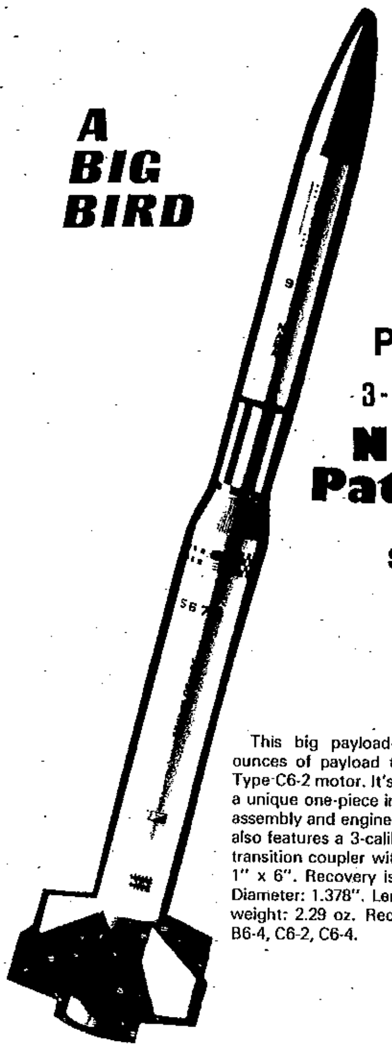
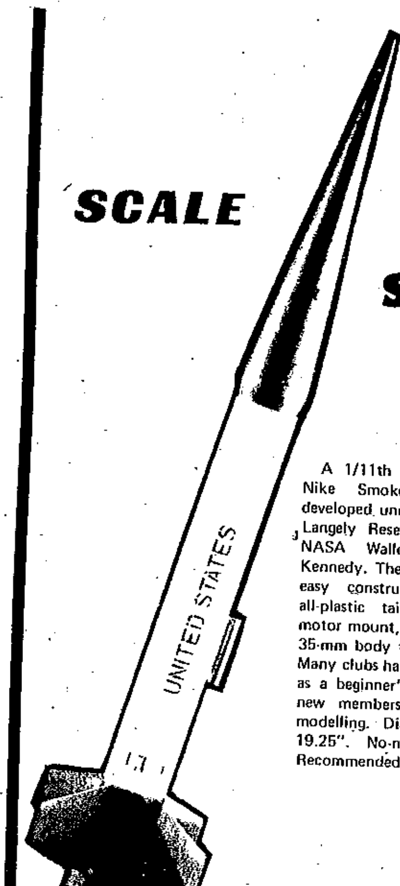
A BIG BIRD



PQ 1
3-0849
Nike Patriot
$2.25

This big payload-toter can lift two ounces of payload to 500 feet using a Type C6-2 motor. It's a husky model with a unique one-piece integral plastic tail fin assembly and engine mount. Nike Patriot also features a 3-caliber plastic nose and transition coupler with a payload section 1" x 6". Recovery is with a 14" chute. Diameter: 1.378". Length: 21". No-motor weight: 2.29 oz. Recommended motors: B6-4, C6-2, C6-4.

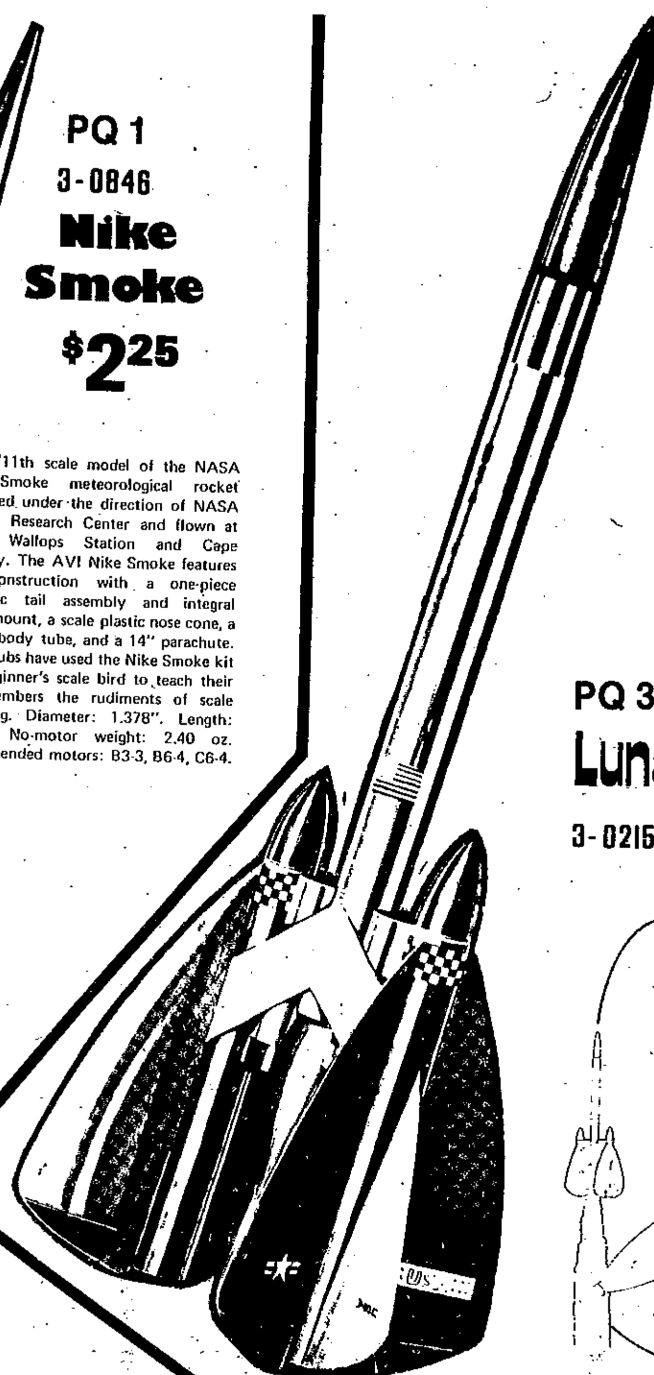
SCALE



PQ 1
3-0846
Nike Smoke
$2.25

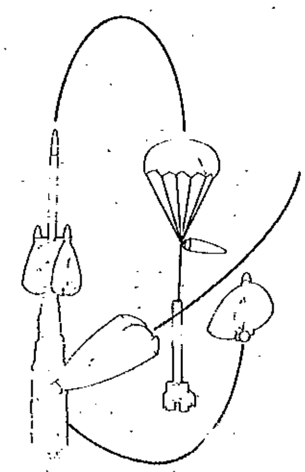
A 1/11th scale model of the NASA Nike Smoke meteorological rocket developed under the direction of NASA Langely Research Center and flown at NASA Wallops Station and Cape Kennedy. The AVI Nike Smoke features easy construction with a one-piece all-plastic tail assembly and integral motor mount, a scale plastic nose cone, a 35-mm body tube, and a 14" parachute. Many clubs have used the Nike Smoke kit as a beginner's scale bird to teach their new members the rudiments of scale modelling. Diameter: 1.378". Length: 19.25". No-motor weight: 2.40 oz. Recommended motors: B3-3, B6-4, C6-4.

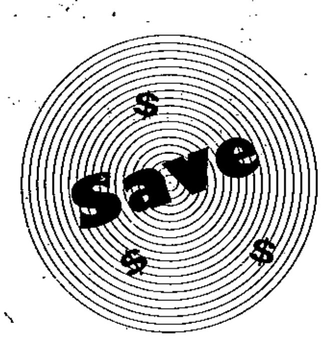
UNIQUE



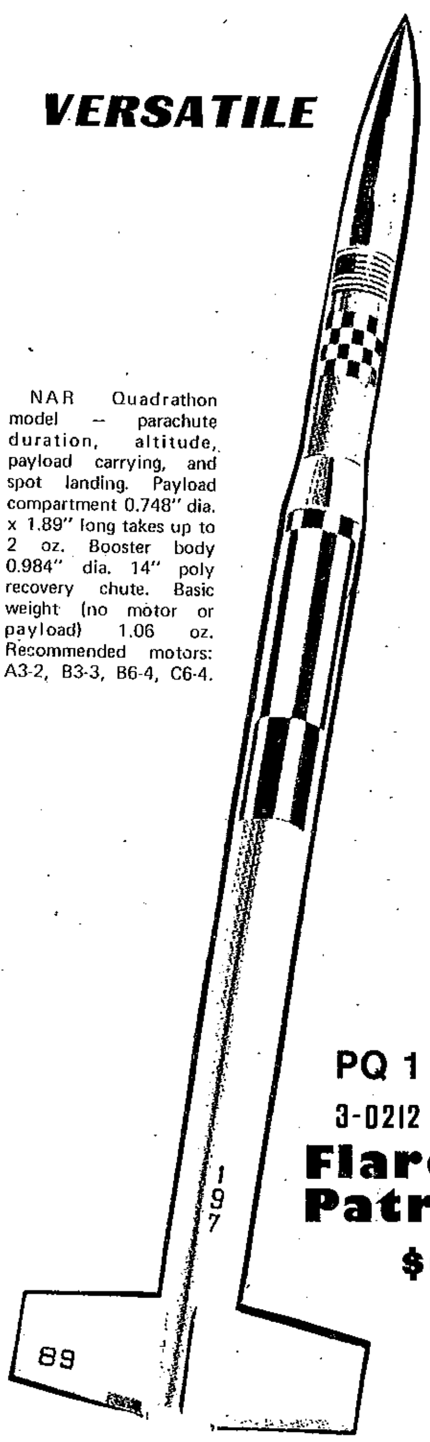
Bill Fileccia's great parasite boost-glider kit! At liftoff, motor in the central "core" carries aloft two delta-wing gliders which detach when the core ejects its recovery parachute. As the core descends, the two gliders swoop and turn to float in for a perfect landing. Paper tube bodies and balsa noses and flying surfaces. Basic tube dia. 0.788". Length: 15". Weight: 2.05 oz. (no motor). Recommended motors: A3-2, B3-3, B6-2, C6-4.

PQ 3
Lunar Patrol
3-0215 **$2.50**





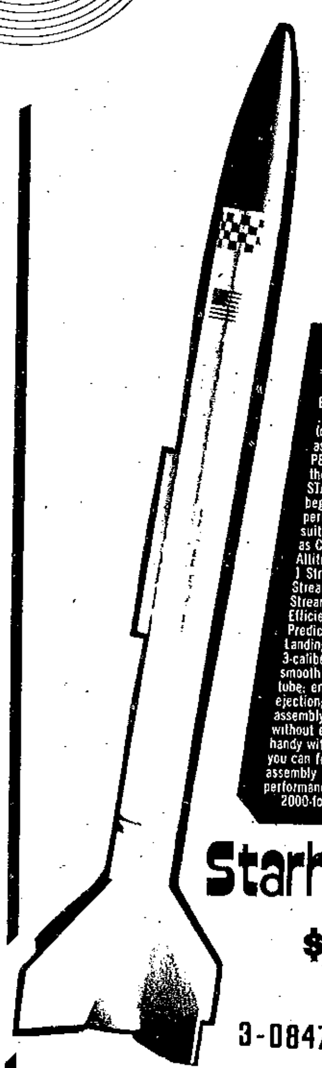
VERSATILE



NAR Quadrathon model -- parachute duration, altitude, payload carrying, and spot landing. Payload compartment 0.748" dia. x 1.89" long takes up to 2 oz. Booster body 0.984" dia. 14" poly recovery chute. Basic weight (no motor or payload) 1.06 oz. Recommended motors: A3-2, B3-3, B6-4, C6-4.

