THE OFFICIAL NEWSLETTER OF NARHAMS SECTION # 139

ZOG-43

MARCH 2001

PHOTO: Dr. Kidwell prepping a MICRO-MAX launch

Photo By : Kevin Johnson

IN THIS EDITION

THE ONLY NAR NEWLETTER PUBLISHED MONTHLY ! !

From the Editor:

It occurred to me on the way home from work one evening last week. Winter is coming to an end and spring is around the corner. How did I come to this conclusion you ask? Well, for someone that spends as much time at work, and traveling to and from work, winter is the pits! You leave for work in the morning it is dark. You leave work for home and it is dark! Last week it was light on the way home all most the entire trip. Talk about a boost for your personal psyche! With springtime just around the corner, a hobbyist thoughts turn to the great outdoors, and actually starts the process of preparing for the upcoming season. For us rocketeers, it means flying with out shivering, and painting, for those that don't have a built in paintbooth in our basement. I hope to be able to spend some more time actually building rockets this coming year, compared to years past. Heck I actually have a couple of models ready for that first coat of primer. WOW! What a concept, models built and ready to be finished! I hope that each of you can find the happiness that this sort of thing brings to me as well.

The upcoming "flying" season once again is chalked full of dates. Check your NARHAMS calendar of events closely. In some instances we actually have separate sport launches not on the same day as contests. The contest events will still have sport flying going on, but it will not be the focus of the day. So if you are coming out to fly just sport flights, the dates for sport launches will suit your needs better. Be forewarned! If you do come to the contest events, and we do want anyone and everyone to come, you may be pressed into actually participating in the contest. Have no fear, we will be gentle with anyone wishing to participate. However, I understand the team division is getting a little crowded, and there were some words being exchanged between a few of the teams at the section meet last fall. I won't mention any names here, but the initials were Murphy's Lawyers and the Tracy, Jim & Matthew team. Tracy was later seen waving her finger at Jim. Your crack reporter couldn't confirm the story one way or the other, if Tracy was upset with Jim due to their models performances, or in the way that Jim put up with all that trash talk coming from Murphy's Lawyers.

NARHAMS has a lot of fun no matter what we do. Come out and support your club by lending a hand at any of the upcoming events scheduled this year. Not only do we have a full schedule of contest and sport launch events, but also a number of outreach events to teach the safety and science of model rocketry. Public demos always need members to help. Don't forget the planned building sessions as well. We are going to offer building sessions open to the public at Hobby Works in Laurel as well as Hobbytown in Frederick. These sessions are planned to teach beginners about the hobby of model rocketry as well as being a promotion to attract new members to the club.

Jim Filler

LAUNCH WINDOWS

SPORT LAUNCH

Middletown Park Odd-Roc Theme
Pot-o-Gold Spot Landing fun event
Mar. 10th 10AM - 4 PM
Contact: Jim Filler 301-371-3365
Planned Notam for up to 3.3 lb.
Limited to "G" class motors

OSTRICH-I REGIONAL MEET

Middletown Park Mar. 24th 10AM - 4 PM
Contact: Jennifer Ash-Poole
Events: OSL, C-ELD, A-SDmr, SpSc, RDD,1/2A-BG
Planned Notam for up to 3.3 lb.
Limited to "G" class motors

OPOSSUM-5 OPEN MEET

Middletown Park April 21 9AM-10PM
Will coincide with the sport/night launch
Contact: Chris Kidwell
Events are RDD, B SD, B PD, SpSc, A SRD.
Planned Notam for up to 3.3 lb.
Limited to "G" class motors

MARS- 27 Hosted by NOVAAR

Great Meadows Va. Also April 21
B SR Alt, C Egg Alt., A BG, B RG, A SD
Contact: John Hochheimer fishdktr@earthlink.net

RAMTEC-9 Hosted by SPAAR

Center Valley, Pa. June 16 & 17
Events: C Egg Dur., D HD, 1/2A BG, A SD, B SR Dur.
Contact: Glenn Feveryear

GUIDE TO FLYING A NARHAMS CONTEST

By: Jennifer Ash-Poole

At the bottom of the Editor's rants in the last Zog, Jim had pegged me to write a beginner's guide to contests. I have done this in the past couple of years, and several people seem to learn something new,or hey, that's why the contest is run that way! If you have any questions about any of the events, or something I have said doesn't make sense, speak up! Someone here is always willing to help. So, since my regional is the first contest of this year, let's start.

