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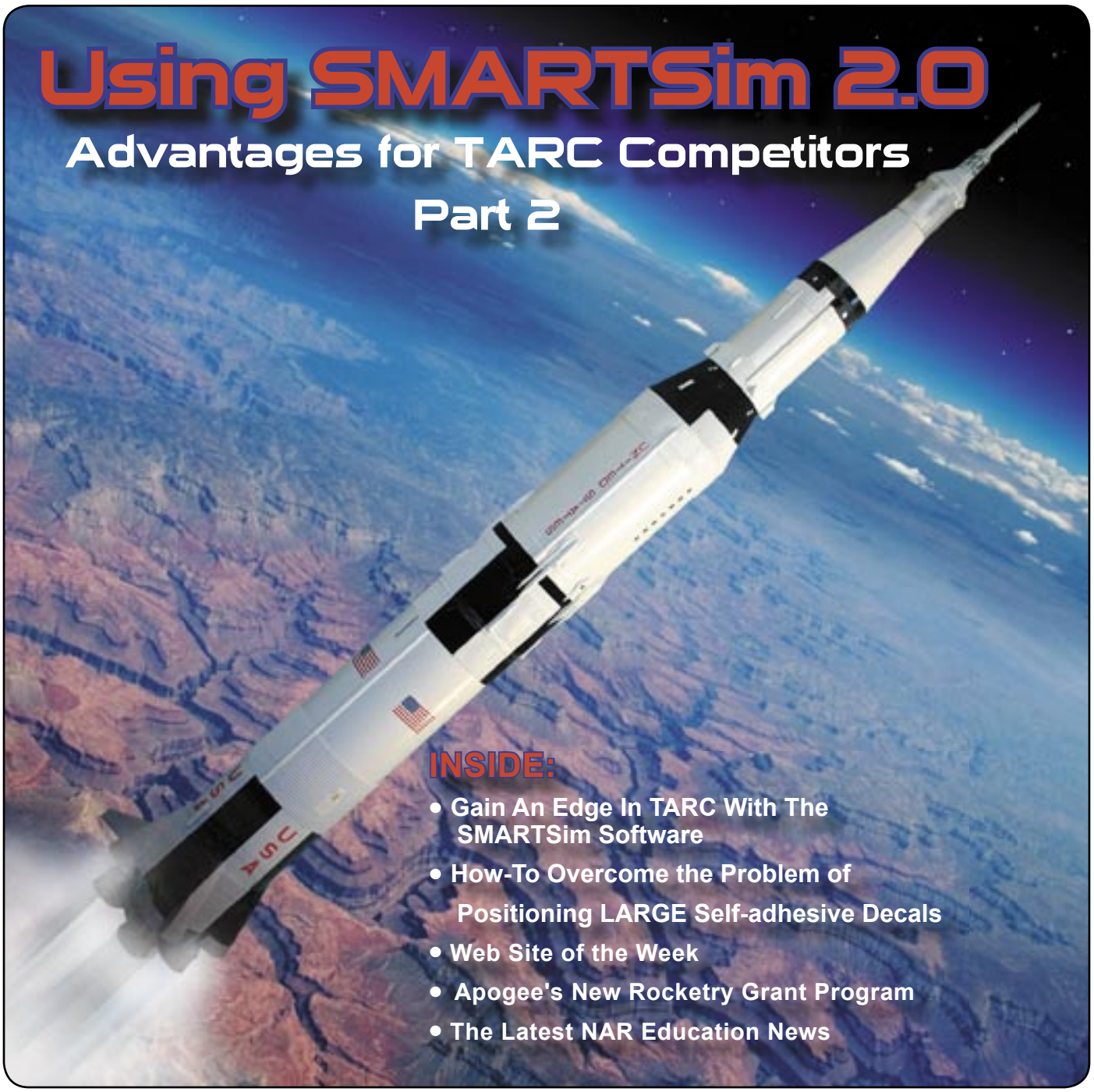
APOGEE PEAK OF FLIGHT NEWSLETTER

Using SMARTSim 2.0

Advantages for TARC Competitors

Part 2



INSIDE:

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Apogee Components
1130 Elkton Drive, Suite A
Colorado Springs, Colorado 80907 USA
www.ApogeeRockets.com e-mail: orders@ApogeeRockets.com
phone: 719-535-9335 fax: 719-534-9050

Advantages of Batch Processing

Using SMARTSim v2.0 Part 2

by Ken Karbon

Introduction

In the last *Peak-of-Flight* newsletter, I introduced the batch processing feature of SMARTSim 2.0. It allows you to run hundreds of RockSim simulations with a simple input file. Instead of haphazard guessing and checking the results, SMARTSim sets up systematic combinations for analysis.

