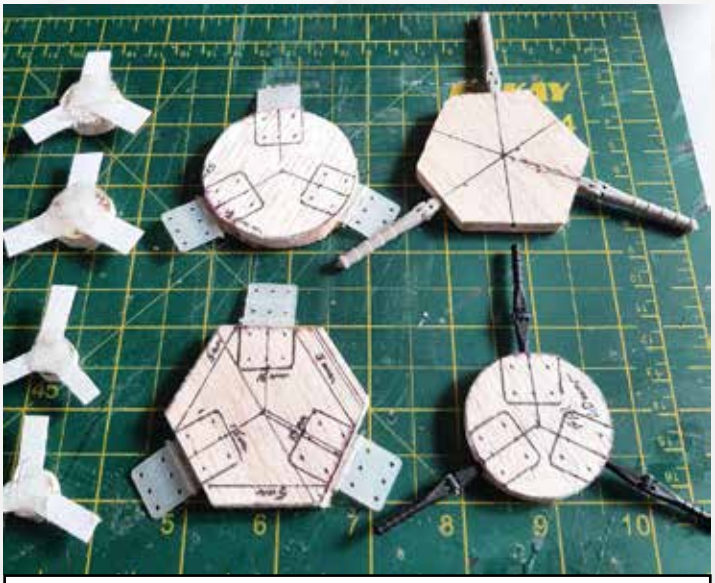


Nylon Pin Hinge Upgrade superior to the Klett hinge



Completed FG backed hub and alternative hinge designs.

Fiberglass backing is on the backside of the plate markings and on the front of the smaller tabs.

To attach the blade, fabricate a hinge pivot block from foam board or balsa and drill a hole, then glue the pin hinge to connect the hinge to the block. Set the blade angle to the desired fixed pitch angle of 8 degrees.

Step 7 Using Alternative Hinging:

For smaller helicopter designs, we substituted SIG fiber tabs and mylar tape for the Barber Spinner One hinge cloth design. These 14mm and 19mm hubs use SIG easy hinges, first attached with CA glue, then covered with epoxy fiberglass. The fiber tab is then glued to a foam board or balsa blade, setting the pitch angle to 8 degrees with a small wedge. The advantage is a quick and simple contact cement or gorilla glue attached hinge, resulting in the lightest possible blade hinge.

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SIG Easy Hinge fiber tabs superior to cloth or packing tape hinge.

Consider using alternative hinging to standard Klett or DuBro Nylon Aileron hinges.

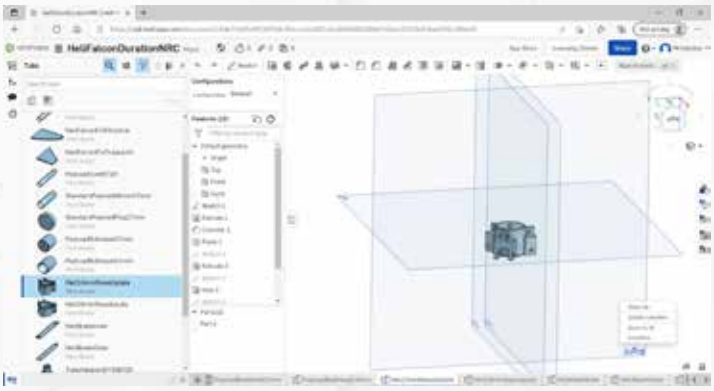
Aircraft Hatch Hinges have built-in 90-degree stops and vertical attachment.

Control Horn Hatch Hinges have built-in 90-degree stops, vertical attachment, and options for RC servo deployment control.

Add coupler tubes to the fiber hinges FG backing. Drill spinner holes in the hub center.

Instead of loose string dihedral deployment limiters, we occasionally use folded, curved cut accordion-style mylar tape or Japanese paper stock. The combined ultralight mylar hinge and mylar Z accordion stop is very similar to a paper Japanese fan.

Step 8: 3D Print the Hub Design



The 13mm version uses one-half of the DuBro Aileron Hinge to reduce mass and fit a small 13mm hub diameter. A central hub plug with a hole large enough for CF rod or small metal rod with stop bushings makes this a free spinning hub. Curved Heli blades are then epoxied to the short balsa rotor blocks.

A hole in the hub with a bead bearing can turn this into a spinning hub after ejection from the coupled body tube. This design is both an interior blade design when using the 40mm coupler tube, and exterior blade design when using the 18mm coupler tube attached to the 3D printed hub.

When using a nose cone instead of a body tube coupler, use a barrel swivel with bearings connected to a Kevlar shock cord riser permits free spinning.

A hollow nosecone, with a bulkhead hole and bead bearings inserted over a metal or CF rod with retainer bushings also creates a free spinning hub design. A long rod helps prevent entanglement with the shock cord riser.