The events are as follows: (don't you just love alphabet soup!)
OSL (open spot landing)
C ELD (C engine Eggloft Duration)
A SD MR (A engine Streamer Duration, Multi-Round)
SpSc (Sport Scale)
RDD (Random Duration)
1/2A BG (1/2A engine Boost Glide)

Yep, 6 events in 6 hours. Wheee! This is not for the faint of heart. However there are several events a novice (with just an Alpha!) can participate in. Yep, three events that you can use just an Alpha and some engines. I'll discuss those events first.

RANDOM DURATION OR RDD

The first one you have to do for this meet is Random Duration (It's in the Pink Book, also known as the rules and regs to contest events).This has to be your first flight of the day.

Here's how it works, I roll a pair of dice (or some other random thing, get it...random) to figure out the amount of time everyone is aiming for. The times will be between 30 seconds and 120 seconds, in 5 second increments. Then you get to pick the rocket, engine, etc and fly it. You only get one shot at it. If you misfire, that's OK, just change the ignitor. Again, only contest certified engines, but you can pick (A, B, C, etc)

The model must be single-staged and recovered in one piece. You can use a helicopter, parachute or streamer to recover the model. You do not need to return the model. This is scored by how close you get to the time randomly chosen. Everyone gets the same time, so this is where Cumberland Ed and his R&D project come in handy.

OPEN SPOT LANDING (OSL)

OK, easy concept. I pick a spot, you pick a rocket and engine (single staged, any recovery device: parachute, streamer, helicopter) and you aim. One chance only again. The shortest distance from the tip of the nose cone to the spot is the winner. Again, here is where your alpha on a streamer or parachute, can be used. You can choose any engine that is contest certified.

A STREAMER DURATION - MULTI-ROUND

This gets thrown in here because you can put a streamer on your Alpha, launch it three times with an A8-3, and be qualified. (Heck, just launch once, bring it back, and be qualified!) A streamer duration is using an A engine and a streamer as your recovery device, launching and timing it. For those of you really new, you time from first motion on the pad to when it hits the ground. Usually, you would only get two flights, and you can have two different models. With Multi-Round, you get three flights, still only two models, and a time limit. For A streamer, the time limit is 120 seconds. This means that if you get 125 seconds on your 2nd flight, you will only be counted for 120 seconds. If two or more people max all three of their flights, then you have a fly-off. NARAM in Colorado had a fly-off for the first time at a NARAM.

Streamers must have a length to width ratio of 5 to 1 or greater and a minimum area of 100 square centimeters (or approx. 15.5 square inches). It has been proven that a 10 to 1 ratio works best for streamer duration. If we use the 10 to 1 rule, we can have a streamer that is 2x20, 3x30, 4x40 (see the pattern?). If we are trying to put a streamer into a minimum diameter tube (10.5) then we will probably go for the 2x20 or 3x30 inches. The type of material used for the streamer has been an R&D project. You can use mica film (plastic), crepe paper, mylar film or even cloth. Sometimes, when I have shredded my streamer, I will use crepe paper in a long stream just to get a qualified flight. I'll let some of the other experts talk about what they use.

How to fold a streamer? Usually, you fold the streamer 75 percent of the way, like this (Side view)

/\ /\ /\ /\ /\ /\ /\ /_____ this end is attached to
/ \/ \/ \/ \/ \/ \/ \/ the shock cord.