In this article, I will show how to use SMARTSim batch processing to help design a rocket to compete in TARC 2007. Two of the contest's requirements are ideal for study with RockSim and SMARTSim – achieve 850 ft maximum altitude AND a total flight duration of 45s. Some of the methods I use in this example are a bit advanced for TARC students and require other engineering tools, but your math and science teachers can probably help with similar, yet simpler approaches. Use the power of simulations to give you that competitive edge.

Designed Experiment for a TARC Rocket

To begin, I created a hypothetical payloader design to carry the required egg and altimeter as shown in Figure 1. Next, I need to define the critical parameters that might affect the flight performance and use them as control factors. For this study, I chose four basic rocket features that can be varied with RockSim - the payload tube diameter, the payload mass object, the parachute diameter, and the engine. The output factors are maximum altitude and flight duration. Table 1 shows the definition of my experiment and a range of values for the control factors. These factors are selected from the rkt file and written to a batch file with SMARTSim.

Figure 1.
Hypothetical TARC Design

	Payload Diameter	Payload Mass	Chute Diameter	Engine	Altitude	Duration
Factor	Control	Control	Control	Control	Output	Output
Type	Continuous	Continuous	Continuous	Quantity	Goal = 850ft	Goal = 45s
Range	2 - 4in	600 - 500g	10 - 60in	E23, F20, F52		

Table 1.
Experiment Design

As an engineer, I have very sophisticated Design of Experiments (DOE) software which I used to set up my experiment. I created 121 runs to define my design space within the ranges given above. I copied the resulting run matrix into the batch file with an Excel spreadsheet as shown in Figure 2. Note that when varying payload outside diameter, I must also change the inside diameter along with the nose cone base diameter and transition front diameter in order to keep the rocket "together" so that RockSim can properly compute mass, Cp, and Cd. Those extra columns are defined in the batch file as well.

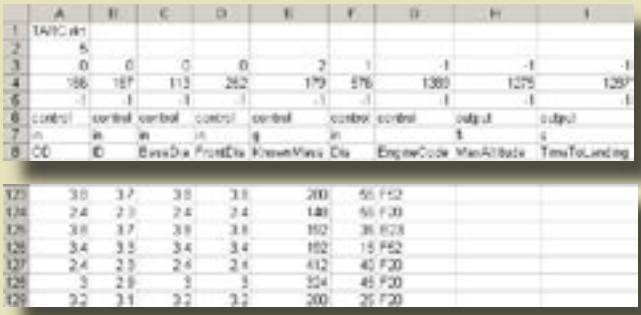

Figure 2.
Batch File for TARC Study (121 Runs)

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Apogee Rocketry Grant Program

Apogee Components, Inc. is pleased to announce the first in a yearly grant program geared toward model rocketry education organizations!

The rules are simple:

1. Entrants must submit an essay to Apogee. There is no length requirement for the essay.
2. Any club, organization, school program, etc. is eligible for entry. This would include rocketry clubs or prefectures, 4H, scouts, etc.
3. The content and purpose of the essay is as follows:
   - If we gave you $300.00, How would you use it to impact the rocketry community?
   - How many people you think it will reach?
   - How many people are involved in the organizing and running of the event?
   - How big of an effect it will have on the rocketry community?
4. One of the biggest things to keep in mind when composing your essay is, "How is what I am planning unique"?

There will be only one winner and recipient of the grant, which is $300.00 toward any order with Apogee Components.

The deadline for entry is November 30, 2006.

The grant winner will be announced on January 1, 2007.

What a great way to start off the new year!

send essay to
1130 Elkton Drive Suite A
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or
johnm@apogeerockets.com

http://www.apogeerockets.com/october_special.asp

continued from page 2

I then ran this batch file in SMARTSim. The 121 calculations took about 6 minutes on my Pentium 4-2.6 GHz PC. Only with batch processing can you attempt such a large number of "what-if" scenarios. It would take you hours upon hours to perform these same simulations by manually adjusting the parameters and pressing the "launch" button in the RockSim GUI! And flight tests? Forget about it. To run this experiment with hardware tests would be costly, time-consuming, and downright impossible. Save your precious prototypes and building materials for validation flights and final tweaking after the simulations.

From the batch output data, I performed a statistical technique called *ANOVA* (ANalysis Of VAriance) to understand the contributions of each of the control factors. Understandably, the choice of engine had the most effect on the altitude and flight duration, with the other factors and interactions having less impact (Figure 3). This result reveals where your design efforts should be focused to achieve the target.

