In preparation for this workshop I had the opportunity to study the history of energetics here in China.

That is a very long history, spanning many thousands of years.

The history of energetics in America is not nearly so long—just a few hundred years.

Today I will share a few highlights of the history of energetics in America.

Compared to China, the United States is a relatively young nation. We declared our independence from Great Britain on July 4, 1776.

July 4th is an important national holiday throughout America.

The holiday is almost always celebrated with fireworks.

Today, almost all of those fireworks are manufactured in China

Based on the pictures here, it may be that our July 4th celebration is similar to your October 1 National Day celebration.

Safety has been the hallmark of the propellants and explosives industry in the United States since the birth of our nation in 1776. The picture of fireworks in America has in it our Statue of Liberty.

The two shown together, Liberty & fireworks, reminds me that the United States owes much for our energetics safety ethic to the first European nation to recognize the independence of our young nation. That nation is France.

The Statue of Liberty, which we consider a symbol of America was a gift to our country from the people in France in celebration of the 100th birthday of the United States.

As a consequence of our early friendship, France was an early investor in the United States. It was French investors and French engineering prowess that enabled E. I. du Pont to build a gunpowder plant in the American State called Delaware in 1802.

Du Pont was a student of the famous French chemist, Antoine Lavoisier. Lavoisier is often called the father of modern chemistry.

Lavoisier stated any early version of the law of conservation of mass.

Du Pont established America's first two industrial laboratories—what we know today as the DuPont Central Research Laboratory and the DuPont Experimental Station.

Through their labs DuPont was quick to implement the inventions of Alfred Nobel in its American factories.

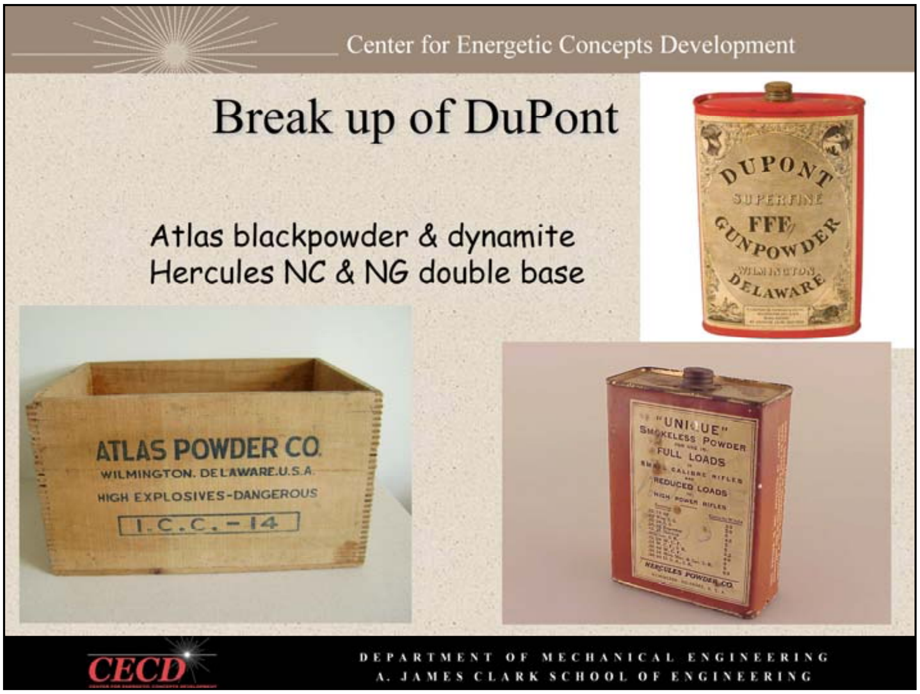
He was able to do the implementation because the newer American facilities were easier to modify than the older plants in Europe.

As an expression of confidence in the safety of his manufacturing procedures, du Pont required that he, or a member of his family, be on site during all explosives operations.

By 1850 DuPont was the largest supplier of gunpowder to the United States military.

By the early 1900's Du Pont was a preferred supplier in Europe too.

The company was so successful that no one could compete with DuPont in the United States and expect to succeed.



In 1912 a United States court took action.