The greatest challenge in streamer is getting the streamer to deploy. However, if the streamer comes out of the tube, it's a qualifiedflight (Self Penalizing) You do have to return one of your models. If you have an engine eject, it's a DQ. How do you win? It's ther person who has the highest total. You add all of your flights up, and that's your score.
i.e.
50 sec + 45 sec + 120 sec = 215 sec 2nd
120 sec + 120 sec + DQ = 240 sec 1st

Whew, One model, three events, 5 flights (if you fly all 3 A streamer flights)

If you have come to the January and/or February meeting, then you have either built or gotten info on two of the events. I'll start with January's - Sport Scale (Most of this is from my posting a year or two agofor ECRM)

SPORT SCALE

According to the Pink Book, Sport Scale is a craftsmanship event. You may enter any model that closely resembles an existing or historical guided missile, rocket vehicle, or space vehicle. Any amateur rocket or missle is excluded from this event, except for historical significance. Usually, the model is judged for static points, and then it must be flown for flight points. The flight must be safe.

Probably the hardest part of the sport scale competition is getting the data for it. The competitor must include a Data packet with the model. You can scratch build your scale model or you can use a kit. For beginners, I would suggest getting a kit and building it as best as you can, including glue joints, painting and finish. Don't worry about how you compare against the Peter Alway or John McCoys of the world. I still have my first scale model, and I cringe when I see all my mistakes on it.

Find a nice kit that you don't mind spending some time with. Make sure you really like it, because you'll have to do data for it as well. Take a look through the Rockets of the World (if you have a copy) if you need some help.

Some kit ideas: Quest Nike-Smoke, Estes Black Brant, Aerospace Specialty Products has several (Ram B, Kappa-7-1, IQSY Tomahawk, Corporal, etc) Apogee.

There may be a couple of things you want to do before putting the kit together. Make sure you finish the fins. What I mean is, sand those fins really smooth, use sanding sealer or other finishing products, and sand again. Some people fill in the spiral in the body tube, and sand that as well to make a smooth finish. I haven't gotten that far in my finishing techniques. John McCoy, and January's meeting suggested 4 coats of primer, sand them down, no spirals. Once you put the kit together, be sure you don't have any stray dried-on glue, and that your fillets are as neat as you can get them. Everytime I build a scale model, I try to improve from my previous model.

You must put together a data packet to hand in with your sport scale model. This packet is to help the judges in giving you points. You need to have an outline of the rocket, showing colors, details, etc. The line drawings in Peter Alway's book "Rockets of the World" (ROTW) will do fine. You also need a color or black and white picture. You can copy the picture from ROTW as well. (now you know why all the scale people own a copy of this book!) If you guys need copies, please let me know. I'll be happy to make copies for your data packet. One the first page of this packet, you should have the model's name, the scale (i.e. 1:10, 1:13.5, etc) your division (A, B, C or T) and your NAR number. Some people think that you shouldn't put your name on the packet, because you may be pre-judged by the judges. This is up to you. Also on the first page, you should state whether this is scratch built or from a kit, and note anything you did to the model to make it more scale. On my Little Joe II, I modeled the second round, and the color scheme was all silver, with the pattern rotated 180 degrees. I noted thisin the packet for the judges. You should also note if you are doing anything or mission points.

Mission points are awarded during the flight of the model. This is when you duplicate the original by staging, having a payload, doing cloud seeding, smoke ejection, etc. I, for one have not tried any mission points yet.

New NAR Model Rocket Safety Code Approved

The National Association of Rocketry Board of Trustees approved a new NAR Model Rocket Safety Code on February 10, 2001. The Board also authorized manufacturers of model rocket products to distribute a simplified, shortened version of this Code with products intended for beginning, first-time model rocketeers. The full-length new Code is the authoritative document for governing model rocket activities conducted in the United States. Out thanks to all of those who contributed to the development of this new Code. We believe that it is significantly clearer and easier to understand than the previous Code, as well as being quite a bit shorter.

