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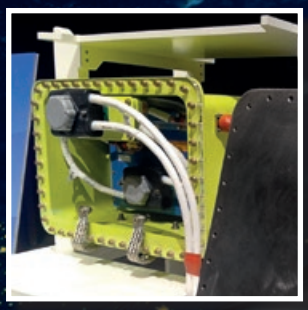
Space Safety Magazine©

Issue 7
Spring 2013

Special Report Potentially Hazardous Asteroids



How the Lithium-Ion Battery Grounded Boeing's "Dream"

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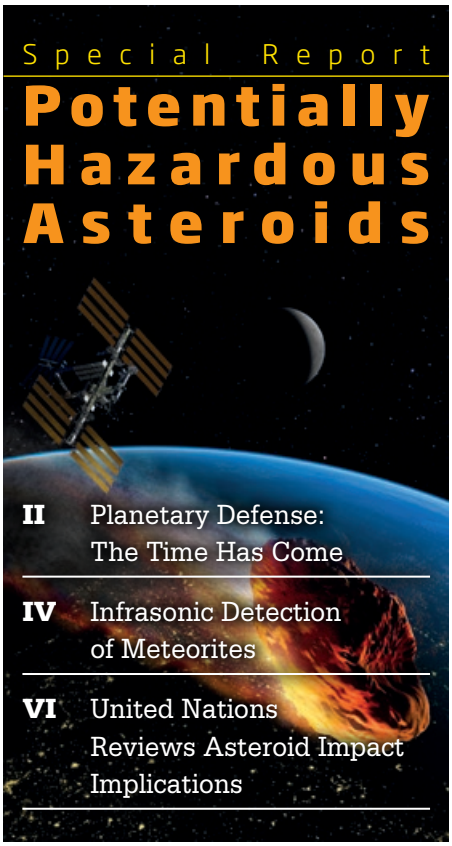

Space Safety Magazine©

Spring 2013
Issue **7**

Space Safety Magazine
Koninklijke Bibliotheek,
n. 12042639 19/12/2012
ISSN: 2214-0379

www.spacesafetymagazine.com
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Postbus 127
2200AC Noordwijk
The Netherlands

The Space Safety Magazine is a joint publication of the International Association for Advancement of Space Safety (IAASS) and the International Space Safety Foundation (ISSF)

INTERNATIONAL ASSOCIATION FOR THE ADVANCEMENT OF SPACE SAFETY

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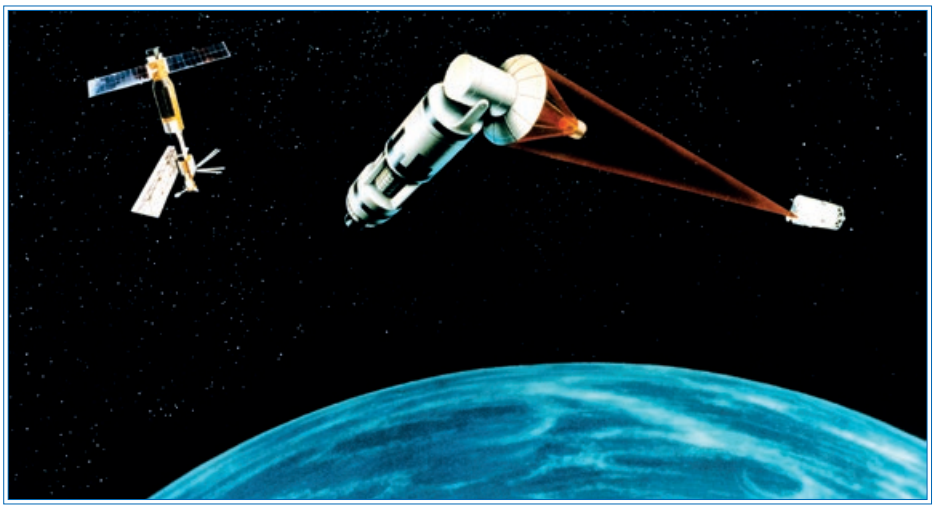
The Time To Organize Space Is Now!

For almost three decades a debate has been raging between the US on one side and Russia and China on the other side regarding the banning of space weapons, the initial concern being an altered balance of nuclear forces among superpowers. The debate is better known as PAROS (Prevention of Arms Race in Outer Space), from the relevant draft treaty proposed jointly by Russia and China.

In 1972, the Anti-Ballistic Missile (ABM) Treaty between the United States and the Soviet Union outlawed development and testing of any missile defense system that was mobile, sea-based, or space-based. The debate was reignited later by US President R. Reagan's decision to launch the Missile Defense Program (a.k.a. Star Wars) in 1985. It encountered major technological difficulties and was later restarted in a diminutive form (a.k.a. Son of Star Wars) by US President G. W. Bush after the terrorist attacks of September 11, 2001. In the meantime, the US became increasingly concerned about the vulnerability of their vast on-orbit military and commercial assets to attack from, for example, small satellites below the detection threshold of US space tracking capabilities.

The compromise solution proposed by the International Code of Conduct for Outer Space Activities, under discussion for the past few years, tries to address the security concern together with non-security issues of space traffic management and space debris, thus risking these latter issues being drawn into the quagmire of a security debate. The International Code of Conduct for Outer Space Activities is based on the following principles:

a) ensuring "freedom of access," a principle already covered by the existing international Outer Space Treaty of 1967;
b) stating the "inherent right to self-defense," a well-established right under international law, but inserted here to justify continuation of research activities in the field of space asset vulnerability/protection;
c) establishing the principle of international governance to prevent all kinds of interferences;
d) establishing that each State will do its best to prevent outer space from becoming an area of conflict (i.e. no deployment of ground-to-space, space-to-space, or space-to-ground weapons).



Artist's conception of a Space Laser Satellite Defense System. – Credits: US Air Force.

With reference to space debris, the International Code of Conduct for Outer Space Activities just reiterates each nation's commitment to observe the UN Code of Conduct for the Mitigation of space debris, which is already failing on its own because of limited enforcement: operators from 70 countries operate satellites but fewer than ten of them have space agencies able to monitor their space activities.

A vague commitment to international governance of space, by sharing as yet to be determined operational data, through a yet to be determined organizational set-up, is all this CoC will provide to the commercial and civil space community. Very little!

The time to organize space is now, and it can be done quickly if the leading spacefaring countries finally gather the political will to do so. There is a valid model of international cooperation, the International Civil Aviation Organization (ICAO), which safeguards national sovereignty while effectively achieving the results that we all witness daily in smoothly managed air traffic. The ICAO Convention was drafted and agreed to within months of the end of WWII, in Chicago, when the military potential of aviation was fully demonstrated and the civil aviation we know today was only a visionary's dream. The ICAO Convention made aviation into the success story we all know. The IAASS is proposing that space safety and sustainability concerns be treated separately from security issues. There are different levels of cooperation that can be achieved in safety vs. security matters, orders of magnitude apart.

The spacefaring countries should agree on a global civil space traffic and environment management framework, while developing a minimum set of civil and military traffic interoperability rules. It was done for air traffic; it can be done for space traffic. Let's give civil/commercial space traffic a chance to get organized quickly. We cannot wait another 30 years to get an ICAO for space!

Tommaso Sgobba
IAASS President

By Matteo Emanuelli

How the Lithium-Ion Battery Grounded Boeing's "Dream"

First flight of Boeing 787 Dreamliner on December 15, 2009. The Li-ion batteries are located on the 787 at fore and aft. – Credits: Dave Sizer

It all began on January 7, 2013 when an electrical fire filled Japan Airlines (JAL) Boeing 787's cabin with smoke a few minutes after passengers disembarked at Logan International Airport in Boston following a flight from Tokyo. The fire was caused by the explosion of a battery used to start the jet's Auxiliary Power Unit (APU), a small turbine engine located in a compartment beneath the tail used to supply power when the engines aren't running. Only one day later, inspectors at United Airlines (UA) found a defective wire bundle connected to the APU battery of another 787 in Boston, while they were performing a check prompted by the earlier incident.

On January 16, an All Nippon Airways (ANA) 787 flying from Yamaguchi to Tokyo with 137 people aboard had to make an emergency landing at Takamatsu after smoke was reported in the cockpit. Five people were injured during the evacuation on an airport taxiway. The smoke was caused by a battery fire in the plane's forward electronics bay.

These were just the latest of a series of battery-related mishaps involving Boeing's 787 Dreamliner. A UA flight from Houston to Newark was forced to make an emergency landing in New Orleans after the failure of one of its power generators on December 4, 2012. One day later, Qatar Airways grounded one of its three Dreamliners because of the same problem and on December 17, UA reported that another 787 had developed electrical issues. Boeing reported a battery malfunction incident even earlier during a pre-delivery test flight in 2010, that had resulted in an emergency landing.

In response to these events, the US Federal Aviation Administration (FAA) announced a safety review of the 787 on January 11. Within a few days, FAA followed the decision by JAL and ANA to voluntarily ground their Dreamliners, with the order that all US registered 787s be grounded as well on January 16. In a domino effect, Poland and the rest of Europe followed the decision by decree of the European Aviation Safety Administration; they were joined a few hours later by India and Ethiopia. The gravity of the decision is underlined by the fact that this was the first time that an entire fleet of aircraft has been pulled out of service since DC-10 in 1979.

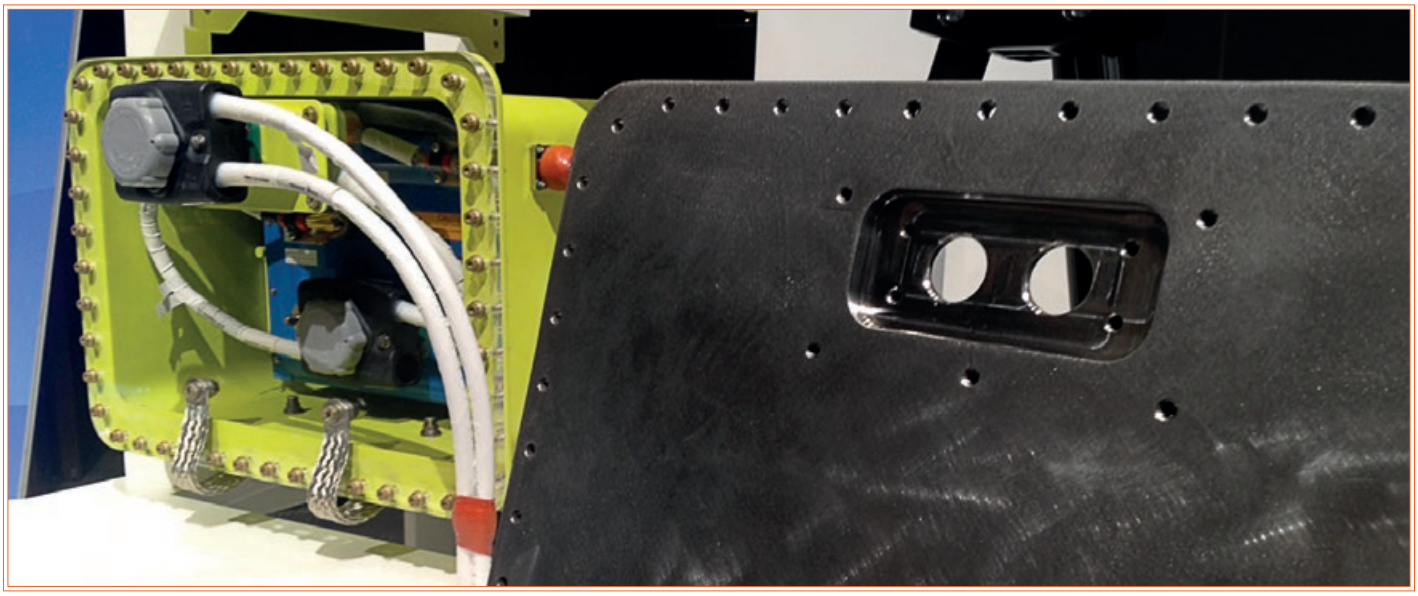
Although it is not unusual to have minor glitches in a newly introduced plane like the Boeing 787 Dreamliner, all the mishaps reported have in common the malfunction of the plane's Lithium-ion (Li-ion) batteries, found in both forward and aft underfloor electronics bays. The two Li-ion batteries aboard each craft have double the size of a typical car battery. The one in the forward electronics bay serves as flight system backup and powers pilot displays, while the one in the aft section is used to start the APU.

> All the mishaps reported have in common the malfunction of the plane's Li-ion batteries

Advantages and Disadvantages

Boeing 787 is not the only aircraft using Li-ion batteries. Airbus A380 also uses the technology, but on the Dreamliner these batteries are used more extensively and are central to the design.

Dreamliner needs very powerful batteries because its control systems are managed entirely by electrical signals instead of hydraulic controls. Since the 787 is designed to be lighter and more efficient than previous generations of jets, the engineers at Boeing had to opt for



The comprehensive set of solutions that Boeing has proposed to the FAA is supposed to address every possible cause of the batteries' failure, according to the company. - Credits: Boeing

> "We have made numerous improvements that we believe will make it a safer, more reliable battery system"

Li-ion technology. Li-ion batteries have high energy density, which means they are smaller, lighter than a traditional Nickel-Cadmium battery for a given amount of power. Moreover, Li-ion batteries have no memory effect, good charge rate capability, and the highest performance efficiency. Finally, Li-ion units can be flexibly shaped, an important characteristic on a plane, where finding space can represent a problem.