The court declared DuPont's dominance of the explosives business to be an illegal monopoly and ordered the company to be broken up.

Under the terms of the court two new companies were formed while DuPont continued to manufacture single base nitrocellulose powders.

Hercules manufactured the nitrocellulose & nitroglycerine double base powders.

The Atlas Powder Company focused on black powder and dynamite.

If you look really closely, you will see that all three companies show a Wilmington, Delaware address on their label.

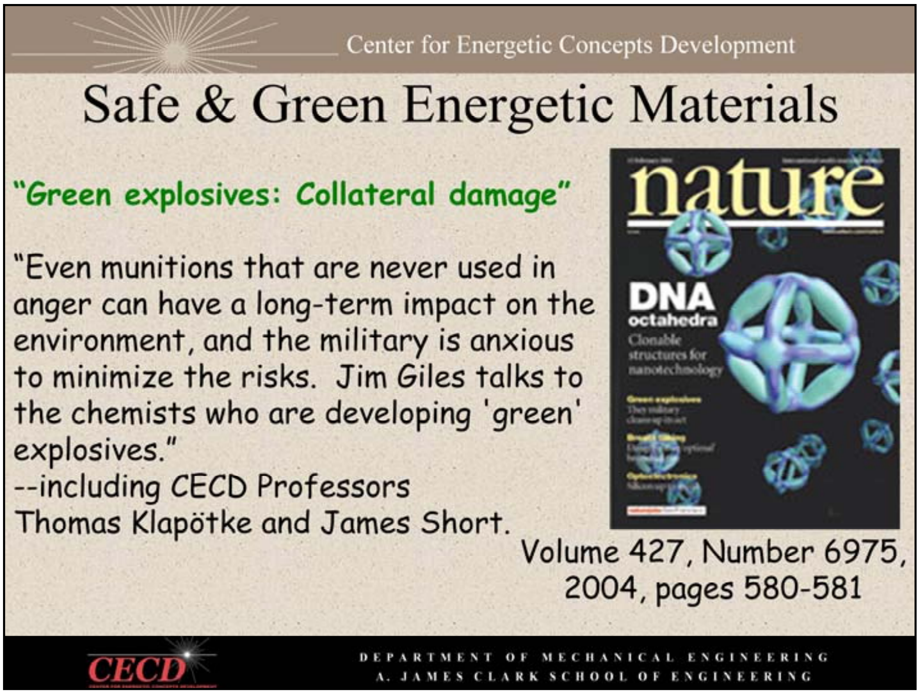
In order to encourage continuation of the DuPont safety ethic in the two new companies, the agreement called for both Hercules and Atlas to be served by the Central Research Laboratory and the Experimental Station. The arrangement was successful. Explosives safety became a hallmark of all three companies.

Safety continues to be paramount to this day through the heirs & successors of the DuPont, Atlas & Hercules companies.

Since the creation of an American explosives industry, the research focus of the industry has been on safe production, safe storage and safe use.

The American history of explosives safety continues through to this day.

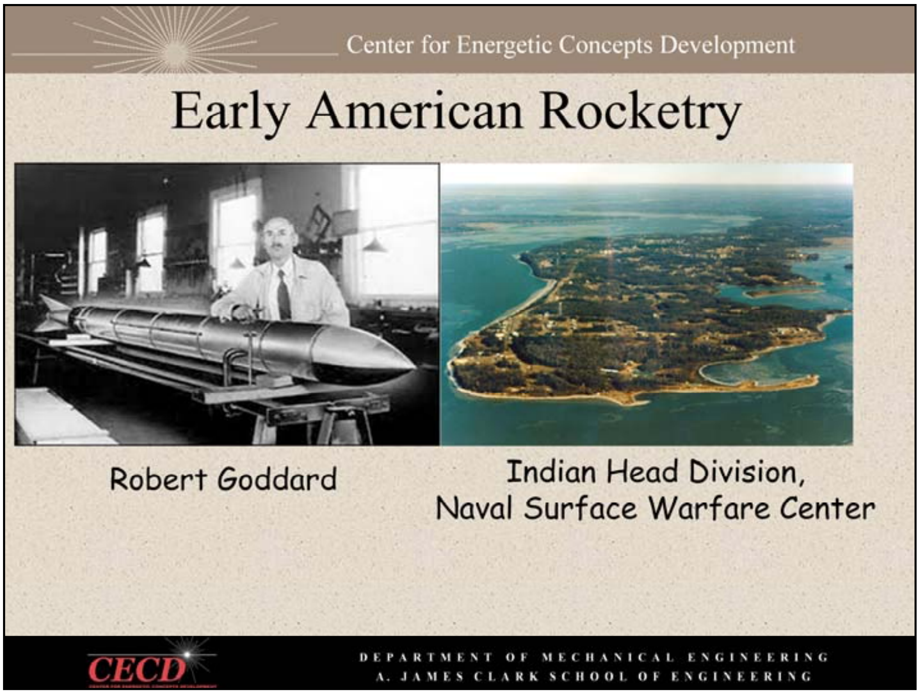
When we have accidents, a new safety research & development program is a likely outcome.