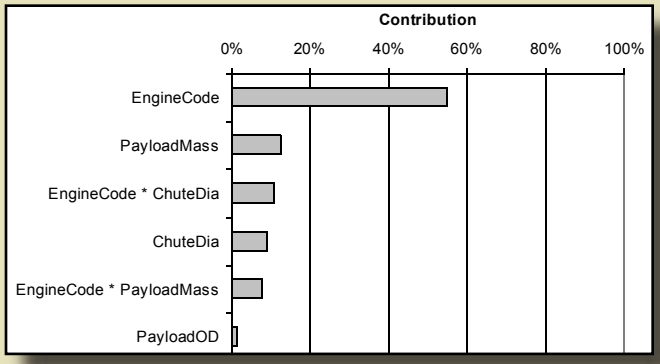


Figure 3.
Flight Duration ANOVA

Lastly, I used Excel programming to analyze the TARC objectives with a numerical model built from the experiment data. For a unique solution to the two outputs (altitude and time), I simultaneously solved for two of the unknowns – payload mass and chute diameter (Table 2). With the surrogate Excel model, I can solve and optimize multiple parameters without having to guess and check in the RockSim GUI. As a confirmation, I plugged in my predicted solution to the four variables back into RockSim and obtained the desired result shown in Table 3.

Payload OD	Payload Mass	Chute Diagram	Engine Code	Max Altitude	Time To Landing
in	g	in		ft	S
3	426.7738607	30.21577122	F52	850.0000009	45.0000002

Table 2.
Solution to the TARC Design from Experiment Model

Max data values:

- Maximum altitude: 850.60256 Ft.

Landing data

- Time to landing: 45.069 Sec.

Table 3.
Confirmation RockSim Simulation Details

Summary

Of course, this hypothetical design does not take into account all the other important factors when building and flying a competition rocket. I purposely left out a lot of the details, because TARC students must create their own designs without help from others. This example is intended to show how engineering problems are solved in practice using efficiently-designed experiments and not brute-force trial and error. The advanced numerical techniques I used here would not be possible without the large number of RockSim simulations that I easily generated with SMARTSim v2.0.

About the Author

Ken Karbon is a rocketeer from Michigan and the developer of SMARTSim. He holds a Masters Degree in Mechanical Engineering and works as an aerodynamicist in the auto industry, specializing in CFD simulation. For more information email smartsim@comcast.net

NAR NEWS

Alabama Girl Scout Space Initiative

The NASA Explorer Institutes (NEI) program "Growing the NASA-Girl Scouts of the USA (GSUSA) Relationship Through Professional Development" is producing a rocketry curriculum at the MSFC with NAR. This is being implemented in Alabama where Scout leaders are trained in rocketry basics by NAR members to teach their girls how to perform science activities and earn a merit patch. It hopes to reach up to 22,000 Girl Scouts in the state. The objectives are: to create a rocketry patch program that is age appropriate for Brownie, Junior and Senior Older Girl Levels, to design and conduct a day-long professional development to train staff to support 'space day' and related events, and to utilize NAR mentors to provide leadership and support for Girl Scout participation in Team America Rocketry Challenge (TARC). Once established and approved, the rocketry patch will be offered to Scout Councils nation wide. See the webpage at:
http://education.nasa.gov/divisions/informal/overview/F_2005_Explorer_Institutes_List.html

Team America Rocketry Challenge Registration Opens

The 2007 Team America Rocketry Challenge registration opened September 6, and closes November 15, or whenever 750 teams are registered, whichever comes first. Each year over 7000 students in 7th through 12th grade across the US measure themselves against a flight performance challenge that requires aerospace engineering and model rocketry skills. Everything is in place to begin the fifth year of this program that is dedicated to building the next generation of U.S. aerospace professionals.

The challenge is for student teams to design, build, and fly a model rocket that carries a raw egg payload and returns it unbroken, while meeting a specific flight performance target. This year the target is to reach 850 feet, and have the flight last 45 seconds from liftoff to egg touchdown. The teams make a local 'qualification' flight, and then progress to the national flyoff in Great Meadows, Virginia in May 2007. Over $60,000 in cash, savings bonds, and other prizes are awarded each year by sponsors. TARC is sponsored by the Aerospace Industries Association (AIA), NAR, in partnership with NASA, the Dept. of Defense, American Association of Physics Teachers, and 39 AIA member companies.