PQ 1
3-0212
Flare Patriot
$1.50

SIMPLE



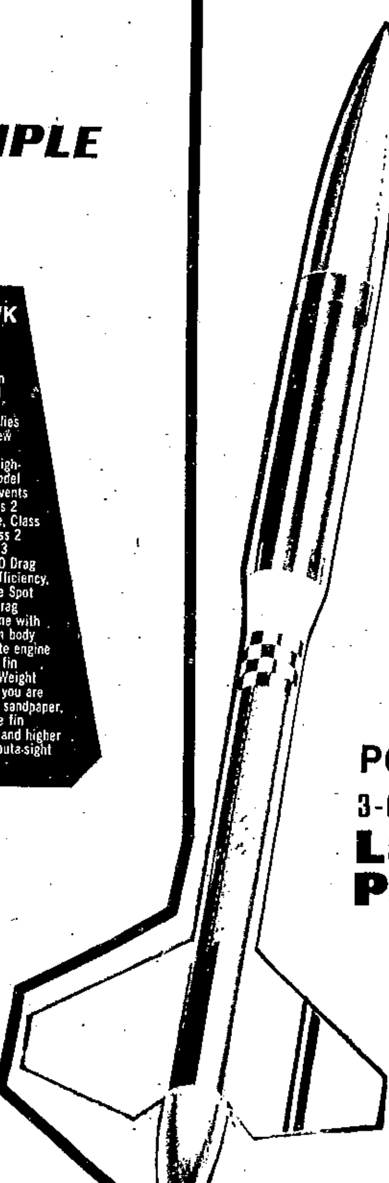
STAR HAWK

Economy
. . . Easy construction (one-piece plastic tail assembly) . . . and PERFORMANCE (it outflies the Pioneer). MPC's New STAR HAWK is both a beginner's bird and a high-performance contest model suitable for such NAR events as Class 1 Altitude, Class 2 Altitude, Class 3 Altitude, Class 1 Streamer Duration, Class 2 Streamer Duration, Class 3 Streamer Duration, Class 0 Drag Efficiency, Class 1 Drag Efficiency, Predicted Altitude, and the Spot Landing events. Uses low-drag 3-caliber parabolic nose cone with smooth finish; 9-inch 20-mm body tube; engine clip to eliminate engine ejection; fluorescent plastic fin assembly for high visibility. Weight without engine: 22 grams. If you are handy with a pattern file and sandpaper, you can further streamline the fin assembly for even lower drag and higher performance. Even so, it's an outa-sight 2000-foot.

Starhawk
$1.00
3-0847
PQ 1

RECOMMENDED ENGINES
A3-2, B3-3, B6-4

POPULAR

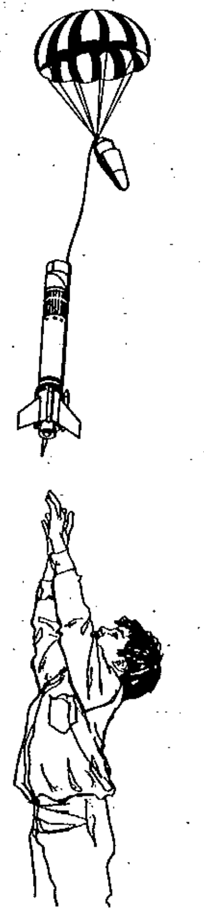


Light weight, hi-acceleration payload lifter. Zero to 3 oz. payload capability in clear compartment 0.945" dia. x 3.15" long. Length: 15". Weight: 0.95 oz. with no payload or motor. Booster dia. 0.788". 14" poly recovery chute. Recommended motors: A3-2 or B3-3 (no payload); B6-2, B6-4, C6-2, or C6-4 with payload.

PQ 1
3-0204
Lambda Payloader
$1.50

CENTURI PRODUCTS FROM AVI

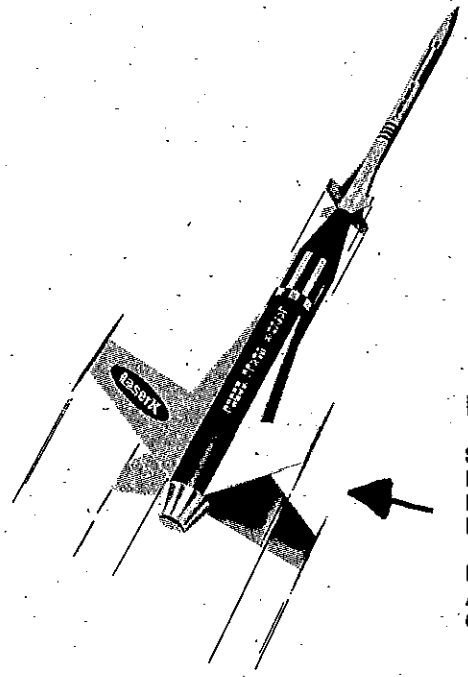
astroport
MINERAL POINT, WI. 53565



We began selling Centuri Model Rockets over the counter in our hobby store back in 1965.

Now, we are proud to offer this fine line to our mail order customers.

AVI Astroport thanks the Centuri Rockets for providing assistance and art work.



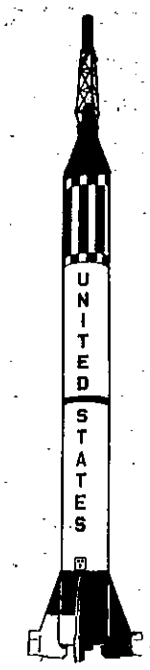
MERCURY REDSTONE

PQ 5

Specifications

Length	29"
Body Diameter	2.04"
Net Weight	3.7 oz.

Recommended Engines
B4-2 C6-3
CEN-5131 $7.00 GF6.50



LASER X

PQ 3

Specifications

Length	21.5"
Body Diameter	1.34"
Net Weight	1.75 oz.

Recommended Engines
A8-3 B14-5 B6-4 C6-5
CEN-5110 $4.50 GF4.25

CENTURI U.S.S. AMERICA™

PQ 3

Specifications

Length	25"
Diameter	1.6"
Fin Span	12"
Net Weight	5.5 oz.

Recommended Engine
C6-3
CEN-5310 $8.00 GF7.50

Engines Not Included With Kit

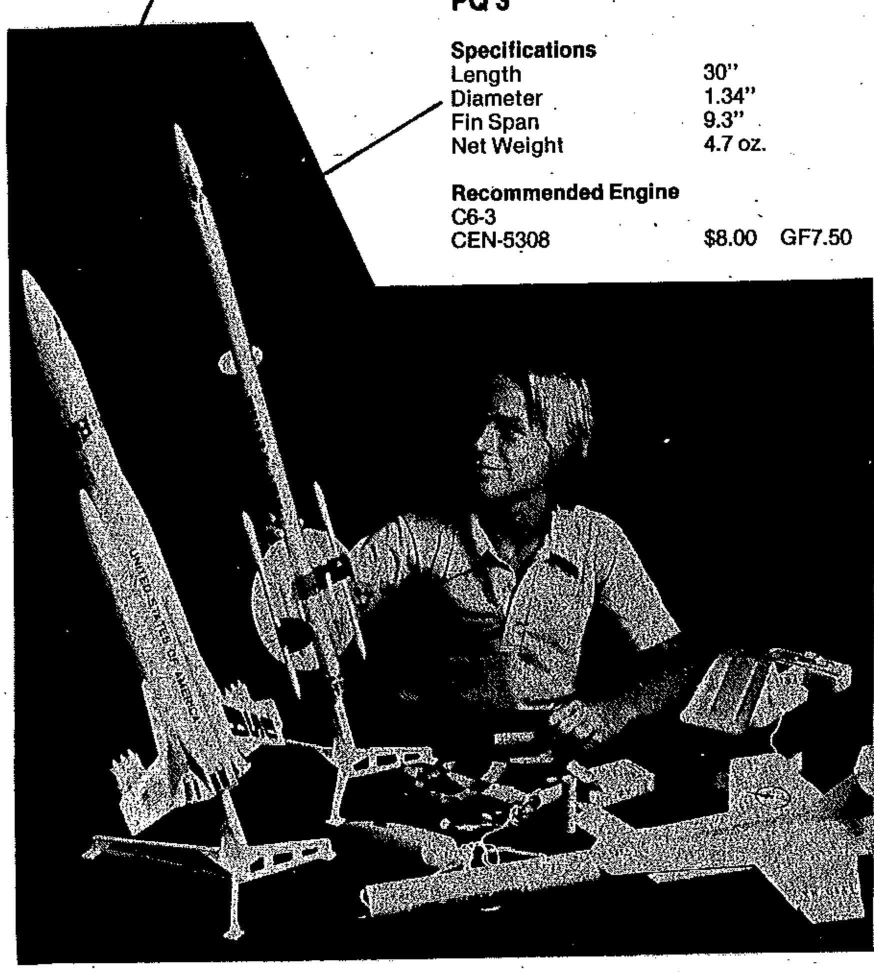
CENTURI U.F.O. INVADER™

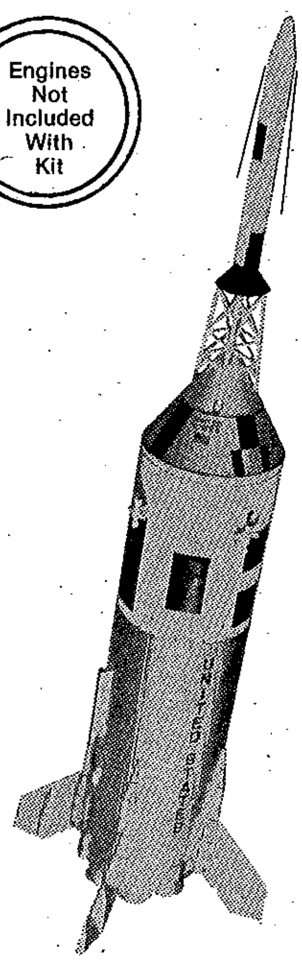
PQ 3

Specifications

Length	30"
Diameter	1.34"
Fin Span	9.3"
Net Weight	4.7 oz.

Recommended Engine
C6-3
CEN-5308 $8.00 GF7.50





LITTLE JOE II

PQ 4

Specifications

Length	23.4"
Body Diameter	3.4"
Net Weight	5.5 oz.

Recommended Engines
3-B4-2's 3-B6-4's 3C6-5's
CEN-5138 $19.00 GF17.50

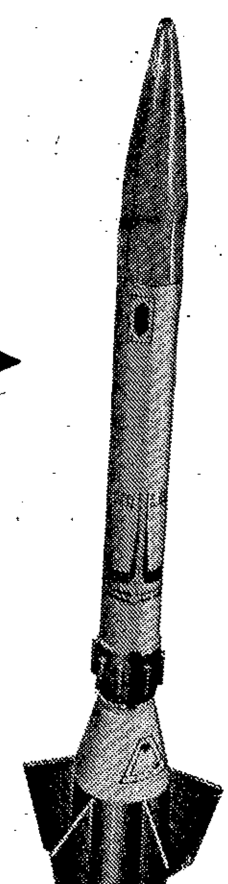
VECTOR V

PQ 3

Specifications

Length	12.5"
Max. Diameter	1.34"
Net Weight	0.9 oz.

