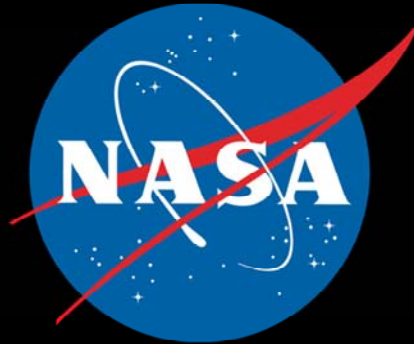


**NASA Technologies:
For the Benefit of All Mankind**

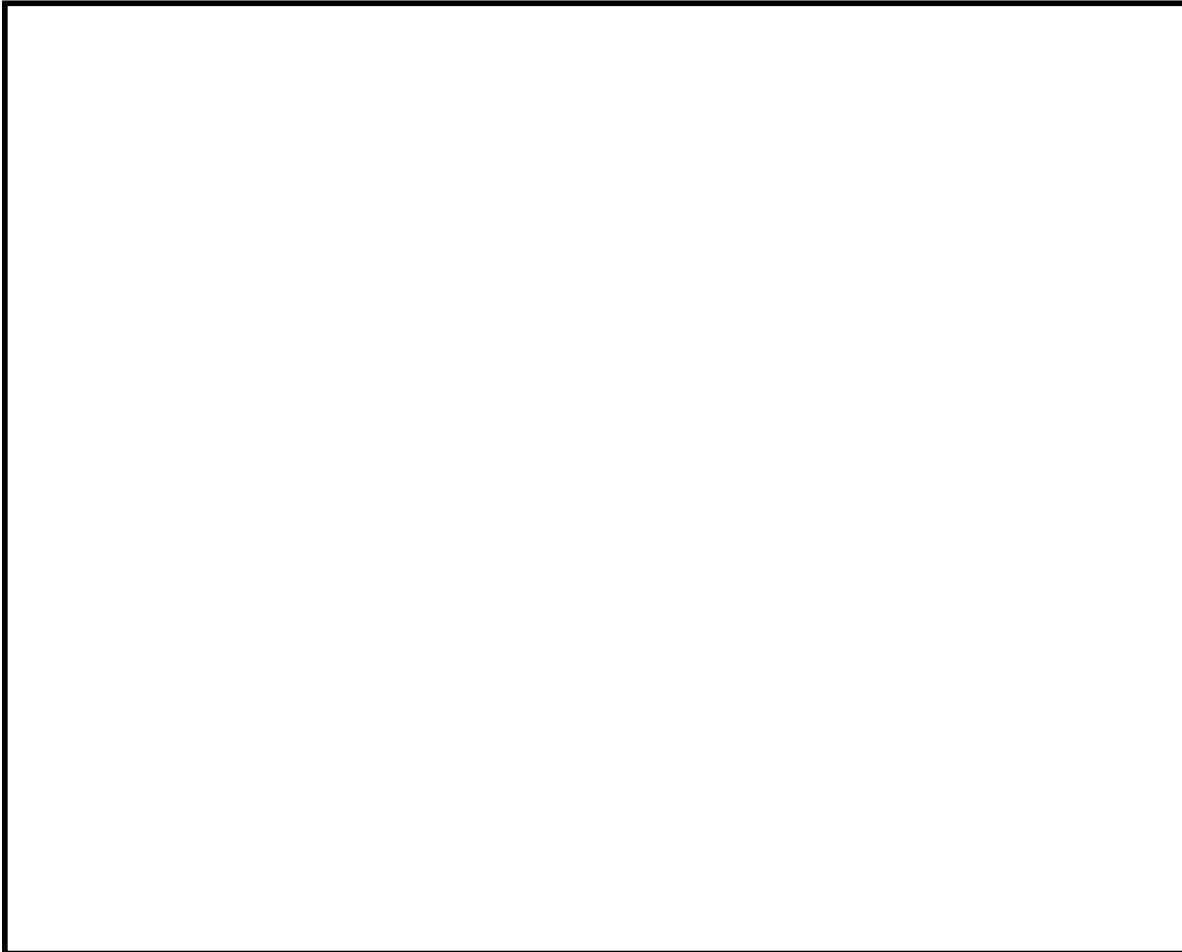


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53rd General Session of the United Nations
Committee on the Peaceful Uses of Outer Space