To learn more about TARC, please sign up at the the web site below. The site contains the contest application, rules, team handbook, information handbook, schedule, and much more.
http://www.rocketcontest.org

Visually Impaired Students Experience Model Rocketry

Twelve visually impaired and blind high school students had an opportunity to explore careers in rocketry in the Rocket On! program, as part of a partnership between NASA and the National Federation of the Blind. The students participated in a week-long rocket science camp, July 14-22, at the Federation's Jernigan Institute in Baltimore and NASA's Wallops Flight Facility, Wallops Island, VA. The program has now finished its third year.

As part of the workshop, the students learned to use MathTrax software, a calculator that enables them to visualize data by translating information into an easily accessible text or audio description. This free MathTrax computer application may be downloaded for Windows and Macintosh platforms at:
http://prime.jsc.nasa.gov/mathtrax/bviDownload.htm

Hopefully, this opportunity will be available for visually impaired students next year as well, and we will keep you updated about the application process in this newsletter. For more information, see the press release below.
http://www.nasa.gov/home/hqnews/2006/jul/HQ_06277_NASA_aids_students_final.html

Customer Testimonial

My order arrived promptly with the contents in excellent condition. Again, it's been a pleasure doing business with Apogee Components and I look forward to future dealings with your company. I would like to offer some additional feedback on three points that I believe are of particular credit to Apogee. As your goal is to keep the hobby of model rocketry thriving, mine is to endorse and support such efforts as a customer and fellow rocketry enthusiast. My points are as follows:

1) Customer Service - Apogee has done a fantastic job of ensuring customer satisfaction through its commitment to quality, responsiveness, and courtesy. Where other companies have sacrificed these fundamentals as a cost-cutting measure, and adopted a "nickel and dime" philosophy, Apogee lives up to its name in its endeavor to develop rewarding relationships with its customers.

2) Integrated Experience - Through its offerings of books, software, kits, and other materials related to the hobby of rocketry, Apogee has brought to market a broad and rich experience that promises years of learning and enjoyment for anyone with interest in the field.

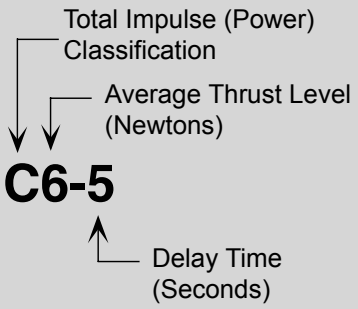
3) Attention to Detail - The attention to detail evident in Apogee's kits, in particular the Saturn 1B and V models, is world class and unique in an industry where a trend toward simplistic, mass-produced toys seems to have taken hold in recent years. In addition to the models themselves, Apogee has gone the extra mile with its multimedia instructions, detailed painting guides, posters, and other goodies. These extras have taken much of the frustration out of building complex rockets without diminishing the challenge and reward. Bravo!

I am very happy with my Saturn 1B kit and will be purchasing a Saturn V upon completion. I'll also be adding a number of books and the RockSim software to my orders in the coming months. I would be happy to recommended Apogee Components to others. With regard to the RockSim software, it's a stellar product and perhaps the only one of its kind available to hobbyists. I've shown it to several co-workers involved in ballistics/aerodynamics R&D for the US Navy and they were impressed.

- Bryan Vandrovec

DEFINING MOMENTS

Every model rocket engine has a designation code printed on it that gives specific information. The first letter in the designation code tells you the power level. For example, a C engine will lift a model approximately twice as high as a B engine, and four times higher than an A engine. The first number in the code tells you the average thrust produced by the engine. This level is expressed in Newtons. In our example, the C6-5 engine produces an average of 6 Newtons of thrust over its burn time. Light models require a low average thrust to lift them and heavy rockets require a high average thrust to lift the them.



From this first number in the designation code you can also determine the approximate burn time. To do this, divide the total impulse at which the engine is rated by the average thrust level that is printed on the label. For example, a C6 engine has a maximum power of 10 N-s, and has an average thrust of 6 Newtons. Therefore, the burn time is 10 divided by 6, which equals 1.67 seconds. Burn time and average thrust are important to modelers who want the rocket to fly to the highest altitudes. The longer the burn time, the higher the model will travel. This is because a slow speed rocket has less drag than a high speed model, so it can coast longer.

The last number in the designation code is the time in seconds between propellant burnout and when the ejection charge fires. A C6-5 has a five-second delay before the ejection charge fires to push the parachute out of the rocket. Choose this delay time very carefully. The delay you pick depends on the mass of the model, how much drag it will produce, the angle at which it is launched, and how stable it is.

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TIP OF THE FIN

Have you ever been working with self-adhesive decals only to have them develop those nasty bubbles underneath? This can be very frustrating, indeed! Here is a great tip to help get those self-adhesive decals on correctly the first time.