Recommended Engines
½A6-2 A8-3 B4-4 B6-4 C6-5
CEN-5032 $2.25 GF2.10



CENTURI E.S.S. RAVEN™

PQ 3

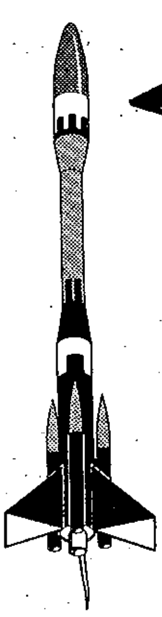
Specifications

Length	30.5"
Diameter	1.6"
Fin Span	10.5"
Net Weight	5.3 oz.

Recommended Engine
C6-3
CEN-5312 $8.00 GF7.50

TAURUS

PQ 3



Specifications

Length	23.3"
Body Diameter	1.34"
Net Weight	2.6 oz.

Recommended Engines
A8-3 B4-4 B6-4 C6-5
CEN-5033 $4.00 GF3.75

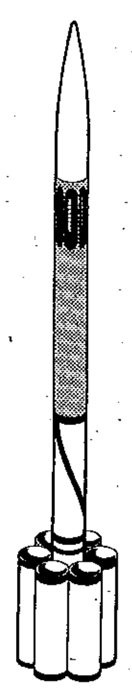
GROOVE TUBE

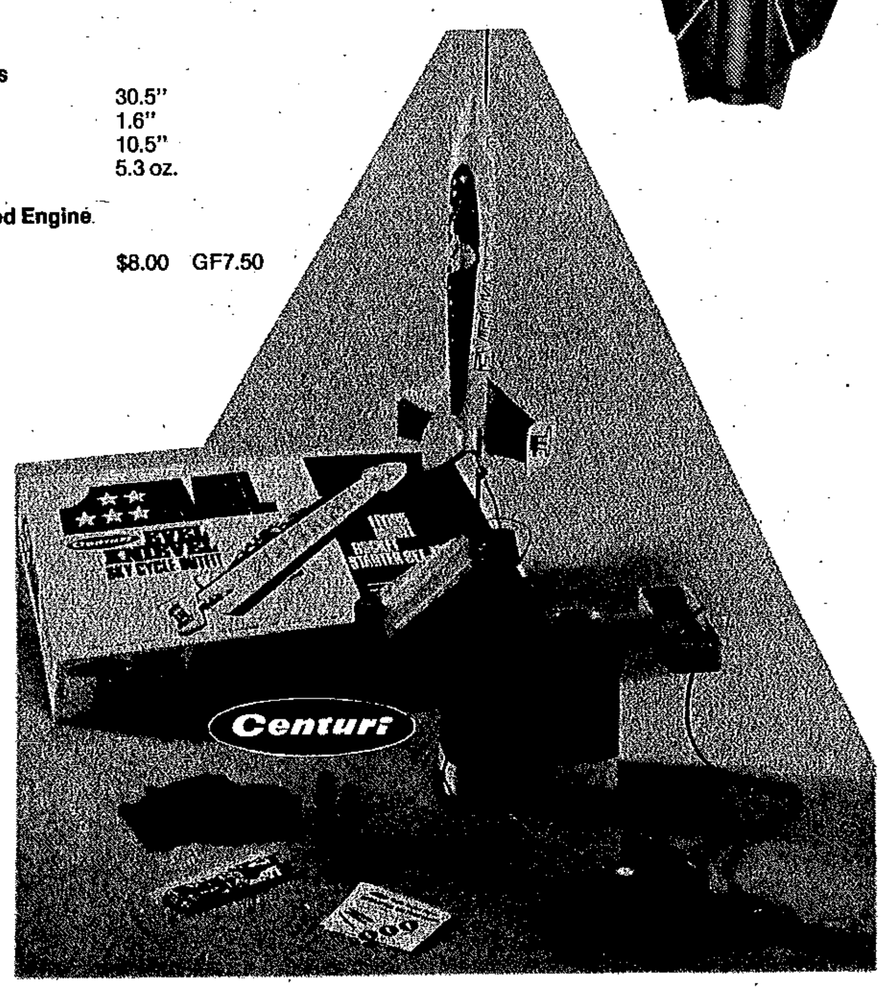
PQ 1

Specifications

Length	18.25"
Body Diameter	0.91"
Net Weight	1.75 oz.

Recommended Engines
A8-3 B4-4 C6-5
CEN-5011 $3.00 GF2.75





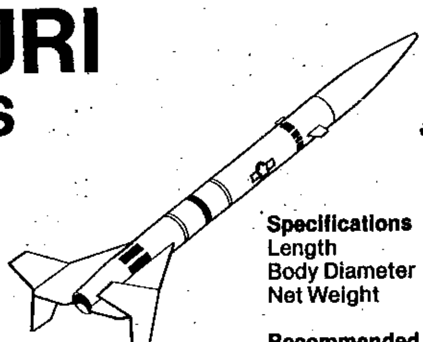
CENTURI EVEL KNIEVEL OUTFIT

Complete Ready-To-Fly Starter Outfit

PQ 1 CEN-5351 $13.00 GF12.00

CENTURI PRODUCTS FROM AVI

astroport
MINERAL POINT, WI. 53565



PQ 2

JAYHAWK

Specifications

Length	12.6"
Body Diameter	0.91"
Net Weight	1 oz.

Recommended Engines
½A6-2 A5-4 B4-6 B6-6 C6-7
CEN-5171 $3.00 GF2.75

CENTURI SPACE 1999
(Awaiting Specifications)
CEN-5316 $8.00 GF7.50

PQ 3

LISTING of CENTURI ITEMS

CENTURI FLYING ROCKET KITS

Kit Number	Description	Length (Inches)	Diameter (Inches)	Launch Weight (Ounces)	Recommended Engines	Standard Price	GF Price	PQ
CEN-5001	Lil' Herc Tumble recovery, balsa fins, plastic nose cone, feather-light and easy to build	6.5	0.76	0.3	½A6-2, ½A6-4	$1.25	$1.15	1
CEN-5002	Twister Spin stabilized, pre-cut balsa fins, plastic nose, parachute, color decals	11.	0.91	0.9	½A6-2, A5-4, B6-6, C6-7	$2.25	$2.05	1
CEN-5003	MX-774 1/37 scale model of America's first supersonic rocket, plastic nose, parachute, boattail fins	11.	0.91	1.1	½A6-2, B6-6, C6-7	$2.25	$2.05	3
CEN-5004	Mach-10 Rocket powered fighter, pre-cut balsa fins, wings and tail, glide recovery, streamer on marker	12.	1.64	1.85	B4-2, C6-3	$3.50	$3.25	4
CEN-5005	Micron Die-cut fins, plastic nose cone, streamer recovery, high flying	8.5	0.76	0.4	½A6-4, A8-5, B6-6, C6-7	$1.75	$1.65	1
CEN-5007	Bandito Streamer recovery, wedge shaped pre-cut fiber fins, decal and chrome trim	15.5	0.76	1.5	½A6-4, B4-6, C6-7	$2.25	$2.10	2
CEN-5008	Excaliber Big! Plastic coupler, nose cone, pre-cut fiber fins, chrome and decals, parachute	26.5	0.91	1.60	A8-3, B4-4, C6-5	$3.00	$2.80	1
CEN-5010	Vulcan Exotic, pre-colored parts, parachute, maximum span is 5.5 inches, unique shape	10.5	...	1.2	B4-2, C6-3	$2.25	$2.10	3
CEN-5011	Groove Tube No 'fins'? Plastic nose, custom decals, chrome trim, unusual	18.25	0.91	1.75	A8-3, B4-4, C6-5	$3.00	$2.75	1
CEN-5012	X-24 Bug Build to glide back to earth. Pre-painted paper construction, wingspan is 7 inches.	7.	...	1.	B4-2, C6-3, C6-0	$1.75	$1.60	3
CEN-5031	Stilleto Two stage with dual streamer recovery on upper stage, tumble first, pre-cut balsa fins	18.25	0.76	1.1	A8-0 + ½A6-4, B6-0 + B6-6	$3.00	$2.75	3
CEN-5032	Vector V Build choice of 12 ways, fiber fins, plastic nose cone, exotic decal, parachute	12.5	1.34 Max.	0.9	½A6-2, A8-3, B6-4, C6-5	$2.25	$2.10	3
CEN-5033	Taurus Planetary space cruiser, plastic body couplings and nose cone, pre-cut balsa fins, decals, parachute	23.3	1.34	2.6	A8-3, B6-4, C6-5	$4.00	$3.75	3
CEN-5034	Skylab Not a scale kit but many features similar to Skylab, molded parts, chrome solar panels, large decal.	24.5	2.04	3.4	B4-2, C6-3	$7.00	$6.50	4
CEN-5035	Nomad Naval missile styling, pre-cut fiber fins, decals, parachute, two color decal sheet, chrome bands	18.0	1.0	1.75	A8-3, B4-4, B6-4, C6-5	$4.00	$3.75	3
CEN-5036	Black Widow Two-stage, plastic nose cone, chute for upper stage, lower stage glides back on large fins, decals	15.0	0.76	1.2	A8-0 + A8-5, B6-0 + B4-6	$3.50	$3.25	5
CEN-5037	Arrow-300 Three stages, 12 pre-cut fiber fins, payload section, decal and parachute, ACTION . . .	37.7	0.91	2.5	B6-0 + A8-0 + ½A6-4	$5.00	$4.60	4
CEN-5039	Argus Plastic tail section, nose cone, coupler, colors built in, dual parachute recovery — Quick!	28.5	1.34	3.0	A8-3, B6-4, C6-5	$5.00	$4.60	2
CEN-5040	Sky Devil Build one of 8 ways, balsa fin sheet, plastic nose cone, colorful parachute . . .	12 to 14	0.76	0.8	½A6-4, A8-5, B6-6, C6-7	$1.75	$1.60	2
CEN-5041	Moonraker Separates into two parts for gyro-tumble recovery, reversible fin, 'cute'	5.5	0.76	0.3	½A6-4, A8-5	$1.25	$1.15	1
CEN-5043	Snip Hunter Plastic nose and coupler, clear 0.91 inch diameter payload department, decals and parachute	12.5	0.76	0.91	½A6-2, A8-5, B6-6, C6-7	$3.00	$2.75	2
CEN-5047	Astro-1 Pre-cut balsa fins, plastic nose cone, decals and colorful parachute, large diameter, beginners kit	16.	1.04	1.1	½A6-2, A8-3, B6-4, C6-5	$3.00	$2.75	1
CEN-5062	Centurion Big for slow lift-off demo bird, colored plastic nose, decal and large parachute . . .	24.	1.64	2.3	B4-2, C6-5	$5.00	$4.50	2
CEN-5064	Long Tom Three feet tall, colored plastic reducer and nose cone, decals and large parachute, two stages	35.5	1.34	3.	A8-0 + B4-4, B6-0 + B6-6	$5.00	$4.50	4

