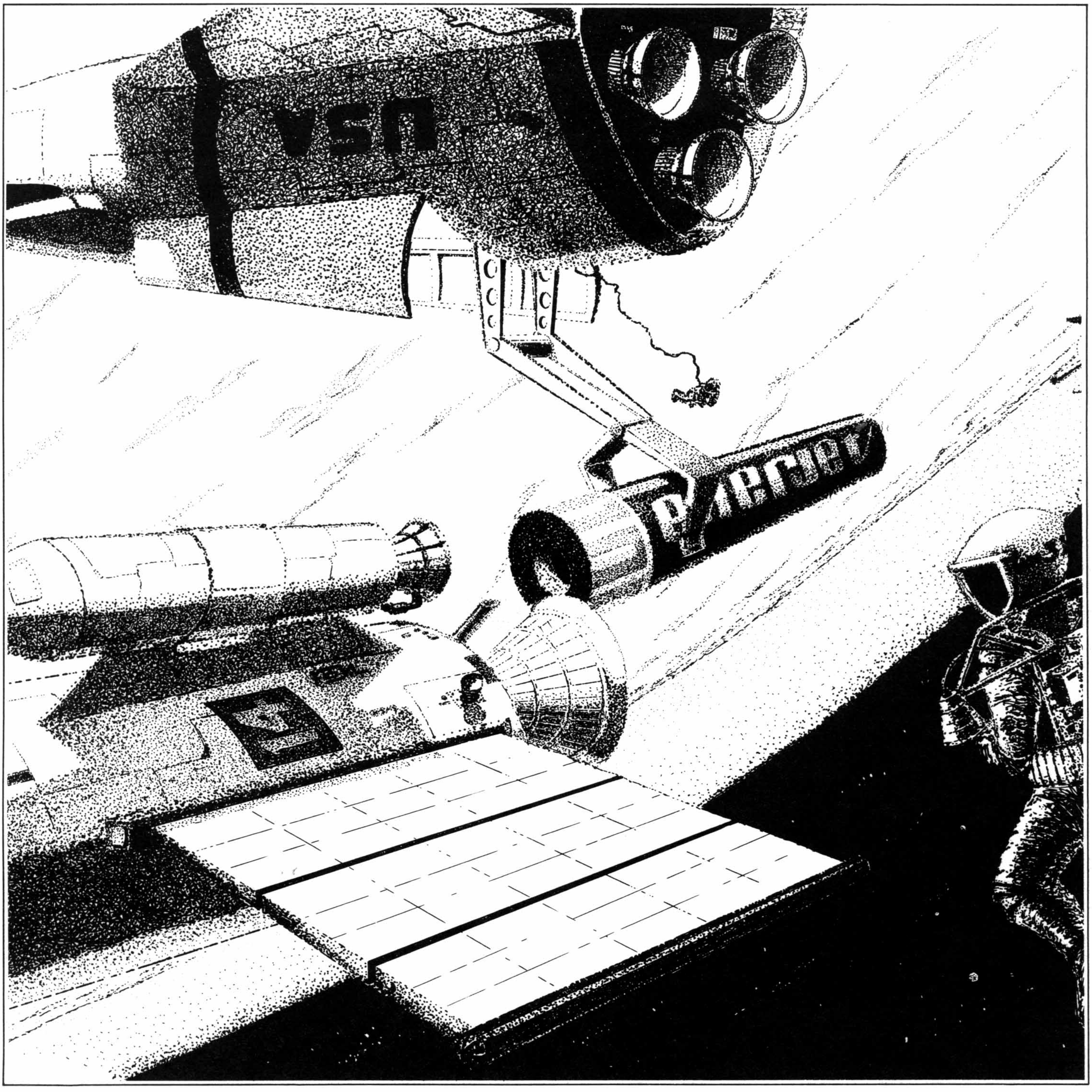
enerjet news

PUBLISHED AS A SPECIAL SERVICE TO OUR FRIENDS ENERJET INC. P.O. BOX 400, PHOENIX, ARIZ. 85001 AUG., 1972 NO.2

A PROMISE OF THINGS TO COME?