All of the research I have been associated with during my 30 year explosives career has focused on safe manufacturing of safe energetics and environmentally benign manufacture of energetics.

Back in 2004, my work as well as the work of Tom Klapötke was mentioned in an article in the prestigious British Journal, Nature.

Today Professor Klapötke and I are Visiting Professors at the University of Maryland.



The father of American rocketry was Robert Goddard. His first launch took place in 1926.

But Goddard’s preference for secrecy and patents left him with little in the way of a legacy today. Often his findings had to be rediscovered by others.

Among those doing the rediscovery in the 1940’s were the scientists at the Naval Proving Grounds at Indian Head, Maryland.

Now known by a different name, I am pleased that we have with us today’s Director of Research at Indian Head, Robert Kaczmarek.

Others doing rocket research back then were at the California Institute of Technology and elsewhere.

Hercules became a prominent propellant manufacturer by capitalizing on the castable double base propellants favored by John Kincaid and Hank Shuey.

I am humbled to say I was privileged to work with them both towards the end of their engineering career; just as I began my career at the White Oak Laboratory.

At the end of World War II, the United States & Soviet Union encouraged German rocket scientists to immigrate.

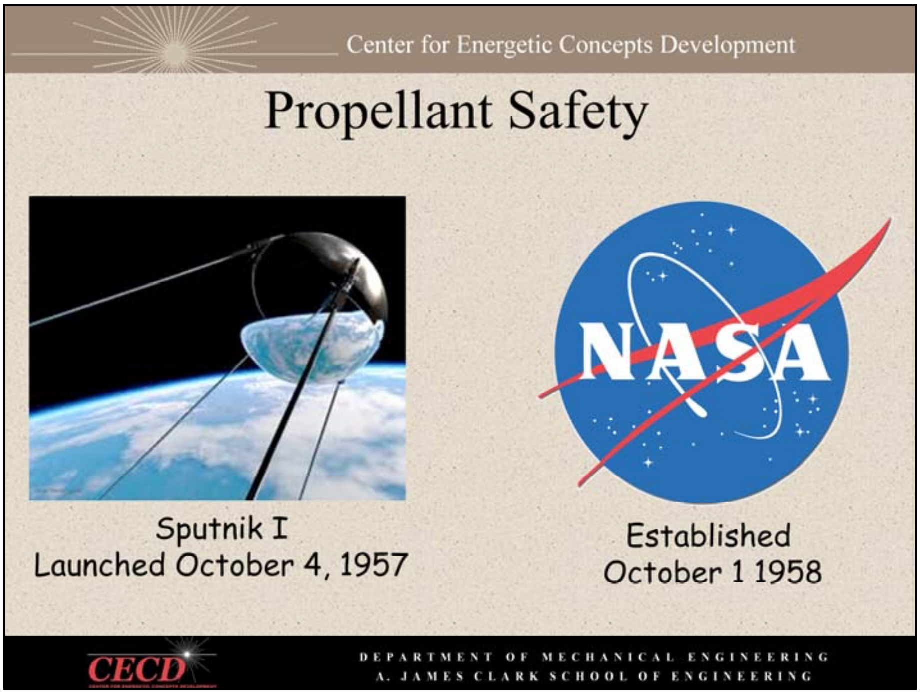
Among those that came to America was Wernher von Braun.

