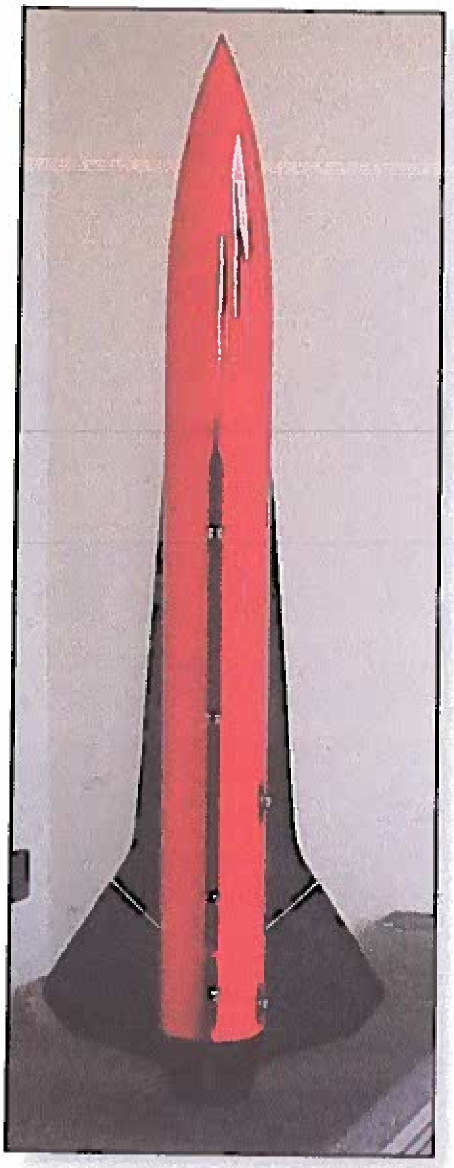
MODULAR DESIGN

and Glueless Construction



The Roccouno is an example of a rocket assembled using modular-mechanical method.

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A model rocket is a flying vehicle that must withstand, during the short time of the burning motor propellant, a series of events, some of these very hard and impulsive. A model rocket is the result of the joining of several parts of wood, cardboard, plastics, and even composite materials. The traditional way to join these parts is to glue them all together in the manner the kit manufacturer suggests in the building instructions. Once you have a rocket finished, totally glued, there is no way to modify it without cutting tubes and removing and regluing parts. Moreover, in the event of damage after a flight, this is also the only way to repair the rocket.

We developed a different method of building model rockets, first in our own ways, and then, after we met, in a common direction. We started building model rockets that had some new characteristics by studying the construction of machines, real airplanes, and real rockets. Using screws and bolts for joining parts of the vehicle, we are now developing the construction of flying machines that don't use glue for joining tubes, airframes, fins, and other structural parts. The modular-mechanical construction offers a series of interesting features:

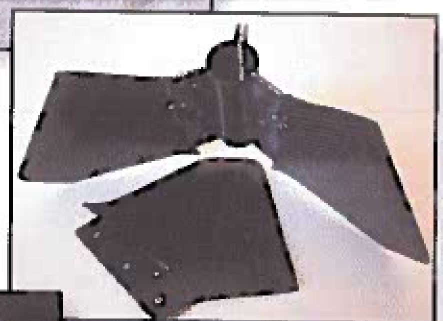
- we can strip down any part of the rocket, even internal parts, for repairing or inspection
- we can modify a rocket by replacing a damaged part or a structural part for diverse flight configurations
- we can modify the rocket, even its structural parts, for new missions or payloads
- we can modify the flight profile of the rocket, even with equal payloads, by replacing fins to obtain a more favourable CG-CP configuration
- we can develop a rocket by future replacement of structural parts with better components as they become available onto the market or through advances in our development program.

So, the vehicle becomes a real rocket machine, which permits more scientific experiments and promotes a fuller comprehension of the flight dynamics, design, and the construction of the vehicle. Modular-mechanical construction provides a deeper experience for the rocketeer as designer and builder. The rocketeer acquires the skill to design and build even more complex rockets, using new materials and systems.