Vienna, Austria
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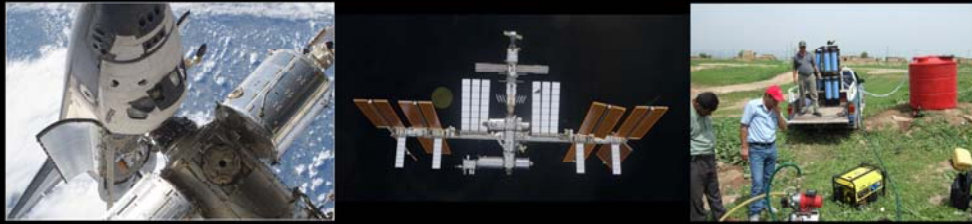
NASA and Public Benefit

- NASA has a long history of applying technologies for public benefit.
- NASA's direction to do this traces to the Space Act that created NASA in 1958:

"The Congress hereby declares that it is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind."

- The Act goes on to say that NASA should:

"Provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof."



Since its creation over 50 years ago, in addition to pushing back boundaries in science and exploration, NASA has nurtured partnerships to transfer its technologies for broad public benefit.

These benefits reach throughout the economy and around the globe.

The basis for NASA's desire to provide these benefits can be directly traced to the opening declaration of policy and purpose of the National Aeronautics and Space Act that created NASA in 1958, which said:

"The Congress hereby declares that it is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind."

The Space Act further directs NASA to:

"provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof."

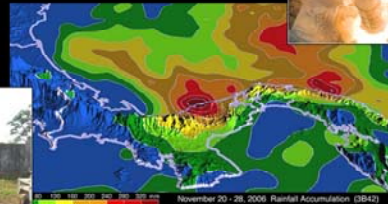
The National Aeronautics and Space Act, Pub. L. No. 85-568, 72 Stat. 426 (Jul. 29, 1958) As Amended.

http://www.nasa.gov/offices/ogc/about/space_act1.html

NASA Technology: For the Benefit of all Mankind

- NASA technologies are being used across the planet for the benefit of the developing world in important areas:

- Clean Drinking Water
- Improved Agriculture and Food Distribution
- Telemedicine and Wireless Networks
- Environmental Monitoring and Management
- Disaster Warning and Relief
- Educational Resources
- Energy Storage
- Hazard Reduction



While many NASA activities, particularly in Aeronautics and Earth Science, are specifically intended to address solutions to Earth's global challenges, there are also corollary benefits to much of NASA's technology whose development was spurred by other mission-focused applications. When NASA technology is put to use in an application that provides public benefit, but is different from that for which the technology was originally developed, that new application is referred to as a spinoff.

Each year, in NASA's *Spinoff* publication, the agency highlights 40-50 recent examples of NASA technology put to public use for the greater benefit of humankind. Over 1,650 such examples have been documented and are available and searchable online.

These repurposed NASA technologies often make significant contributions in other arenas, such as solving problems in developing countries. This briefing provides some representative examples of how NASA technologies directly benefit the developing world in the following areas:

- Clean Drinking Water;
- Improved Agriculture and Food Distribution;
- Telemedicine and Wireless Networks;
- Environmental Monitoring and Management;
- Disaster Warning and Relief;
- Educational Resources;
- Energy Storage; and
- Hazard Reduction.

Learn about NASA spinoffs at spinoff.nasa.gov, and see how they are present in houses and cities at www.nasa.gov/city.

A searchable database of NASA more than 1,650 documented spinoffs is available online at <http://www.sti.nasa.gov/spinoff/database>.

Clean Drinking Water



- The Microbial Check Valve (MCV) was developed to ensure safe water for space explorers and has been used on all Space Shuttle missions.
- Lack of clean water is a problem for over 1 billion people on Earth.
- This MCV technology developed for space is now deployed in rural areas and developing countries around the world.



**Kampung Salak,
Malaysia**



Kendala, Iraq



Chiapas, Mexico

According to the United Nations, there are 1.1 billion people, or 18 percent of the world's population, who lack access to safe drinking water; and an estimated 42,000 people die every week from diseases related to poor water quality and an absence of adequate sanitation. The major sources of this contaminated water are bacteria, viruses, and cysts.

Ensuring a supply of clean water on-orbit is critical for safe operations of the Space Shuttle and the International Space Station.