Initially von Braun worked for the United States Army at Redstone Arsenal.

He proved successful both as a rocket scientist and as an inspiration to the American people, winning their support for space exploration.

He wrote articles for popular American magazines and became a regular visitor to Walt Disney's weekly television show.

Of course Disneyland on the nearby Lanau Island is named after Walt Disney.



So now let me move from expjlosives to the other element of energetics--propellants.

America was caught by surprise when the Soviet Union launched Sputnik in October 1957.

Von Braun led the design of the Jupiter-C rocket that launched America's 1st artificial satellite, Explorer I, into space on January 31, 1958.

The United States was committed to the peaceful exploration and use of space.

It was important to President Eisenhower, a retired Army General, that America's space program be run independent of the military.

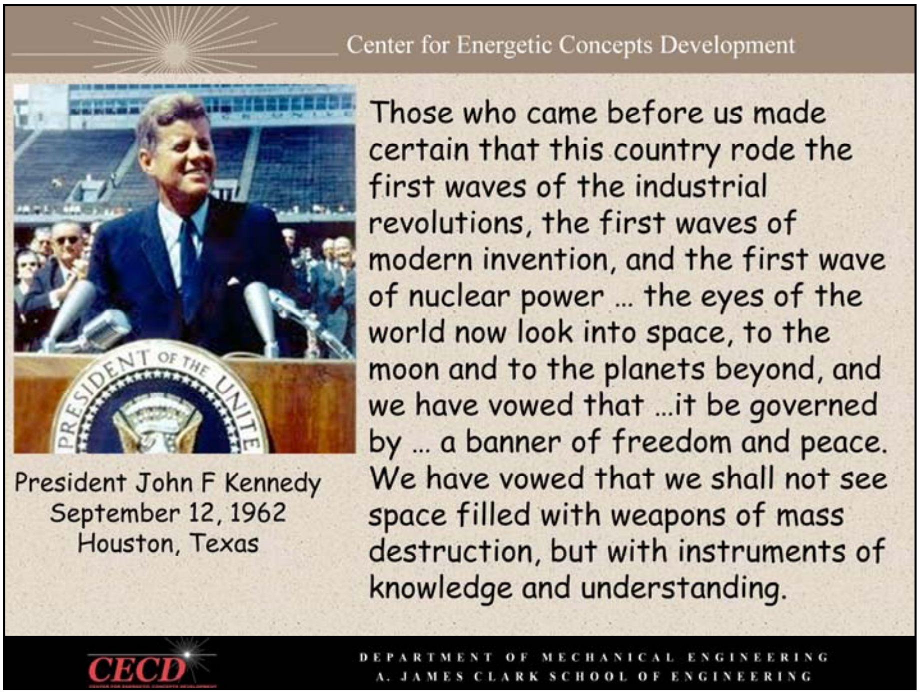
In less than a year the United States created a civilian agency called NASA, the National Aeronautics & Space Administration.

Von Braun moved to NASA from Redstone in the fall of 1958.

The opportunity NASA created for the exploration of space prompted a large number of young Americans to become space scientists & engineers.

We called them the Sputnik generation of American rocket scientists.

I am a member of the American Sputnik generation.



On May 25, 1961 our beloved American President Kennedy committed the United States to landing a man on the moon and "returning him SAFELY to the earth."

In Houston, Texas on September 12, 1962 Kennedy reaffirmed America's commitment to landing a man on the moon during the 1960's.

Houston became the home of manned space flight in the United States.

To land a man on the moon the United States would need a rocket propellant deemed safe for a manned system.

This is quite a different constraint than we placed on the missiles being designed at Redstone Arsenal and elsewhere in America.

President Kennedy's 1961 commitment to landing a man on the moon and "returning him SAFELY to the earth" before December 31, 1969 assured the same safety ethic would grow into the American propellant industry as is present in the explosives industry.

Thiokol, the inventor of synthetic rubber, emerged as a leader in American propellant manufacturing.