The revised code is now available at the NAR website, and Pat Miller, the NAR's representative to the NFPA Committee on Pyrotecnics will introduce this version as a replacement for the old Code in Appendix B of NFPA 1122, Code for Model Rockets. We urge manufacturers to use the appropriate version of the new Code as their products containing printed versions of the Code come up for reprint. Nothing in the new Code contradicts or changes any specific requirements of the old Code, so those who fly under the old one are still following all the provisions of the new one. www.nar.org

---

Experiences in Upscaling

By: Don Brown

A few years ago, I was looking through the Estes kits at the hobby shop and saw the Quark. The price was right (under $3.00) and it looked interesting, although very small. So I bought it and built it right away. It really did make a nice finished product. I chose to paint it the light blue and white stock scheme with the decals supplied with the kit. I wasn't sure how it would fly or if I would ever get it back after launch. I got a chance to fly the Quark a few months later and tried it on an Estes A3-4t. This model is designed for tumble recovery after it ejects the spent motor. I'm not fond of motor ejection, but knew that I would fly it carefully. The day for its first flight was perfect. The sky was clear and there was no wind. That, in itself, is amazing since I was at Middletown! The flight went very well. The Quark got a lot of altitude and ejected the motor after the 4 second delay. I did not lose sight of it and was able to retrieve it after a tumbling recovery. I flew it a few more times on A3's that day.

Well, the little rocket looked nice and flew nice, but it sure was tiny and lacked any excitement when flying. So, I decide to try an upscale version of it. Since bigger is better and biggest is best, I decided to use an Estes BT-80 tube for the body. The 2.6" tube diameter of the BT-80 works out to be a 4.8X upscale of the original Quark. For the nose cone I used an Estes NC-80b (like the one in the Estes Phoenix kit). The first fin that I cut was 3/16" thick balsa. That was a mistake. Balsa was too flimsy for these long fins. So I tried 3/16" basswood. Those were sturdy and had a nice surface for finishing. (Continued on next page)

For the Big Quark I picked a 24mm motor tube so that I could fly it on D12's and E or F reloads in my 24mm Aerotech casing. Construction was simple with two 1/16" aircraft plywood centering rings supporting the motor tube. A standard Estes engine hook was used, but I put a heavy centering ring in the motor tube forward of and butting against the little right angle tab on the end of the engine hook. This ring would transfer the motor thrust to the body instead of a 1/8" wide metal strip that would certainly tear out. The fins were attached to the body with double glue joints of yellow carpenter's glue. I made a cardboard template with a hole for the body tube and 4 slots for the fins to hold them square while the glue cured. It worked great. Next, I installed a 1/4" elastic shock cord. For a stability check, I made a cardboard cutout of the whole rocket and balanced it. Using that CP, I added lead shot mixed with epoxy in the nose cone until the CG was 3' forward of the CP. Finally, I painted it the same scheme as the original Quark.

The day of the first flight was exciting for me since this was my first scratch-built rocket. I loaded it with an Estes D12-3 and an 18" parachute. Conditions were good that day and the first flight was perfect. The liftoff was slow and she flew straight up with full parachute deployment. I was a happy camper! Now, I don't know about you but if my rocket flies well on any given motor, my next step is always more power. So I next tried an E18 Aerotech reload. Even better! She flew perfectly.

Over the next few months I flew the Big Quark five more times on D12's and an F39. But, the happy flying days came to an end on April 4, 1999. The day started out fine. We had clear weather and 3 to 5 mph winds at Middletown. I inspected the rocket and found no damage from previous flights. I loaded it with an Aerotech E28 reload and an 18" parachute. The motor ignited and Big Quark blasted off the pad, arcing slightly over the spectators. There were a lot of oohs and ahhhs as she roared overhead. That's when things went wrong. At about 100 feet off the ground, one fin snapped off followed by failure of the other three fins. Then the body with nose intact dove into the ground. The ejection charge then blew the body off the nose cone that was imbedded in the soil. The only components that survived were the motor casing and the parachute! I am still not sure why the basswood fins failed on the eighth flight. They broke under boost on an E28, but had been fine on an F39 on the fifth flight. Also, the broke across the fin about 1" from the body tube, not at the glued joint.