MODEL ROCKETS IN SUPERSONIC FLIGHT

By Lawrence W. Brown

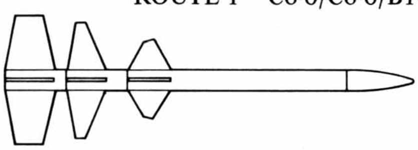
CAUTION: THIS REPORT IS FOR INFORMATIONAL PURPOSE ONLY . . . IT IS NOT A GUIDE FOR CONDUCTING EXPERIMENTS

The possibility of supersonic flight for model rockets has long been a popular and fascinating subject. The speed of sound is approximately 762 miles per hour, at sea level. Two major concerns are propulsion and verification. Supersonic speed is not easily reached and it is not easy to know if and when a supersonic attempt is successful. This report will deal with these two major concerns.

PROPULSION vs. DRAG

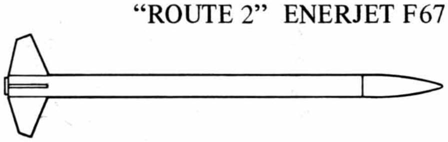
A featherweight rocket powered by a B14 motor can reach 400 miles per hour. It seems simple enough to add several stages under this featherweight rocket to add the "mere" 300 mph necessary for sonic flight. Such an attempt is certainly an economical route. We will call this approach route 1, and a route 1 vehicle might look like this:

"ROUTE 1" C6-0/C6-0/B14



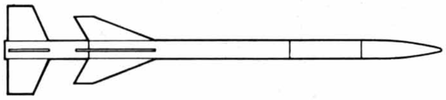
A second approach to the propulsion problems is to find an unusually high impulse motor and construct an optimum rocket shell around it. The Enerjet F67 is such a motor and this Route 2 is open. A route 2 vehicle might look like this:

"ROUTE 2" ENERJET F67



A third possible approach involves the use of motors less powerful than the Enerjet motors yet much more powerful than B14 and C6 motors. These motors are staged for supersonic performance. This approach was successfully applied by Centuri Engineering with their fabled Mini Max motor (produced 1962-1967) the predecessors in power to Enerjet motors. This approach we'll call route 3. The Centuri vehicle, produced for the Atomic Energy Commission several years ago looked like this:

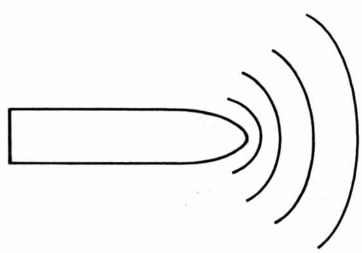
"ROUTE 3" STAGED MID-RANGE



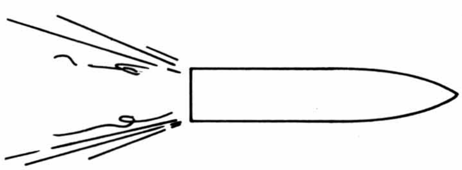
Every high speed flight attempt has drag as its impacable enemy. Drag increases with the square of velocity. If drag at 300 mph is X, drag at 600 mph is not merely 2X; it may be 4X or even higher. Thus one must do more than double the power of a rocket to double its speed. Any rocket engineer will tell you that the atmosphere is a fluid. For an extremely fast model rocket, air is thick as pea soup.

How do big research rockets conquer drag? They don't. They simply get out of the atmosphere as rapidly as possible to avoid it. Model rockets spend almost all their flight time in subsonic or occasionally "transonic" flight. Drag during transonic flight is most severe of all. Imagine a row boat pulling across a lake. It moves slowly, pushing water before it. It's bow wave is rounded and proceeds the bow of the boat.

We can liken the row boat to the subsonic rocket. The still air is "warned" of the rocket's approach by a shock wave of air pushed along in front of the nose cone.