Established in 1929, Thiokol had visions of a huge demand for it's patented synthetic rubber. The huge demand did not develop.

In 1945 Charles Bartley at the California Institute of Technology discovered Thiokol's synthetic rubber was a magnificent stabilizer in solid rocket fuels.

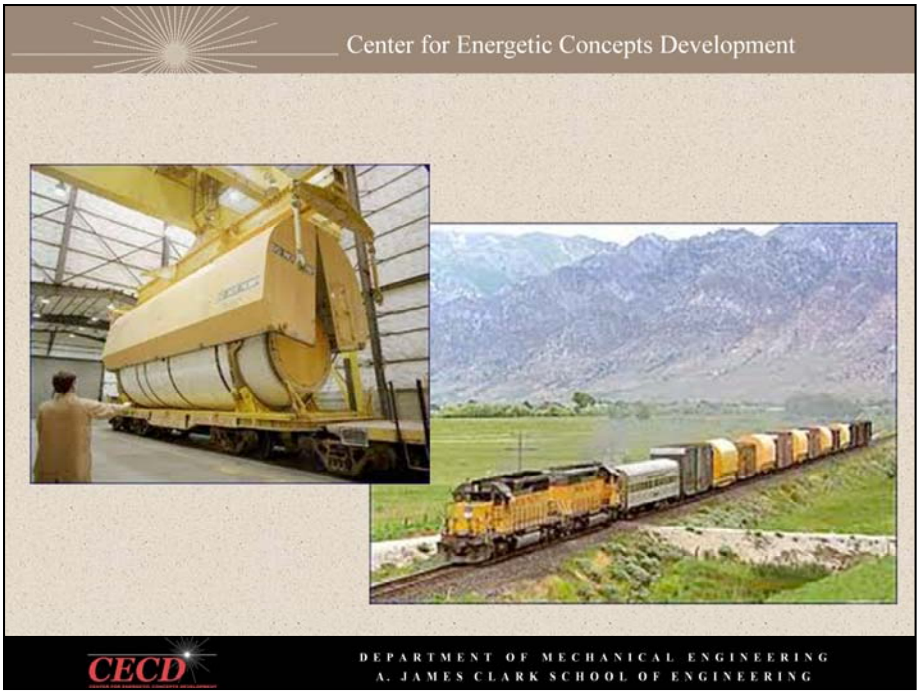
That led to an unexpected future for Thiokol manufacturing rocket propellant.

In 1974 they won a NASA contract to build the solid rocket boosters for the American Space Shuttle.

Next February the United States will launch a Space Shuttle for the 134^{th} and last time.

All have been launched with Thiokol propellant.

The propellant is 70% (by weight) ammonium perchlorate (NH_3Cl_4), 16% aluminum, 12% polymer binder, and 2% of an epoxy curing agent.



Each launch requires two solid rocket boosters.

Each rocket weights 1.3 million pounds (590,000 Kg), including 1.1 million pounds (500,000 Kg) of propellant.

The two motors lift the space shuttle to an altitude of 150,000 feet (46,000 meters).

Each is 150 feet (46 meters) long and 12 feet (3.7 meters) in diameter.

The rocket propellant is manufactured at an isolated desert location in the State of Utah.

The propellant is loaded into the recoverable boosters that are transferred to a small railroad station about 10 miles (16 Km) away to begin their 2500 mile (4000 Km) trip to Cape Canaveral, Florida.

I find it amusing that the size of American railroad cars and the placement of American railroad tracks had an influence on the diameter and length of the solid rocket boosters.

The solid rocket booster propellant is manufactured in segments.

The propellant segments are about 12 feet (3.7 meters) in diameter.

The propellant segments are about 27 feet (8 meters) long.

A defining moment for the relationship between our two countries today was the decision of our President Richard Nixon to visit China in 1972.

I speak to that in the book that is our gift to you for participating in this workshop.

Coincidentally there were two separate energetics accidents that took place about the same time that led the United States to begin an intensive energetics safety research program that continued for almost three decades.

We called it our insensitive propellants and explosive research program.

One accident took place aboard our aircraft carrier, the USS Forrestal.