CENTURI FLYING ROCKET KITS

Kit Number	Description	Length (Inches)	Diameter (Inches)	Launch Weight (Ounces)	Recommended Engines	Standard Price	GF Price	PQ
CEN-5066	Space Shuttle Booster and shuttle loft together, separation and engine pod returns on streamer as two elements glide.	15.	1.64	3.05	C6-3 only	$6.00	$5.50	5
CEN-5068	Orion Great plastic detailing, corrugated body wrappers, pre-cut balsa fins, large decals, large color chute	22.5	2.04	4.5	B4-2, C6-3	$7.00	$6.50	4
CEN-5072	Starfire Two parachutes, pre-cut balsa fins, plastic nose cone, special decals . . . contest winner . . .	16.	0.91	1.	½A6-2, B6-6, C6-7	$3.00	$2.75	2
CEN-5077	SST Shuttle Swept wing glider separates to glide back, main ship returns by parachute, decals, detailed plastic and balsa	22.5	1.04	2.8	B4-2, C6-3	$6.00	$5.50	5
CEN-5080	Payloader II Clear payload section, pre-cut balsa fins, parachute, plastic nose, decals . . . flying test lab.	18.5	1.0	1.2	A8-3, B6-4, C6-5	$3.50	$3.25	2
CEN-5091	Javelin Plastic nose cone, pre-cut balsa fins, decal and parachute, square cut fins	12.5	0.76.	0.6	½A6-4, A8-5, B6-6, C6-7	$2.25	$2.10	1
CEN-5110	Laser X SHARP! Pre-cut balsa fins, parachute and extra-large decal . . . Futuristic space probe	21.5	1.34	1.75	A8-3, B6-4, C6-5	$4.50	$4.25	3
CEN-5131	Mercury Redstone Scale 1/36 replica of Alan Sheppard's Freedom 7, pre-formed plastic parts, balsa fins, extra large decal sheet, both escape tower and booster return on separate parachutes. NICE!	29.	2.04	3.7	B4-2, C6-3	$7.00	$6.50	5
CEN-5138	Little Joe Scale 1/45, printed chrome mylar corrugated wrap, 3-engine cluster performance, press-on roll pattern, dual-chute recovery, historical brochure, pre-cut balsa fins, molded parts, die-cut stimulated nozzles, more!	23.4	3.4	5.5	3B-4-2, 3B6-4, 3C6-5	$19.00	$17.50	5
CEN-5140	Saturn 1B 1/100 scale, two engine cluster that recovers on two separate parachutes, premolded plastic parts, large decal sheet with detailed instructions, also historical brochure. OUTSTANDING!	26.8	2.62	4.4	2B6-4, 2C6-5	$15.00	$13.75	5
CEN-5142	Saturn V 1/100 scale, model of ship that took man to the moon, scaled from NASA blueprints, many molded parts, clear plastic stabilizing fins, main body returns on twin 24 inch chutes, tower on single 20 inch chute, decals and complete instructions. CHALLENGING!	43.6	3.96	9.2	3C6-3 only	$25.00	$23.00	5
CEN-5145	Nike Smoke 1/10 scale, molded nose cone, authentic decal sheet, pre-cut balsa fins	23.7	1.64	2.3	B4-2, C6-5	$4.50	$4.25	2
CEN-5171	Jayhawk Looks like a naval target drone, 3-color decal, pre-cut fiber fins, plastic nose cone, parachute	12.6	0.91	1.0	½A6-2, B6-6, C6-7	$3.00	$2.75	2
CEN-5173	Screaming Eagle Glue is all you need! Pre-formed parts, plastic fin unit, nose cone, shiny chrome multi-color wrap, parachute	16.4	0.91	1.6	A8-3, B6-6, C6-7	$3.00	$2.75	1
CEN-5174	Scram-Jet Off center pre-cut balsa fins, plastic nose cone, parachute recovery, super decal	18.8	0.76	1.3	½A6-4, A8-5, B6-6, C6-7	$3.00	$2.75	3
CEN-5175	Excalibur II Molded plastic nose cone, body reducer, colorful decals, chrome trim and parachute recovery on upper stage	29.5	0.91	2.1	A8-0 + A8-5, C6-0 + C6-7	$3.50	$3.25	3
CEN-5301	Two Bitz Two kits in a single package, pre-printed construction materials, tumble recovery	4.5	0.54	0.2	¼A4-2M, ½A4-3M, A4-4M	$1.00	$0.90	2
CEN-5302	Satellite 62SL Gyro-spin recovery, chrome trim, plastic nose cone, long 'antenna' fins . . .	8.0	0.54	0.2	¼A4-4M, ½A4-5M, A4-6M	$1.25	$1.15	1
CEN-5303	Star Trooper Rear-ejection of streamer, plastic nose cone, pre-cut balsa fins, alternate long version, decals . . .	5.6	0.54	0.3	¼A4-4M, ½A4-5M, A4-6M	$1.50	$1.40	2
CEN-5304	NOVA Fly with either a nose ejected parachute or a tail ejected streamer, pre-cut balsa fins, long balsa nose.	12.4	0.76	0.6	¼A4-2M, A4-4M, ½A4-3M	$2.25	$2.10	3
CEN-5305	Fireflash Semi-scale of British missile, 12-inch parachute, plastic nose cone and pre-cut fiber fins, silver and black decal	11.5	0.54	1.2	½A4-3M, A4-4M	$3.00	$2.80	5
CEN-5306	Mini-Dactyl Fly with one or two gliders, balsa parts and nose cone, used in contests in single glider configuration.	15.0	0.54	...	½A4-3M, see instructions	$3.50	$3.25	4
CEN-5308	UFO Invader Alien vehicle, dual parachute recovery, big color decal, display stand, pre-shaped fins, molded nose cones and cockpits, other features . . . NEW, 9.3 inch fin span	30.	1.34	4.7	C6-3 only	$8.00	$7.50	3
CEN-5310	USS America Realistic wing pods, display rack, dual chutes, 6" x 12" decal sheet, 12" fin span. SHARP! NEW!	25.	1.6	5.5	C6-3 only	$8.00	$7.50	3
CEN-5312	USS Raven Large decal, dual parachutes, molded parts and pre-cut fins, large and WAY OUT! NEW and SPECIAL!	30.5	1.6	5.3	C6-3 only	$8.00	$7.50	3
CEN-5350	EVEL Knievel Sky Cycle Kit, red, white and gold large decal sheet, pre-colored parts, molded nose, parachute	10.5	1.34	1.5	½A4-3M, A4-4M	$3.50	$3.25	1
CEN-5316	Space 1999 Eagle Transporter					$8.00	$7.50	3

CENTURI STANDARD 18x70 ROCKET ENGINES

Prod. Number	Type	Prices 3 for	Total Impulse N-sec.	Average Thrust Newtons	Thrust Duration seconds	Delay Time 15% seconds	Engine Weight ounces	Recom. Max. lift-off wt. (with engines) (ounces)
SINGLE-STAGE ENGINES (GREEN LABEL)								
CEN-5550	½A6-2	$1.30	1.25	6.23	.20	2	.53	2.5
CEN-5560	A8-3	$1.40	2.50	7.81	.32	3	.57	4.0
CEN-5564	B4-2	$1.50	5.00	4.15	1.20	2	.70	4.5
CEN-5566	B4-4	$1.50	5.00	4.15	1.20	4	.74	4.0
CEN-5572	B6-4	$1.50	5.00	6.00	.83	4	.78	5.0
CEN-5578	B14-5	$1.70	5.00	14.23	.35	5	.69	6.0
CEN-5584	C6-3	$1.70	10.00	5.86	1.70	3	.88	5.0
CEN-5586	C6-5	$1.70	10.00	5.86	1.70	5	.91	4.5
SINGLE-STAGE ENGINES FOR LIGHTWEIGHT ROCKETS (PURPLE LABEL)								
CEN-5552	½A6-4	$1.30	1.25	6.23	.20	4	.54	1.0
CEN-5562	A8-5	$1.40	2.50	7.81	.32	5	.62	2.0
CEN-5568	B4-6	$1.50	5.00	4.15	1.20	6	.78	2.0
CEN-5574	B6-6	$1.50	5.00	6.00	.83	6	.71	3.0
CEN-5580	B14-7	$1.70	5.00	14.23	.35	7	.73	3.5
CEN-5588	C6-7	$1.70	10.00	5.86	1.70	7	.95	3.0
BOOSTER ENGINES (RED LABEL)								
CEN-5558	A8-0	$1.40	2.50	7.81	.32	0	.51	4.0
CEN-5570	B6-0	$1.50	5.00	6.00	.83	0	.58	5.0
CEN-5576	B14-0	$1.70	5.00	14.23	.35	0	.68	6.0
CEN-5582	C6-0	$1.70	10.00	5.86	1.70	0	.80	5.0

CENTURI MINI 13x45 ROCKET ENGINES

Prod. Number	Type	Prices 4 for	Total Impulse N-sec.	Average Thrust Newtons	Thrust Duration seconds	Delay Time 15% seconds	Engine Weight ounces	Recom. Max. lift-off wt. (with engines) ounces
SINGLE-STAGE MINI-MOTORS (GREEN LABEL)								
CEN-5500	¼A4-2M	$1.40	.63	3.6	.16	2	.22	1.5
CEN-5502	½A4-3M	$1.50	1.25	3.6	.31	3	.25	2.0
CEN-5506	A4-2M	$1.60	2.50	3.6	.63	2	.29	3.0
CEN-5510	A4-4M	$1.60	2.50	3.6	.63	4	.30	2.5
SINGLE-STAGE MINI-MOTORS FOR LIGHTWEIGHT ROCKETS (PURPLE LABEL)								
CEN-5502	¼A4-4M	$1.40	.63	3.6	.16	4	.23	1.0
CEN-5506	½A4-5M	$1.50	1.25	3.6	.31	5	.26	1.5
CEN-5512	A4-6M	$1.60	2.50	3.6	.63	6	.31	2.0

CENTURI ROCKETRY STARTER SETS

CEN-5351	Centuri Evel Knievel Outfit - Starter Set	$13.00	$12.00	1
CEN-5404	Centuri Eagle Power Starter Set	$10.00	$9.50	1
CEN-5406	Centuri Big Shot Starter Set	$15.00	$14.00	1
CEN-5314	Centuri SPACE 1999 Starter Set	...	...	1

CENTURI ACCESSORIES

CEN-5609	Powr-Pad/Tiller Complete Launch System	$9.00	$8.50	1
CEN-5601	Power Tower Tripod Launch Stand Only	$5.00	$4.75	1
CEN-5623	Powr-Control Launch Controller	$6.00	$5.50	1
CEN-6500	Rocket Rack Display Stand	$1.25	$1.15	2

Many other Centuri parts are available direct from AVI Astroport. Order by the number you have and give complete description of the parts. Use 1976 prices only. We are listing with minimal description.

PREVIEW of KITS

CONTACT with EXTRATERRESTRIAL CULTURES

The time is near for intense searching for alien cultures in the Galaxy.

There have already been government sponsored programs by both the United States and the Soviet Union to listen in on signals that might be coming from other beings associated with particular stars that lie near us in our arm of the Milky Way.

Some people believe that certain cultures have already made contact and are studying us. They may be doing that right now, and they have begun their investigations millions of years ago or thousands of years ago as the Ancient Astronaut theory followers believe.