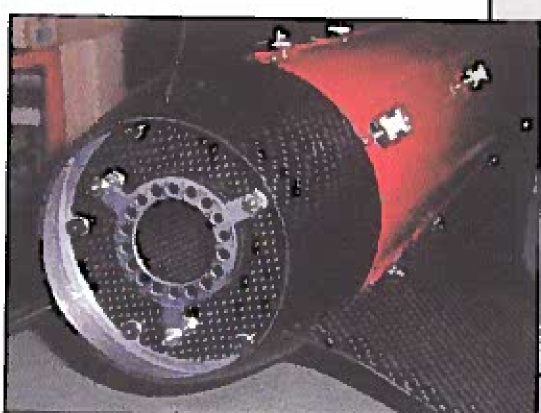
On the converse side, a rocket built with modular-mechanical techniques is more delicate and will require maintenance and care. But this happens in the real rocketry and is the price to pay for gaining more experience. Gluing the parts of a commercial model rocket kit together is easier and faster than using modular-mechanical techniques. The finished traditional rocket has few final sub-assemblies, only two or three (usually the airframe with the fins, and the nose-payload section), and the rocket is very strong. This is because the adhesives penetrate into the fibers of the materials, making very strong joints (but a permanent configuration that is not easily modified). The strength of traditional rocket construction allows such models to accommodate even very powerful HPR motors.

The rocketeer who wants to design and build new and original rockets often understands that commercial kits are very limited when it comes to experimenting with different designs. Thus, he starts to modify the kit. First he wants to give the rocket a different appearance with different fins, or by adding/removing parts of the airframe; but he also wants to conduct experiments

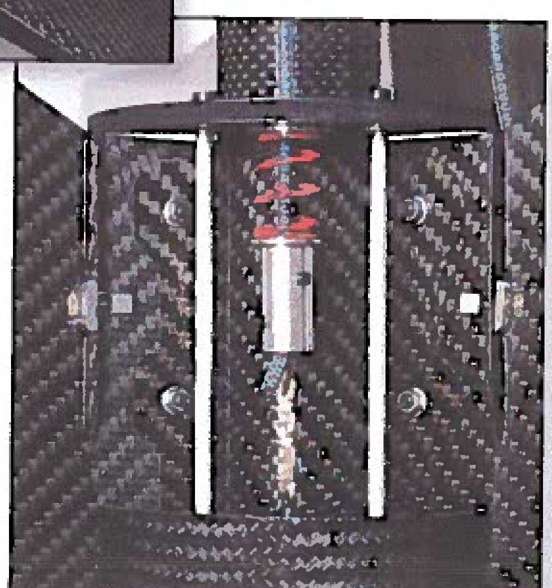
(above) The Roccouno model disassembled into its components.



(right) Detail view of the Roccouno's fin assembly. The Roccouno makes extensive use of composite materials.



(left) The tail of the Roccouno model. The rocket features positive motor retention and rail buttons for launch.



(below) The shock cord mount of the Roccouno is located in the fin area. The mount features a spring-loaded shock absorber.

that require larger or smaller payloads sections and nosecones. Sooner or later he thinks of using a wider variety of motors, even in clusters. This leads to designing diverse motor mounts to accommodate rocket motors of various diameters.

It becomes evident that gluing parts together is a limitation to model rocket experimentation. It is impossible to try all the modifications listed above in a model built with glues (without building several rockets to incorporate the different elements). The construction of an original rocket requires diverse detachable elements that must be joined to the others with screws and bolts. This is the first step toward the mechanical construction of a real flying rocket machine.

A rocket built with mechanical-modular techniques can incorporate a virtually endless series of elements. Every single component of the airframe, or structural part, can be replaced or repaired or modified, and joined in the proper place by screws (and so: glueless). This permits the study of every component of the vehicle and the repair or replacement of only those that fail or perform poorly. The vehicle can be totally disassembled into elemental parts. Experimentation can concentrate on modifying just the parts of the system that are least effective that need replacement. This is the way the great companies build real space vehicles and this is defined as "developing the vehicle."

Developing our own vehicle can open infinite possibilities, and we can modify our rocket so that it becomes, after every little change, a little bit better than it was previously. Naturally, this happens after a long period of experimentation, and after several years of "developing." Each of us acquires his personal experience and becomes a unique model rocketeer, with a fantastic and wide vision of designing and building.

A simple way to try out the techniques of mechanical-modular construction is to start by modifying a commercial kit. We

That Seven-D's Rocket

It's High Power, Dude!

That Seven-D's Rocket, featured in the July/August issue, requires an FAA waiver and Level 1 High Power Certification to fly when fully loaded. Any rocket containing more than 125 grams of propellant is a High Power Rocket, by definition, and you must adhere to the High Power Safety Code when flying it. With one D12-5 and six D11-P motors, That Seven-D's Rocket contains 168.1 grams of propellant, so it is a "complex" high power rocket and you must launch it from a minimum personnel distance of 200 feet.