Li-ion batteries, however, are known for their safety drawbacks and they need more careful management than traditional units, as highlighted by the recent spate of incidents. These batteries tend to be very sensitive to operating conditions and easily overheat or short out when overcharged or exposed to temperatures higher or lower than their design capabilities. The high temperature environment is dangerous since it causes a breakdown of the electrodes and decomposition of electrolyte leading to a thermal runaway and fire. Very low temperatures could easily lead to an internal short during the charging process, resulting again in a fire and/or thermal runaway. When not used in its nominal condition, a Li-ion unit can also release irritating and corrosive gas from the batteries' electrolyte fluid. Moreover, 787's batteries use a lithium cobalt oxide configuration which is among the most energy-dense and flammable chemistries of Li-ion batteries on the market.

Boeing's Investigation

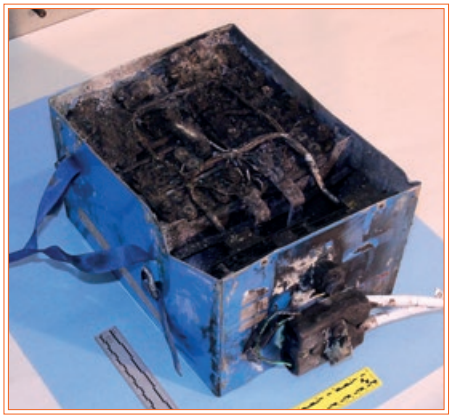
After months of investigation, it is still unclear exactly what could have caused the 787's problems. Up to now, Boeing has not been able to reproduce the issue on a flight test. However, the company has developed a comprehensive set of improvements to the 787 Li-ion batteries, hopefully covering all the possible issues. If these improvements pass the certification testing, FAA and the other international regulators will likely let operators resume 787 commercial flights. By the time this goes to publication, test flights are expected to be complete.

"We will be positioned to help our customers implement these changes and begin the process of getting their 787s back in the air," said Boeing Commercial Airplanes President and CEO Ray Conner in a 787 technical briefing in Tokyo on March 12. "Passengers can be assured that we have completed a thorough review of the battery system and made numerous improvements that we believe will make it a safer, more reliable battery system."

Improvements include enhanced production and operating processes, improved battery design features, and a new sealed battery enclosure able to contain any released flame, smoke, or gas that may result from the simultaneous failure of all eight battery cells.

An Inherently Unsafe Design?

When the 787 issue first came up, experts fingered the cell assembly or the control circuit design as the most likely culprits. SpaceX and Tesla Motors CEO Elon Musk, despite not being ▸▸



The JAL Boeing 787's APU battery involved in the Boston incident, on January 7, 2013. Credits: National Transport Safety Board

Li-Ion batteries have been used in space over the past decade for long term satellite applications

associated with Boeing or the 787 investigation, commented publicly that the Boeing pack architecture is inherently unsafe. Instead of Boeing's architecture using a battery with a grouping of eight large cells, Musk proposed the architecture developed for Tesla cars, containing thousands of smaller cells that are independently separated to prevent fire in a single cell from harming the surrounding ones. "When thermal runaway occurs with a big cell, a proportionately larger amount of energy is released and it is very difficult to prevent that energy from then heating up the neighboring cells and causing a domino effect that results in the entire pack catching fire," said Musk in an email to Flightglobal.com.

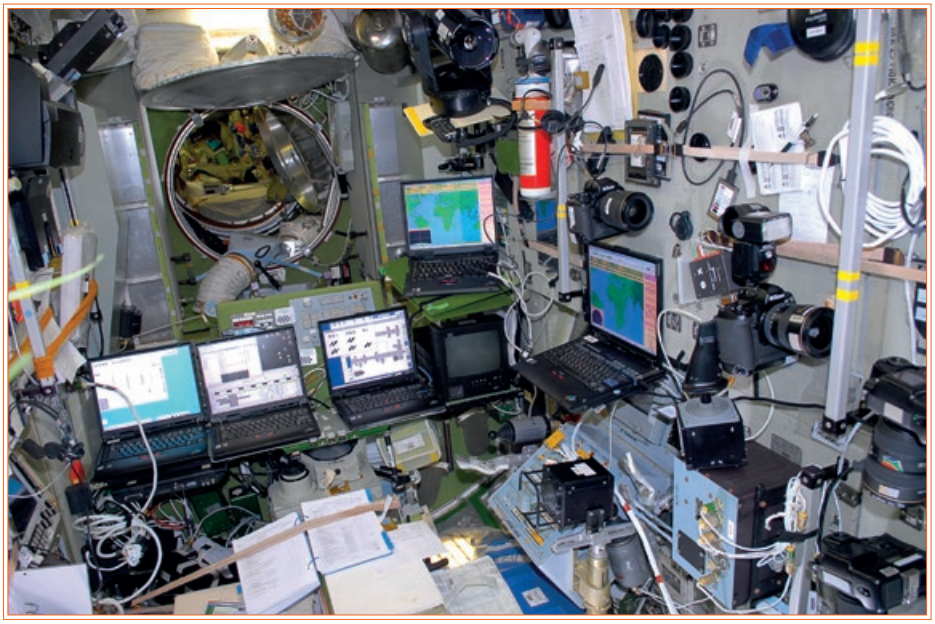
Tesla's battery has been used, with appropriate modifications, in SpaceX's Falcon 9 space launch vehicle and Dragon Capsule. However, Musk's comments must be seen in the context of SpaceX's competition with United Launch Alliance, a Boeing/Lockheed Martin joint venture, for the launch market.

Musk's claim was backed-up by Donald Sadoway, a professor of electrical engineering at the Massachusetts Institute of Technology. "I'm glad someone with such a big reputation put it on the line," said Sadoway to Flightglobal.com. "He's engineered [Tesla's battery] to prevent the domino effect, while Boeing evidently doesn't have that engineering." Sadoway suggested Boeing implement an active cooling system including temperature sensors to monitor the temperature of each of the cells or switch to Nickel metal-hydride battery chemistry: less efficient in terms of energy storage, but safer.

A Difficult History

Li-ion batteries have been used for 10 years in many commercial devices like laptops and mobile phones. Recently, they have been used also in electric cars including the Tesla Roadster, Chrysler Volt, and Nissan Leaf. Planes and spacecraft are more recent entries to Li-ion application.

The industrial implementation of Li-ion technology, however, presented technical and economical problems even in earlier, smaller devices. Dell recalled 4.1 million laptops in 2006 after several battery units overheated or caught fire. Defective batteries inside the iPhone 3GS have been known to overheat, expand, and even split apart the device's housing. Replacing the battery in the all-electric Tesla Roadster because of ignored low-charge warnings could cost up to $40,000. American Li-Ion battery manufacturer A123 went bankrupt in 2012 after a series of safety issues that forced the company to spend $51 million to replace faulty batteries manufactured for the Fisker Karma hybrid car.



ThinkPad laptops aboard the International Space Station mount Li-ion batteries just like laptops on Earth. - Credits: Lenovo

Consequences for Space Applications

The Li-ion battery chemistry has been used over the past decade for long term satellite applications in low Earth and geostationary orbits for its superior performance efficiency and longevity. Li-ion batteries are used to power laptops aboard the International Space Station. In November 2012, Boeing's battery supplier, GS Yuasa Lithium Power, Inc. (GYLP) was awarded a contract to provide Li-ion batteries for use in the ISS Electrical Power System as an upgrade to existing Nickel Hydrogen batteries.

In a January 18 interview, Dr. Judith Jeevarajan, NASA Johnson Space Center's Battery Group Lead for Safety and Advanced Technology, told Space Safety Magazine that, "Although the cells are made by the same manufacturer who made the batteries for the Dreamliner, they are of different capacity and construction." She also highlighted that the result of the Dreamliner's investigation will enhance NASA's capability to prevent future issues on the station.

Although it is too early to predict when the Dreamliner will be cleared to take to the sky again, the crisis has already provoked the significant consequence of forcing Airbus to drop its plans to use Li-ion batteries on its forthcoming A350-XWB. While Airbus doesn't want to delay production for the tricky chemistry, trusting to the older Nickel-Cadmium chemistry instead, Boeing is sticking with Li-ion technology, proposing a brand new design of the battery. However, the root cause of the original issue is still not clearly identified. The Seattle company is probably worried that a backward step to a previous technology will lead to a recertification of the whole electrical system, further delaying Dreamliner's return to operations. And Boeing is losing money and customers for every day that the Dreamliner fleet remains grounded.

By Danielle DeLatte

The Day After Fukushima
Interview with Prof. Satoshi Tadokoro

When you have just been hit by a massive earthquake and tsunami, and your country is facing a serious emergency in one of its biggest nuclear power plants, the last thing you would think about is your research project. But when the earthquake and tsunami hit the Tohoku area on March 11, 2011, Prof. Satoshi Tadokoro realized that the project he was working on with several colleagues at Tohoku University and the Chiba Institute of Technology could be exactly what was needed to address the nuclear crisis at the Fukushima reactor.

Space Safety Magazine recently had the opportunity to sit down with Tadokoro, President of the International Rescue System Institute, professor of Information Science at Tohoku University in Sendai, and primary investigator for the Quince project. Quince is a tread robot that can climb stairs and provide human operators with video and sensor data. Its narrow frame, HD camera, 2D/3D map generation, semi-autonomy, and climbing ability made it uniquely suited to climb the stairs of the five-story Fukushima reactor and carry out a series of scouting missions.

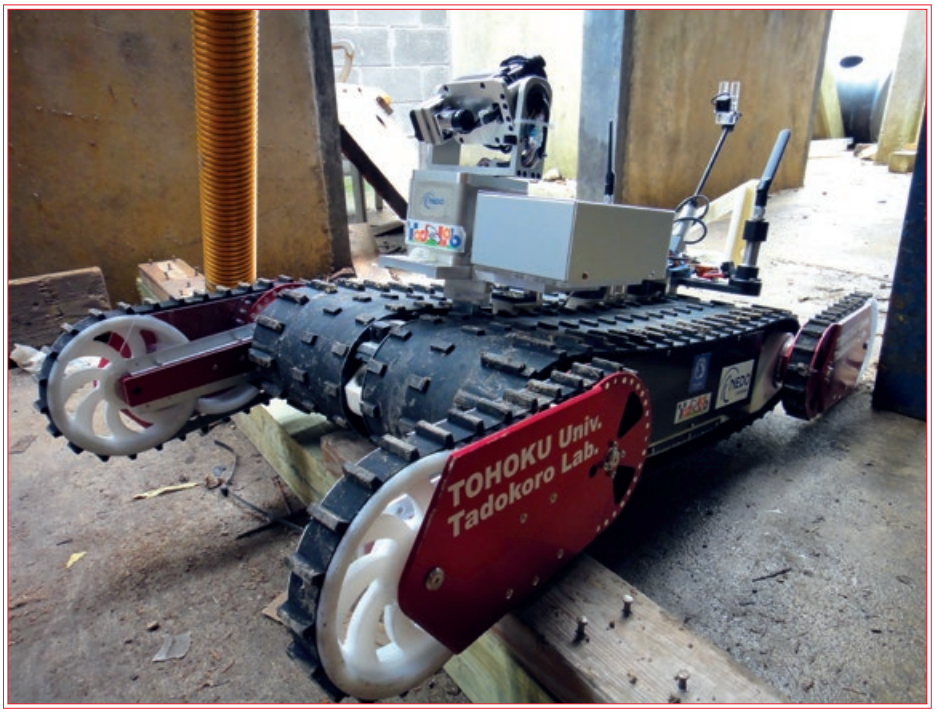
Born for Mission Impossible

Quince developed from a NEDO (New Energy and Industrial Technology Development Organization) funded project as a joint program between the International Rescue System Institute, that worked on the hardware aspects, and Tohoku University, that handled systems integration, software, and artificial intelligence. The purpose of the project was to develop a robot that could investigate confined spaces possibly containing chemical agents. This research was conceived following the 1995 Subway Sarin Incident when a religious cult released a chemical agent in Tokyo's subway system that killed 13 people and injured nearly a thousand, so a response to this type of attack was on people's minds. "Quince would investigate situations by entering subway, buildings, or underground areas where responders are at risk from chemical agents," Tadokoro explains. The class of incidents to which Quince would respond is known as CBRNE for chemical, biological, radioactive, nuclear, explosion.

> "Specialists in nuclear power plants said robotic systems are not necessary, because accidents would never happen"

The nuclear power plant of Fukushima right after the earthquake and tsunami that struck Japan on March 11, 2011. – Credits: DigitalGlobe

Quince was not developed to respond to nuclear plant accidents. After the 1999 Tokaimura JCO accident at the nuclear fuel manufacturing company, the Japanese government made development of response robots a priority. That priority didn't last long, however. "Specialists in nuclear power plants said such robotic systems are not necessary, because such accidents would never happen," Tadokoro explains. Tadokoro finds such naiveté regarding the perfection of nuclear technology disappointing. "The engineer should not believe that type of thing: it is not scientific." According to Tadokoro, the statement was politically rooted, as nuclear lobbyists were trying to



Tohoku University's Quince model is designed for mobility. - Credit: International Rescue System Institute

Search and rescue is just starting to come into its own – much like space robotics

silence concerns raised by anti-nuclear activists. As a result, nuclear reactors were not considered dangerous and little research was done for that type of disaster scenario.

The Aftermath of a Nuclear Emergency

When the Fukushima reactor was damaged by the earthquake of March 2011, it was impossible to know how bad the damage was or what the radiation levels were without measuring them in person. Such a task would be incredibly dangerous for a human, and readings were needed from a five-story building with narrow metal stairs. On the International Nuclear Event Scale, Fukushima was rated maximum severity.