The Supersonic rocket is analogous to the high speed hydroplane. It's wake is Vee shaped and straight lined.



In this case, the boat speeds ahead of its own shock wave. The water ahead is unprepared for the boat's approach.

The rowboat and speed boat wakes resemble subsonic and supersonic shock waves. The transonic situation exists when air speeding up (over the airfoiled fins for example) goes supersonic and partial supersonic shock waves form inside a generally subsonic pattern. These shock waves interfere with each other; drag climbs rapidly.

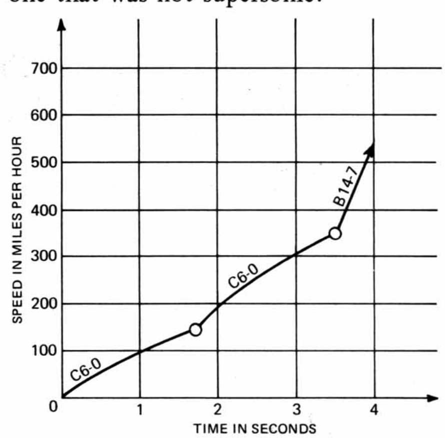
You cannot sneak up on the speed of sound. The transonic situation must be crossed as rapidly as possible. Otherwise, with a gradual acceleration, drag will build up and velocity will plateau. Additional energy will be wasted. We need a rapid, decisive dash into supersonic flight.

How might this be done with our Route 1, 2 and 3 approaches?

ROUTE 1

A three stage rocket is powered by C6-0, C6-0 and B14-7 motors. B14 motors rely on high thrust-to-weight rations for high speed flight. At the beginning our rocket is fairly heavy and a C6-0 will lift the vehicle off on a smooth climb. We need about 150 miles per hour from that C6-0. The second C6-0 adds another 200 miles per hour to the flight speed and we are still cruising smoothly, sneaking up on sonic speed. At 350 mph, still clearly subsonic, the B14-7 ignites. If the attempt succeeds, the B14 will make a rapid penetration into sonic flight during its short, but violent .35 second burn.

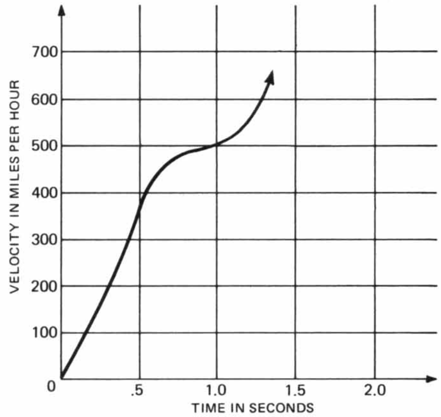
The flight history of a route 1 attempt, one that was not supersonic:



ROUTE 2

Our rocket uses a single motor - an F67-14. The Enerjet thrust-time curve is very characteristic, climbing to a quick peak, dropping off slightly, then climbing in thrust constantly to burnout. If the route 2 rocket is to succeed, the crucial period involves that constantly climbing thrust level.

The flight history of a route 2 attempt; probably transonic.



ROUTE 3

A two stage rocket is sufficient if both stages are F powered. When an Enerjet booster appears, speeds up to 800+ miles per hour may become possible. The performance of the booster requires a burnout velocity of around 350 miles per hour; the second stage must be capable of a rapid acceleration through the transonic region.

We will deal with verification next. A representaion route 1, 2 and 3 vehicle has been successfully flown with no direct claim made for performance. A 30 lb/sec professional Enerjet motor has burned its leading fin edges during a test flight, indicating very high speed - probably supersonic.