- To address this technology challenge for NASA, the Microbial Check Valve (MCV) was developed by the Umpqua Research Company of Myrtle Creek, Oregon, with funding from NASA's Small Business Innovation Research (SBIR) program.
- Since its development, MCV technology has been used on every Space Shuttle mission, to prevent growth of pathogens in the crew's drinking water supply, and is now also the basis for water purification systems currently deployed in rural areas and developing countries around the world.
- Deployment of these systems in developing countries is accomplished through a licensing partnership.
- The Water Security Corporation (WSC) of Sparks, Nevada has licensed the MCV technology from Umpqua and now provides MCV-based systems to developing countries where the lack of safe drinking water is a serious health concern. See video at <http://www.youtube.com/watch?v=wlsM0ervlcw>.
- <http://www.sti.nasa.gov/spinoff/spinitem?title=Clean+Water+for+Remote+Locations>

Applications of this technology include:

- Vera Cruz, Mexico; October 2008 flood relief.
- Kendala, Northern Iraq; System mounted on truck services multiple Kurdish villages, cleaning well water; Sponsored by Concern For Kids, non-profit charity; See video at http://www.watseco.com/video/broadband_water_iraq.html.
- Sabana San Juan, Dominican Republic; 300 person mountain village, Nearest drinkable water 5 miles away, permanent unit cleans contaminated spring water, using solar power.
- Chiapas, Mexico; Systems deployed in small remote villages providing only potable water.
- Bakalot, Pakistan; Earthquake relief, water gravity fed from mountain stream.
- Kampung Salak, Malaysia; Pedal-powered unit providing only safe drinking water to community of 600 people, pursuing development of network of systems in 11 Southeast Asia countries.

Improved Agriculture and Food Distribution



- NASA conducts research on plant growth and food safety for space missions.
- Increased crop yield, disease resistance, and food preservation are key challenges facing farmers in developing nations.
- NASA research yielded growth chambers and ethylene reduction systems.



AiroCide helps farmers avoid rotted crops by extending the time to market in India and elsewhere.



Minitubers resist disease and increase crop yield throughout the world.

The Expedition 20 crew members share a meal in the Unity node of the International Space Station. There is a lot of research that goes into making sure their food is nutritious and safe. This research yields important applications that benefit developing countries.

To conduct research on plant growth in space that could provide a food source for long duration space missions, NASA developed growth chambers that incorporated unique lighting technology, high-efficiency temperature and humidity controls, and automation technology.

- American Ag-Tec International used this growth chamber as the perfect vehicle for growing minitubers, which serve as nuclear seed stock for potatoes.
- This allows minitubers to be grown year-round in extreme environmental settings, such as deserts or excessively cold regions.
- The ability to accelerate the growth cycle of minitubers allows for the introduction of new varieties of potatoes that grow more than three times faster than those grown using other methods.
- The production of these minitubers—enabled by space technology—eliminates seasonal and geographical limitations and increases crop yield. These tubers are also more resistant to disease and are available for shipment and distribution throughout the world.
- <http://www.sti.nasa.gov/spinoff/spinitem?title=Space+Age+Spuds>

NASA-funded researchers produced an ethylene reduction device for a plant growth unit, designed to remove the naturally-occurring ethylene, a ripening agent, but also capable of removing other airborne contaminants.

- KES Science and Technology Inc., specializing in sustaining perishable foods, licensed the ethylene scrubbing technology and partnered with Akida Holdings, which now markets the NASA-developed technology as AiroCide.
- The AiroCide technology is being used in remote regions of the world, where harsh environments and underdeveloped infrastructure complicate food storage and distribution.
- AiroCide also reduces infections by providing photocatalytic air purifiers in remote hospitals that can eliminate bacteria, mold, fungi, viruses and even anthrax.
- <http://www.sti.nasa.gov/spinoff/spinitem?title=Air+Purifiers+Eliminate+Pathogens%2C+Preserve+Food>

Telemedicine and Wireless Networks



- **NASA needs telemedicine for remote delivery of medical care for spaceflight missions.**
- **Remote regions have limited infrastructure.**
- **Space telemedicine technology is being applied in many locations around the world.**



Intelesense networks in Vietnam, Thailand and Iraq are improving public health monitoring.



In Ethiopia, a network links 126 remote medical clinics to 5 hospitals.

NASA needs technologies for remote delivery of medical care – or telemedicine – for long-duration spaceflight missions.

To help develop those technologies, the National Biocomputation Center was established as a partnership between the Stanford University School of Medicine's Department of Surgery and NASA's Ames Research Center.