The first robot to enter Fukushima after the incident was Packbot, a military robot series manufactured by iRobot. Packbot was "thought of as a specialist of response robots," says Tadokoro. "I really appreciate iRobot's donation of Packbots to TEPCO. If they did not have Packbot, the cool shutdown of the plant would have [been] delayed significantly." But Packbot had a problem: stairs. The stairs were steep, at 42-45 degrees, and slippery with water. "Packbot could not go up to the 2nd floor," says Tadokoro. "Packbot is really a good robot, but [it] was not designed for steep steps nor rubble piles." Then, Prof Eiji Koyanagi of the Chiba Institute of Technology immediately proposed using Quince, whose design had focused on difficult terrain. "We found this area of disaster had no information because every avenue of communication was cut," Tadokoro recalls. The team spent a week trying to track down someone in an official position, but with communications down, the situation was complete chaos. After a week, they gave up trying to find an authority and just started working.

First, the team tried to construct the scenario Quince would face. "Our starting point was the 1995 Great Hanshin/Kobe earthquake, a huge earthquake in which more than 6000 people died," recalls Tadokoro. In that disaster, though, 90% of the deaths were due to the earthquake itself. The later Hanshin-Awaji earthquake was next considered, in which over 80% of the deaths were caused by people being buried by collapsed buildings. In this type of situation, mobility in confined spaces is the priority. "Quince has very high mobility – that is the reason that we thought Quince would be a very nice solution," said Tadokoro.

In mid-March 2011 Tadokoro finally got a hold of the Economic Trade Ministry and insisted that Japanese robots would be critical to managing the disaster and suggested a demonstration of the technology. On April 4th, Quince was demonstrated for the ministry. Koyanagi began remodeling Quince on March 18th, in collaboration with many researchers. On June 24th, Quince received his first mission.

Winning over the Skeptics

There was skepticism at first. Quince was only a research robot, not a fully developed search and rescue instrument like iRobot's Packbot. And at first, the skeptics seemed to be right. On his first mission, Quince got stuck on the stairs while ascending due to a mistake in the building's blueprints. Learning from that event, the Quince researchers were later able to successfully maneuver Quince so he could travel to all the upper floors for his next five missions.

Quince's July 4th mission was particularly successful. Quince was assigned to check the status of the water spray cooling system. "Quince went to [the] 2nd floor and checked the pipes and valves." Takodoro recalls the excitement as Quince confirmed: "the cooling system is alive!" While there, Quince also measured radiation levels so plans could be made for workers to perform repairs for safe time durations. After that, there were few skeptics left.

Lessons Learned from Space Radiation

Although industrial robotics is a well-developed field, the area of search and rescue is just starting to come into its own – much like space robotics. The fields share similarities in that flex- ▸▸

> "There were so many problems where robots could have helped"

ibility and autonomy have increased importance when searching through a rubble field or scouting a planetary surface. In the case of nuclear accident response, they share one more commonality: radiation.

Quince wasn't designed to operate in a nuclear environment, so one of Tadokoro's priorities during the remodeling phase was to find out exactly how much of a problem radiation was going to be. For answers, he turned to his colleagues at Tohoku University. Space radiation can cause two types of damage to electronic boards: component damage and bit flips. Only the former is caused by gamma radiation, the type that is present in a nuclear reactor. The researchers were able to save a lot of time by focusing on mitigating only a specific type of hazard.

Shielding vital components on Quince would require much more weight than was available. "If it becomes such a heavy creature, the mobility is seriously lost," Tadokoro remarks. The increased weight would greatly reduce the mobility of the robot, and would make it impossible for it to climb Fukushima's stairs. Luckily, Tadokoro reported, "Quince has enough tolerance." Through a series of experiments testing component failure, the research group determined that Quince would survive for 400 hours with its non-radiation hardened components. This meant that Quince would be able to complete his mission without needing expensive radiation hardened components. This approach of using "good enough" off the shelf components is on the rise for short term, low cost space applications as well.

Quince's great success proved that search and rescue robots and even research robots are able to significantly contribute in disaster scenarios and keep humans from danger. Robots working together with humans produce incredible results when each is given the proper tasks. Quince, Packbot, and other search and rescue robots have an important role to play in future disaster management, as human-robotic cooperation does in future space exploration.

Quince benefited from space radiation research, and robots being designed to work with astronauts will benefit from insights gleaned from the search and rescue robots that work with rescuers. Research in this field is great for the space industry and greater partnership would benefit both.

Quince and the Future of Disaster Robotics

What next for Quince? After six missions, the original Quince unit got stranded in Fukushima, where he still sits, due to a worker accidentally severing his communication cable. But Quince is now a series of rescue robots. In the second and third iterations, the team focused on improving worker-robot and robot-robot interactions, so, for example, one Quince could save another Quince unit that encountered difficulty. "If one Quince stuck somewhere, another will come there and start communication," explains Takodoro, potentially saving the troubled unit.

The stranded Quince is now too radioactive to be recovered, but he has served his purpose and more. "The Tohoku earthquake was the first case where so much robotics were used," says Tokadoro. Given their success, disaster robotics is sure to become a popular field of research. One sign of such popularity is the newly created International Research Institute of Disaster Sciences within Tohoku University, of which Tadokoro is a member. "There were so many problems where robots could have helped," says Tokodoro. "It is important for responder agencies to have and use them every day through training and exercise."

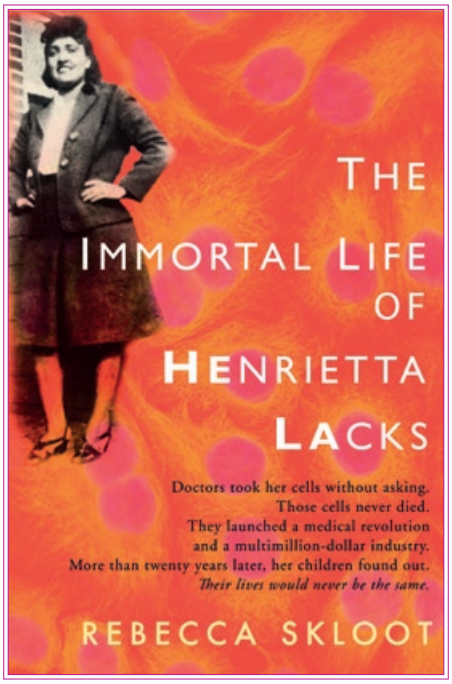
The development of disaster robotics has continued in Fukushima's aftermath with the recent announcement of a robot that uses dry ice to "vacuum" radioactive material. This robot joins a suite of disaster robots coming out of Japan. These and future developments will enable rescuers in the next disaster to respond more effectively and with less personal injury.

This type of debris-strewn room is exactly what Quince was designed to navigate.
Credit: International Rescue System Institute

Los Alamos National Laboratory Muon Radiography team assess the use of cosmic ray radiography to image locations of nuclear materials in the Fukushima Daiichi reactor complex.
Credits: US Department of Energy

By Tereza Pultarova

HeLa Cells: Immortal Space Travellers



Rebecca Skloot revealed the whole story behind the HeLa cells in her bestselling book "The Immortal Life of Hernietta Lacks." – Credits: Manda Townsend

It was early April 1961. As 27 year old Yuri Gagarin and 26 year old Gherman Titov were getting ready for the historic first manned spaceflight, still unaware of which of them would be chosen to fly first, a team of microbiologists from the Institute of Experimental Biology of the Soviet Academy of Medical Sciences were keen not to miss this excellent opportunity. The upcoming event meant they could send some new experiments into orbit and start answering the question: what effect does space environment have on cells and tissues? It was not simple scientific curiosity driving them. Everyone involved in the nascent space program was aware that such information would be vital if any future long duration exploration and maybe even colonization of outer space by humans were to be considered.

Among the samples they prepared for the journey were cultures of bacteria Escherichia Coli and human cancerous cells known as HeLa. Despite the reality of the Cold War, the team led by microbiologist N. N. Zhukov-Verezhnikov had acquired vials of HeLa cells from their American colleagues several years earlier. In fact, these cells made it to space prior to Gagarin, as they were on board the satellite Korabl-Sputnik 2 in 1960 [1].

HeLa cells were known since 1951 when George Gey, a scientist from the John Hopkins University Medical Center in Baltimore, US, managed to turn tissue taken from a cervical tumor of a 30 year old African American woman into the first immortal line of human cells.

First Cells to Survive in Lab

George Gey was the head of tissue culture research at Hopkins. He aimed his scientific efforts at keeping human tissue cultures alive indefinitely. Such a line of cells would be continuously dividing and replenishing itself. The cell line, descending from one original sample, would never die, and each generation would be identical to the previous one, making it a perfect standardized subject for scientific research in human microbiology. By 1951, each of his attempts had failed.

> These cells made it to space prior to Gagarin

That year, cervical cancer expert Richard TeLinde approached him and both men started working together. TeLinde's goal was to compare cellular characteristics of healthy cervical tissue with those of carcinomas in different stages of progress, in order to see whether the more invasive tumors differ from the less invasive ones on a microbiological level.

The deal was that TeLinde would supply Gey with tissue samples of patients his colleagues were operating on and Gey would culture them. Among the tissue samples that landed in Gey's laboratory in 1951 were two taken from a 31 year old African American woman named Henrietta Lacks – one containing healthy cervical tissue, the other one a tiny piece of her cervical tumor.

While the normal cells didn't survive long, those taken from the cancer began dividing at a remarkable rate, doubling every 24 hours. They weren't merely surviving, they were thriving! Soon, George Gey knew he had achieved a break through success – he had created the first ever immortal line of human cells! Taking the first two letters of the donor's first name and surname, the scientist named the cell line HeLa. Within months, Gey's team started growing HeLa cells in large quantities and distributing them for free to every researcher who expressed interest; a new era of breakthroughs in cellular biology commenced.

Who knows whether George Gey realized that the woman whose cells enabled him to achieve the greatest highlight of his career died that very same year. As super-fast as the cells were propagating in culture, cancer was spreading in Henrietta's body.

As super-fast as the cells were propagating in culture, cancer was spreading in Henrietta's body

She died without knowing that she entered science history books, her identity only revealed to the general public more than two decades later. In the 1950s, a patient's consent to provide tissue for scientific purposes wasn't needed and so Henrietta, as well as her family, was completely unaware that she had donated to science. Perhaps, she wouldn't even have understood.

Henrietta Lacks

Mother of five, Henrietta was an illiterate descendant of slaves. She was born and raised at the same Virginia tobacco farm where her captive ancestors used to live and work. According to available sources, she was one of ten children of Eliza and John Randall. Her mother died when Henrietta was just four years old, while giving birth to her youngest sibling.

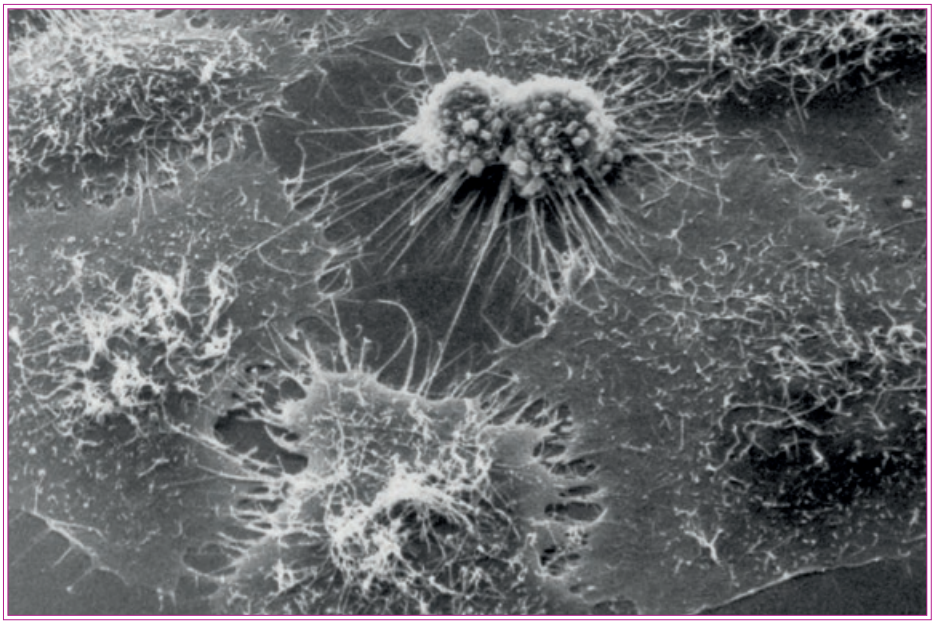
After Eliza's death, John Randall felt incapable to look after his large family. He took the children to Clover, Virginia, and left them with various relatives. Little Henrietta ended up living with her grandfather.

In 1941, she married her cousin David Day Lacks and later moved with him and their two eldest children to Maryland. Three more children followed during the next ten years, with the youngest one being born only four months before Henrietta was diagnosed with cancer.

It was January 1951 when she decided to go to the John Hopkins Hospital, the only medical facility in the region that treated African Americans. After giving birth, she started experiencing unusual bleeding. Her doctor discovered a small tumor on her cervix and prescribed a treatment with radium tubes. During a surgical procedure when the tubes were inserted, the surgeon also removed those two small tissue samples that were sent to the laboratory of Dr. George Gey.

In spite of the treatment, her condition was deteriorating rapidly. In August, she was admitted to and remained in the hospital until her death two months later. The post-mortem examination revealed that cancer had managed to spread throughout her body.

While her family was burying her body in an unmarked grave in her hometown of Clover, Virginia, scientists in the John Hopkins Hospital were already sending vials with her cells to researchers working on a polio vaccine. By 1954, these cells were being commercially mass produced and sold to scientists around the globe.