To begin, you will need a bowl and some liquid dish soap. Put a drop or two in the bowl and add some warm water as you can see in picture 1. You don't want a lot of suds, so be sparing on the soap. Now take a decal and pull the backing off as seen in figure 2. You will then need to dip the decal in the soapy solution that you made up. It won't need to soak; just dip it in and take it out, as long as it gets wet (I know this sounds strange, but bear with me). This is shown in picture 3.

Photo 1

Photo 2

Photo 3

After taking the decal out, go ahead and position it where you want on your model. Don't worry about not placing it exactly the first time. After you move the decal into the final position that looks best to you, take a paper towel and carefully dry up the suds that are oozing out. It's best to hold on to the decal at one side so that it doesn't move (see picture 4).

Photo 4

After you initially soak up the majority of the water, take a dry paper towel and press out the rest of the water and air bubbles with it in a "squeegee" fashion. Picture 5 shows the finished product and as you can see, it makes the decal look very nice. It is recommended to put on a clear coat of paint to seal it down.

Photo 5

RockSim: The Software That Lets You Design Amazing Rockets!

FREE demo version. Download it today.

RockSim is the leading software for designing rockets, and finding out how high they will fly. Here is what rocketeers are saying about it:

"After a lot of searching on the Net, Rocksim is the best rocketry simulation software I have seen. In terms of sophistication, 'Rocksim' is to 'VCP' as 'VCP' is to 'cutting out pieces of cardboard'." – Brian Crosse

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QUESTION AND ANSWER CORNER

Dave Miller asks, "I ordered your book "69 Science Fair Projects" (http://www.apogeerockets.com/science_fair_book.asp) which I am very pleased with. My daughter would like to do the project on the optimal weight of a model rocket (so that it will reach its optimal altitude). She found in a book that an "ideal" real rocket should be 91% propellant, 3% tanks, engines, hardware, and 6% people and instruments. These percentages seem way off for a model rocket. Do you have similar percentages for model rockets or could you point us to a source(s) that might have this information"?

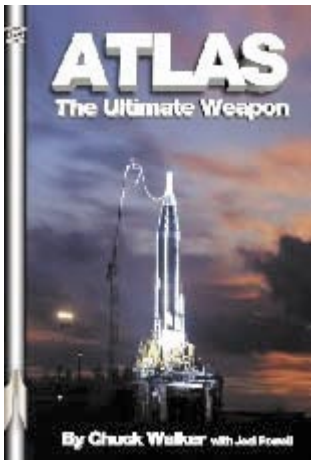
Mr. Rocket says, "There are no good formulas for model rockets. It all depends on the size and shape of the rocket, and the type of rocket motors that you use. What most modelers do is to use the RockSim software to calculate the optimum mass of the particular design and motor combination. With a click of the button, you can get the answer. For most typical model rockets, it is physically impossible to make the rocket light enough, as the weight of the motor case is more than the optimum mass allowable. But there are some very tiny motors, like the Estes A10-3T motor where it is possible to build the rocket at the optimum mass. It is easier to use big motors when doing optimum mass studies. The drawback is that they are more expensive."

Download the free demo version of RockSim from my web site. You'll find it at:

http://www.apogeerockets.com/rockSim_demo.asp

You might also be interested in the article about optimum mass that can be found in Technical Publication #15 which can be found at:

http://www.apogeerockets.com/technical_publications.asp".



If you want to build REALLY big rockets try these two great books from Apogee Space Books

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Web Sites Worth Visiting

Do you need to keep up on your space-related news? Then Spacetravels is the website for you! At http://www.spacetravels.gr/html/index_gb.html you will find the latest and the greatest on topics such as space missions, tourism, technology, health, and science, just to name a few.

You may be familiar with the Ansari X-Prize; this site has the details about Anousheh Ansari. Anousheh is the first female space tourist and has dreamed of space exploration since childhood. Her family provided the title sponsorship for the Ansari X Prize, a $10 million cash award for the first non-governmental organization to launch a reusable manned spacecraft into space twice within two weeks. This feat was accomplished in 2004 by legendary aerospace designer Burt Rutan.

Sir Richard Branson

Anousheh Ansari

Also in the news is the new spaceport in New Mexico. "This state has worked hard to bring us to their exciting new spaceport facility," stated Will Whitehorn, President of Virgin Galactic. "The state has several factors that make it an ideal operations base: climate, free airspace, low population density, high altitude, and stunning scenery. Our team was highly impressed by the professionalism and the competitive pitch the state and its advisors developed". Take a look at this and see what's up in our corner of the universe.