

# CopterBox: Disposable Airdrop System

## Description:

CopterBox (U.S. Patent 5,947,419) is a lightweight, disposable air cargo delivery system that was designed to deliver 60 pounds of logistical supplies from a wide variety of aircraft with drop speeds of up to 140 knots. Payloads of up to 100 pounds are possible but with a higher touchdown speed. The high-strength, corrugated paper box employs three rotor blades that use the principle of autorotative lift to slow the box and its payload to a gradual descent prior to ground contact. Because it spins at approximately 450 RPM, it cuts through tree cover and requires no prepared drop zone. Since the payload has been limited to what a single person can carry or drag, no special handling equipment is required for loading into the aircraft or for hauling out of the drop area. This feature is particularly useful for special units who need to receive their supplies quickly, particularly when they are on sensitive missions or are in contact with enemy forces.

CopterBox makes economic sense in applications where a parachute would not be practical or prudent due to high associated logistical costs. CopterBox requires very little time and training to pack and rig prior to launch.



**CopterBox in autorotative descent.**



**CopterBox rigged and ready to deploy.**

Each CopterBox ships from the factory as a rectangular box with all of the parts included inside to allow for efficient storage on trucks, in warehouses and aboard ships. Upon assembly, the outer, rectangular shipping box is formed into the CopterBox hexagonal container and all parts are used with very little rigging waste. A CNC-bent and welded wire rotor hub is used to withstand the aerodynamic and centrifugal forces of flight during descent. The same part is also used as a landing skid that protects the container and the aircraft while the unit is being maneuvered during loading and egress. This design maximizes part commonality. If desired, the rotor hub and landing skid can also be used as camp stoves after landing. Rotor blades are made of high-strength corrugated paper and are folded into an efficient, faceted airfoil shape that varies with span for efficient rotary lift. Blank yardsticks are used as rotor blade spars. A small pilot chute, coupled with a strategically stitched serpentine metering line, delays the opening of the rotor blades until CopterBox is safely away from the drop aircraft. Once the metering system (U.S. Patent 6,712,317 B1) pulls tight against the pilot chute, CopterBox is oriented into the relative wind, causing the rotor blades to open and start the spin-up and autorotative lift begins. CopterBox assembles easily in minutes using simple zip-ties and a small wire-bending tool to fasten the rotor blades to the hub. The tool is provided in the kit. The high-strength corrugated paper fuselage has embedded strapping tape to withstand cargo loads during autorotative descent and landing. The cargo spins with the CopterBox assembly to minimize complexity by eliminating expensive bearings. A custom paper honeycomb plug in the bottom of the box acts as a shock absorber. The cells in the plug are large to provide easy crushability for slower deceleration of the designed payload size.

CopterBox has been developed using 100 percent private funding by the shareholders of DropMaster, Inc. (DMI). DMI received a 98 percent rating by Natick Soldier Center on Phase I of a Small Business Innovation Research (SBIR) Grant that proved the feasibility of the CopterBox technology. DMI was selected for SBIR Phase II but not funded.

### **Development:**

Early R&D (May 1995) involved reverse wind tunnel testing to try different rotor blade shapes, blade pitches and construction methods. A 1987 Ford Taurus Station Wagon was used on an airport taxiway (with tower coordination for safety) with a test fixture that attached to the front bumper mounts and the luggage rack. A digital scale was used to measure the force created by the spinning rotors and an ultra-light airspeed indicator was used to measure the rotor's forward speed. The goal was to maximize force with minimum airspeed. The data acquisition proved to be more entertaining than useful in the end because a CopterBox would not have to react to the momentum of a Ford during descent. One day at the airport, a farmer working an adjacent field once asked, "Does that there contraption pull that car?"



**Wind Tunnel Testing (1995).**

Follow-on work involved using two triangular shipping tubes combined to make a hexagonal box. Simple plywood rotor blades with foam ribs and brown paper upper skin were attached with hook-and-loop tape. The rotor blade airfoils were copied from a Bentsen Gyrocopter that was sitting in the workshop at the airport. This simple design was first successfully tested out of a Cessna 172 with 15 pounds of sand in June of 1995.



**The First CopterBox Prototype in the door of a Cessna 172 (1995).**

Subsequent testing showed that a stronger rotor hub was needed, which we developed with the help of a CNC wire bending and welding company. We then resorted to hand-measured, folded and cut parts, which led eventually to CNC cutter table prototype parts from a local box manufacturer. Most of the testing since then has been to iteratively test ideas that did or did not work. Early versions required that the center of mass needed to be towards the bottom of the box for the rotor blades to open. Before we started using the pilot chute to orient the box to open the blades, we tried mouse traps, rat traps and dropping the box upside down to try "tumbling" them open. An impressive list of unsuccessful ideas resulted in lots of video footage of boxes loaded with 60 pound buckets of sand slamming into our drop zone. Dropped from 500 to 1,000 feet, they make quite an impressive thumping sound when they land close to the observer. All of this testing was logistically challenging and quite expensive considering we had to coordinate getting airplane availability, pilots, staging areas and camera operators. One of the principal developers owns what is known as the Secret Research Center (SRC), which has always been the primary drop area. Through creative bartering and much effort, bulldozers were used to create a landing strip at the SRC, which put all of our testing capability in one place. Airplanes were then able to land, take off and drop CopterBoxes with ease. In fact, a sheriff's officer once stopped by to make sure we were not delivering drugs! Once we explained that it would be ridiculous for us to deliver drugs to ourselves, he drove away content.

**Production:**

All of our vendors have identified methods to simplify manufacturing, rigging and use of the product and have been critical in getting CopterBox to market. We have gone from CNC-cut paper parts to steel rule die tooling for high-speed production. The paper honeycomb shock absorber plugs are now stamped out in lieu of labor-intensive hand measuring and tiring hand-held electric sawing. All nylon parts are custom-made by a certified parachute manufacturer.

**More information and Parts List:**

More information and CopterBox kits are available at [www.dropmaster.com](http://www.dropmaster.com). Pricing is on a sliding scale from \$600 each for quantities of less than 300 to \$350 each for quantities of more than 1000. CopterBox is specialty hardware that is the result of rigorous development, testing and real-world use.

**The CopterBox MPEG-1 video can be downloaded from the website:**

[http://mywebpages.comcast.net/dropmaster/CopterBox\\_2005.mpg](http://mywebpages.comcast.net/dropmaster/CopterBox_2005.mpg)