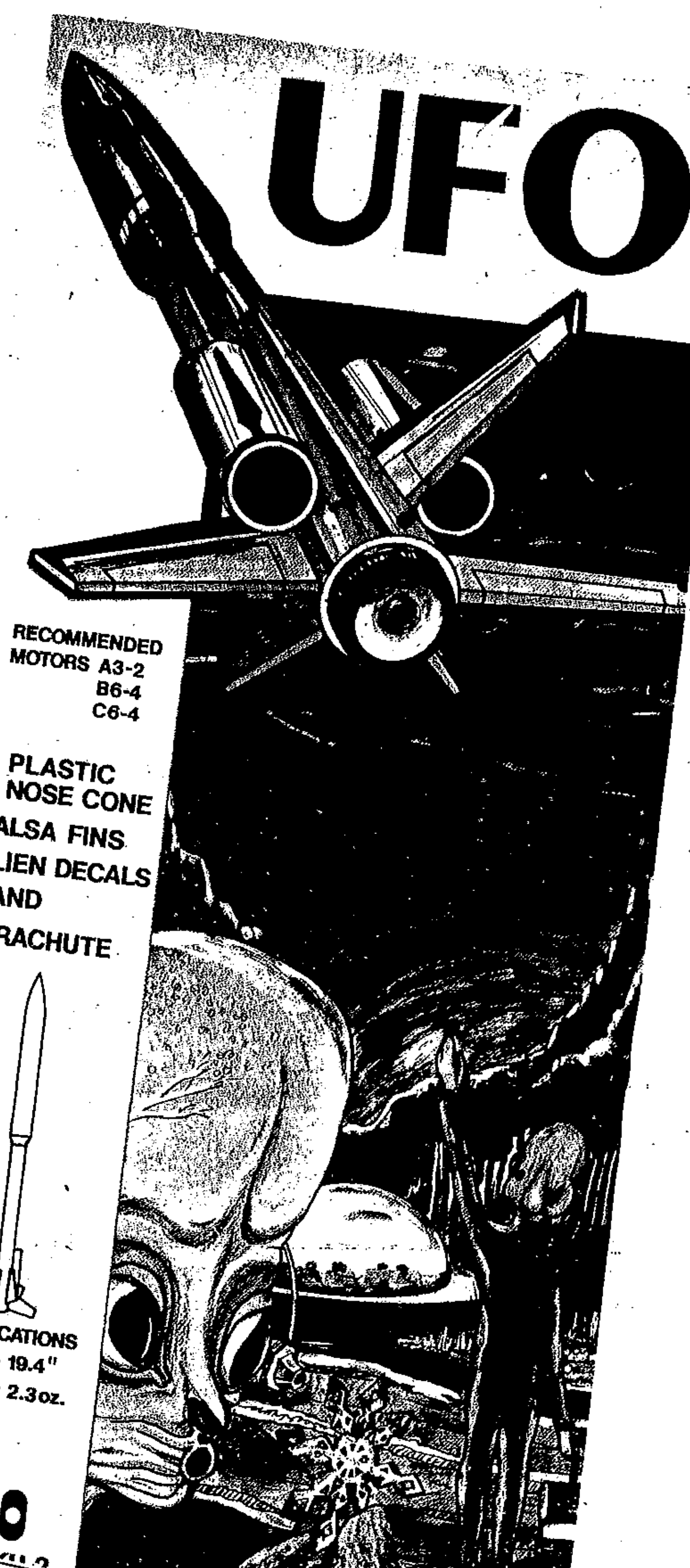
In any case AVI Astroport has created four cultures from other star systems in a manner consistant with our current understanding of the physical universe. These four cultures come from widely varying environments and each has a story of its own. A portion of that story is included in each kit.

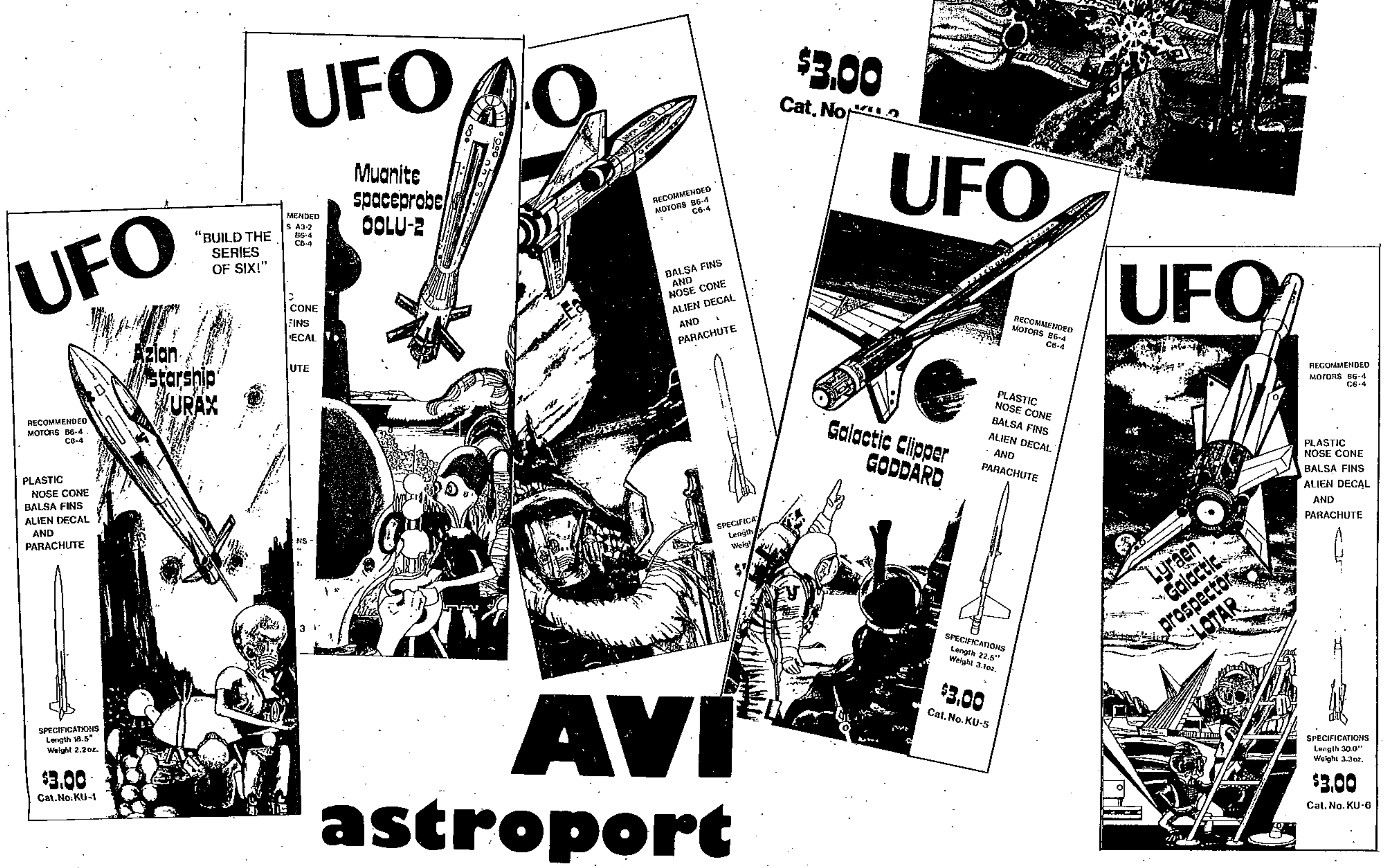
The rockets themselves are unusual designs engineered to make use of the Earth's atmosphere for stability.

THESE KITS ARE NOT AVAILABLE NOW

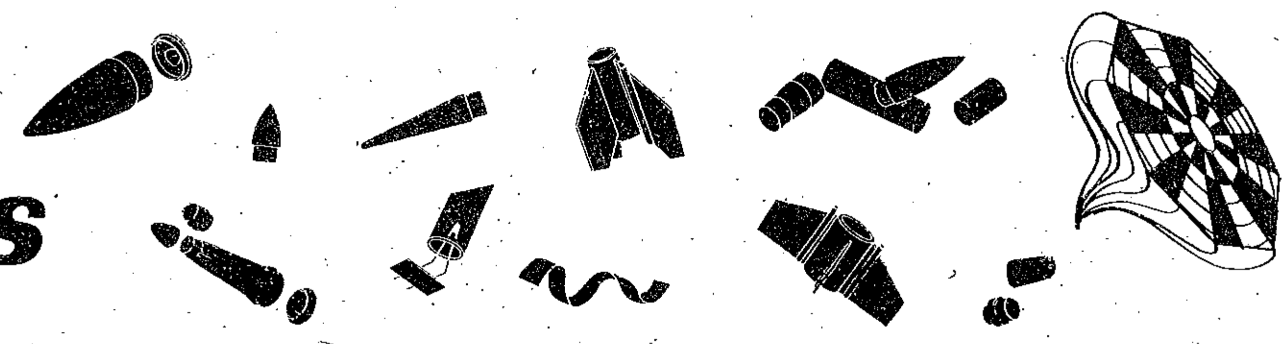
THIS IS A PREVIEW FOR YOUR CONSIDERATION AND COMMENT

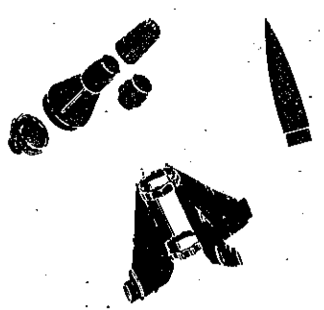
Each model rocket kits will contain special UFO decal sheets, the story of the culture (plausible science fiction), and all the parts necessary to construct an unearthly model.





BULK PARTS



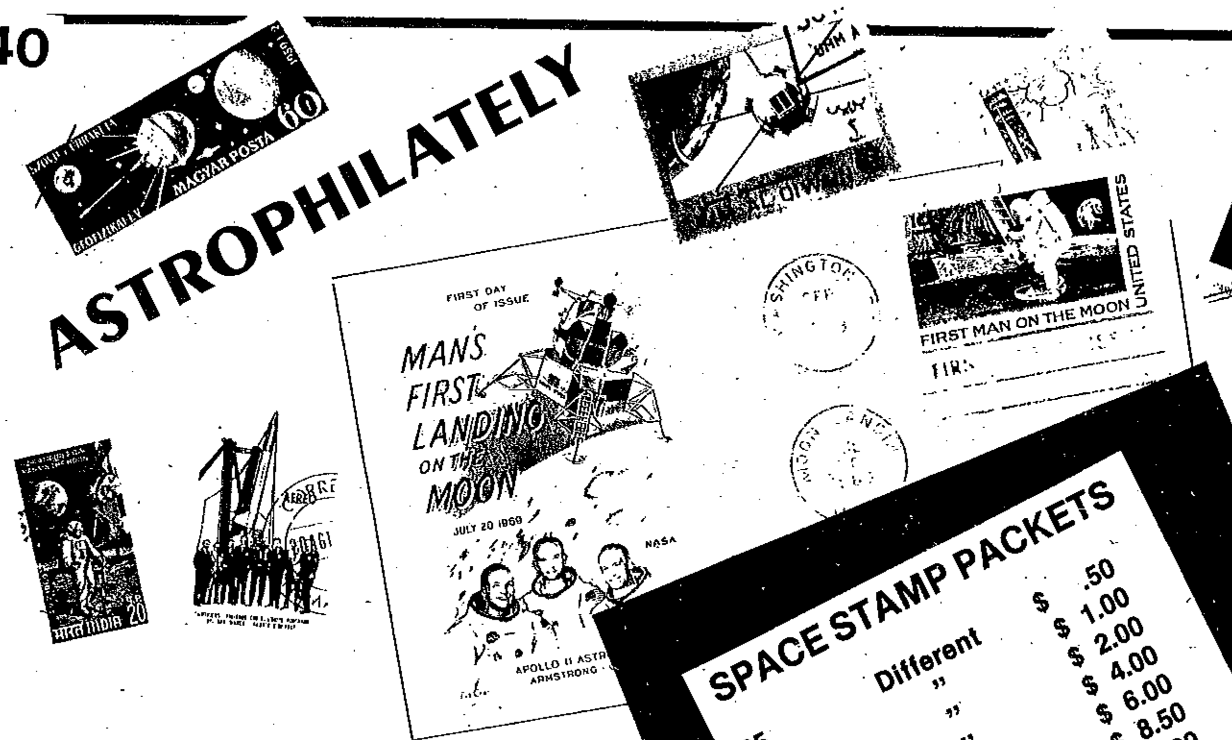


AVI ASTROPORT Offers Parts, Components and Accessories in Bulk Packs. Rocketeers, Clubs & Schools Receive the Same LOW PRICES.