You can get within the legal limits for Large Model Rockets by launching it with one D12-5 and *four* D11-P motors (a total of 119.1 grams of propellant), but flying it still requires FAA notification (although not a waiver).

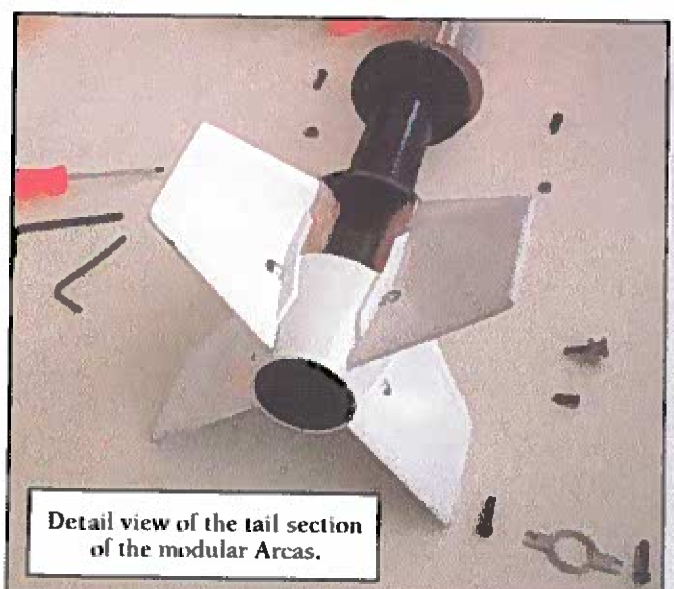
(above) An Arcas model constructed with modular-mechanical techniques.

The Arcas, disassembled to show its internal construction.

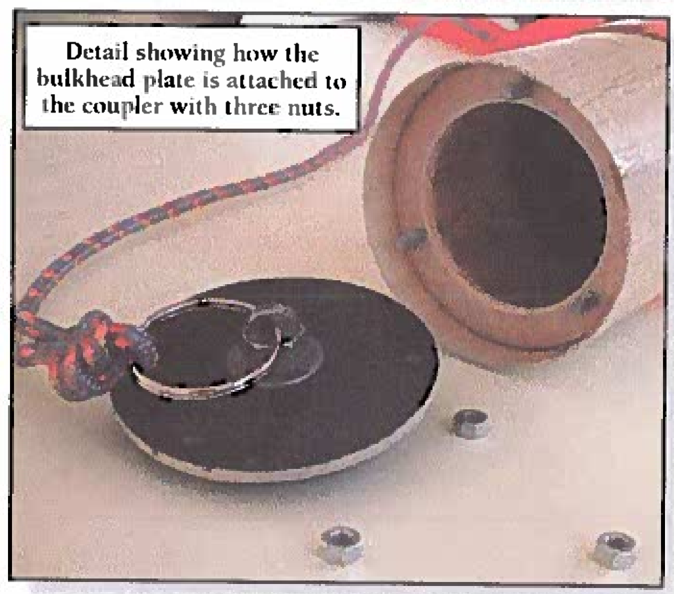
can modify it to allow the motor mount to be removed from the airframe. This system enables us to observe the effects of the thermal stresses of motors and ejection charges on the motor mount and stuffer tube (if present). It is very interesting and—this is a gift!—we can note if the motor mount suffers any damage after every or few flights. This is an invaluable experience.

Another advantage is the fact that it is simple to replace a damaged or burned shock cord. And in the case of a zipper in the airframe tube, we can replace only the tube with a new one, conserving the remaining parts (and not buying additional parts).

Screws passing through the tubes and penetrating into the bulkheads (which are built with thicker wood or other materials) are easy to extract to allow replacement of parts—much better than having to cut part of a glued tube or glued motor mount.



Detail view of the tail section of the modular Arcas.



Detail showing how the bulkhead plate is attached to the coupler with three nuts.

Modular-mechanical construction results in a vehicle that is more readily modified and better supports even small experimental upgrades compared to a similar model assembled with adhesive. But the rocketeer's spirit that chooses to embrace this concept demonstrates the desire to know its "machine" in every single part—studying, planning, and constructing to a very deep level. Moreover, in our modern era we are fortunate to have composite materials available that help us remarkably in the modular construction—but that is a topic for a future article.

For more information, see our web sites: Riccardo Palean NAR 85185 at <www.web.tiscali.it/paleair/> and Cristiano Casonati NAR 85186 at <www.criscaso.com>.