A spinoff company, Intelesense Technologies, is applying this technology in many locations including Vietnam, Ethiopia, and Pacific Islands.

- In Ethiopia, the company is developing a network for communicating public health information from 126 remote medical clinics to 5 hospitals.
- The sensors connect all these players with a robust, wireless infrastructure, in an area where there is no reliable cellular or telecommunications network, and even power supplies are unreliable.
- <http://www.sti.nasa.gov/spinoff/spinitem?title=Sensor+Network+Provides+Environmental+Data>

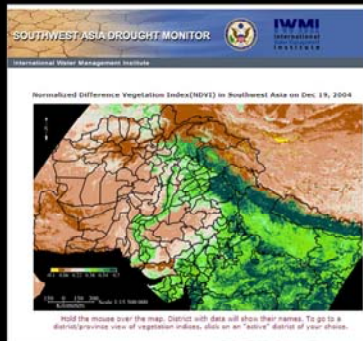
NASA Johnson Space Center, Henry Ford Hospital in Detroit, and Houston-based Wyle Laboratories collaborated on NASA's Advanced Diagnostic Ultrasound in Microgravity (ADUM) experiment, which developed revolutionary medical ultrasound diagnostic techniques for long-distance use.

- Mediphan commercialized this technology, drawing on NASA expertise to enable ultrasound users with minimal training to send diagnostic-quality ultrasound images and video to medical professionals via the Internet in near-real time—allowing patients in remote locations to receive medical attention as soon as it is needed.
- United Nations Millennium Project, which has among its goals improved maternal care in underserved areas, plans to use the telemedical procedure in developing countries.
- The plan is to use the techniques and technologies developed for use on the ISS to diagnose a wide variety of medical issues, such as traumatic injury, problematic pregnancies, and certain infectious diseases.
- <http://www.sti.nasa.gov/spinoff/spinitem?title=Image-Capture+Devices+Extend+Medicine%27s+Reach>

Environmental Monitoring and Management



- NASA has a network of Earth observing spacecraft with many applications, such as:
- Famine Early Warning Systems Network (FEWS NET) in Africa, providing early warning on emerging food security issues.
- The South Asia Drought Monitor (SADM) supplying timely information on drought onset, progression and areal extent.



The purpose of NASA's Earth science program is to develop a scientific understanding of Earth's system and its response to natural or human-induced changes, and to improve prediction of climate, weather, and natural hazards.

(<http://appliedsciences.nasa.gov/>)

Some examples of space-derived data used to solve water-related problems here on the Earth:

- Altimetry products are being used for lake and reservoir elevation monitoring.
- Data from the Moderate Resolution Imaging Spectrometer (MODIS) on the Terra and Aqua satellites is used for various applications, including:
 - Products for use by the Famine Early Warning Systems Network (FEWS NET) in Africa. FEWS NET is a USAID-funded activity that collaborates with international, regional and national partners such as NASA to provide timely and rigorous early warning and vulnerability information on emerging and evolving food security issues. (<http://www.fews.net/Pages/default.aspx>)
 - Products for use by the South Asia Drought Monitor (SADM). SADM is an evolving international drought monitoring tool supported in partnership with the U.S. that works to supply timely information on drought onset, progression and areal extent; (<http://dms.iwmi.org/index.asp>)
- Landsat data is used internationally to estimate evaporation rates to better manage water resources.
- Data from the U.S.-Japanese Tropical Rainfall Measuring Mission (TRMM) is used internationally to estimate flood potential.
- Satellite precipitation products (from TRMM and other missions) are used internationally to monitor heavy rain events and prepare landslide forecasts.

Forecasting key ecological parameters can support accurate prediction of many important factors as much as 3 to 6 months in advance:

- agricultural shortfalls or bumper crops,
- agricultural irrigation demand,
- epidemics of vector-borne diseases such as malaria and West Nile virus, or
- wildfire danger,

Such forecasting provides adequate lead time to alter management decisions. NASA Goddard Space Flight Center and U.S. Department of Defense researchers have determined, for example, that vegetation density can be used to pinpoint regions of heavy rainfall in Africa—regions ripe for outbreaks of rainfall-correlated diseases like mosquito-borne Rift Valley fever. (http://www.nasa.gov/topics/earth/features/riftvalley_fever.html)

Environmental Monitoring and Management

- **NASA is helping countries of Central America with SERVIR, a satellite visualization system that monitors weather and climate.**
 - SERVIR helps track and combat wildfires, improve land use and agricultural practices, and respond faster to natural disasters.
 - Helped Dominican Republic's response to extensive flooding from Tropical Storm Noel.
- **NASA, the U.S. Agency for International Development (USAID) and their partners established SERVIR-Africa in Nairobi, Kenya.**
 - Integrates satellite resources into a Web-based Earth information system.
 - Helps address natural disasters, disease outbreaks, biodiversity and climate change.