bp 1	**Decals** An assortment of decals from our kits. More than one of a type. Five or more varieties. Four color, two color and single color.	20 for $2.00 100 for $8.50
bp 2	**Plans** An assortment of plans taken from our regular kit line. All kits use the exclusive Metrix parts. At least 7 different types in a given assortment.	10 for $1.25 100 for $10.00
bp 3	**Body Tubing** An assortment of T15, T20, T25, T30 and T35 tubing with none under 6 inches in length. This is an unbelievable bargain. Compare with others.	20 for $2.00 100 for $8.50
bp 4	**Balsa Blocks** Scrap ends from our nose cone production.	Fifteen Pieces for only $1.00
bp 5	**Rocket Fin Sets** An assortment of Balsa and Plastic fins at least 5 different types. An astounding buy.	10 for $2.50 100 for $20.00
bp 6	**Nose Cones** A variety to fit several sizes of tubing. A mixture of plastic and balsa types. At least 5 different types.	10 for $2.50 100 for $20.00
bp 7	**Adapters, Nose Blocks** Assorted to couple several size tubes. At least 5 different types in each assortment. Plastic and Balsa.	10 for $2.50 100 for $20.00
bp 8	**Engine Clips** Special metal clips to hold engines in engine compartment during ejection charge activation. Superior to others on the market. For standard size engines.	25 for $2.50 100 for $9.00
bp 9	**Engine Blocks** An assortment for both standard size and minijet engines to thrust against.	30 for $1.25 100 for $3.25
bp 10	**Launch Lugs** Lugs to be glued to the side of body tube to fit over 1/8" diameter launch rod. Two lengths in each assortment.	30 for $1.25 100 for $3.25
bp 11	**Shock Cord Mounts** A design introduced to the hobby by AVI-MPC. They must be glued into place to hold shock cord securely.	40 for $1.50 200 for $6.50
bp 12	**Parachute Sheets** Both 10" and 14" two color printed parachute sheets in ultra-thin polyethylene. No strings or tape discs.	20 for $1.75 100 for $7.50
bp 13	**Balsa Sheets** 3/32"x3"x12" sheets of high quality balsa wood especially for use in model rockets. All sheet lengths are approximate. Use for fins and details.	6 for $1.25 100 for $20.00
bp 14	**Launch Rods** Two piece collapsible launch rod. Lower half is 1/8" diameter, upper section is 1/16" to prevent hang-up at junction point when in use. Overall length is 36 inches.	5 for $2.25 100 for $40.00
bp 15	**Screw Eyes** Many applications. Use to attach parachute or other recovery devices to balsa nose cones, etc. You may receive a single size or an assortment of sizes.	25 for $1.25 100 for $4.00
bp 16	**Shroud Tabs** Use with parachute sheets to attach shroud lines. Strong with permanent adhesive and low in weight. Six or eight strips per sheet, you may receive all of one type or some of both.	25 for $1.50 250 for $12.00
bp 17	**Lead Weights** Small lead discs with central punch hole. Sub T19 size to use in trimming most standard rockets. An order may contain more than one size.	15 for $1.50 100 for $9.00
bp 18	**Steel Blast Plates** Five inches in diameter. Steel plate to protect your launch platform from hot rocket engine exhaust.	4 for $1.00 100 for $22.00
bp 19	**Micro Clips** The smallest clips for attaching power source through the hand controller to the rocket engine igniter. Compare price and buy in bulk.	10 for $1.50 100 for $13.50
bp 20	**Launch Cord** Roughly 18 foot lengths of multi-strand two conductor wire that is used to carry power from controller to the launch pad. Check this price. Many other applications.	3 for $2.25 100 for $65.00
bp 21	**Ceramic Deflectors** A prize winning parabolic cross-section design cast in ceramic heat treated to provide a unique non-conductive blast deflector for your launch pads. This item should set upon the steel blast plate in BP-18.	5 for $3.50 100 for $60.00
bp 22	**Alligator Clips** Attach your power source to your firing system using two of these heavy duty clips. Larger than micro-clips but not as large as terminal clamps.	10 for $2.00 100 for $18.00
bp 23	**Motor Tubes** Standard size 2.75" x 0.700" diameter. The same tubing that is used in our motor manufacturing. Many uses but not intended for loading with propellants.	15 for $1.20 100 for $6.00
bp 24	**Motor Tubes** Minijet type, 2.25" x 0.500" diameter. The same quality that is used in our regular motor production. Do not attempt to load these with hazardous materials. Many other uses.	20 for $1.25 100 for $5.00
bp 25	**Streamers** 18 inch lengths. It is best to use several on any contest models. Bright orange ultrathin poly material.	25 for $1.00 200 for $6.00
bp 26	**Igniters** The original formed igniter. Nichrocrome ignition wire formed into a small hair-pin shape with a coating of pyrogen on the tip.	40 for $1.25 400 for $10.00
bp 27	**Shock Cord** Fabric covered shock cord material. Superior quality with flame resistance. Approximately 24" lengths.	20 for $1.30 100 for $5.00
bp 30	**Centering Rings** More than one type of centering ring for use in mounting motors or centering tubing in other tubing. More than one size. These are not complete motor mount kits.	30 for $1.20 300 for $10.00

***NOTE:* Assortments may vary in content, each may be different.**

ASTROPHILATELY



SPACE STAMP PACKETS

25	Different	$ .50
50	"	$ 1.00
100	"	$ 2.00
200	"	$ 4.00
300	"	$ 6.00
400	"	$ 8.50
500	"	$14.00
600	"	$20.00

APOLLO ISSUES (Complete Sets Only)

100	Stamps	$ 6.00
200	"	$15.00
300	"	$25.00
350	"	$35.00

AVI astroport
MINERAL POINT, WI. 53565

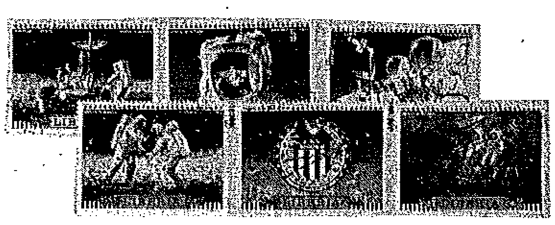
Space Art in Miniature. Thousands of varieties of stamps have been issued by countries around the world. Often the artwork on the stamps reflects the art of the particular culture where the stamp was issued.

Many countries issue stamps as a revenue producing product, therefore, many small and unusual countries produce the greatest variety of stamps. In any case they do get the job done of commemorating many flights and advances in Space Technology that are ignored by our own country.

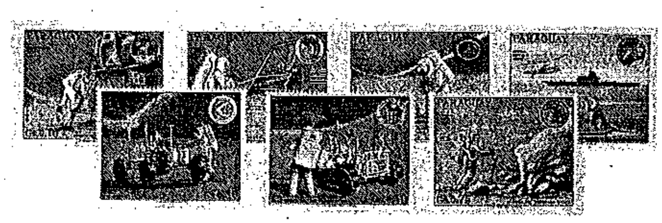
All Stamps are GUARANTEED GENUINE, a few are mint, many are cancelled to order by the issuing country. We refuse to promote them as having any investment potential. AVI Astroport does feel that they are interesting as small pieces of space art and commemoratives.

The items offered at this time are assortments that may or may not contain stamps illustrated above. No first day covers included.

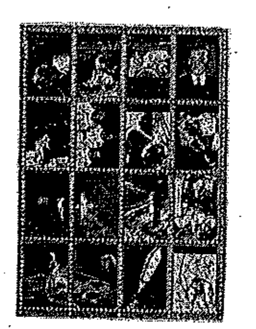
SETS



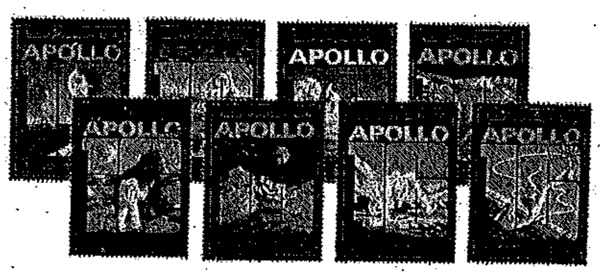
#ASP-L01 Liberia Apollo 16 Mission 6 Val CTO $0.55



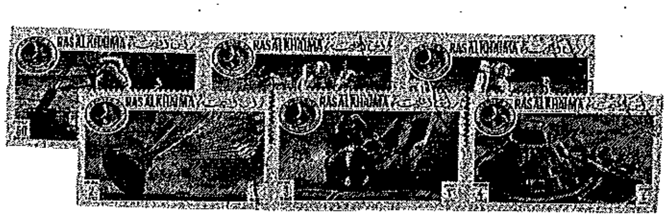
#ASP-P01 Paraguay Apollo Missions 7 Val Mint $1.00



#ASP-A02 Ajman Miniature Sheet 16 Val CTO $0.30

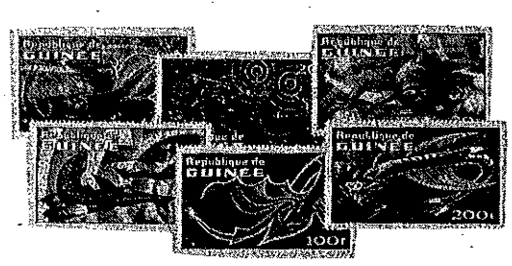


#ASP-A01 Ajman Apollo 8 Val CTO $2.00

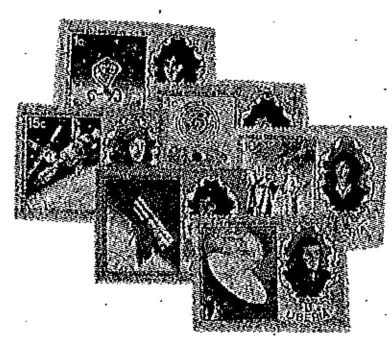


#ASP-R01 RasAlKhaima Apollo 14 6 Val CTO $0.55

#ASP-L02 Liberia Apollo 14 Mission 6 Val CTO $0.60

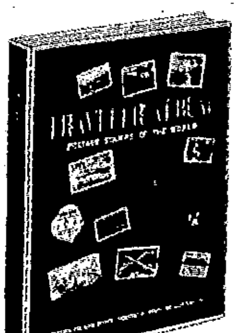


#ASP-G01 Guinee Space Creatures 6 Val CTO $0.60



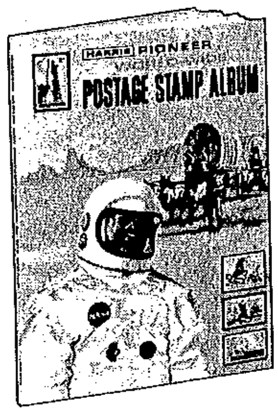
#ASP-L03 Liberia Copernicus 6 Val CTO $0.60

TRAVELER ALBUM



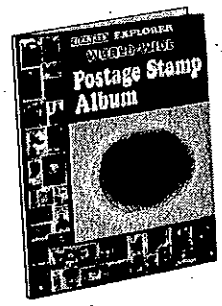
Specially prepared to help the beginner collector to start and to continue properly and enjoyably in the stamp hobby. Spaces for nearly 12,000 stamps; thousands of clear identifying illustrations. Five-color, hard cover binder; durable, expandable, soil-resistant, loose-leaf.
Cat. No. HAR-0105 Each $4.95 GF4.50