A free spinning hub and rod design enhancement to the Apogee Gyro Chaser hub, carbon fiber rod, and aluminum tube free spinning design requires only a carbon fiber rod, slipped through a smaller hub hole, and attached to a PLA printed or vacuum molded nose cone allowing it to free spin.

Step 9: Assemble the PLA Printed Rotor Hub: We used Walmart Jewelry eyelet pins, hot glue, or epoxy to attach hinges to the PLA rotor hub. Perhaps there are other types of adhesives or fasteners that could offer better performance or ease of use.

Next, attach the blades to the swashplate hobby hinges using epoxy. Glue a small 3mm plywood support pad onto each blade to serve as a rubber band anchor lift pin.

To provide a block plate rotor dihedral stop, glue a circular PLA printed or plywood motor mount centering ring above the hub. This version uses two matchstick hobby components from Walmart, notched to serve as a rubber band standoff and guide.

The match sticks create less drag than a rotor stop tab glued to the blade or swash plate glued to the hub just above the hinges.

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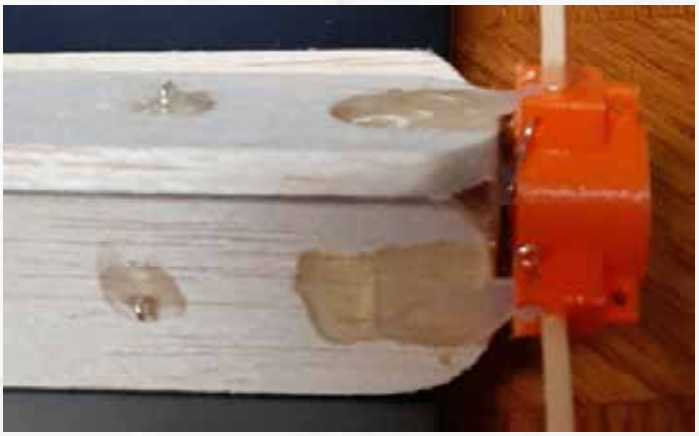
Model Rocket Helicopter Hub Design

By Michael Hatcher

A 13mm coupler to a 14mm body tube or epoxied to a 13mm nose cone makes this a fixed hub and tube design.



3D printed 13mmhub, jewelry eyelet pins, and rotor stop tabs.

A design iteration to the PLA hub uses a rotor stop built into the hub and blade connector design just above the hinge attachment point.

A coupler tube is generally placed on the bottom of the rotor hub.This is an exterior blade design.

The fixed hub Heli Falcon is connected by the coupler tube to the 13mm body tube, fins, and motor mount.

HeliFalcon1 13mm PLA 3D printed hub fixed mount design and Nose cone.

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Alternatively, another fixed hub design places the hinges mounted vertically into the foamboard nosecone bulkhead to create an interior 40 mm hub and blade design.

Alternatively, a wooden dowel can be used instead of a CF or metal rod.

Curved blades are epoxied and pinned to the rotor blocks at an 8-degree lift angle.

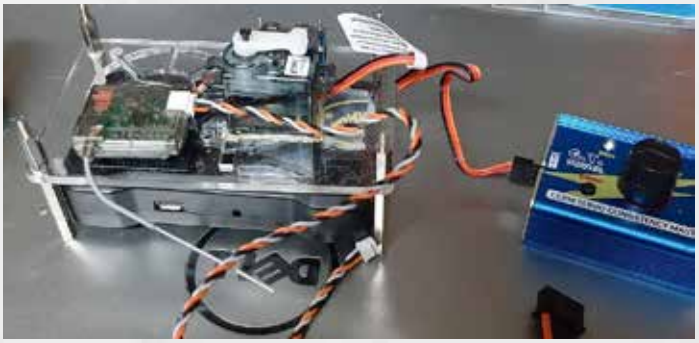
A hook attached to the CF rod, and then attached to a wind-up rubber band, model airplane style, with a one-way winding clutch notch step in the hub can be used to auto power the initial autorotation at deployment release. A wound spring kicker like those on model airplane propeller blades used to start the motor could alternatively be used to kickstart autorotation at deployment release. The rules do not seem to prohibit this as long as the descent is an autorotation.

There is a huge variety of possible hinge designs, interior and exterior blades attached to variable angle rotor blocks, spinning and non-spinning rotor hub and nose cone variations possible.