Electron microscopy image of HeLa cells dividing. – Credits: National Institutes of Health

Cells of Henrietta Lacks made it to space almost a year before Yuri Gagarin, here pictured during a 1964 visit to Malmö, Sweden. Credits: Sydsvenskan

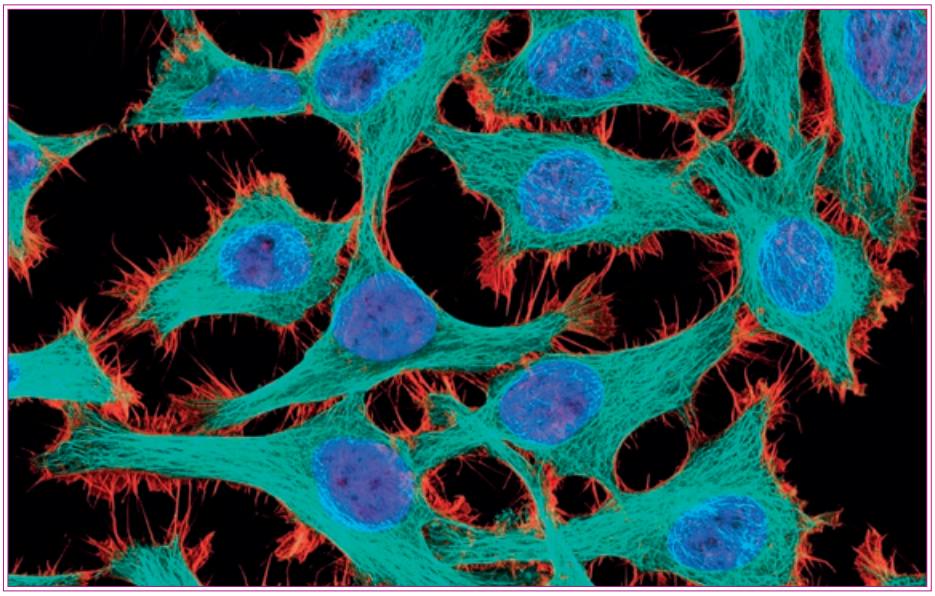
Medical Breakthroughs

Polio vaccine, research into cancer, AIDS, virology, effects of radiation and toxic substances, gene mapping – HeLa cells enabled researchers worldwide to push the frontier of human cellular biology a giant leap forward. According to Rebecca Skloot, author of the critically acclaimed 2010 book "The Immortal Life of Henrietta Lacks," more than 60,000 scientific articles have been published about research performed on HeLa cells.

Though today they are not the only immortal human cell line available, HeLa cells are still massively popular. It was on HeLa cells that scientists first examined human cell division in detail. These were the first human cells to be cloned, the first to enable accurate calculation of chromosomes, first to be centrifuged, to travel under the sea and into space. In 1965 scientists fused these cells with mouse cells and created the first cross-species hybrid. Remarkable achievements were made possible thanks to a woman who herself wasn't even able to write.

HeLa Cells in Space

When Yuri Gagarin successfully completed the first orbit and landed safely in Saratov, the USSR celebrated the glorious triumph over ▸▸



This 2-photon fluorescence 300x image of HeLa cancer cells won 12th place at the Nikon Small World 2011 competition. - Credits: Thomas Deerinck and Mark Ellisman, NCMIR, UCSD

their rival in the space race, the United States. The small container with cells of an unknown American woman was probably of interest only to Dr. Zhukov-Verezhnikov and his colleagues.

As Gagarin's flight lasted merely one hour, no special effects on the viability, proliferation, or morphology of HeLa cells were observed post-flight. Some interesting information started showing up later on, after the cells hitched a ride in 1962 on Vostok 4, in 1963 on Vostok 5 and 6, in 1964 on Voskhod 1, and on Zond 5 in 1968. Some discrepancies occur in the publicly available data from these missions, though.

Rebeca Skloot claims in her book that what space researchers found "was disturbing: in mission after mission, noncancerous cells grew normally in orbit, but HeLa became more powerful, dividing faster with each trip." However, as pointed out by Ari N. Schulman in an article entitled "What is the body worth" published in The New Atlantis, the results were not all that straightforward. Based on the information available in a Soviet paper published in 1964 and Katherine J. Dickson's "Summary of Biological Spaceflight Experiments with Cells," it seems that even though there were several cases when the proliferation and viability of HeLa cells increased after spaceflight, there was a similar number of occasions where these properties were unchanged or even decreased.

This of course doesn't belittle the importance of the first immortal human cell line to take flight in the history of space microbiology.

> "Mission after mission, HeLa became more powerful, dividing faster with each trip"
>
> R. Skloot

Some sources suggest that HeLa Cells were also on board of the 1960 US satellite Discoverer 18, but no significant effects were observed post flight.

Ethical Issues

When journalists started inquiring about the origin of the HeLa cells, they were frequently given false clues. The woman who provided the tissue was claimed to be called Helen Larson or Helen Lane. It was only in 1973 when Henrietta's name was leaked to the press. At that time, the Lacks family was still living in complete poverty in Baltimore and southern Virginia. Despite the fact that the biotechnology industry had made billions from the cells of Henrietta, the Lacks weren't even able to afford health insurance.

In fact, the only time when researchers actively reached out to the Lacks was to ask them to donate blood for genetic testing. The dangerously viable HeLa cells, being able to survive on gloves, hands, dust particles, or unsterilized laboratory equipment, had contaminated other cellular cultures and researchers wanted to find genetic markers to help them sort out the HeLa cells from the rest.

Exposing the background of the story initiated a broad public discussion about patients' rights and ethics of tissue research and business. Despite certain controversy, the family has never been offered any compensation.

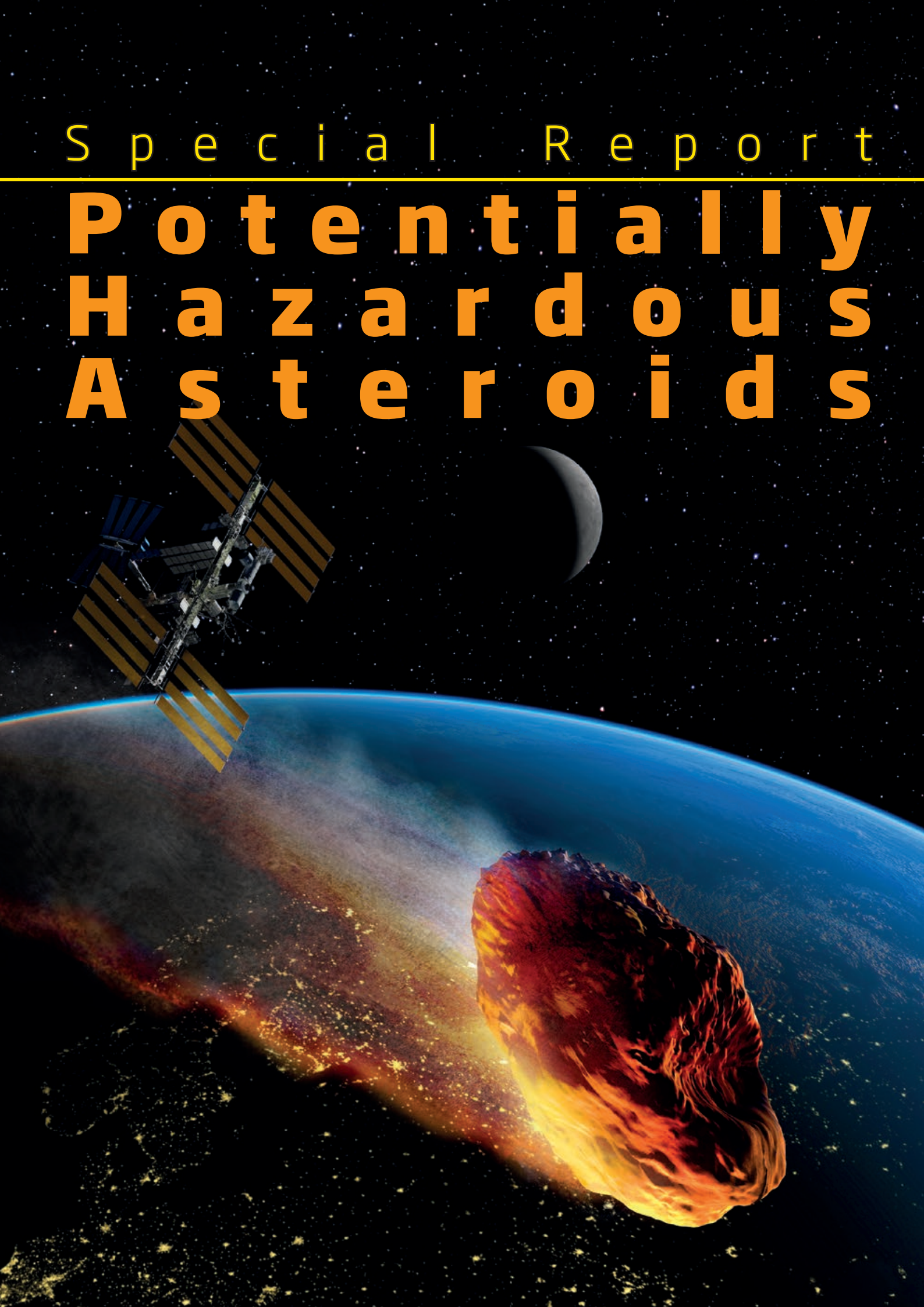
In 1970, George Gey, the man who created the first immortal human cell line from the cervical tumor of Henrietta Lacks, was diagnosed with pancreatic cancer. According to Rebecca Skloot, he asked the surgeons who were scheduled to perform a procedure to remove his tumor to cut out a small piece of the cancerous tissue from his liver. His wish was to create his final immortal legacy – a cell line cultured from his own cells. But that wish was not fulfilled. After cutting open his body, the doctors discovered that cancer had already spread to the lymph nodes, lungs, and heart. It was too late for him; no operation could have saved his life. To Gey's great chagrin, the doctors didn't take any tissue sample. He entered the history books, but wasn't allowed to live on as a part of the research to which he had devoted his whole life. This privilege was meant to stay with Henrietta.

[1] Dickson, Katherine J. 1991. Summary of biological spaceflight experiments with cells. ASGSB Bulletin 4(2):151-260.

Astronaut Frank de Winne works with the cell biology experiment facility in the Japanese laboratory KIBO. – Credits: ESA

Special Report

Potentially Hazardous Asteroids



PLANETARY DEFENSE: THE TIME HAS COME

By Joseph N. Pelton

Shortly after 0900 local time, on a crisp February day in Chelyabinsk, Russia, Marat Ahmetvaleev went to one of his favorite spots to catch some photographs of the rising sun. Instead, he captured this streak of fire, smoke, and stone. At maximum brightness, the burning 17m rock travelled at 18.6km/s.

For a small percentage of the many trillions of US dollars spent on military systems, the people of Earth could invest in protecting ourselves against one of the great perils to the human race, near Earth objects (NEOs), Potentially Hazardous Asteroids (PHAs), and other space rocks. We have now suddenly become alerted to this danger by a battleship-sized rock that crashed down over Siberia on February 15, 2013. It came down with the force of a nuclear weapon and injured thousands of people and buildings. Yet it was just 15 meters across.

We need a global planetary defense program because these lethal space hazards can kill us all at once, or totally wipe out the infrastructure that allows us to sustain a human population that could reach 12 billion by 2100. A big enough asteroid could also stir up a dust cloud that could block out the Sun and ultimately kill most of the vegetation that sustains us and warms our planet.

A TIMELESS THREAT

Space rocks have the power to damage or exterminate life as we know it on planet Earth. Today we think we know where 90% of all near Earth objects or hazardous space rocks larger than one kilometer in diameter are. Yet that leaves 10% unaccounted for. Perhaps more scary is that 80% or more of the space rocks smaller than one kilometer are still unidentified.

NASA has calculated that if the space rock named Apophis, about 300 meters in diameter, were to hit us at 64,000 kilometers per hour it would cause an explosion equivalent to perhaps a thousand atomic bombs. The amount of damage that could be done is almost impossible to estimate.

Neil deGrasse Tyson, American astrophysicist and TV personality, explains that these space hazards have been threatening to kill life on Earth for eons. He has noted

how, some 65 million years ago, an eight kilometer wide space rock hit Earth on the coast of Mexico and left a 160 kilometer (100 mile) diameter crater. The dinosaurs did not have a space program to warn them and no preventive measures in place. Today the dinosaurs are gone, but the so-called K-T event that eliminated about two-thirds of all living species on Earth remains as a warning that it could happen again.

Since 1900 there have been 12 major earthquakes and tsunamis around the world with a total death toll that exceeds two million people. Since 1900 there have been four major volcanic eruptions that have taken lives with an estimated death toll around 105,000. Since 1900 there have been eight hurricanes, typhoons, cyclones, and floods with a total estimated death toll exceeding 6 million. Since 1900 there have been 10 major famines and pandemics that have resulted in some 100 million deaths.

Yet one collision by a near Earth object like Apophis would not only release the equivalent of thousands of atomic bombs, but very likely would result in more deaths than all of these catastrophes combined—by a wide margin.

SMARTER THAN DINOSAURS?

There are a lot of things we need to do smarter and better with respect to ensuring the survival of humans than we are doing. We need a program of planetary defense that could be carried out at much less than 5% of what we are currently spending on space-related activities. This is something we should be doing if we really want the human race and many other species to stick around and survive. Former astronaut Rusty Schwieckart and his B612 Foundation believe that a great deal could be accomplished within a budget of just $250 billion. But what specifically should we do under a Planetary Defense undertaking?

First of all, we need to expose the world community to the Torino Scale, a classification method adopted at Unispace III that explains on a scale from 1 to 10 what the threat level is from potentially hazardous asteroids and the likelihood of their occurrence based on what we know. This needs to be updated as we acquire more knowledge.