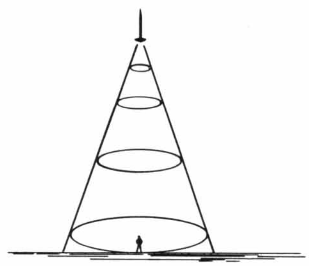
VERIFICATION

How do you know whether a rocket has gone supersonic? Presumably radar could tell you, but model rocketeers hardly have access to radar. By calculations, you can predict that a rocket should go supersonic. Working the same values you can predict the rocket's altitude. By tracking the flight, you have reason to believe that an accurate altitude prediction implies an accurate velocity prediction as well. But, no proof. Several possible methods of verification exist.

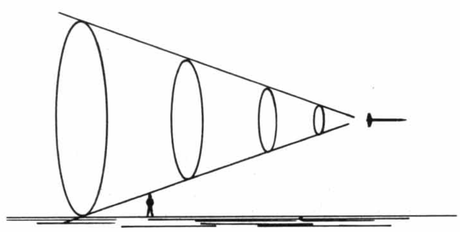
Speed Trap –This involves flying a sonic attempt at a very low angle and such a flight is NOT APPROVED by any organization or manufacturer, Enerjet included. If you have a real firing range COMPLETELY devoid of property or people you might wish to proceed as an amateur (not model) rocketry experimentor. Using either motion pictures or electric eye, a rocket is timed through a measured distance. Ideally, you want burnout to occur just as the rocket clears the trap. Problems of accuracy, safety and equipment are obvious.

Temperature sensitive paint is available from other sources. If laboratory tests or data is available to indicate the required air speed to generate X degrees of heat, you might have a fairly simple method. Color changes indicate temperature exposure.

Sonic Boom–The Centuri tests for the AEC involved repeated supersonic flights at low angles. Down range observers reported a cracking sound likened to a cracked bullwhip. Range safety requirements make this method as hazardous as the speed trap method. Why can't a sonic boom be heard as a rocket rises vertically? The shock waves form a cone, and the cone does not form until the speed of sound is reached. You cannot hear the "boom" because you are inside the cone and because the boom is very weak.



Flying parallel to the ground, the shock cone sweeps along behind the rocket. The boom is much stronger and may be audible.



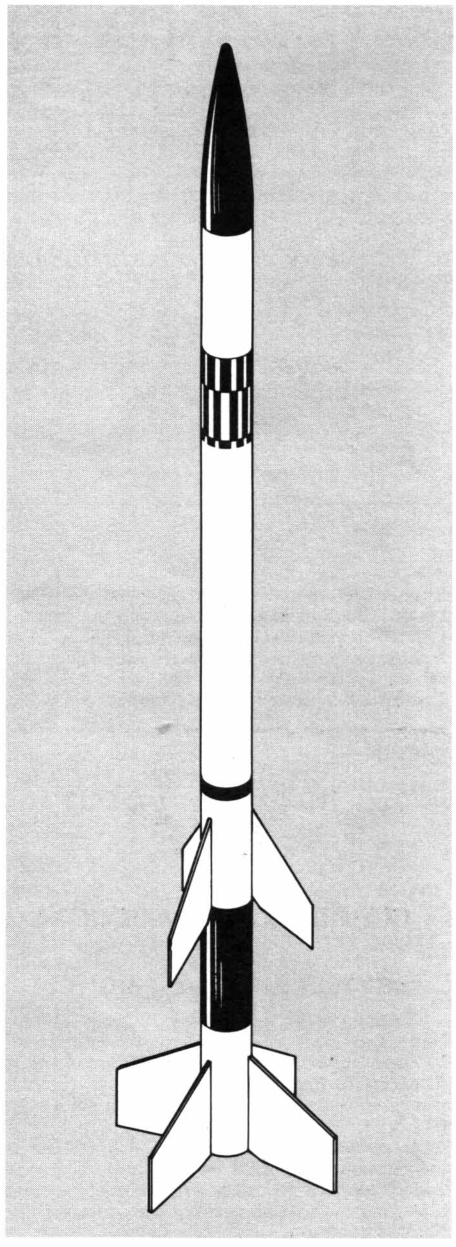
We do not know whether a rocket of route 1 size (.76" in diameter) can generate an audible sonic "boom". It should be remembered, too, that the boom lasts only while the rocket is supersonic (about a second's time). If you are not within the area swept by the shock cone you will hear nothing.

