

The Beauty of Explosion

Abstract

According to Oxford English Dictionary, explosion scientifically suggests the action of “going off” of gas or gunpowder with an often deafening noise under the influence of suddenly developed internal energy. Explosion occurs in the event of boiling, bombing and gun firing. Electron discharges may also result in an explosion, as chemist Thomas Thomson wrote in his famous A System of Chemistry in 1807, “Electric explosions are made to pass through this gas.” This paper explores the art, business and technology aspects of explosion and is titled “The Beauty of Explosion.”

Within the title, an oxymoron is applied rhetorically by placing a pair of markedly contradictory terms, namely beauty and explosion, together in conjunction for emphasis. Explosions are often associated with natural disasters, arson, and military attacks. Take for example the recent nuclear explosion in Japan and the civil war and coalition intervention in Libya. A catastrophic explosion threatened Japan's core nuclear complex on March fourteenth; the explosion damaged the reactor's crucial steel containment structure and the fire spewed large amounts of radioactive material into the air; On the other hand, soon after the successful revolt in Egypt and Tunisia, Libya experienced a full-scale overthrow of the Gaddafi regime beginning on February 2011. On March seventeenth 2011, the United Nations Security Council passed Resolution 1973, which sanctioned the establishment of “no-fly zone” and allowed the attack of operations Odyssey Dawn and Elammy, launched by the United States and United Kingdom. The firing of more than 110 Tomahawk cruise missiles caused several huge explosions and casualties.

Nevertheless, explosions are not always disastrous and war-related. This paper guides its readers thoroughly to discover the aesthetic perspective of explosion, specifically its usage in art, business and technology. Finishing reading this paper, the reader will have a new understanding of explosion and be amazed by how intimately it plays an entertaining role in our daily lives

Objectives

The paper serves to help the reader gain an understanding of the beauty of explosion. To fully realize how explosion is applied in real life, one shall study the functionality and theory of explosion. Thus, the history as well as chemistry of gunpowder is introduced in the beginning. Soon follows are three case studies focusing on usage of explosion in fireworks, contemporary arts, and multimedia. In each of the three case studies, research in art, business and technology is conducted. This paper gains a lot of inspiration from outdoor fireworks shows, action movies, cartoon anime, Broadway musicals, live concerts and military documentaries. This paper hopes to conscientiously and carefully develop its thesis but at the same time entertain the reader and even be a little bit playful. This is an exciting yet challenging project. "Fiat Lux" (Let There Be Light/ Explosions)

Discussion

1. Overview of Explosion

Explosions are an example of the Law of Conservation of Energy, which states that energy can neither be created nor destroyed, but can be transformed from one form into another. To describe explosion from physics perspective, it is a rapid increase in volume and release of energy in an extreme manner, usually carrying high temperatures and accompanied by an emission of heat, light and sound. There are three main kinds of explosions: natural, chemical and nuclear. Natural explosions include the eruption of volcano and supernova in the outside space; chemical explosions usually involve a rapid and violent oxidation reaction that produces large amounts of hot gas. As will be introduced shortly, gunpowder was the one of the first discovered explosives that was put to use; nuclear explosions, on the other hand, derive their destructive force from the atomic reaction of fission or fusion.

2. History of Gunpowder

Once upon a time, gunpowder was discovered in the 9th century by Chinese alchemists desperately searching for an elixir of immortality. The word “gunpowder” in Chinese means “fire medicine.” Also known as black powder, gunpowder is a mixture of sulfur, charcoal and potassium nitrate, all of which burn rapidly and produce a volume of hot gas consisting of carbon dioxide, water and nitrogen. The discovery of gunpowder by alchemists led the creation of fireworks and the earliest gunpowder weapons in China. Centuries after, the Mongols introduced gunpowder weapons in the Arab world, Europe and India.

The Mongols were under the guidance of the great Genghis Khan and his descendents. Genghis Khan clinched his power by uniting many of the nomadic tribes of northeast Asia. He was the founder, ruler and emperor of the Mongol Empire. After coming to the throne in 1206, he started the Mongol invasions which would result in the conquest of most of Eurasia. Although these military invasions often caused large-scale massacres of the local populations, the Mongols introduced many modern military weapons to the western world. These include fireworks and gunpowder weapons. Nowadays, gunpowder is widely used as propellant in firearms and pyrotechnic composition in modern fireworks display, ironically, thanks to the invasion of the West by the Mongols.