Fires in Central America



Nzoia River Basin in Kenya

NASA is working with the developing countries of Central America on SERVIR (Spanish for “to serve”), a high-tech satellite visualization system that monitors weather and climate, helps to track and combat wildfires, improves land use for city planning and agricultural practices, and helps local officials respond faster to natural disasters.

Last year, NASA research brought together radar imagery and other satellite data to help the Dominican Republic's government respond to extensive flooding in the wake of Tropical Storm Noel.

NASA, the U.S. Agency for International Development (USAID) and their international partners cut the ribbon last November in Nairobi, Kenya, for SERVIR-Africa.

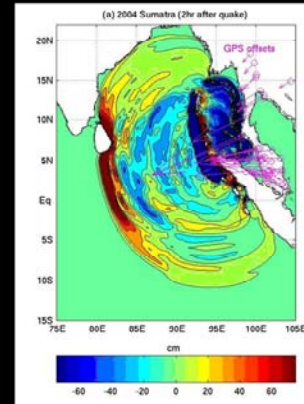
- The SERVIR-Africa system integrates the satellite resources of the United States and other countries into a Web-based Earth information system.
- This effort puts previously inaccessible information into the hands of local scientists, government leaders and communities to help address concerns related to natural disasters, disease outbreaks, biodiversity and climate change.

http://www.nasa.gov/mission_pages/servir/index.html

<http://www.servir.net/>

Disaster Warning and Relief

- **Conventional tsunami warning systems can result in false tsunami alarms with negative societal and economic effects.**
 - Researchers at NASA's Jet Propulsion Laboratory have developed GPS-based methods of prediction leading to more reliable global tsunami warning systems, saving lives and reducing false alarms.
- **Data from NASA spacecraft and NASA research improve the accuracy of forecasts for landfall, track and intensity of hurricanes, and increases the lead-time for warnings for both hurricanes and floods.**
 - More accurate forecasts, enable improved decision-making and improved preparedness for these types of events.



Conventional tsunami warning systems rely on estimates of an earthquake's magnitude to determine whether a large tsunami will be generated, not always a reliable indicator of tsunami potential.

- Between 2005 and 2007, five false tsunami alarms were issued worldwide. Such alarms have negative societal and economic effects.
- Researchers at NASA's Jet Propulsion Laboratory have demonstrated that real-time data from NASA's network of global positioning system (GPS) stations can detect ground motions preceding tsunamis and reliably estimate destructive potential within minutes, well before it reaches coastal areas.
- This new method estimates the energy an undersea earthquake transfers to the ocean to generate a tsunami by using data from coastal GPS stations near the epicenter. With these data, ocean floor displacements caused by the earthquake can be inferred.
- The method could lead to development of more reliable global tsunami warning systems, saving lives and reducing false alarms.
 - www.nasa.gov/topics/earth/features/tsunami-20080117.html

Data from NASA satellite missions make significant contributions in the area of hurricane and flood prediction.

- NOAA combines satellite-derived estimates of precipitation and wind speed and direction from NASA spacecraft with data from other sources such as hurricane buoys, hurricane hunter aircraft, and air-borne Doppler radar.
- Doing so substantially improves the accuracy of forecasts for landfall, track and intensity of hurricanes, and increases the lead-time for warnings for both hurricanes and floods.
- More accurate forecasts, in turn, enable improved decision-making leading to more enhanced community preparedness for these types of events.
 - http://www.nasa.gov/mission_pages/hurricanes/main/index.html

Disaster Warning and Relief

- **Balakot, Pakistan, devastated in 2005 by earthquake, had refugees with no clean water until a NASA-derived water purification system was on the site.**
- **Also after 2005 earthquake, an individual delivered tens of thousands of space blankets, a NASA spinoff.**
- **After the Haiti earthquake this year, communications were enabled with GATR inflatable antenna, and structures are being assessed with NASA software.**



Balakot, Pakistan, which was devastated by earthquake in 2005, had many refugees with no source of clean water other than what was brought in by tankers for months.