THE NEW "PIONEER" ALBUM

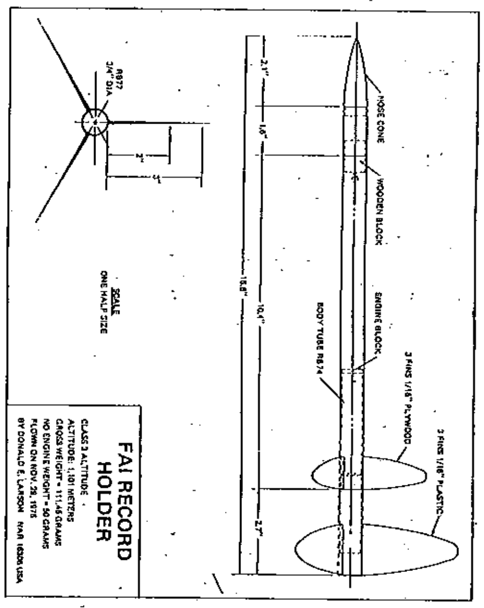


An outstanding value for the young beginner. Spaces for nearly 7,000 stamps of the world. Cover lacquered to prevent soiling.
Cat. No. HAR-X02 Each $1.95 GF1.75

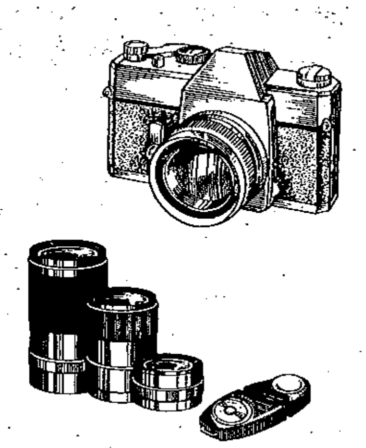
THE NEW "EXPLORER" ALBUM



Big bargain for the small-fry. Contains 128 pages, an abundance of illustrations.
Cat. No. HAR-X01 Each $1.00 GF0.90



CONTESTS



Many rocketeers have requested that we have contests that they can enter. Here are two for your consideration, we hope that you enter each one often. Each contest is run on the basis of the calendar month and **one winner** will be chosen each month **for each category.** The prize will be a $50 merchandise certificate. In both cases. Enter each contest as many times each month as you like.

ROCKET DESIGN

Rules:

1. Designs may be of complete model rockets, launch systems, unique components or the like.
2. Employees of model rocket manufacturing firms may not enter. AVI Astroport employees and members of their immediate families may not enter.
3. Design entries will be judged on originality, operability, thoroughness, neatness and clarity.
4. A parts list must be included and a description of features that must be specially fabricated.
5. The design should be drawn on an 8½x11 piece of paper or larger if necessary. Indicate special paint job required and/or decal design.
6. All entries become the property of AVI Astroport and cannot be returned.
7. Winners will be notified during the month following the contest month.
8. Be sure to include your name and address on each piece of paper that is part of your entry.

ROCKET PHOTO

Rules:

1. Any photo of a model rocket or model rocketry activity may be entered.
2. Employees of model rocket manufacturing firms may not enter. AVI Astroport employees and members of their immediate families are not eligible.
3. Photographs will be judged on the uniqueness of the subject matter, quality of the print and the caption included. The caption should describe fully what, when, who and how of the subject matter.
4. Any size photo will be accepted. Do not send negatives or slides.
5. Entry may be a black and white or color print.
6. All entries become the property of AVI Astroport and cannot be returned.
7. Winners will be notified by mail during the month following the contest month.
8. Be sure and include your name and address on the reverse of the photo. Press lightly when writing on the reverse so as not to damage your entry. Your name and address should also be on the sheet containing the caption.

1976 Calendar

JANUARY

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

FEBRUARY

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29						

MARCH

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MAY

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30	31					

JUNE

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SEPTEMBER

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1976

APRIL

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JULY

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AUGUST

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OCTOBER

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31						

NOVEMBER

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28	29	30				

DECEMBER

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12	13	14	15	16	17	18
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26	27	28	29	30	31	

CALENDAR

This space will contain information on club meeting dates, conferences, contests and other events of interest to model rocketeers. Please send information concerning the activity to AVI Astroport Calendar, Mineral Point, WI 53565. Because this catalog is printed on a quarterly basis we cannot guarantee that your event will be listed, as it may be over before the next issue comes out.

March 12, 13, 14 —Pittsburgh, Pennsylvania. Name: Eleventh annual Pittsburg Spring Convention. Host: Steel City Section (#157). An intense model rocketry experience for all model rocketeers, no matter what age or level of technical competence, involving films, discussion groups, talks, manufacturer demos, the second annual song contest, friends, and fun. (And, if our Pittsburgh weather is atypical this year, we'll hold a launch.) For more information, contest rules, etc. contact: Pittsburg Spring Convention, c/o E.C. Sadowski, 1824 Wharton St., Pittsburg, Pennsylvania 15203.

April 3, 4 — Burlington, Wisconsin; (Open Contest). Host: Kenosha's Aerospace Team. Events held at Bong Recreational Base, Burlington. Contact: Tim Vaccaro, C.D., 2219 — 17th Avenue, Kenosha, Wisconsin 53140.

April 16, 1976 — Elizabeth City, North Carolina. Rocket contest. Host: The Dominion. Contact: Chris Johnson, Route 3, Box 748, Elizabeth City, North Carolina 27909.

April, 1976 — Columbus, Ohio. Name: KROC '76 (King Richard Open Contest). Host: CSAR 113.

May 1, 2, 1976 — Burlington, Wisconsin.

May, 1976 — Nashville, Tennessee. Name: Music City Competitors Annual Regional-2 (MCCAR-2). Host: Music City Competitors. #345. Contact: Andy Katz, 401 Wayside, Nashville, TN 37205. Telephone (615) 352-8533.

May or June, 1976 — Oconomowoc, Wisconsin. Name: WORM IV. Host: OMRS No. 294. Contact: Tom Gressman, 328 S. Main St., Oconomowoc, Wisconsin 53066.

May or June, 1976 — Ft. Lauderdale, Florida. Name: Southland Modroc Conference Competition 3. Host: Broward County Model Rocketry Association No. 217.

June 5, 6, 1976 — Burlington, Wisconsin.

June, 1976 — Batavia, Illinois. Name FEAR 76. Host: Northern Illinois Rocket Ass'n No. 117.

June, 1976 — Annapolis, Maryland. Name: AAROM-4 Area Meet. Host: Annapolis Association of Rocketry #102.

June, 1976 — Columbus, Ohio. Name: MMRR-76. Host: CSAR-113.

June, 1976 — Des Moines, Iowa. Name: CUSS-3. Host: DART #317.

June, 1976 — Center Valley, Pennsylvania. Name: AARDVARK-IV. Host: SPEAR Missile Minders #133.

July 10, 11, 1976 — Burlington, Wisconsin.

July, 1976 — Fort Wayne, Indiana, Name: HEAVEN-III. Host: Summit City Aerospace Modelers (SCAM) No. 282.

July, 1976 — Joliet Army Training Base, Illinois. Name: EMRA-TIROS Regional-6. Host: EMRA #240.

July 9, 10, 11, 1976 — Cambridge, Massachusetts. Name: 9th Annual MIT Convention. Host: MIT Rocket Society. Come to the first MIT convention to be held in the warm summertime. Events include discussion groups, lectures, movies, building session, records trial, R&D contest, photo contest, and a land rocket drag race. Contact: MIT Rocket Society, MIT Branch P.O. Box 110, Cambridge, Massachusetts 02139.

ORDERING INFORMATION

ORDERING INFORMATION

The prices in this catalog are in effect 1 January 1976 and they are subject to change without notice. The availability of certain items will change and we reserve the right to drop items from the line without prior notice.

If an item is out of stock or dropped you will receive a credit slip that may be exchanged for products or cash upon request. We will not back-order any materials.

Do not send cash through the mail. Use checks, US or bank money orders, or bank drafts in US funds.

All retail orders must include payment in full including the postage and handling charge, and 4% sales tax from Wisconsin residents.

Keep a copy of your order for one will not be returned with your shipment.

A postpaid envelope is included with each order to enable you to contact us concerning any shortages or problems with the shipment. Please use the envelope to mail in your next order if for no other reason.

DOMESTIC

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SPACE COMMUNITIES

THE NEXT FRONTIER

Dr. Gerard K. O'Neill, Professor of Physics at Princeton University, since 1969 has investigated the possibilities of research, manufacturing and human habitation in space. He works in the field of high-energy experimental particle physics. He is a graduate of Swarthmore College, and received his Ph.D. in physics from Cornell University. Dr. O'Neill is a Fellow of the American Physical Society, and a member of the American Institute of Aeronautics and Astronautics, Phi Beta Kappa, Sigma Xi, the Soaring Society of America and the Experimental Aircraft Association.

BY GERARD K. O'NEILL
Professor of Physics,
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Within the last year a new possibility for the direction and motivation of our thrust into space has reached the stage of public discussion. We have yet to find an appropriate name for this new concept; space colonies, space manufacturing facilities, space industrialization have all been tried, but none is wholly appropriate. The definition of the topic is best made operationally:

• To establish a highly industrialized, self-maintaining human community in free space, where solar energy is available full-time.

• To construct the community almost wholly out of lunar surface materials and, later, to use the same source for materials to be processed into finished products; not to be used directly on Earth, but for use in high orbit.

• By so freeing the construction effort from launch-vehicle limitations, and by reducing the total launch requirements from the earth, to initiate the space-colonization program soon—within a time frame appropriate to the space-shuttle and to a simplified shuttle-derived lift vehicle.

The possibility of space colonization brings up a curious distinction, not often made: Some lines of research and development require nothing new in the way of physical understanding or of materials technology, but have not previously been worked on and therefore seem strange. In contrast, there are lines of development which we accept as inevitable simply because we have been exposed to them for a very long time, even though they may still require for their realization new physical understanding or real breakthroughs in materials technology. Fusion energy research is perhaps a classical example of the second class, and space colonization seems to typify the first.

Although my own work on this topic began in 1969, originally as an academic exercise, I later found that others had considered pieces of the problem much earlier. Of these, Konstantin Tsiolkowsky, J. D. Bernal, John Stroud, Dandridge Cole, Arthur C. Clarke, G. Harry Stine and Kraft Ehricke should all be mentioned, but in my opinion the work of Tsiolkowsky is particularly relevant to the present developments.

The key ideas of space colonization are, first, the utilization of solar energy in the environment where it can be used most efficiently, at the desire of the user: in free space, remote from the shadow of any planet, second, obtaining materials from the weak gravity of the moon rather than from the strong gravity of the earth.

An automatic, lunar-based electromagnetic launching device which we now study for transporting those materials is unusual from an aerospace industry viewpoint: it would operate no higher than room temperature and, in contrast to any new rocket or jet engine, would make no demands on high-strength materials technology.

In essence, it would be a recirculating linear electric motor, in which vehicles would be constrained by the phenomenon known as dynamic magnetic levitation, which involves permanent magnets flying above a conducting metal surface producing lift with low drag. This "mass-driver" would accelerate a small vehicle to the lunar escape speed. Over a kilometer of track length, following acceleration, velocity errors would be sensed by precise laser measurements. They would be corrected by pulsed magnetic fields before the payloads were released to climb out of the moon's gravitational field. The vehicle, slowed and recirculated for another payload, would be re-used every 150 seconds, so its own capital cost would be negligible when amortized over the payloads launched. The total weight of several hundred such vehicles would be less than one ton. The mass-driver can be analyzed by Maxwell's electromagnetic theory (magnetism created by an electric charge in motion), which was well-understood a century ago.