Well, I would not let that failure stop me. I have since rebuilt the 4.8X version with a few improvements. The motor tube is now 29mm to accommodate Econojet F and G motors and has 1/8" plywood bulkheads. The fins are 3/16" thick aircraft plywood and go through the body tube to the motor tube. All structural joints use epoxy adhesive and are filleted. A four clamp retention system replaces the Estes motor hook. The shock cord is attached to threaded steel rod that passes through both motor bulkheads. Failure is not an option any more! She is big, bad and ready to rumble!

I had hoped that my experience with the upscaled fins would provide some revelation that I could pass on to the readers of this article. But I am sorry to say that the experience has left me older, but not wiser. I don't know why they broke, but have increased their strength with better material. Look for Big Beefy Quark's maiden flight at ECRM on an Econojet F or G motor.

NEW REVISED SCHEDULE FOR CURRENT RCP CYCLE

By: Jim Filler NAR # 27862
RCP Chairman NAR Contest Board

Due to a few different problems within the NAR and outside of my control, the current RCP cycle has been revised to allow for the membership to comment and vote on proposals up for consideration. I will not go into what caused the problems, I am here to fix them and lay out the plan to try and keep the process working. For the active cycle which was to go into effect originally this July 1st (excluding NARAM-43), the schedule has been revised and will work as follows:

June 15th 2001- Deadline for RCP Chairman to receive comments from membership on proposals (The comment form and proposals were printed in a previous edition of The Model Rocketeer) Remember, comments can be forwarded via e-mail to zog43@starpower.net

Aug. 1st 2001- Comments and ballot forwarded to Model Rocketeer for publishing

Sept. 30th 2001- Deadline for ballots to be received by RCP chairman

Oct. 30th 2001- Deadline for ballots to be tabulated and forwarded to Model Rocketeer to be published.

Jan 1st 2002- Proposals that pass go into effect.

According to the Rules Revision Process this does not follow the timeline normally used. The NAR Board of Trustees has issued an exemption due to the problems incurred with this cycle. Normally rules revisions always take effect the first day (July 1) of the new contest year. The NAR Contest Board sees no problem with this revision taking effect mid-year due to the nature of the proposals.

Keep in mind, the NAR Board of Trustees decided to change the rules revision process from a 2 year cycle to a 1 year cycle. The deadline for submitting Rules Revision Proposals for the 2002 / 2003 contest year is June 30th 2001. In order not to cause anymore confusion, look for the schedule in an upcoming edition of the Model Rocketeer.

MARCH - MARS - MÄRZ - MARZO & THE SKY

Paul Miller, NAR 51615

Let's focus on Mars. It was merely a little more than 2100 years ago that Mars (Martios) was the first month of the year. First it was changed to March, then moved to the third month, thanks to the Romans. At least Marcg has always had 31 days. Its name honors Mars, the Roman god of war.

On March 25, 1634 Lord Baltimore's gang anchored off St. Clements Island in the Potomac River (Maryland Day). It was near here that his brother Leonard Calvert founded the colony of Maryland. It was just a little north that Leonard discovered a huge clearing on the Potomac. Free of trees and reasonably flat, Lenny reasoned that this could be a great landing site (for boats, of course). By amazing coincidence, about 330 years later, a young fair-headed guy named John McCoy reasoned that this could be a great launching site for rockets. Close by, some high school students were starting a model rocket club. The rest is HISTORY, NARHAMSters!

The big announcement for March is: "Mars is coming!" Mars passes north of the star Antares during the first two weeks of March. Mars is coming closer and will be increasingly brighter. Not since 1988 will Mars grab this much attention by Earth-bound observers.

The fantastic opposition of Mars is fast approaching. Mars is now in Scorpius at dawn in our southern sky. Check it out this month as it wanders near Antares, the Scorpius alpha star. These two red rivals will share the sky until late September, In fact, the name Antares means "rival of Mars." Mars will quickly brighten this month and will match Antares in brilliance as March ends. In June and July Mars will be spectacular. Unfortunately, it will never venture too far above the southern horizon at our latitude.