3. Chemistry of Gunpowder

As described previously, gunpowder, or so-called black powder, is a granular mixture of nitrate, charcoal and sulfur. Potassium nitrate (KNO_3) is a typical nitrate which supplies oxygen for the explosion; charcoal provides carbon, and sulfur (S) lowers the temperature necessary to ignite the mixture. Among the three major constituents of black powder, Potassium nitrate is the most important ingredient in terms of both bulk and function simply because the combustion process releases oxygen from the potassium nitrate, promoting the rapid burning of the other ingredients. A common chemical equation for the combustion of gunpowder is $2 \text{KNO}_3 + \text{S} + 3 \text{C} \rightarrow \text{K}_2\text{S} + \text{N}_2 + 3 \text{CO}_2$. Following this section about the chemistry of gunpowder, three case studies will be demonstrated. First note that because gunpowder is less powerful than TNT (gunpowder contains 3 mega-joules per kilogram and TNT contains 4.7 mega-joules per kilogram), the amount of heat and gas volume it generates is a lot less

harmful than those created by TNT; hence gunpowder has been widely used in firearms and pyrotechnics.

Case Studies

1. Fireworks

i. Overview

On New Year Eve of 2005, nearly 80,000 people swarmed the streets around Taipei City Hall to welcome 2006 as the Taipei 101 fireworks show and an all-night pop music concert turned Xinyi District into a big festival. Men and women, the elder and the young, all tried hard to secure a spot with the best view of the party and the fireworks show. Taipei 101 was presenting a 188-second-long firework show sponsored by SONY BRAVIA. More than 22000 shots of explosives were fired. According to official, 2 million dollars were spent, with 1 million dollars sponsored by SONY. The spectacular fireworks display attracted the attention of CNN, BCC and other well-known international news media. The words "SONY BRAVIA" were to be displayed on the top of the building at the end of the display.

ii. Art

Fireworks are universally loved by most all of the public and are used to celebrate all sorts of events. Specifically, fireworks are applications of explosive pyrotechnics used for aesthetic and entertainment purposes. Often appreciated as the ideal show for big celebration events such as New Year Eve count-down, fireworks outshine by producing the four major effects: noise, light, smoke, and floating materials. Colored flames and sparks including orange, yellow, red, green, blue and silver are burned to make fireworks display colorful and appealing. Therefore, fireworks displays are common throughout the world and are the focal point of many cultural and religious celebrations.

iii. Business

It was stated previously that black powder was first invented in China and brought to the West world by the Mongols. Fireworks were also invented in ancient China in the 12th century to scare away evil spirits with loud noise and to pray for happiness and prosperity. Eventually the art and science of making fireworks developed into an independent profession.

Back to the Taipei 101 fireworks display, the average cost for the show is US\$ 10,638 per second, totaling 2 million dollars in the duration of 188 seconds. SONY successfully negotiated with Taipei 101 by agreeing to pay a promotional fee of 1 million dollars for showing the mark of SONY displayed on the very top of the 101 building. In this way, SONY received several minutes of publicity during the show, thus hoping to increase awareness of its brand, and hopefully leading to increased sales of SONY products in the region.

Now, China is the largest manufacturer and exporter of fireworks in the world according to WTO. China experienced its major economic reform in the late twentieth century and the reforms under Chairman Jiang Zemin in the 1990s have slowly weaned local fireworks manufacturers off government subsidies, forcing them to compete on the open market. Consequently better, cheaper and bigger

pyrotechnics materials are available in the market worldwide.

On the other hand, tougher safety standards were enforced in the United States since the Sept. 11, 2001 terrorist attacks. At the federal level, industry regulation straddles numerous agencies, including the Department of Transportation, the Occupational Safety and Health Administration, the Consumer Product Safety Commission, the Bureau of Alcohol, Tobacco, and Firearms, and the Motor Carrier Safety Administration. Today nearly all states allow retailers to sell some kinds of fireworks. The consumer fireworks market was estimated to have generated 1 billion dollar revenue in 2004, according to APA, American Pyrotechnics Association. The future of fireworks market is promising, but market owners need to develop much stronger relations with manufacturers in China. Most importantly, they have to make sure that products delivered by Chinese manufacturers adhere to safety standards increasingly enforced by the federal government.

iv. Technology

Recall that gunpowder, or so-called black powder, is a granular mixture of nitrate, charcoal and sulfur. Furthermore, a typical chemical equation for the combustion of gunpowder is $2 \text{KNO}_3 + \text{S} + 3 \text{C} \rightarrow \text{K}_2\text{S} + \text{N}_2 + 3 \text{CO}_2$. The current standard composition for the black powders that are manufactured by pyrotechnicians can date back as far as 1780s. The common proportions of chemical compounds are 75% potassium nitrate, 15% softwood charcoal, and 10% sulfur. The ratio varies by different usage purpose including visual, sound and smoke effect.