Yet, because it is so unlike a rocket engine, it is sometimes viewed with suspicion by aerospace engineers—including those who would consider acceptable the doubling of chamber pressures and the raising of temperatures by several hundred degrees in the next rocket engine to be developed.

The practicality of space colonization rests on at least two factors:

1. The factor of 20 in energy by which it is easier to transport to free space a payload from the moon than from the earth;

2. The factor of about 10 in time-averaged intensity between sunlight in free space and sunlight at the earth's surface in our midwinter.

Those two numbers suggest the first likely use of a space colony: for the manufacture of satellite solar power stations, to be relocated in geosynchronous (24-hour) orbit to supply energy to the earth through a microwave link. The energy interval between lunar orbit, where a space manufacturing facility would be located, and geosynchronous orbit is only 1/30 as large as the interval from the earth's surface to geosynchronous.

If a space colony is to be useful, it must be large enough and attractive enough to attract talented, hardworking people as residents; it must be far more than a space-station.

It was a surprise to me to discover, six years ago, that a pressure vessel in space, containing an atmosphere, and rotating to provide the equivalent of earth-normal gravity, could be made as large as several miles in diameter, within the limits of the ordinary structural materials with which we are familiar.

The largest colonies now foreseeable would probably be formed as cylinders, alternating areas of glass and interior land areas. From those land areas a resident would see a reflected image of the ordinary disc of the sun in the sky, and the sun's image would move across the sky from dawn to dusk as it does on earth. Within civil engineering limits, no greater than those under which our terrestrial bridges and buildings are built, the land area of one cylinder could be as large as 100 square miles. It would be a very long time before there would be a need to build colonies of so large a size. Even for the early small colonies, though, there would be the same options of independent control over the day-length, climate and seasons.

Agriculture for a space community would be carried out in external cylinders or rings with atmospheres, temperature, humidity and day-length chosen to match the needs of each crop being grown. Agriculture in space could be efficient and predictable, free of the extremes of crop-failure and glut which the terrestrial environment forces on our farmers.

Heavy industry at a space colony could benefit from the convenience of zero gravity. In external, non-rotating factories, zero gravity and breathable atmospheres would permit the easy assembly, without cranes, lift trucks or other handling equipment, of very large, massive products. These could be the components of new colonies, radio and optical telescopes, large ships for the further human exploration of the solar system, and power plants to supply energy to the earth.

In the early years of this research, before the question of implementation was seriously addressed, it seemed wise to check whether an expansion into space would soon encounter "growth limits" of the sort which humankind is now reaching on earth, and which have been described for us vividly by Professor Jay Forrester of M.I.T., in studies supported by the Club of Rome.

In the long run, it seems fairly certain that the materials source for space colonies will be the asteroids rather than the moon. The asteroids have, in addition to those minerals found on the lunar surface, carbon, nitrogen and hydrogen. Typical asteroids are no more remote in energy from lunar orbit than is the earth, and no high thrusts are required to transfer materials or finished colonies from the asteroid belt. Given that source of materials, the "limits of growth" are absurdly high; the total quantity of material within only the three largest asteroids is quite enough to permit building space colonies with a total land area more than ten thousand times that of the Earth.

As Hubert Davis of NASA-Houston has aptly pointed out, the introduction of the space colony option is equivalent to releasing us from what must otherwise be a "zero-sum game" on the surface of the earth. The practical and immediate question is how to establish the first colony; once it exists and is in full production, it will serve as a beach-head in space, manufacturing additional colonies as well as other products.

During the summer of 1975 a group of about 25 people meeting at the NASA Ames Laboratory, in cooperation with Stanford University, studied the space-colony concept from two viewpoints: first, to find whether there is any essential flaw in the arguments set forth in the first paper on the topic (Physics Today, September 1974); second, if no such flaw is found, to examine in more detail the optimizations and tradeoffs which would control the cost and time-scale for an actual construction project. In that effort the group, working under a program of the American Society for Engineering Education, was aided by having access to the papers of 1974 and 1975 Princeton Conferences on this topic.

No "fatal flaw" was uncovered in the original arguments. In detail, some conclusions were reached which were not suspected at the time the study began. It is easy first to dispose of those items which were anticipated but which now have been put on a firmer basis.

First, the details of launch vehicles and deep-space tugs were established through papers by Hubert Davis and Adelbert Tischler at the 1975 Conference. Nothing more advanced than the space-shuttle main engines is required, and the assumption is made that transport from the Earth will be by the shuttle, for people, or by a simple lift vehicle with shuttle main engines, for freight. In deep space, only a chemical tug is assumed. In keeping with those assumptions, if the cost of transport to low earth orbit is taken as one unit, transport to lunar orbit is taken as four units and, to the lunar surface, eight units.

The optimum location for the first colony is not yet established at the time of writing. The L4 and L5 Lagrange-points* of the earth-moon system have been considered, as have geosynchronous orbit and high lunar orbit. Geosynchronous orbit appears to be less advantageous, mainly because it would raise the costs of materials transport from the lunar mine to the processing facility.

It is assumed automatically by most people who consider the space-colony concept that materials processing would be carried out on the moon. So far, that does not appear to be a cost-effective choice. Processing machinery carried to the moon would be saddled with a large additional amortization cost due to its transport, and it would lose the advantages of full-time solar energy and of adjustable gravity. The absence of the zero-gravity option would alone be a grave disadvantage. As it now appears, even unselected lunar surface material is close enough to ideal in its element-concentrations that there seems not much point in processing it on the lunar surface. The unselected Apollo-11 fines, for example, are 40 percent oxygen by weight, more than 30 percent metals, and about 20 percent silicon. Baseline Colony One designs, with a total mass of 500,000 tons, require about 150,000 tons of metals, 150,000 tons of soil, and smaller amounts of glass—materials that seem to be well matched to those available on the moon. Work by the Summer Study group has substantiated earlier indications from the 1975 Princeton Conference, to the effect that the original estimates of agricultural growing-area needs were pessimistic by about a factor two; the agricultural specialists now conclude that under the ideal growing conditions of a deep-space greenhouse, a growing area of 45 square meters per person should be enough. A normal type of North American diet, with vegetables, poultry, dairy products and meat is assumed.

We take a conservative approach to electric power plant masses; although further improvements may come with time, for the purposes of cost estimation the Study Group assumed for the surface of the moon a nuclear reactor, weighing 45 tons per megawatt of power. It would be rated at about 170 megawatts, of which just under 160 would be devoted to the mass-driver. That would be sufficient for the transport of 900,000 tons/year assuming 70 percent reliability. For the deep-space applications, we assume at present a solar thermal system with a turbogenerator, as has been studied by Gordon Woodcock of Boeing. We assume, however, a performance appropriate to an early timeframe: that is, 10 tons per megawatt instead of 5.

Unexpectedly, the summer study has shown up a possible physiological limit more severe than had been anticipated. Until now, on the basis of advice from those experienced in aerospace physiology, we had assumed that rotation rates of up to three rotations per minute (rpm) would be acceptable to nearly all prospective colonists after initial acclimatization. To those of us who have logged some centrifuge time, that rate seems rather slow. It seems, though, that there is enough disagreement among physiologists that contingency plans must be made. Conceivably, the rate may have to be held below 1 rpm, because of the fraction of the work force which will be commuting daily between the rotating environment and the zero-gravity assembly areas.

This possible limit prompted more attention, in the summer study, to habitat geometries than was anticipated initially. For constant gravity, if the rotation rate is cut from 3 rpm to 1 rpm, the required radial dimension of the habitat must go up from 100 meters to 900 meters. For Earth-normal gravity a rotation rate of 3 rpm translates to 100 meter radius, for which the atmospheric pressure dominates the equation for habitat total mass. At 1 rpm the radius must go to 900 meters, and there the gravity itself dominates the mass equation.

A number of geometries have been considered. The most efficient in terms of mass is probably a tethered pair of pressure vessels, but that arrangement is inconvenient for passive cosmic-ray shielding. The next most efficient may be a cable-supported band structure, and after that a wheel. It appears that for a population of 10,000 people a total land area (residential, service, recreational and agricultural) should be about 900,000 square meters—about one-half square mile—if the density is to be as low as in attractive suburban areas of the U.S. and Southern France, so far taken as models. For 1 rpm the summer study chose a wheel geometry, as a compromise between esthetics and spin rate. Passive shielding against cosmic-rays would be possible though inconvenient with that geometry.

Until further experiments on the physiological tolerance-range are carried out, we retain an alternate design which would be more attractive esthetically and which would lend itself naturally to cosmic-ray shielding, but which would rotate at 1.95 rpm. Its circumference would be 0.87 mile, and its external agricultural areas would use the efficient cable-supported band structure.

In preparing for testimony before the Space Science and Applications Subcommittee of the House Committee on Science and Technology (July 23, 1975), I calculated, with the aid of Mark Hopkins, a number of economic scenarios for the growth of space manufacturing facilities, and for their construction of satellite solar power stations. One such calculation assumes an investment of about $96 billion over a six-year period during the establishment of the first beachhead-colony, and an additional $80 billion over the next decade as the initial colony builds others as well as power stations. We assume payment of 10 percent interest per year on the outstanding investment. The key factor entering the estimates is productivity; conservatively we assume that, in spite of the advantages of zero gravity and of any improvements which automation may bring, the productivity per person-year will be only about the same as it is in heavy industry on earth.

Including all processing, manufacturing and assembly, it appears that a population of 10,000 could manufacture about one new colony every two years, and could in addition build two power stations per year of 5,000 megawatts each. As in all the others which we considered, the program builds toward a steady-state population of about 160,000 people in space. In all cases, even with program costs of up to $300 billion, the payback in dollars exceeds the total investment and interest; profits from the sale of power begin in the ninth year and grow rapidly; total payoff of the program cost, including all interest charges, occurs after about 20-25 years.

In these scenarios the amount of energy supplied to the Earth is quite sufficient to end the energy-crisis permanently. Typically, 13 years after the beginning of construction the amount of energy being supplied to the earth each year in the form of usable electricity at the busbar (the point where power enters the distribution system) exceeds the peak capacity of the Alaska pipeline (two million barrels per day) and a few years later the total electrical energy supplied to date could exceed the estimated fossil fuel capacity of the Alaskan North Slope.

For us who work in technical fields it is easy to become immersed in performance optimizations and cost-benefit analyses. Such work is necessary, though, and the practicality of a space-colonization program is becoming better established mainly because additional people are giving their talent and hard work to the research on that topic.

It seems clear, though, that the extraordinary amount of interest which the space community concept has aroused during the last year stems at least in part from an intangible payback: the beginning of hope that our near-term future may not be one of despair or resignation in an increasingly rigid, resource-limited society, but of freedom and new opportunities on a frontier which is just within our reach.

In the great days of American progress and enthusiasm, it was the private sector which spurred the drive toward industrial expansion. It remains to be seen whether industry retains the drive and imagination to take an active part in the next advance, or whether it will be content to leave both the risks and the opportunities to government. I believe that it will be more healthy for the country if industry takes an active role in exploring the new possibilities.

In 1772 Astronomer Joseph L. Lagrange computed points in space equidistant from the Earth and moon—points of triangles 237,000 miles on a side—where a satellite or space station would remain in constant orbit above the Earth. L4 (east) and L5 (west) are the two stable positions.

This conception of a space colony features a bridge comparable in size to the San Francisco Bay Bridge to emphasize the eventual sizes of such colonies. Solar energy would supply power to the habitat while raw materials would be derived from lunar rocks or asteroids.

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