- There was a high mountain stream nearby, but the water was not suitable for drinking.
- Water Security Corporation worked with a Pakistani relief organization to bring an MCV-based water purification system to the site.
- Water is gravity fed from the stream to the system which then purifies the water for the local population. (http://www.watseco.com/projects_bakalot.html)

Also in response to the 2005 earthquake, Richard Berger was moved by the plight of the people in the remote villages of Pakistan and worked with relief organizations to deliver tens of thousands of space blankets, a NASA spinoff.

(<http://www.sti.nasa.gov/spinoff/spinitem?title=Reflecting+on+Space+Benefits%3A+A+Shining+Example>)

After the Haiti earthquake this year, communications were enabled with GATR inflatable antenna, and structures are being assessed with NASA software.

- GATR developed an inflatable portable antenna based on NASA research, and fields units which enable high-bandwidth Internet, phone and data access for deployments and projects in Afghanistan, South Africa, South America, Haiti, Korea, as well as assisting hurricane disaster recovery.
 - They are currently supplying communication support for the recovery efforts in Haiti. (http://www.gatr.com/index.php?option=com_content&task=view&id=60&Itemid=26)
- Purdue University recently signed a software usage agreement to use 3D Scene Analysis software from NASA's Kennedy Space Center for a humanitarian mission in Haiti.
 - Civil engineering researchers at the university, participating in Purdue's Global Engineering Program, plan to use the software to quickly measure a proxy for a building's lateral strength to seismic mass ratio in earthquake damaged zones and identify structures that urgently need repair.
 - The 3D Scene Analysis software was originally developed to measure the size of debris in the vicinity of the Space Shuttle Orbiter as part of the Columbia accident investigation.

Educational Resources

- **GLOBE (Global Learning and Observations to Benefit the Environment) is a worldwide student-teacher-scientist partnership.**
 - It allows students to directly participate in research by helping collect global data.
 - Since 1995 GLOBE has grown to 110 countries 20,000 schools around the world.
- **The Global Connection Project is a joint project of Carnegie Mellon University, NASA, Google, and National Geographic.**
 - The project develops software tools and technologies to use images to connect, inform, and inspire people.
 - In collaboration with UNESCO, the project has distributed Gigapan to students in South Africa, and the Republic of Trinidad and Tobago.



The GLOBE (Global Learning and Observations to Benefit the Environment) program is an excellent worldwide student-teacher-scientist partnership. (<http://www.globe.gov/>)

GLOBE's vision promotes and supports inquiry-based investigations of the environment and the Earth system working in close partnership with NASA and NSF in study and research about the dynamics of Earth's environment.

GLOBE began operations on Earth Day 1995.

- Today, the international GLOBE network has grown to include representatives from 110 participating countries and 128 U.S. Partners coordinating GLOBE activities that are integrated into their local and regional communities.
- Due to their efforts, there are more than 50,000 GLOBE-trained teachers representing over 20,000 schools around the world.
- GLOBE students have contributed more than 20 million measurements to the GLOBE database for use in their inquiry-based science projects.

The Global Connection Project is a joint project of Carnegie Mellon University, NASA, Google, and National Geographic.

<http://www.cs.cmu.edu/~globalconn/index.html>

The project develops software tools and technologies to use images to connect, inform, and inspire people to become engaged and responsible global citizens.

- Providing imaging support for disaster relief efforts.
- Publishing National Geographic content in Google Earth.
- Creating gigapixel panoramas for sharing and exploration.

In collaboration with the United Nations Educational, Scientific and Cultural Organization (UNESCO), the project has distributed Gigapan to students in South Africa, and the Republic of Trinidad and Tobago, encouraging them to photograph their local culture and share those panoramas with the world.

Energy Storage

- **NASA needs advanced energy storage method for long term space flights.**
 - Working with a former NASA scientist, Deeya Energy began developing iron-chromium hybrid flow battery technologies in 2004.
- **Deeya is now installing systems in rural areas in the developing world to provide for improved communications and significant emissions reductions.**
 - Plans include “power-station-in-a-box” products for village electrification, combining solar and wind generation sources.



A novel energy storage innovation is based on a battery technology originally developed by NASA in the early 1970's as a potential energy storage method for long term space flights.