Fireworks produce various shapes, ranging from simple rotating circles, stars to complicated palms, rings or spiders. Colors of fireworks are generated by pyrotechnic stars, which produce intense light when ignited. Fuel, oxidizer, color-producing compounds, binder and chlorine donor are the five major ingredients inside a star. Color-producing compounds are among the most important keys for colorful fireworks display.

Here we introduce some of the most commonly used color-producing compounds. Red color is produced by Strontium and Lithium, such as SrCO_3 (strontium carbonate) and Li_2CO_3 (lithium carbonate). Orange color is produced by calcium, examples including CaCl_2 (calcium chloride); yellow color is produced by sodium, such as NaNO_3 (sodium nitrate); Green is produced by barium, an example of such is BaCl_2 (barium chloride); Blue flames can be made from copper and halides, such as CuCl_2 (copper chloride); Indigo can be produced using cesium, such as CsNO_3 (cesium nitrate); Violet can be made from potassium and rubidium, such as KNO_3 (potassium nitrate) and RbNO_3 (rubidium nitrate). Finally, gold flames can be produced by charcoal, iron, or lampblack, and white flames, titanium, aluminum, and beryllium.

2. Cai Guo-Qiang

i. Overview

This paper brings the reader Cai Guo-Qiang, one of the most well-known and influential Chinese contemporary artists. He is most famous for his explosion art. Cai's explosion practice draws on a wide

variety of symbols, narratives, traditions and materials such as fengshui, Chinese medicine, shanshui paintings, science, flora and fauna, portraiture, as well as fireworks. Internationally acclaimed explosives artist Cai Guo-Qiang literally exploded the accepted parameters of art making in our time. Cai's art is itself a form of mutable social energy, linking what he refers to as "the seen and unseen worlds." His idea of art draws freely from military history, Taoist cosmology, Buddhist philosophy, ancient mythology and Chinese medicine.

ii. Art

Cai is well known for applying explosions into his large-scale display of artwork. In 2008, he presented nine real cars in a cinematic progression that simulated a car bombing, occupying the central atrium of the Solomon R. Guggenheim Museum, New York, in 2008. His large-scale and allegorical installations in Guggenheim Museum recuperated signs and symbols of Chinese culture and exposed the dialectics of local history and globalization. Nine cars were decorated with sequenced multichannel light tubes with variable dimensions. Cai's exhibition in Guggenheim represented art as a process that unfolds in time and space, dealing with ideas of transformation, expenditure of materials, and connectivity.

iii. Business

Well known for his explosion arts, Cai makes his living by participating in art museum exhibitions, outdoor art shows, and auctioning his own art works. Before the display of his car explosion art at New York Guggenheim Museum, he negotiated with Thomas Krens, director of the Guggenheim Foundation, and Alexandra Munroe, the museum's senior curator of Asian art. Eventually, his explosion art filled nearly the museum and introduced to the visitors his masterpiece in contemporary art using gunpowder. In addition, the museum was full of sound of explosions and sight of suspended objects and wildlife. In November 2007, Cai broke the record for auction of Chinese avant-garde work, preciously led by Chen Yifei, who set a record of USD 4.7 million by *Eulogy of the Yellow River*. Cai sold a series of fourteen drawings that sold for USD 8.5 million at the Asian Contemporary Art sale organized by Christie's Hong Kong on 25 November 2007. 2007 was the year when China moved up to the third place in the global art revenue ranking behind the United States and the UK. The third position was previously taken by France. The growth of China's art market was boosted by major international auction companies. In 2007, the Chinese market generated no less than 75 sales above the million-dollar line with a top price of USD 8.5 million for a work by Cai Guo-Qiang.

iv. Technology

Cai was born in Quanzho, China, in 1957. He studied stage design at the Shanghai Drama Institute. In the 1980s he emerged as a member of the burgeoning experimental art world of China's post-reform era. In 1986 he studied abroad in Japan, where he mastered the use of gunpowder to create his signature gunpowder drawings and the related outdoor explosion events. His art practices integrated science and art in a process of creative destruction and reflect Cai's philosophy that conflict and transformation are interdependent conditions of life, and hence art.