Venus will be at its brightest at the beginning of this month in the evening sky. It will set in the west up to 3 hours after the Sun. By mid-month Venus will be much dimmer and will rise at dawn as we enter April.

Remember those sensational views of Jupiter and Saturn in Taurus last year? Your last BIG chance will come on March 29 and 30 when our gas giants join a crescent Moon and Aldebaran above the southwestern horizon. Now Jupiter will quickly slip away from Saturn. You will be much older when these two meet again.

For those of you that squirm a lot on March 9, that Full Moon is known as the Full Worm Moon. For something to look forward to? - 2:00 am on April 1st, daylight Saving Time begins! Spring forward NARHAMSters! (or is that Pay Forward?)

Your March Dates to Remember:

2 - Jupiter 3° north of Moon (2001)
4 - Jupiter's ring discovered (1979)
10 - Rings discovered around Uranus (1977)
13 - Wm. Herschel discovers Uranus (1781)
14 - Albert Einstein (my hero) born (1879)
15 - Mars 1.8° south of Moon (2001)
16 - Robert Goddard launches first liquid fuel rocket (1926)
18 - Largest Asteroid Ceres 0.5° south of Moon (2001)
- Alexi Leonov makes first spacewalk (1965)
20 - Vernal Equinox 8:31am EST (First day of Spring 2001)
23 - Wernher von Braun born (1912)
28 - Saturn 1.7° north of Moon (2001)
29 - Jupiter 2° north of Moon (2001)

BUILDING SESSION AT COLLEGE PARK AIRPORT

By: Jennifer Ash-Poole

On Saturday, February 24, the club had the second of a series of building sessions held around Maryland. This time, College Park.I showed up around 10am, and checked in with the airport, to make sure we had the annex all to ourselves. We did. I rearranged some chairs, and was moving tables when Dr. Kidwell showed up (I did have to chase him off of my table!)

Chris had brought streamers to fold, part of his Research and Development project. I brought an assortment of sport models. (Egads! A Board of Trustee member building a sport model! That's against the laws of physics) New club member Jeff, showed up with parts, trying to figure out what he wanted to do with them. He had gone to the hobby store, picked up parts,and came to the building session with no plan in mind. I realized that I had forgotten to bring sandpaper. But there was hope! A Home Depot had opened at Route 1 and 495 (just inside the beltway!). We left for lunch and took an excursion into the building place. I got sandpaper, Dr. Kidwell bought spray paint (silver metallic for the Iris) and sandpaper as well. We hit an Italian place nearby, and came back.Jeff saved his money for lunch. Sitting there, fixing his night launch model, was John McCoy. He waslate getting to the session because he slept in and he had to paint a body tube. Jeff had to leave to go house hunting, and the rest of us sat, building and chewing the fat. We packed up and left by 4pm. I got 2 models done, and another almost finished (glued 2 out of 6 fins)

Next building session is planned for Frederick. Stay tuned for details!

From the NAR Records Subcommittee

By: Dan Winings NAR Contest Board

I have been concerned for a long time about the lack of notification to the Records Subcommittee of some legitimate records. I am therefore implementing the following procedural changes in the notification of new records to the Subcommittee:

1) It is recommended that Contest Directors check all flights against existing records to determine if any records where surpassed. He may then notify the Records Subcommittee via mail or e-mail of any pending new records. The notification should include the aspirant's name, age division, date of flight and the actual record. The CD may also photocopy the flight card and the CB-170 of the contestant and forward them to the Records Subcommittee. Such notification should occur within 2 weeks of the record attempt.

2) A contestant if he feels he has set a record may also notify the Records Subcommittee via mail or e- mail. Notification must include the aspirant's name, age division, date of record attempt, and the actual performance achieved. He may also request a copy of his flight card and CB-170 so that he can forward it to the Records Subcommittee.

3) The Regional Contest Board Chairman must certify all record attempts and forward the name of the contestant, his age division, date of record and the actual performance with two week of receipt of the contest results.

