

Rubber Powered Free Flight – 35cm Class FAI equivalent – F1R

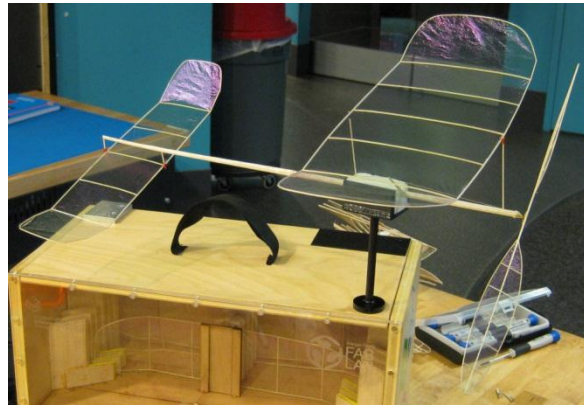


This is the entry for the Museum of Science and Industry, Chicago in the 2012 Fab World Cup. Our entry has two parts, the first is a free flight rubber powered model airplane of the F1R class for Fédération Aéronautique Internationale (FAI) competitions (the FAI is the international governing body for aeronautic competitions of all types, model or otherwise.) The second part of the entry is a custom carrying case/stand/winding stooqe/tool holder that is an integral part of the flight process for airplanes of this type. Detailed descriptions of each component are below. Overall, the construction of these airplanes and the case involved the use of several Fab processes, including laser cutting/etching, 3D printing, vinyl cutting, large routing on the Shop Bot and soldering.

Airplane

The airplane itself is a specific type of indoor free flight model airplanes. Indoor free flight models are generally rubber powered and once released, the pilot/builder has no control over the flight. All of the controls must be built into the model itself (e.g. the models must be built to constantly turn in a large circle so as to avoid walls.)

Competitions are judged exclusively on absolute time aloft, with a number of different classes of model dictating wingspan, minimum model mass, maximum rubber mass, construction



materials, etc. This model qualifies for the 35cm class, whose only restriction is a maximum wingspan of 35cm. As a result of the loose restrictions and strong correlation between low flying mass and flight time, these models are extraordinarily light. Depending on the exact combination of components (multiple propellers, wings, motorsticks, etc. were constructed both to accommodate different flying situations and to deal with anticipated breaks) the overall mass of the complete model is somewhere between 0.45g and 0.65g (which is actually a little heavy for this class! We built them heavy for extra “durability.”) For comparison, this is approximately half as much as a single US dollar bill. In order to achieve such a small mass, very specialized materials and construction techniques are used. In particular, we utilize a large number of jigs and custom building blocks to create the aerodynamic shapes. All of these jigs were either laser cut in the lab and pictures of the model under construction are in the photo album folder included with the rest of the files. A complete step by step guide for constructing these models is available on sites such as www.indoorduration.com, www.indoornews.com or hippocketaeronautics.com. The components that used Fab processes include:

Wing tip and Stabilizer Tip form – Laser Cut from acrylic

Rib templates (the ribs are curved and sliced from a sheet of balsa) – Laser Cut from acrylic

Tail boom form (the motor stick and tail boom are hollow, like straws and formed by wrapping a sheet around a form) – 3D printed

Propeller pitch form (the propeller is twisted in a specific manner) – 3D milled on the Shop Bot using Part Works 3D and a large block of balsa

Carrying case

While the airplanes themselves are very specialized, the case may be even more (and happen to be Matt's favorite part!) The case serves several functions; it not only protects the models during transportation and storage, but also carries all the associated tools and provides a location to wind the rubber band during flight times. The box was designed and constructed to do all of that while being small enough to carry on to a commercial airplane. The overall volume of the case was minimized to reduce the volume of air inside the case. These models are so light, the interior air weighs more than the models and its momentum is able to break components. The front of the case is a clear sheet of acrylic so airport security can view inside and hopefully not ask to open it (again, to prevent damage to the models.) When closed, the top of the case serves as a winding and staging platform. There is a winding hook and Velcro for a torque meter. A magnet is embedded into the lid, to allow a magnetic model stand (visible in the middle picture to the right) to stand on top. The exterior is decorated with stickers, including MSI and Fab Lab logos as well as derivatives of the artist Roy Lichtensteins' brushstroke series. The components that used Fab processes include:

- Frame/interior – Cut from plywood on Shop Bot
- Front cover – Laser cut from acrylic
- Tool carrying box – Laser cut from acrylic
- Compartment divider – Laser cut mahogany sheet
- Wing/Stab divider jigs – 3D Printed
- Motorstick/tail boom holder – Laser cut mahogany
- Stand base – Laser cut acrylic
- Stand upper holder – 3D printed
- Stickers – Vinyl cut