Second, we need to up our game to find out what dangers from NEOs are actually out there. NASA's Wide Field Infra-Red Survey Explorer (WISE) space probe provided a much better understanding of the 20,000 to 45,000 asteroids that could impact Earth in very unwelcome ways in coming decades, centuries, or even millennia. New space assets to identified hazards should be a priority. We need more resources like the 16 inch WISE system to track more precisely asteroids like 1999 RQ36. This asteroid is now thought to have a remote chance of actually hitting the Earth at some point before the year 2200, with the most likely impact date being 24th September 2182. The problem with 1999 RQ36 is the crowd that it hangs around with: a cluster of asteroids that are all characterized as NEOs. We need to find not only dangerous asteroids, but dangerous clusters like this one.

Third, we need to better understand phenomena that could impact and change the orbit of NEOs and bring them on a collision course with Earth. The recently discovered Asteroid 2011 AG5 (first noted in January 2011) could clobber us in 2040 if it should hit the so-called "gravitational keyhole" as it circles the Sun, altering course enough to put it on a lethal trajectory. Even the Sun's radiation impacts trajectories via the Yarkovsky effect and we need to study and better understand this effect as well.

THE TORINO SCALE

No Hazard	0	The likelihood of collision is zero, or is so low as to be effectively zero. Also applies to small objects such as meteors and bolides that burn up in the atmosphere as well as infrequent meteorite falls that rarely cause damage.
Normal	1	A routine discovery in which a pass near the Earth is predicted that poses no unusual level of danger. Current calculations show the chance of collision is extremely unlikely with no cause for public attention or public concern. New telescopic observations very likely will lead to re-assignment to Level 0.
Meriting Attention by Astronomers	2	A discovery, which may become routine with expanded searches, of an object making a somewhat close but not highly unusual pass near the Earth. While meriting attention by astronomers, there is no cause for public attention or public concern as an actual collision is very unlikely. New telescopic observations very likely will lead to re-assignment to Level 0.
	3	A close encounter, meriting attention by astronomers. Current calculations give a 1% or greater chance of collision capable of localized destruction. Most likely, new telescopic observations will lead to re-assignment to Level 0. Attention by the public and by public officials is merited if the encounter is less than a decade away.
	4	A close encounter, meriting attention by astronomers. Current calculations give a 1% or greater chance of collision capable of regional devastation. Most likely, new telescopic observations will lead to re-assignment to Level 0. Attention by the public and by public officials is merited if the encounter is less than a decade away.
Threatening	5	A close encounter posing a serious, but still uncertain treat of regional devastation. Critical attention by astronomers is needed to determine conclusively whether or not a collision will occur. If the encounter is less than a decade away, governmental contingency planning may be warranted.
	6	A close encounter by a large object posing a serious, but still uncertain treat of global catastrophe. Critical attention by astronomers is needed to determine conclusively whether or not a collision will occur. If the encounter is less than three decades away, governmental contingency planning may be warranted.
	7	A very close encounter by a large object, which if occurring this century, poses an unprecedented but still uncertain treat of global catastrophe. For such a threat in this century, international contingency planning is warranted, especially to determine urgently and conclusively whether or not a collision will occur.
Certain Collisions	8	A collision is certain, capable of causing localized destruction for an impact over land or possibly a tsunami if close offshore. Such events occur on average between once per 50 years and once per serveral 1000 years.
	9	A collision is certain, capable of causing unprecedented regional devastation for an impact over land or possibly a tsunami if close offshore. Such events occur on average between once per 10,000 years and once per serveral 100,000 years.
	10	A collision is certain, capable of causing a global climatic catastrophe that may threaten the future of civilization as we know it, whether impacting land or ocean. Such events occur on average between once per 100,000 years, or less often.

The Torino Scale is a method for categorizing the impact hazard associated with near-Earth objects (NEOs) such as asteroids and comets.

Finally, we need a well-funded NEO-Shield program to develop the most effective way to divert hazardous space rocks away from an Earth collision or to steer them into the Sun.

To begin this process, the space agencies of the world should form a group like the Inter Agency Space Debris Coordinating Committee (IADC) to coordinate and develop an integrated program to undertake all of the above activities and more. This should include new IR space systems like the WISE probe and more ground-based observations to track PHAs. New research to study aspects such as the keyhole and Yarkovsky effects should be funded, and new targeted ways found to cope with asteroids in killer orbits. This threat, along with other problems associated with solar flares and coronal mass ejections are key cosmic dangers that space agencies and groups like the B612 Foundation, the International Space Safety Foundation, and the International Association for the Advancement of Space Safety need to address seriously.

Dr. Joseph Pelton is Former Dean of the International Space University and Chair of the IAASS Academic Committee.

INFRASONIC DETECTION OF METEORITES

By Matteo Emanuelli

Exploding 32km off the ground with the force of 30 atomic bombs, the Chelyabinsk meteor arrived. Traffic stopped throughout the region as the sky briefly flashed bright white, washing out even the morning Sun. Only after the flash had passed did the sonic boom reach the city: the total impact energy was 440 kilotons of TNT. With the boom came the shattering of thousands of panes of glass, injuring 1200 people. The -17°C cold of the Siberian morning rushed into every building.

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In the early morning hours of November 17, 1998, a bright fireball was observed over northern New Mexico, about 150km away from Los Alamos. The bolide was part of the annual Leonid meteor shower. Although the event did not produce any sonic boom reports, it was detected by an infrared radiometer and by an intensified camera located in the state. Los Alamos National Laboratory (LANL) investigated the sighting in its role as a part of the International Monitoring System (IMS) created following the Comprehensive Test Ban Treaty (CTBT). LANL found the presence of an infrasonic signal detected by six infrasound arrays. The signal matched the time and the direction of the fireball seen in the sky. The infrasound recording indicated that the explosion occurred at 93.5 kilometer, matching the measurements from the camera. The velocity obtained for the bolide from the signal was between 920 and 1150km/s. The meteorite was calculated to have a source energy equivalent to about 1.14 tons of TNT, where source energy is the kinetic energy when the shock wave is produced because of the passage through the atmosphere or the fragmentation of the meteoroid itself.

METEORS AND NUCLEAR WEAPONS

CTBT bans all nuclear explosions in all environments for military or civilian purposes. It was adopted by the United Nations General Assembly in 1996 but it has not entered into force as of April 2012, since it has been ratified by only 36 countries of the 44 required. One of the points of the treaty is to establish and operate 337 facilities of the IMS; as of April 2011, the system was 80% complete. To detect nuclear explosions, IMS employs infrasound stations using microbarographs (acoustic pressure sensors) to detect very low frequency

sound waves. The investigation conducted by Douglas O. Revelle and Rodney W. Withaker at LANL showed that these detectors could also have been used to detect and measure objects entering the atmosphere. More recently, infrasound detectors were used to study the meteorite that exploded over Chelyabinsk, Russian Federation, on February 15, 2013.

Earth's orbit through the solar system passes through much solid particle debris from both comets and asteroids. These meteoroids can arrive from very different orbits and are composed of different materials such as iron, rocky stones, or carbonaceous compounds. Moreover, they can have a large range of possible sizes and densities as well as a large range of possible entry velocities.

The interaction of these meteoroids with the atmosphere produces shockwaves, partly due to the very high speed at entry and partly due to the compressibility of the atmosphere. The entry speed can typically range from 50 to 300 times the speed of sound (Mach) while, to make a comparison, Lockheed SR-71 Blackbird, the fastest manned air-breathing craft, had as maximum peak speed Mach 3.2. A direct consequence of this high speed is an explosion generated along a cylindrical path on the entry trajectory. The blast wave radius delineates the size of the region in which an explosion has occurred. Large meteoroids, such as the one that exploded above Chelyabinsk, penetrate the atmosphere down to heights where the atmosphere is sufficiently dense to produce a shock wave. While thunder usually produces a sound source with a wavelength on a scale of about 2-3m, the shock wave generated by meteorites can range from 10 meters to many kilometers in length. Sound sources of such magnitude in the atmosphere can have very large amplitudes, enough to break glass windows at close range as observed in the Chelyabinsk region. The frequencies are low enough that they can be characterized as infrasound, meaning the peak energy is below the range of audible sound waves.

As the blast wave radius increases, the frequencies become progressively lower. In the Tunguska event, in 1908, ultra-low sound frequencies of 1/60 Hz were observed at great distances from the entry trajectory.

LISTENING TO INFRASOUND

According to Revelle, an array of low frequency sensors horizontally separated by a few hundred meters to a few kilometers can be used to determine both the direction and the elevation angle of the signals. The determination uniquely locates the infrasound sources in a three-dimensional space within the atmosphere within certain errors.

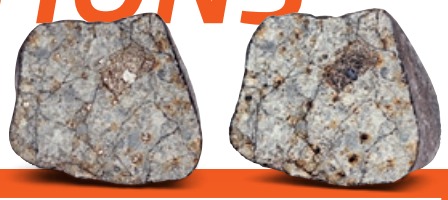
Such data are also useful to estimate the frequency of occurrence of certain types of meteoroids. Revelle estimates that an event with the energy level of 10Mt, such as Tunguska, is likely to happen once every 120 years. However, data from infrasound measurements reported that 30 ±9 large bolides with an energy level of 0.1kt are likely to enter Earth's atmosphere every year. The data shows that the number of entering debris increases as the source energy decreases and vice versa.

Historically, the primary source of data collection for reentering objects has always been visual or optical observations. However, due to the extensive deployment of ILS infrasound sensors, this mode has shown its relevance along with radar and optical observation for the study of meteor physics. The Los Alamos investigation was one of the first times that infrasound detection has been used to study objects reentering the atmosphere. Revelle's pioneering theoretical work on interaction between meteors and atmosphere led the way for future studies.

Within moments, the sky cleared of any traces of the flaming meteor, leaving the city to gather its wits, begin cleaning up, and ask how such a thing could happen with no warning at all. An asteroid had been expected February 15, with the well predicted record breaking passage of 2012 DA14. Many experts spent the days that followed insisting that their predictions had not been off: the Chelyabinsk Meteor came from another direction entirely.

UNITED NATIONS REVIEWS ASTEROID IMPACT IMPLICATIONS

By Leonard David



It did not take long for the scramble to begin. After an unsuccessful search at the bottom of a murky, frozen-over Lake Chebarkul for the stone that created a 6m hole in its icy surface and a 3m crater in its bed, meteorite hunters began scouring the region. These images, taken by a resident of Chelyabinsk on February 28, show the blackened stones standing out sharply against the pristine snow.

It could be considered a cosmic convergence of celestial objects and international politics – but also a wake-up call. The Russian fireball detonation over Chelyabinsk and the close fly-by of Earth by asteroid 2012 DA14 in February came at a moment in time when near Earth object (NEO) experts were convening to scope out international responses to NEO threats to our planet.

Detailed talk about the Russian event and asteroid 2012 DA14 punctuated the agenda of Action Team-14 (AT-14) during the 50th session of the Scientific and Technical Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS), held February 11-22 at the United Nations headquarters in Vienna.

The United Nations Office for Outer Space Affairs (UNOOSA) serves as the Secretariat to the Working Group on NEOs of the Scientific and Technical Subcommittee and supports the work of the AT-14 on NEOs. Sergio Camacho, a former UNOOSA Director, serves as the Chair of AT-14.

DELIBERATIONS AND DECISION-MAKING

The multi-year work of AT-14, a group that was established in 2001, is focused on pushing forward on an international response to the NEO impact threat. AT-14 has been deliberating over the years regarding the makeup and focus of an Information, Analysis and Warning Network (IAWN), designed to gather and analyze NEO data and provide timely warnings to national authorities should a potentially hazardous NEO threaten Earth.

In a draft report of the Working Group on NEOs following deliberations in Vienna, it was noted that there are three primary components of threat mitigation: 1) discovering hazardous asteroids and comets, and identifying those objects requiring action; 2) planning a mitigation campaign that includes deflection and/or disruption actions and civil protection activities; and 3) implementing a mitigation campaign, if the threat warrants it.

This meteorite, one of the largest found, was eventually recovered from Lake Chebarkul by Victor Grochowski, the Ural Federal University expedition leader. Compositional analysis showed the meteorite to be a carbonaceous chondrite containing 10% iron. It likely came from the Apollo group of near Earth asteroids.

Photography by Pavel Matsev and Denis Panteleev
http://pavelmaltsev.ru

The Working Group emphasized the value of finding hazardous NEOs as soon as possible in order to better characterize their orbits. This would help to avoid unnecessary NEO threat mitigation missions or facilitate the effective planning of missions, should they be deemed necessary.

ACTION ITEMS

At the February gathering in Vienna, given the output from AT-14, the Working Group recommended that three actions should be taken. First, an international asteroid warning network, open to contributions from a wide spectrum of organizations, should be established by linking together the institutions that are performing the proposed functions, to the extent currently possible. While existing institutions address discovering, monitoring, and physically characterizing the potentially hazardous NEO population, such a network would introduce an internationally recognized clearing house for the receipt, acknowledgment, and processing of all NEO observations. Such a network would also recommend criteria and thresholds for notification of an emerging impact threat.

Second, the IAWN would interface with the relevant international organizations and programs to establish linkages with existing national and international disaster response agencies to study and plan response activities for potential NEO impact events. It would also recommend strategies using well-defined communication plans and procedures to assist governments in their responses to predicted impact consequences. These communication linkages do not limit the possibility of organizing additional international specialized advisory groups, if necessary.

Finally, a Space Mission Planning Advisory Group (SMPAG) should be established by Member States of the United Nations that have space agencies. The group should include representatives of spacefaring nations and other relevant entities. Its responsibilities should include laying out the framework, timeline, and options for initiating and executing space mission response activities. The group should also promote opportunities for international collaboration on research and techniques for NEO deflection.

AT-14 further detailed an Impact Disaster Planning Advisory Group (IDPAG), a body that would be initiated by IAWN. Its duty would be to study past large-scale disasters and develop action plans should an asteroid impact occur. It would be formed by representatives of existing national and international disaster response agencies.