3. Multimedia

● Staging

i. Overview

How explosion is used in multimedia, including staging, movie, and video gaming, will be studied in the following sections. Visual explosion effect is widely used in stage arts. One of the perfect examples is Michael Flatley's *Feet of Flames*, an Irish tap dance performance directed by Michael and scored by Ronan Hardiman.

ii. Art

Michael Flatley is one of the top dancers and choreographers in modern performing arts. He launched the spectacular *Feet of Flames* premiered on July 25, 1998 before an audience of over 25,000 in London. Flames, torches and canons were used and performance was also the biggest, most visually dazzling dance show ever staged.

iii. Business

The outstanding performance of *Feet of Flames* led by Michael Flatley has been globally recognized. The show was made famous by the musical *Riverdance* and was first created based on Michael's *Lord of the Dance* in London's Hyde Park on July 25, 1998. The DVD of *Feet of Flames* has become one of the best-sellers in multimedia market.

iv. Technology

Bombing and different colors of flames are used in *Feet of Flames*. One of many visual effects is based on a scientific fact that the high-pressure wave of an explosion can be extremely destructive to ambient objects. Besides, the explosion of bombs is an example of a chemical explosion: The chemical energy stored in the molecules of the explosive is converted into kinetic energy, heat, light, and sound.

● Movies

i. Overview

Explosion scenes such as fireworks display occur in many movies, especially *V for Vendetta*, a 2006 dystopian thriller film directed by James McTeigue. The movie was set in London in a near-future dystopian society. Hugo Weaving plays V- a bold, erudite anarchist driven to overthrow the existing government. One monumental scene in the movie is when V invites Evey to enjoy his delicate fireworks show, the explosion of the Parliament.

ii. Art

The movie overall is an allegory of oppression by government. The fireworks show is accompanied by Tchaikovsky's *1812 Overture*. The ear-shattering orchestra matches the explosions of government buildings seamlessly. The music is played in an ironic way that portrays V's uplifted spirit as well as excitement.

iii. Business

V for Vendetta deals with issues of race, homosexuality, religion, totalitarianism, and terrorism. The

film led the United States box office on its opening day, estimated \$8,742,504 in revenue and remained the number one film for the remainder of the week. *V for Vendetta* also opened in 56 IMAX theaters in North America, grossing \$1.36 million during the opening three days

iv. Technology

The destruction of the Parliament is well-planned by V. He must have understood the basic chemistry of explosion before he started his terrorist tactics. An explosive is a substance that can produce an explosion through a chemical reaction. Explosives generally contain fuel and an oxidant and it is the chemical reaction between them which releases stored chemical energy.

● **Gaming**

i. Overview

In addition to application in staging and movie, explosions also appear frequently in anime and video games. The last multimedia case study focuses on *Gundam*, a meta-series of anime created by Sunrise studios that features giant robots called "Mobile Suits." It was first appeared on April 7, 1979 as a serial TV show called Mobile Suit Gundam. The plot emphasizes the fighting of giant robots using innovative weapons, which cause explosions and other beautiful visual-stunning effect.

ii. Art

The anime *Gundam* has spawned a franchise that has come to include works released in numerous media, including video games, anime, newspapers, commercial advertisements, novels and comic books. It is one of the most successful anime in Japan's history.

iii. Business

As of January 21, 2008, the *Gundam* franchise is a 50 billion yen trademark. A year 2000 press release stated that retail sales of *Gundam* items had totaled \$5 billion. Furthermore, plastic model of *Gundam* holds 90% of the Japan character plastic model market.

iv. Technology

We have seen a very large number of explosion scenes in *Gundam* anime. Based on the level of damage caused, explosions could be divided into two types: detonation and deflagration. In a detonation, the speed at which the chemical reaction moves through the explosive is greater than the speed of sound in that material. High explosives, such as dynamite, generally undergo detonation and have a characteristic shattering effect on their surroundings; on the other hand, a deflagration occurs when the speed of the chemical reaction of the explosion travels through the explosive slower than the speed of sound in the material. Some examples include the impact of low explosives, such as a mixture of air and gasoline vapor or sugar and potassium chlorate.

4. Conclusion

Explosion is a form of art. This project paper provides its reader a chance to view explosion as art from many perspectives, including staging, movie, celebration display and video gaming. An overview of explosion unveils the topic. Different causes and properties of explosion are introduced. In addition,

the history of gunpowder, specifically how the Mongolians brought gunpowder to the West, is mentioned briefly. Finally, three case studies discover the beauty of explosion and its application in the real world. Each case study integrates business, art and technology. "Fiat Lux" (Let There Be Light/ Explosions)

5. Appendix

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| Taipei 101 Fireworks, sponsored by SONY | Cai Guo -Qiang, Chinese artist | Michael Flatley and his <i>Feet of Flames</i> | <i>V for Vendetta</i> : V with mask | <i>Gundam</i> : model of giant robot |

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