Step 10: Building an Advanced Servo Attitude and Descent Rate Control

We are currently in the process of fabricating and building this final design step. The design is based on our previous work on autonomous drones and autonomous RC controlled Rocket Gliders, as described in our previous unpublished paper on fully autonomous Rocket Glider model build and design. Much of the design is also detailed in our books “How to Succeed at Understanding Advanced Model Rocketry” and “How to Succeed at Understanding Drone technology.” (Available at Amazon)

When Servo controls are added to the blade control linkage or control horn, with wire linkage or blades mounted directly to the servo drive, a Transmitter RC receiver or flight controller can control deployment or blade pitch angle. When combined with a flight controller to sense vertical velocity, a VVI sensor, LIPO battery, voltage regulator, RC receiver, and GPS Telemetry, the gyro and accelerometer will sense stability changes, correct stability with a 3-axis swashplate and helicopter linkages to pitch and roll servos. The helicopter duration event rotor hub simply needs an RC helicopter swashplate and lightweight ABS or PETG 3D printed linkage upgraded design.



We’ve conducted servo testing for the Helicopter Hub and hinge deployment design using Pixhawk2.4.8 and a Remote Spektrum receiver. We’ve also tested the servo linkage for the Helicopter hub deployment design using APM2.6 Ardupilot and a Spektrum AR620 receiver. In the background is the Omnibus F4 Pro V2 buildup of the same design.

As servos and control systems become lighter and easier to build more complex designs with 3D FDS or SLA printing of components, it will be possible to build a model rocket free spinning hub using variable pitch control using sensors to optimize VVI descent rate. The desired end state is to enable variable pitch control and to control VVI descent rate, control HeliFalcon prototype flight path along waypoints, and to sense and remain within thermals to increase VVI ascent rates using a directional Swashplate helicopter hub linkage. As the technology crossover knowledge from helicopter duration event finally catches up with fully autonomous airplane and autonomous drone

technology, these new types of model rockets and helicopter drone hybrids can be built more easily than the modern racedrone or ciniwhoop drone camera systems. This represents an exciting advancement in the field.

Resources for designing model rocket helicopter hubs:

1. https://www.nar.org/wp-content/uploads/2022/01/Helicopter-Duration-Presentation-Jan-22.pdf
2. https://www.apogeerockets.com/education/downloads/Newsletter375.pdf
3. https://www.apogeerockets.com/Rocket-Kits/Skill-Level-4-Model-Rocket-Kits/Gyro-Chaser
4. Tim Van Milligan, 2008 3rd edition Model Rocket Design and Construction: A book by Timothy S. Van Milligan provides comprehensive information on how to create and build unique and exciting model rockets, including helirocs page 219, Chapter 121.
5. National Association of Rocketry: Building tips for model rockets2.
6. Instructables: Step-by-step guide on building a model rocket3.
7. NASA/JPL Edu: Educator guide on how to make a Mars helicopter4.
8. Tim Van Milligan, Aug 1991, NARAM33 Calculating the rate of descent of a helicopter duration rocket.
9. John Demarr, 9 Aug 1994, Whirl-a-While.
10. Bob Kaplow, 2002, RotaCrock, 2003 Sep/ Oct Sport Rocketry
11. Art Rose, RosaRock12
12. George Gassaway, Oct 27, 2007 mini-Rotaroc.
13. Chris Flanigan,1976, Journal of MIT Rocket Society, Basic Theory of helicopter duration, page 22-27.
14. Trip Barber, 1976, Spinner One, Journal of MIT Rocket Society, page 28-31
15. Trip Barber, 2008, NAR, Model Rocket Helicopter (Gyrocopter) Duration
16. Allison, Van Milligan, 2014, NARAM56, Finding the best helo blade.
17. Pinkas, Wickart, 2002, NARAM44, Design of a competitive heliroc.
18. Tim Barklage, 1988, NARAM29, Helicopter Duration Research, Mar 1988 American Spacemodeling.
19. Rebecca Zurek, 2021, NARAM62, Comparing Auto-gyro Recovery Blades.

ABOUT THE AUTHOR

Michael Hatcher's journey in the realms of engineering and technology is as diverse and dynamic as the systems he has engineered. His fascination with model rocketry traces back to his early days as a Space Shuttle Test Engineer, where he honed his skills in aerothermal testing and ECLSS engineering. Michael's aerial pursuits extended beyond the Earth's atmosphere, transitioning from a USAF military officer and combat veteran to a seasoned Air Force pilot with expertise in C5ISR military drone systems. This trajectory led him to explore the cutting edge of drone technology, collaborating with companies like Theta Composites and TEQ Strategy, contributing to Guinness World record pursuits for articulating drones. In his role at Energy Physics LLC, Michael has become a driving force in modern drone architectures, embracing 3D modeling, 3D printing, and PCB manufacturing. His commitment to education is evident in founding the National Space Science University (NSSU) and National Drone Science University (NDSU), where he imparts knowledge on nanosatellites, drone science, space science, and quantum field theory. Michael's aerospace odyssey is marked not only by his technical prowess but also by a passion for continuous learning, as evidenced by ongoing studies in electrical engineering, physics, and space sciences. As he ventures into the realms of veterinary technology and earns an MBA, Michael Hatcher remains a pioneer in engineering, a prolific author, and an advocate for the future of space and drone sciences.