MORE WORK TO DO

Detlef Koschny of the European Space Agency's European Space Research and Technology Center (ESTEC) in Noordwijk, The Netherlands, is an active member in the UN NEO Action Team and working group discussions. In his view, there are a number of items still on the table to be dealt with.

"Well, of course the immediate next steps will be to start implementing what we have proposed," Koschny told Space Safety Magazine; however, he flagged the fact that there are a few things still open. "We need to focus more now on looking outside our direct 'NEO-expert horizon.'"

"The Impact Disaster Planning Advisory Group needs to be established," he added. "We still have work to do in the legal area." For example, just assume the IAWN informs COPUOS about an imminent impact and the SMPAG and IDPAG provide their input on how to react. Suppose it is predicted to hit a country without space capabilities. "How can we ensure that proper action is taken? People have asked what the legal framework for this would be. We have started to address these things, but much more work needs to be done," Koschny emphasized.

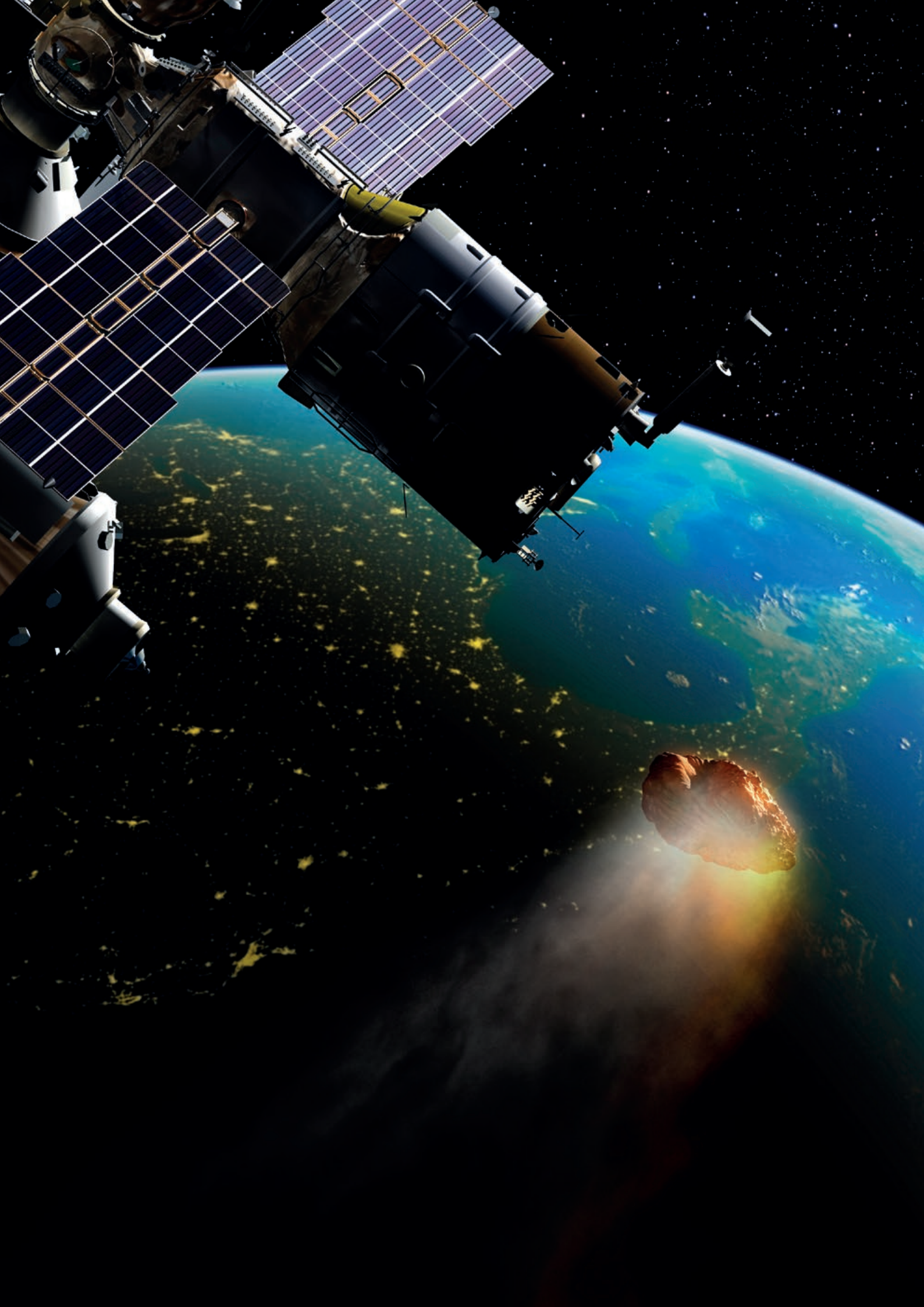
In Europe, Koschny pointed out that there is the additional complexity of countries with their own space agencies – plus a European Space Agency. "Often this setup is advantageous, but it also adds another layer into the whole process which we now need to address. So, while I am very happy that we came as far as we did, there is still a lot before us!"

GIGGLE FACTOR: GOING, GOING, GONE

The fireball detonation over Russia, coupled with the very close passage by Earth of space rock 2012 DA14 "certainly underscored the importance of the UN Working Group on NEOs," said Ray Williamson, a senior advisor to the Secure World Foundation and also a member of AT-14.

"The giggle factor…that's gone, over, done with," Williamson told Space Safety Magazine.

"We are in a lot better shape," Williamson added. "There is certainly more awareness of the issue worldwide. And that is worth something…in the sense that now countries are aware that they need to put some expertise into the equation and also resources to provide information that would ultimately protect Earth from these threatening asteroids."



Under Pressure: A Brief History of Pressure Suits
Part 2

By Phillip Keane

In the previous issue, we examined the sub-aquatic origins of the pressure suit, effects of pressure and high acceleration on the human body, and the development of pressure suits until the end of WWII.

The Jet Age

Although the turbojet had been designed in parallel by English engineer Frank Whittle and German engineer Hans Von Ohain, jet engines were largely ignored until 1944, when the RAF and Luftwaffe began using jet aircraft operationally. Jet engines allowed for even higher acceleration than previous piston engines, and due to the compressors inherent in turbojets, allowed aircraft to fly at much higher altitudes where the air was less dense. This development meant that the human body would be subjected to stresses far greater than anything before, and required further innovations in pressure suit design.

The SK-1 spacesuit. – Credits: Mikhail Shcherbakov

The Cold War

Following the Second World War and the newly invented jet engine, the Cold War caused a surge of aviation development, including high speed and high altitude based projects such as the X-1, X-15, and the Lockheed Martin U2 programs. Pilots of the X-1 aircraft were the first to utilize the operational capstan pressure suits, specifically the S-1 and later the T-1. It was reported, however, that Chuck Yeager wore a standard flight suit for the first supersonic flight, as he didn't reach a sufficient altitude where a pressure suit would be needed.

During the late 1940s and through most of the 1950's, the US Air Force (USAF) and US Navy divided their efforts in terms of development. USAF focused largely on partial pressure suits for their fighter pilots whereas the Navy focused on developing full pressure suits with immersion protection for the pilots who ended up "in the drink." One such naval development was the Mark 1 Mod III Omni-Environmental full pressure suit, which was designed by BF Goodrich. This suit underwent many modifications over a 10 year period, and culminated in the Mark IV, which formed the basis for the suits worn in the next chapter of American pressure suit development: the Mercury program and the dawn of the Space race against the USSR.

> The Cold War caused a surge of aviation development

Orbit and Beyond

The 1957 launch of Sputnik-1 by the Soviet Union had caused panic in the American government, which resulted in the creation of NASA and ARPA the following year. The race to put a man into space began with initiation of the American Mercury program and the Russian Vostok program.

The Russians succeeded in placing Yuri Gagarin into orbit on April 12th, 1961. For the purpose of this spaceflight, the SK-1 spacesuit was developed by Russian company NPP Zvezda. The SK-1 was used on all Vostok missions, with a modified version, designated as SK-2, used for Valentina Tereshkova, the first woman in space. The SK-1 was a full pressure type suit, and was designed to keep the cosmonauts alive for up to 5 hours in the event of cabin pressure loss.

In March 1965, Alexey Leonov became the first man to perform an EVA from his Voskhod-2 spacecraft. Leonov used the SK-1 derived Berkut spacesuit, which contained additional life support equipment. At the end of the EVA, the suit ballooned due to the vacuum, which prevented Leonov from reentering the capsule. He was forced to bleed air out of the suit to enter the vehicle.

The American Mercury program ran from 1959 to 1963, and was also ▶▶

Gemini suits were seen as adequate for the purpose until the Apollo 1 fire

directed towards putting a man into orbit. The Goodrich Mark IV suit was seen as adequate for that purpose. However, the subsequent Gemini and Apollo programs required EVA maneuvers, and therefore additional protection from temperature extremes and radiation.

For the Gemini missions, NASA worked with David Clark Company to create the G3C and G4C suits based on the suits used by the X-15 pilots. The Gemini suits were constructed of six layers of nylon, including an interior nylon bladder and Nomex.

America made its first EVA in June 1965 as part of the Gemini 4 mission. The G4C suit used on Gemini 4 was similar in construction to the G3C, except it contained extra layers of Mylar to aid with thermal insulation, and a visor to prevent blindness during EVA. The early versions of the full pressure helmet contained a plexiglass faceplate, whereas the later models used polycarbonate. These suits were used on all Gemini missions except Gemini 7, which used a stripped down version of the G3C, known as the G5C, to enable donning and doffing whilst on the longer duration mission. Additionally, the G5C featured a soft hood, which could be removed far more easily than the fiberglass helmets of the previous models.

For the initial Apollo Block 1 tests, NASA utilized a slightly modified G3C suit, which was given the designation A1C. The main innovation in the A1C was an inflatable "Mae West" device, which was necessary in case of emergency water landing following launch escape. The Gemini suits were seen as adequate for the purpose until the fire in Apollo 1 forced NASA to insist on fireproofing on the exterior of the suits. The contract for the Apollo suits was then awarded to ILC Dover, and the new Apollo Block II suits were designated as A7L. The A7L was used on all manned Apollo missions, as well as Skylab and the Apollo-Soyuz missions. Neil Armstrong described the suit as "tough, reliable and almost cuddly." The AL7 was the suit used during EVA on the lunar surface. Additional features on the EVA version included a micrometeoroid shield and cooling system, which interfaced with the astronaut's backpack. The A7L was used until the discontinuation of Apollo in 1975, and lent many of its features to high altitude flight suits in the same period.

Jim Lovell wearing the hooded G5C suit, prior to the launch of the Gemini 7 mission. – Credits: NASA

The Soviet Union had also been developing suits for their ill-fated lunar landing program. In 1967, NPP Zvezda began development of the semi-rigid Krechet-94 pressure suit. This suit weighed in at 90kg, and had an aluminum alloy torso with flexible arms. It also contained a rear entry system, to enable quicker donning and doffing, which also contained an integrated life support system. This rear entry hatch bears some resemblance to the rear entry system on the experimental Z-1 suit currently in development by NASA. At the same time, the Soviet Union began development of the Orlan spacesuit, which was designed primarily for EVAs in microgravity. Variants of the Orlan have been used on space stations ever since, and are still used today onboard ISS.

A Krechet-94 suit, showing the entry port and integrated life support system.
Credits: Richard Kruse, Historicspacecraft.com

Combat Edge

The high altitude U2 and SR-71 programs spawned a protective garment that evolved into the partial pressure Launch Entry Suit, and later the full pressure Advanced Crew Escape Suit (ACES), both of which were used on the Space Shuttle. These Shuttle suits were designed and manufactured by the David Clark Company. A modified version of the ACES suit is being developed for use on the future manned Orion missions. The ACES suit is also similar in design to the Russian Sokol suit, which is used by astronauts who fly on board the Soyuz. Both the ACES and Sokol are intended to protect the crew in the event of cabin pressure loss, and are unsuitable for EVAs.

The 1970s saw the rise of the 4th generation of fighter jets, including the F-15 and F-16. What was remarkable about these aircraft was their high thrust to weight ratios, which enabled the aircraft to perform perfectly ▶▶

NASA astronaut Rex Walheim undergoes a fit check of his Sokol spacesuit in 2011. Credits: NASA

vertical climbs for sustained periods of time, meaning loads of +9-Gz, and rapid ascent to high altitude. The ultra maneuverability of these new aircraft meant pilots required new garments allowing extra levels of protection as well as increased flexibility to operate the planes.

These new requirements led to the creation of the Tactical Life Support System development program, which combined g-suit garments with pressure breathing equipment in a single ensemble, as opposed to previous efforts that focused on developing separate garments. In addition to the acceleration and altitude protection, the program aimed to equip the suits with NBC protection (Nuclear Biological Chemical), liquid cooling garments, and thermal flash protective goggles. Several different ensemble variations were presented to the USAF; however, the final suit selected for operation consisted of an extended pressure-vest/torso garment, a modified CRU-73 regulator, and a CSU-13B/P type g-suit. This ensemble would ultimately evolve into the Combined Advanced Technology Enhanced Design G-Ensemble, also known as "Combat Edge."

The Combat Edge ensemble is still used by fighter pilots today, although its efficiency and safety has been questioned in the light of several recent F-22 Raptor incidents, where pilots have experienced hypoxia-like symptoms. Initial reports had pointed to a fault in the breathing regulator/anti-g (BRAG) valve, that forces the vest to remain inflated, even when the pilot is not undergoing heavy g-loads. It is suspected that this garment is forcing the pilots into a state of shallow breathing, which in turn causes hyperventilation. The root cause has not yet been completely established, although investigators will be looking into all protective garments worn by F-22 pilots. Whatever the result of the investigation, given the fact that in the early 1970s pilots were still wearing pressure suit and g-protection countermeasures which had their roots in WWII technology, it may be a good time to ask why 21st century fighter pilots are wearing technology that was developed for 1970s aircraft.