A transmitter drifting down on a parachute with a sensitive microphone might pick up the boom of a vertically launched sonic attempt. This would, of course, be very tricky.

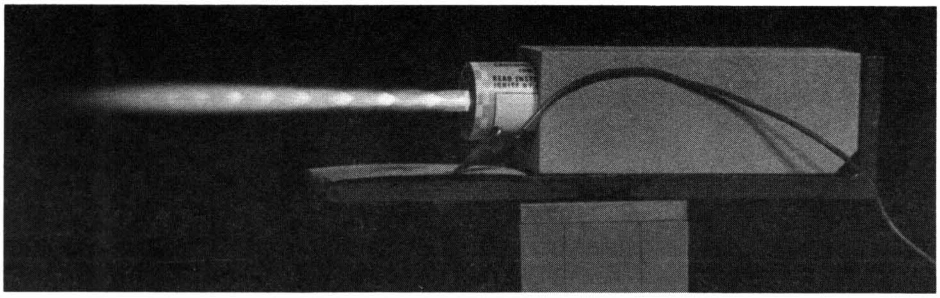
SUMMARY:

It is difficult to say which is more difficult to do, achieve supersonic flight with model rockets or, having done so, to prove you did. Some computer program predictions by modelers around the country indicate that a single Enerjet will power a rocket to sonic speeds, other studies place burnout speed in high transonic.

A good study might be this. Since the best one can hope for is low supersonic, high powered model rockets are more properly considered transonic probes. Very little is known about this region. Optimising designs for maximum altitudes with flight test verification would indicate which shapes have least drag at transonic speed. This information would be new and valuable. Such a vehicle shape has the best chance, in the process, of achieving true supersonic flight.



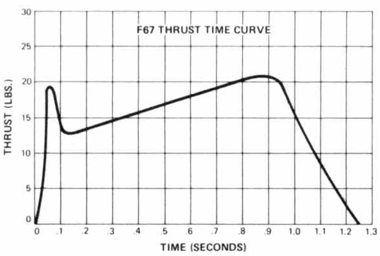
Standing 36 inches high, this two stage rocket was developed by Centuri Engineering in 1967 at the request of the Atomic Energy Commission. Several of these rockets were positioned directly over a deep shaft leading to an underground necular device. The rockets were launched at the instant of detonation. A special payload in each rocket recorded radiation at the surface and the rockets cleared the area just before the shock waves from the blast reached the surface. It was during low angle flight testing of these vehicles that small sonic "booms" were noticed by the research team.



"Mach diamonds" are clearly visible in this photo of a night-time static firing. Quality testing for performance and safety goes on constantly at our motor productions facility.

HOW AN ENERJET MOTOR WORKS

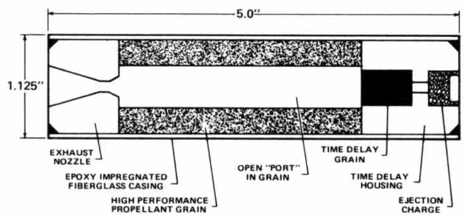
All Enerjet motors are "port burners". Combustion begins along the entire interior surface of the propellant grain, and consumes the propellant by burning out toward the casing wall. As shown in the thrust curves, thrust jumps instantly for a quick liftoff, tapers off somewhat, then gains power continually until burn out. A built in time delay allows your rocket to coast to apogee before the motor performs one last operation – a light retro "kick" to eject the parachute.



Enerjet motors may well be the most significant breakthrough in Model Rocketry in the past ten years. For years model rocket solid fuel has been technically limited to a specific impulse of 80-90 sec. (comparable to gas octane rating). Now Enerjet offers a specially developed composite propellant with a specific impulse of 185-200 seconds! In other words, Enerjet's fuel packs two and one half times more power into each ounce of fuel – driving your rocket higher and faster than ever before.