Note these changes are procedural in nature and do not constitute a change in the Pink Book rules. It is still the obligation of the Regional Contest Board to certify new records a forward them to the Records Subcommittee.

Unfortunately in some cases I have not been receiving record substantiation in a timely manner or in other cases at all. These new procedures will allow for some checks and balances. Any new record forwarded to me will be listed as pending until I receive a copy of both the flight card and the CB-170 of the contestant.

Forward any record substantiation to:
NAR Records Subcommittee
C/O Dan Winings, Chairman
12000 Falcon Ridge Drive
Fredericksburg, VA 22407
e-mail dwinings@erols.com

Italian Module Set for Flight to Alpha

By Steven Siceloff *Florida Today*

CAPE CANAVERAL, Fla. -- Every new house needs a moving van to carry its stuff, and Space Station Alpha is no exception. Leonardo is the moving van for the outpost, a kind of U-Haul trailer tucked into shuttle Discovery's cargo bay. The shuttle is scheduled to carry its load into space March 8. But instead of coffee tables and lamps, the module will be stuffed with computers and experiments. And, like any moving van, the Leonardo module will be moved out of the driveway when it is emptied and returned to the shed until it is needed again..A 20-foot- (6-meter-) long aluminum cylinder, Leonardo is one of three such modules built by the Italian Space Agency to resupply Alpha. The other two, which will fly to the station later, are called Rafael and Donatello. All were named for renowned Italian Renaissance artists.

The three modules are sophisticated gems of Space Age technology. They're also the main commitment by the Italian government to the international project, expected to cost between $60 billion and $95 billion by the time Alpha is completed in 2006. The modules are not powered, but are pressurized, meaning they hold an atmosphere on the way up to space and back. They are outfitted with circuits and valves that allow it to act like any other space station module, even though they will be only temporary pieces of the station.

The Italian modules were designed to keep station experiments intact during the dangerous climb into orbit and the bumpy ride back to Earth. Other cargo ships have a mixed record for returning experiments to Earth unharmed.

Previous space stations such as the Russian Mir did not have a cargo vessel to carry intact research bays to Earth. The Russians had Progress modules that brought supplies into space, but they do not survive reentry to Earth. Roger Crouch, NASA's chief scientist, said Progress and other spacecraft did not allow whole segments of equipment to be changed inside an orbiting station. "In the old days, you had to use what was already in orbit," he said. "[The Italian modules] make Destiny a living laboratory." Because of the relative roominess of the module, the experiments to be ferried back and forth can be larger than previous space stations could handle.

For researchers on Earth, the chance to trade whole segments of equipment means experiments can be larger than in the past and much more sophisticated. "Rather than have generic hardware, [scientists] can use specific equipment," Crouch said. "One of the problems with Mir became that the furnaces were out-of-date. It sort of stymied their materials research."

Leonardo's temporary home will be in a port of the Unity docking hub. Unity has proven an intersection of sorts for the budding outpost. Launched in late 1998, the 18-foot- (5.5-meter-) long segment is a connection between American and Russian modules on the station. On one end, the Russian Zarya and Zvezda modules, including living quarters for station crews; on the other, the newly added U.S. Destiny lab with its suite of computers and outfitted research bays. A 70-foot- (21-meter-) high tower of solar arrays stands on top of Unity. A docking tunnel for visiting shuttles is attached to the bottom of the Unity, but Discovery will move it to the port side of Unity to make room for Leonardo.

Once Leonardo is in place, astronauts and cosmonauts inside the station will pull its racks out of the walls, float them through a couple of hatchways and install them inside Destiny. Destiny was launched with five racks in place, each carrying communications and backup life support systems. Leonardo will carry six more, one dedicated to human research. Station residents will take radiation readings inside the station and other measurements and samples for analysis. Because the laboratory was just attached to the station last week and no research has been done there yet, there are no racks to bring back to Earth. NASA envisions future shuttle flights carrying 10 tons of equipment on the Leonardo or its sister modules and bringing back almost as much weight in completed experiments.