Neil Armstrong described the A7L as "tough, reliable and almost cuddly"

The series continues in the next issue, where we will look at the future of pressure suits, including NASA's Z-1 and the Biosuit.

F-22 Raptor pilots have had a spate of incidents in which overinflated vests caused hypoxia-like symptoms. – Credits: US Air Force

By Matteo Emanuelli

Training for Fear
Interview with Mindy Howard

First came Dennis Tito, introducing the reality of commercial space tourism when he funded his own trip to the International Space Station (ISS) via a Russian Soyuz in 2001. He was quickly followed by Mark Shuttleworth in 2002, Gregory Olsen in 2005, Anousueh Ansari in 2006, Charles Simonyi in 2007 and 2009, and Guy Laliberté in 2009. Apart from their passion for space, they all had in common a very large wallet to fund their journeys, which cost up to $40 million for some flights.

In 2004, the space competition Ansari X Prize, won by Scaled Composites with SpaceShipOne, opened the way to commercial, and cheaper, suborbital flights. About 500 people have already booked a $200,000 ticket to space with Richard Branson's Virgin Galactic aboard SpaceShipTwo. Space Expedition Corporation is offering $95,000 tickets aboard XCOR's Lynx Space plane starting 2014. EADS Astrium and Armadillo Aerospace have also announced space tourism projects.

Dr. Mindy Howard, flight member of Astronauts4Hire, created Inner Space Training (IST) when she realized that soon a lot of people would get access to space without sufficient preparation. Howard is a New Yorker who moved to the Netherlands in the early '90s to get a PhD in Industrial Engineering from Eindhoven University. She always dreamed of becoming an astronaut and she applied to NASA's astronaut selection, entering several times into the "Highly Qualified Astronauts Candidate" list in the last 18 years. Unfortunately, she has not yet been successful in making it to the interview stage of the application. In the meantime, she started working at Royal Dutch Shell Group as a Human Factor Engineer. She had a number of different roles in her 17 years at Shell, ending up as Global Manager for Sustainability. When Shell went through a reorganization, Howard volunteered to leave the company to resume pursuit of her dream to go into space and Shell offered her the opportunity to take the National AeroSpace Training and Research (NASTAR) Center for Suborbital Scientist Training Program, which provides specific training for prospective "Suborbital Scientist-Astronauts" wishing to fly experiments on upcoming suborbital space missions.

IST addresses the mental and emotional challenges that may be experienced during flight

A US Air Force pilot looks discomfited as he undergoes centrifuge training, his trainer looking on. – Credits: US Air Force

Flight Psychology

The idea for IST was born at NASTAR. "When we were in the centrifuge there was a camera on people's faces and you can see people's eyes become wide when they were scared," says Howard. She noticed that there were a lot of differences in terms of how people were performing and psychologically reacting to centrifuge, altitude, and different g-forces. "I was really surprised," says Howard, "when I asked people if there were any courses or training out there to help people psychologically" to not be fearful and was told there were none. Howard realized there was a need for dedicated space training to teach people how to deal with stressful situations and fear relating to the space experience.

Most of the future commercial astronauts, both suborbital scientists and space tourists, will likely have only one chance to achieve the "once in a lifetime experience" that is a suborbital flight. It is therefore advisable for participants to acclimate psychologically before the flight to get the most out of the experience. IST addresses the mental and emotional challenges that may be experienced during flight, alleviating such challenges by ensuring that participants understand each phase of flight and know what to expect and what comes next. This understanding, commonly called situational awareness, provides the conditions for a peak experience.

Although IST was originally designed for commercial astronauts, since the majority of the training relates to dealing with stressful and fearful situations, it can also be useful for people that are not necessarily going to space.

Dr. Mindy Howard demonstrates the MindSpa Brainwave Entrainment device.
Photo Courtesy of Mindy Howard

There are space-specific elements but there are also parts that are all about preparing for and recovering from a life-changing event.

Training Objectives

IST's training objectives deal with preparing for before, during, and after the flight in terms of understanding the challenges of the different flight phases and appropriate responses to deal with these challenges while they are happening. Moreover, the training teaches how to deal with other passengers on the flight. This component of the training is especially applicable for Virgin Galactic flights, where there will be six people on board. Each of those passengers will have their own personal objectives that can possibly interfere with each other. Knowing how to reconcile the different experiences the passengers want to have on the flight is an important part of ensuring a worthwhile experience. The course equally approaches how to deal with coming back to Earth, how to make good use of a life-changing event, and using the memory of the experience in a positive way. IST adopts MindSpa, a specific tool that uses Brainwave Entrainment technology. The human brain has repetitive neural activity, called brainwaves, that occur at different frequencies. There are alpha waves, delta, theta, beta, and gamma. Depending on different states of mind there are different dominant frequencies; when a person is concentrated and calm, alpha activity (8-12Hz) is dominant. Brainwave Entrainment is a kind of "high-tech and quicker version of meditation," says Howard. It uses binaural beats, in which subjects listen to sounds at two different frequencies (200Hz and 210Hz). The brain interprets the difference of 10Hz, forcing itself into an "alpha" meditative state. While hearing this sound, a trigger or anchor is also introduced to train the brain to recognize the link between the calm state and the anchor. So, when in a stressful situation, recalling the anchor will instantly trigger the calm state or at least drop the level of fear.

Howard believes that when people start to fly in larger numbers, more people will become aware of the necessity for space training to involve psychological preparation, not just a health clearance stating that the customer is prepared to withstand gravitational forces. Commercial companies as well as insurers should strongly recommend training to, on one hand, ensure the customer's experience, and on the other hand, guarantee that everything possible has been done to keep the customer and other passengers safe.

Beyond Commercial Space

According to Howard, NASA and ESA are not focusing too much attention on psychological and emotional training because they have very much a technical focus. There is the idea that if astronauts are well trained for the mission, they don't need to necessarily think about the psychological fear that they might experience, because they can deal with it using their technical training. However, this perspective doesn't consider that even if astronauts get trained in mission objectives, they are still human and they still get scared and have anxiety. Howard believes that for longer spaceflights, like a mission to Mars, more psychological issues will certainly come up. From a mission specific point of view, it is not possible to train for every conceivable challenge, particularly because of the wide range of issues a mission like that can involve. The astronauts, because of the delay in communications with mission control, will have to develop self-sufficiency in dealing with psychological challenges. Howard has no doubt that future astronauts involved in exploration missions must be provided with psychological training and situational tools to ensure their ability to deal with stress, fear, and other issues that can endanger the mental balance of astronauts on a mission.

Brainwave Entrainment is a kind of "high-tech and quicker version of meditation"

ESA astronauts performing EVA training at the Neutral Buoyancy Lab. According to Dr. Howard, technical training alone is inadequate to prepare spacefarers for their journey. – Credits: ESA/NASA

By Giulia Federico

iDocking
Interview with Iacopo Baroncini

Soyuz controls "look like old sink knobs from the beginning of the 20th century"

Every space enthusiast dreams of having a chance to go into orbit on a space mission. Besides the excitement of the launch, the exhilarating experience of floating free in microgravity and the stunning view, the chance to "test drive" a real spacecraft during on-orbit operations is a once in a lifetime opportunity that many dream of. Iacopo Baroncini, known as Spacedroider by his fans, has designed and developed SoyuzSimulator, an affordable mobile application to train aspiring cosmonauts to dock a Soyuz to the International Space Station (ISS). And we are not talking about an ordinary cell phone game: the app has been complimented for its realism by astronauts and cosmonauts who tried it. Space Safety Magazine had a chance to meet Baroncini and learn about his app, how he came up with the idea to develop it, and what he plans for the future.

Training as an Astronaut in Cologne

Baroncini is an eclectic and creative engineer from Livorno, Italy. Space was not his original dream: "I studied computer engineering at the University of Pisa and worked at Scuola Superiore di Perfezionamento Sant'Anna in its facility for robotic sciences for a few months," he explains.

Then, in 1997, he joined the ESA Young Graduate Trainee program as ground segment software engineer. "When I started as a trainee, I didn't know that space would be so important for me," he says. Baroncini describes his first approach to the space world as "like when you meet the woman of your life. Without any plan in mind, you suddenly fall in love with her." Today he works as a project manager in the Strategic Planning and Outreach Office of ESA's Directorate of Human Spaceflight and Operations. During one of his trips to the European Astronaut Centre in Cologne, he fulfilled a dream shared by many space enthusiasts: "I had the opportunity to experience basic astronaut training and to test their simulator for manual Soyuz docking to ISS."

He was impressed by Soyuz's functional, yet vintage, design from the sixties, and he took inspiration from the contrast between modern touch screen reality and the old and bulky Soyuz systems that could nevertheless maneuver a capsule in outer space with an accuracy of centimeters. "Today there are digital components, but some elements such as the control knobs, have not changed at all," he explains. "They really look like old sink knobs from the beginning of the 20th century that you can move as joysticks. They are made for astronauts' heavy gloves that do not allow nimble movements."

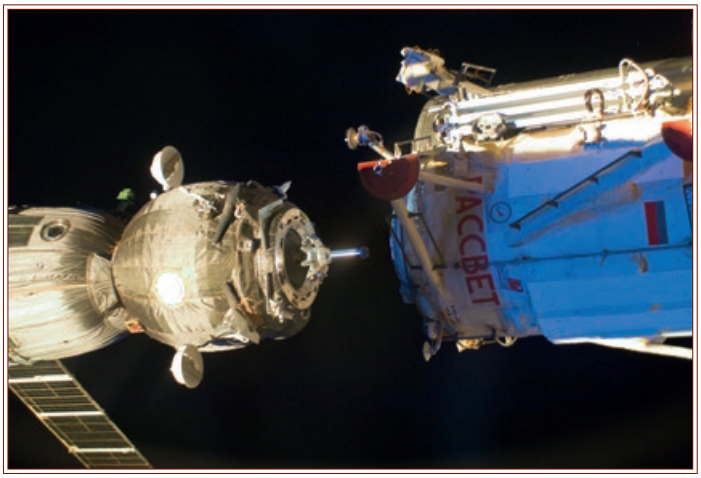
Baroncini came up with an idea to share his unique experience with everybody: "I developed the idea of an application that could simulate the Soyuz docking system without trivialization." There are no similar applications on the market, Baroncini noted: "There are flight simulations apps, which are sold to a large range of prices, but nothing to dock a Soyuz to the ISS." So he got to work on the idea.

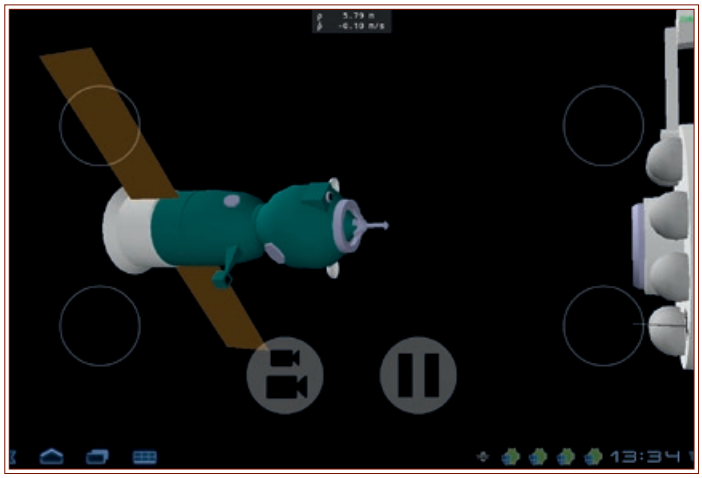
Iacopo Baroncini inside the Soyuz Simulator at the European Astronaut Centre in Cologne.
Photo courtesy: Iacopo Baroncini

Creativity and Engineering

Baroncini immediately opted for the Android platform that he appreciates for its open source nature, for the use of the Java language and for the availability of the Opengl 3D library. "I also considered doing the same for iPhone but because I had limited time I never followed through," he adds.

"I designed a simple 3D model of the ISS and performed all the math to calculate orbital mechanics." ▸▸





A Soyuz docking to Rassvet module (left) compared to Baroncini's simulated Soyuz docking to Zvezda module. Note how the 3D model is both simple and accurate. – Credits: NASA and Iacopo Baroncini

Baroncini wanted a 3D model that could be both accurate from the point of view of simulation and simple from the point of view of rendering. Such compromise allowed him to recreate the docking experience without overloading the limited resources of the tablet system, "otherwise the user would have a lousy view," he explains.

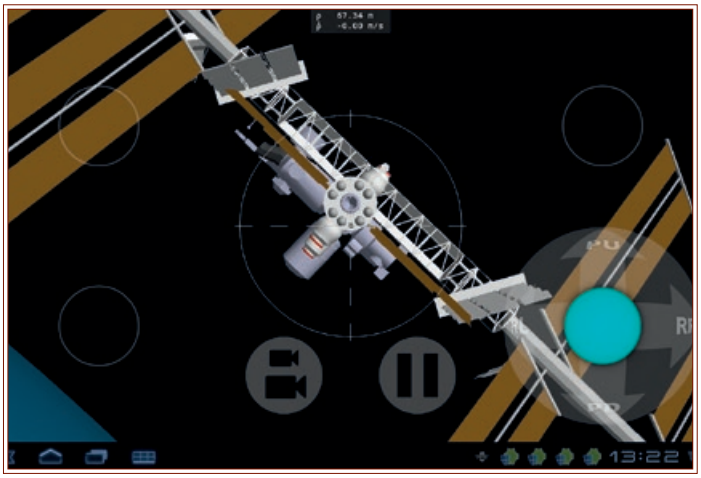
The app simulates docking scenarios to the aft port of Zvezda, to the zenith port of Poisk, and to the nadir ports of Pirs and Rassvet. The virtual knobs on the touch screen enable the user to control the attitude and trajectory of the spacecraft with respect to the docking target. The user can select from two different points of view: Soyuz's periscope view and virtual camera. Movements and speed of rotation "were the fruit of empirical estimation based on the simulator at Cologne and docking videos," says Baroncini.