- Working with a former NASA scientist, Deeya Energy began developing iron-chromium hybrid flow battery technologies in 2004.
- The battery technology involves mixing reactive chemicals to provide higher charge efficiency than normal rechargeable batteries.
- http://www.sti.nasa.gov/tto/Spinoff2008/er_2.html

Deeya is now installing systems in rural areas in the developing world to provide for improved communications and significant emissions reductions.

- The system achieves reduced cost and increased performance in providing critical infrastructure support for low availability service areas, and optimizing bulk renewable energy penetration within the energy industry.
- Plans include “power-station-in-a-box” products for village electrification, combining solar and wind generation sources.
- <http://www.deeyaenergy.com/>

Hazard Reduction

- **Each year, thousands are injured or killed from the millions of active land mines around the world.**
 - Thiokol Propulsion, builder of NASA rocket boosters, is using NASA's surplus rocket propellant to produce a flare that destroys land mines safely and easily.
- **Using the solidified rocket fuel as an incendiary, the flare burns a hole in the land mine's case and ignites the explosive contents.**
 - With the explosive material burned away, the mine is disarmed and no longer poses a threat.



- It is estimated that between 60 and 120 million active land mines are scattered around the world in about 70 countries. Every year, 26,000 people, usually women and children, are killed or maimed by a land mine.
 - Two techniques commonly used to disarm mines are a direct, attended operation or a remote operation using high explosives, both with safety issues.
 - Thiokol Propulsion is using NASA's surplus rocket propellant to produce a new flare that destroys land mines safely and easily.
- The technique, developed by Thiokol in collaboration with DE Technologies, Inc., involves placing a Thiokol-produced flare next to the uncovered land mine.
 - Using the solidified rocket fuel as an incendiary, the flare burns a hole in the land mine's case and ignites the explosive contents.
 - With the explosive material burned away, the mine is disarmed and no longer poses a threat.
- Locations where the demining flare devices have been deployed include Kosovo and Jordan.
 - <http://www.sti.nasa.gov/spinoff/spinitem?title=Saving+Lives+With+Rocket+Power>
 - <http://www.humanitarian-demining.org/demining/pubs/catalog/contents/clean44.htm>



- **LAUNCH is a new initiative to identify and support innovative and disruptive work poised to contribute to a sustainable future for life on planet Earth.**
 - LAUNCH is convened by NASA in partnership with USAID, Department of State, and private entities.
 - LAUNCH leverages the collective expertise, networks and influence of a diverse community of leaders to identify, support and accelerate innovative and often disruptive approaches toward critical sustainability challenges.
- **The inaugural event, LAUNCH: Water occurred on March 16-18, 2010 at NASA's Kennedy Space Center.**



LAUNCH is a global initiative to identify and support innovative and disruptive work poised to contribute to a sustainable future for life on planet Earth, convened by NASA in partnership with USAID, Department of State, and Nike.

LAUNCH is composed of two core components – a 2-day Sustainability Forum in conjunction with a space launch and the LAUNCH accelerator – and ongoing effort to accelerate the tangible and measurable progress of the LAUNCH Innovators.

LAUNCH has been created to leverage the collective expertise, networks and influence of a diverse community of leaders, whose purpose is to identify, support and accelerate innovative and often disruptive approaches toward one of humanity's sustainability challenges.

Some of the innovations explored at the inaugural LAUNCH: Water event held at NASA's Kennedy Space Center in March, 2010 include:

- Affordable Soil Moisture Sensors,
- ElectroChemical Arsenic Remediation,
- Floating Sensor Network,
- Large-scale Vertical Hydroponic Ag System,
- Low-Cost Bacterial Water Tests,
- Manna Energy Projects in Rwanda, and
- Subsurface Vapor Transfer Irrigation.

Learn more about Launch at <http://launch.org/overview/>.

Summary

- **These examples provide a representative sample of the kinds of practical benefits coming from NASA.**
- **NASA is delivering on the mandate it received from Congress more than 50 years ago—to broadly disseminate its results for the benefit of all mankind.**
- **NASA stands ready to continue its progress of innovation and exploration, to inspire and enlighten.**
- **NASA's work will undoubtedly continue to yield amazing scientific discoveries and technological breakthroughs.**
- **As NASA pursues these challenges, we will continue to seek opportunities to apply what we learn to help address needs of the developing world, for the betterment of the human condition and our planet.**

These examples provide a representative sample of the kinds of practical benefits coming from NASA.

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Please contact me with ideas or suggestions for partnerships:

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www.nasa.gov

Thanks.

Questions?