The incident involved a person destined to be a 2008 candidate for President of the United States, John McCain.

An airplane preparing to take-off accidentally launched a missile held under one of its wings. The missile ran into a stack of bombs on the flight deck, initiating an enormous fire.

Within a few minutes, the bombs began to detonate. It is a phenomena we call cook-off and sympathetic detonation.

134 sailors were killed by the detonation of the bombs or fighting the fires. Even more were injured. Repairs to the ship were so extensive that it was out of service for about a year.

In America the safety testing required for an explosive and a propellant are quite different. Explosive safety testing is more extensive than propellant safety testing.

The reason for the difference is that an explosive detonates while a propellant only burns.

Not too long after the Forrestal fire a rocket motor was being static tested at Thiokol in Utah.

It was a cross-linked double base (XLDB) propellant.

About 20 seconds into a planned 60 second test the motor did what it was not supposed to do—it detonated.

As a consequence of these two accidents a unique team was formed, drawing from U.S. propulsion and explosives communities, to learn each other's technologies and terminology to eventually resolve the problems.

There were people from the Navy's White Oak & China Lake laboratories, the Los Alamos & Livermore laboratories, the Air Force Research Laboratory, and the industrial sector like Hercules & Thiokol.

What happened on the deck of the Forrestal was not too hard to figure out. A couple of items in the Standard Operating Procedure were violated. The result was that an errant electrical charge launched the missile in spite of the launch system not being armed.

But the Navy learned from the accident how little time was available to fight a fire before cook-off and sympathetic detonation could devastate a ship. The American explosives safety research program enabled the design of more cook-off resistant explosive formulations as well as other safety procedures, such as covering munitions with an ablative coating, so there was more time to fight a fire.

The rocket motor detonation was a more difficult problem to understand. The interdisciplinary propulsion and explosives team required more than three years to understand what had happened

The team needed more time to fully appreciate and master the design and material nuances required to safely harness the cross-linked double base propellant.

This collaboration between shock hydrodynamicists from the weapons community and propulsion engineers was a key enabling step for the future generations of high-performance motors.

The mastery of this technology truly enabled the move to the next generation of solid rocket motors.

The inter-disciplinary & inter-laboratory friendships that grew from the collaboration continues through to this day.

I was fortunate to begin my career after the group came to understand what happened and formulated a research plan intended to assure it would not happen again.

I got to execute their research plan.

The research was enormously successful.

The results are captured in many places including the Proceedings of the International Detonation Symposium that I chaired & edited for 20 years;

and the Journal of Energetic Materials of which I am now the executive editor.

Through these friendships and interdisciplinary collaborations we came to better understand detonation physics phenomena and develop tests and analyses of Deflagration-to-Detonation Transition (DDT), Shock-to-Detonation Transition (SDT), and motor implosion.

Advances were made in explosives chemistry as well, such as the synthesis of CL-20.

And that brings me to my hope for what may come from this workshop—the development of new friendships and new collaborations.

Preparing the book I looked at the abstracts of 1000's of your publications. Your contributions to the advancement of detonation physics and energetics chemistry become more impressive with each year. The scientific progress in China since my first exposure to your work at the 1981 Detonation Symposium is remarkable.

I am hoping we can make possible collaborative fundamental research among our scientists and engineers .

I hope some of you and your colleagues that are skilled reading and writing English might volunteer to review manuscripts submitted to the Journal of Energetic Materials. Even better, I would like to see manuscripts submitted to the Journal that are written by both Chinese and American authors.

I would like to receive more submissions to the Journal of Energetics from China. The quality of the written English in the papers the Journal receives from China today too often falls short of the literary standards I have established for the journal. I am hoping that you can help me find a way for your colleagues not so skilled in reading and writing English to get writing assistance from others who are skilled.

I am flattered to have been invited to join the International Advisory Committee for the 2011 International Autumn Seminar on Propellants, Explosives & Pyrotechnics.

While I won't pretend it will ever be practical for me to learn to read and write your language, I do hope to make some positive contribution to the success of the Nanjing seminar next September.

I am pleased to be with you here in Hong Kong. I look forward to what the future may bring us.

Thank you.