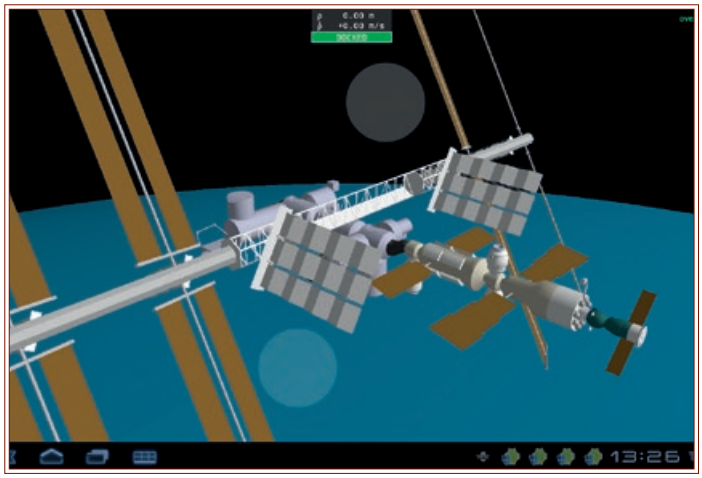
Before using the application, the user must read an introduction document that explains how the application works and how the Soyuz moves. When this phase is concluded, the user can decide whether to buy the application or not. The cost is €2.75, a reasonable price for a space adventure. "My idea was not meant for commercial use, but for fun and education," says Baroncini. "In these cases, a few cents could really change the sorts of the application on the market. I just wanted some recompense for the tools I used to develop the application and the time I spent."

> "Engineering is for me an instrument to transform an idea into something concrete"

The promotional video for the app is, as Baroncini describes it, "made from nothing: my creativity has helped me to develop audio and video content." Baroncini enjoyed the whole process. "It took me 5 months, about 6 hours per week. I met some astronauts during a conference: Paolo Nespoli, Samantha Cristoforetti and Sergei Krikalev. They gave me positive feedback, especially Krikalev, who knows the Soyuz inside out."

"Now I am waiting for another good idea," says Baroncini about the future. He needs something that will make use of both his technical and creative sides to really get excited. "Engineering is for me an instrument to transform an idea into something concrete," he says. "I need a good input, and from that I start to develop the idea. The most important step is when I decide to make it real: I am waiting for this kind of inspiration."





Two screenshots of the app, showing two different views: Soyuz's periscope view (left) and the virtual camera view (right). Credits: Iacopo Baroncini

Safety Design for Space Operations

Interview with Tommaso Sgobba

By Andrea Gini

Editor(s) : F. Allahdadi, I. Rongier & P. Wilde
Editor in Chief : T Sgobba
Elsevier, Apr 2013
Hardcover, 1072 p.
ISBN: 9780080969213

The needs posed by commercial infrastructures like Virgin Galactic's SpacePort America in New Mexico require a new generation of safety-aware engineers and managers.
Credits: Virgin Galactic

> "Advancing space safety requires first of all the improvement of safety education"

The International Association for the Advancement of Space Safety (IAASS) has just published the book "Safety Design for Space Operations" (Elsevier, 2013). The book comes four years after "Safety Design for Space Systems," a university level textbook recently translated into Chinese. With contributions from more than 40 authors, chosen from among the best in their respective fields, the project was coordinated by IAASS President Tommaso Sgobba, and edited by Dr. Firooz Allahdadi, Isabelle Rongier, and Dr. Paul Wilde.

This unique reference brings together essential material on several key topics in operations safety design that were previously only available dispersed over several unrelated textbooks and papers. The book reviews the best design practices relating to space operations, such as the design of spaceport facilities for unmanned and manned missions, and containment design for nuclear powered payloads. It presents advanced analysis methods, such as those used to calculate launch and reentry debris fall-out risk and to select safe trajectories. It covers the implementation of safe operation procedures, such as rendezvous and docking, collision avoidance maneuvers, and on-orbit space traffic management. Finally, it deals with safety considerations relating to the general public, aviation, and the environment, in addition to ground personnel and asset protection.

Covering launch operations safety relating to manned missions as well as unmanned missions, such as the launch of probes and commercial satellites, "Safety Design for Space Operations" provides a comprehensive reference for engineers and technical managers within aerospace and high technology companies, space agencies, spaceport operators, satellite operators, and consulting firms. Space Safety Magazine met with Sgobba to learn more about this book and its expected impact on the industry.

A Unique Book

The idea behind this book is related to IAASS' belief that advancing space safety requires first of all the improvement of safety education," says Sgobba. "Its purpose is to complement 'Safety Design for Space Systems,' providing the complete reference set for the establishment of much needed future graduate and postgraduate education programs in space systems safety," he says.

Sgobba explains that space safety engineering is not generally taught in aerospace engineering schools, as it is currently not considered a specialized branch of space systems engineering but rather as a sparse set of issues related to various specialized fields of engineering. "Engineers selected for performing safety related jobs currently receive only some focused on-the-job-training, but no wide specialized education," he adds. "They end up developing their knowledge through internal information exchanges, brain storming, discussions, and short seminars in a sort of master-to-apprentice relationship with senior expert colleagues."

Space safety, as defined by the IAASS, is not only about safety of astronauts and cosmonauts and about space vehicles design: it includes spaceport operations safety, prevention of collisions in space, ground and atmospheric pollution, space debris mitigation and ▸▸

Tommaso Sgobba, IAASS President and Editor-in-Chief of Safety Design for Space Operations, during a 2011 IAASS convention in Washngton. – Credits: Andrea Gini

remediation, as well as anything that can ensure the safety of the uninvolved public during launch and reentry. "This is the first and only book to date covering all aspects of safety in space operations," he says. "It identifies all key technical principles and contributes very much to defining space safety as a specialized branch of systems engineering."

The Need for Safety Engineering

The ultimate goal of Sgobba and his colleagues is to stimulate the emergence of a new technical profile, the space safety engineer, "to support and execute the design and operations safety certification processes covering all mission phases from launch to on-orbit and reentry or disposal, and to expand the safety engineering knowledge of project teams."

Sgobba believes that the complexity of space systems design, combined with that of the organizations involved in its realization, demands broader knowledge of the key principles and techniques of safety engineering, and a multidisciplinary awareness of the associated hazards and potential vulnerabilities inherent in the system and its operations. "The difficulty of minimizing the occurrence of design errors is exacerbated by the limited systems safety engineering culture of design teams as a whole," he says. According to Sgobba, future safety and system engineers must gain a broad understanding of multidisciplinary safety aspects in order to be able to perform integrated analyses and resolve risk issues at the earliest design stage of a program. Managers and other non-safety engineers involved in space program teams need to gain certain basic knowledge and awareness of space safety engineering.

Safety and International Cooperation

In an era characterized by a competitive industry regulated by market laws, confidentiality concerns, and international regulations limiting technology transfer, Sgobba believes that it is time to reconsider the role of communication and cooperation to ensure the safe development of the sector.

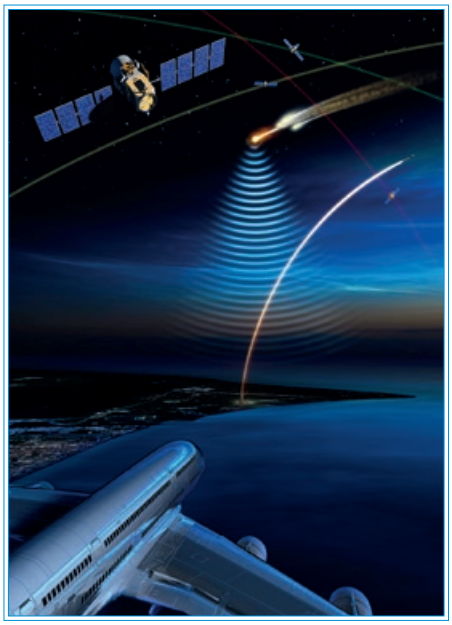
"In the early decades of space missions, the US and USSR tried to protect their leadership in space technologies as a strategic advantage for military, commercial, and foreign policy dominance," he explains. But human spaceflight programs in China and India, along with the emerging human spaceflight industry, have demonstrated that the time for technological monopolies in space projects is past. "Today, the growing awareness of space threats is pointing towards the need for wider international cooperation in space," he adds. "The awareness is rising that competition is in the past, while cooperation is the future, in two directions. One is the involvement of all space faring countries in future human planetary exploration programs, like missions to Mars. The other is the unavoidable cooperation to make commercial space activities in the orbital Earth space safe and sustainable."

The importance of international cooperation is also stressed by Yannick

> "Competition is in the past; cooperation is the future"

d'Escatha, president of the French space agency CNES, who wrote the book's preface. "The publication of this book is a fine and promising example of the pooling of experience acquired in the safety issues surrounding space operations, of the benefit of public safety and the protection of the environment," writes d'Escatha in the preface. "I am certain that the relationships and the dynamic created during this project will contribute to future success in international scientific and technical cooperation in the field."

According to Sgobba and the IAASS, interoperability and safety of space systems is the future. "Technological and foreign-policy dominance will not be assured through ITAR or other isolationistic measures," he concludes. "Society organizational models, national prosperity, and quality of life improvements will be achieved by pursuing innovation leadership in a world that is getting more and more globalized and interdependent, characterized by a free flow of information. Around the common safety goals it is not only possible, but also necessary to create a new vision of national and international cooperation in space missions."



Artist's conception of air and space traffic management. – Credits: Kristhian Mason

Mysterious Sphere Found in Texas

Dean Gentz, an American electrician, spotted a strange object in his cow pasture near the tiny town of Buna, east Texas. When he decided to pick it up, he was astonished: the 35 cm diameter object didn't look like anything Mr. Gentz had ever seen before. "The way one side of the sphere was melted – I didn't think someone could have done that with a torch, plasma arc, arc gouge, or any other means I knew about. Also, the melted metal spalling was blown back over the sphere; I knew that it had been done in an 'event,' not by humans."

As he continued his examination, Gentz became suspicious that the object might in fact be space debris. "I saw what I thought was a sure sign it was from the aerospace industry. The plug and the 'bung' where the plug was screwed in were both drilled twice for safety wire. That was the biggest thing – the safety wire holes!" he recalls.

Dean Gentz and his mysterious space ball. - Photo Courtesy: Dean Gentz

The whole mystery was leaked to local media when a similar sphere was discovered in a nearby pasture. So far, NASA has exhibited no interest in Gentz's find. If you have any idea what the object might be, let us know. We will keep you posted on the developments and hopefully will be eventually able to find the truth.

Source: Tereza Pultarova

Read the full story:
http://bit.ly/gentz_sphere

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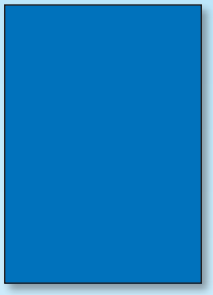

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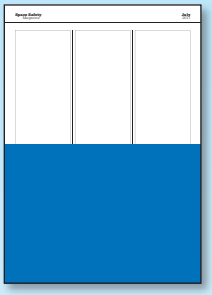

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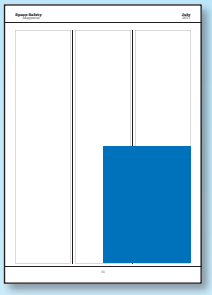

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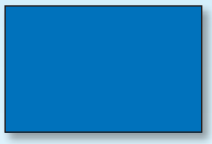

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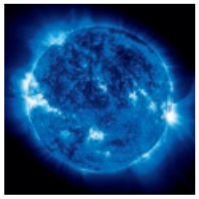


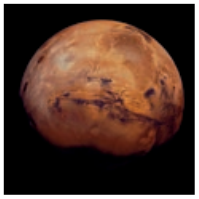


Commercial Airliners, Electrical Grids Weathering the Solar Storm

Despite warnings that Tuesday's massive solar flares and associated coronal mass ejection (CME) might cause disruptions to power systems on Earth, th almost no effects as X-class s flares, solar storm since 2005, were predicted to cause a geomagnetic storm of between

Robotic Refueling Mission Demo Underway on ISS

Tests of tools and techniques for in-space servicing and refueling of satellites has begun on the ISS with the Robotic Refueling Mission (RRM) system, which was delivered to the ISS on the final Shuttle flight in July 2011.

A ect will Dextre robotic two-armed manipulator system, which was built by MDA Space

Capturing Aurorae from Space

Astronaut Don Petit is no stranger to aurorae. He's taken photographs of aurorae from space on each of his three missions - to ISS in 2002, the Space Shuttle in 2008 and now on his second stay aboard the space station. After his first mission, Petit described

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Red Lines in Outer Space

Source: Matthew Kleiman and Sonia McNeil for The Space Review Secretary of State Hillary Rodham Clinton recently announced that the United States would join international efforts to develop an International Code of Conduct for Outer Space Activities. Space systems are "of vital interest to

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Quality Assurance for Space Projects
25-27June 2013
Athlone
Ireland

2013 SEPTEMBER 23-27
64th IAC
23-27 September 2013
Beijing
China

2013 JUNE
Composite Overwrapped Pressure Vessels (COPV) Best US Practices
June 2013
Munich
Germany

2013 OCTOBER
Materials for Space Projects
October 2013
Livorno
Italy

2013 SEPTEMBER
Reliability for Space Projects
September 2013
Athlone
Ireland

2013 NOVEMBER
ISS Payload Safety
November 2013
Bergen op Zoom
Netherlands