As shown above, a night-time static firing reveals the uniqueness of the Enerjet power plant: The motor starts up with a cracking hiss that deepens quickly. The brilliant exhaust jet is studded by "mach diamonds" - the dramatic mark of high engine efficiency. In the plasma-like exhaust, they stand out like pearls on a string. Just before burnout the diamonds crowd together and disappear one by one back up the nozzle. The motors burn as cleanly as a liquid power plant. In the daylight there is little smoke, only a brilliance at the rocket's tail end as it disappears into the sky.

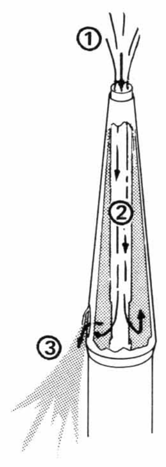
F67 MOTOR



ENERJET NIKE SMOKE

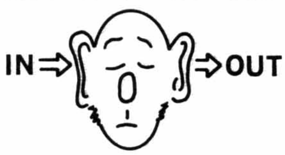
The Enerjet Nike Smoke is a semi-scale model of a NASA sounding rocket. The NASA rocket was designed to measure wind currents at high altitudes by pumping a dense smoke from its long nose cone. Zigs and zags in the contrail revealed wind direction and speed at various altitudes.

The Enerjet model Nike Smoke simulates this operation. Ram air pressurizes the nose cone and pumps a fine powder into the moving airstream to produce a billowing contrail behind the rocket as it climbs into the sky. Test fly this one yourself.



OPERATION OF ENERJET'S NIKE SMOKE CONE

1. Air enters the core tube, in flight.
2. Air exits relief holes in core tube, agitates powder.
3. Powder in suspension blows out smoke vent, producing a contrail.



MOODS

CURRENTS AND OPINIONS

CONTEST ARE FUN – RIGHT ?

Summer is the special time for Model Rocket Meets and Contests. Most of these events are run by members of The National Association of Rocketry, a very hard working group of people dedicated to the promotion of safe Model Rocketry. NAR rocket contest events are actually problems solved simultaneously by a group of people solved simultaneously by a group of people under competitive conditions. Rivalry between clubs and individuals is often very intense - the results impressive.

The climax of The NAR year is the NARAM-The National Championship meet. Last year's NARAM was a demonstration of both the great personal qualities of its organizers and the limitations of the contest system applied on a mass scale for one week. The range was one huge Model Rocket Launching Machine. The effects of fatigue and constant pressure were evident. Many complained that there were too many people. Perhaps too many events are attempted within the time available . . . At the moment, NARAMS are simultaneously the year's Annual Social Bash and an elite Championship.

It is none of Enerjet's business how (or if) NAR resolves these occasionally conflicting functions. As spectators and occasional participants in NARAMs we simply observe that NAR's most precious contribution to the nation's Rocketeers is COMMUNITY. We manufactures offer products and occasional services. We do what we can, but only NAR offers a real possibility of fellowship for model rocketeers as a group. The staff of Enerjet realishes our fleeting opportunities to meet you people, but we can't offer you what NAR does. It would be a shame to see that fellowship lost while snarling at each other over a place in the check-out line.

SOMETHING NICE: Many contest events are showing a subtle resurgence of fun and sense of humor. The howls of glee and relief when that outlandish glider goes "flap-slip-klunk-sproing" and suddenly wings sprout, counter weights slap in place and the thing actually glides, are not unlike the reactions of the modeler who has successfully gotten his Space Shuttle to do what Centuri promised it would. We need an event for "free modeling" in which the contestant can do anything he wants; accompanies his rocket with a brief paper promising what it will do etc. Judging would be tough: Degree of difficulty, workmanship, originality, flight performance (did it do what he said it would?) etc. Points or not, it would be fun.

"Editorial commentary reflects only the personal eccentricities of the editor."