



# Beyond the BOOM

## How Fireworks Work

### Research

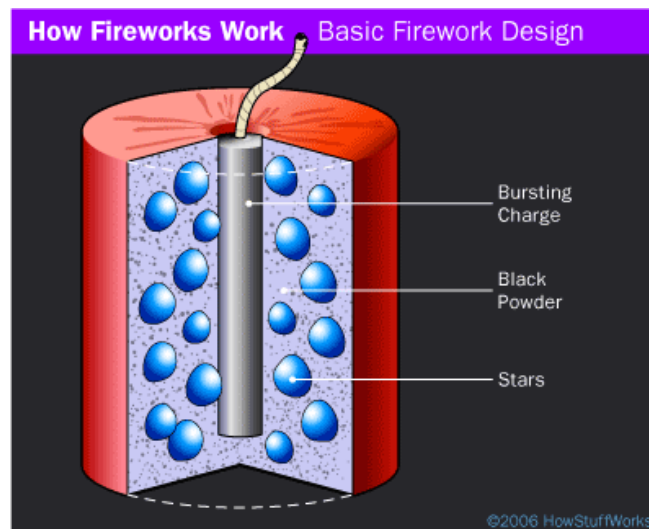
Pounds of fireworks purchased each year in the US: 213.2 lbs

Annual fireworks industry revenue: \$940 million

<http://www.statisticbrain.com/firework-statistics/>

### Dissecting the Display

- The shell is launched from a mortar
- In the bottom of the mortar there is a Lifting charge of black powder that explodes to launch the shell
- When the lifting charge fires, it lights the shell's fuse
- The shell's fuse burns until it's targeted altitude, then ignites the bursting charge



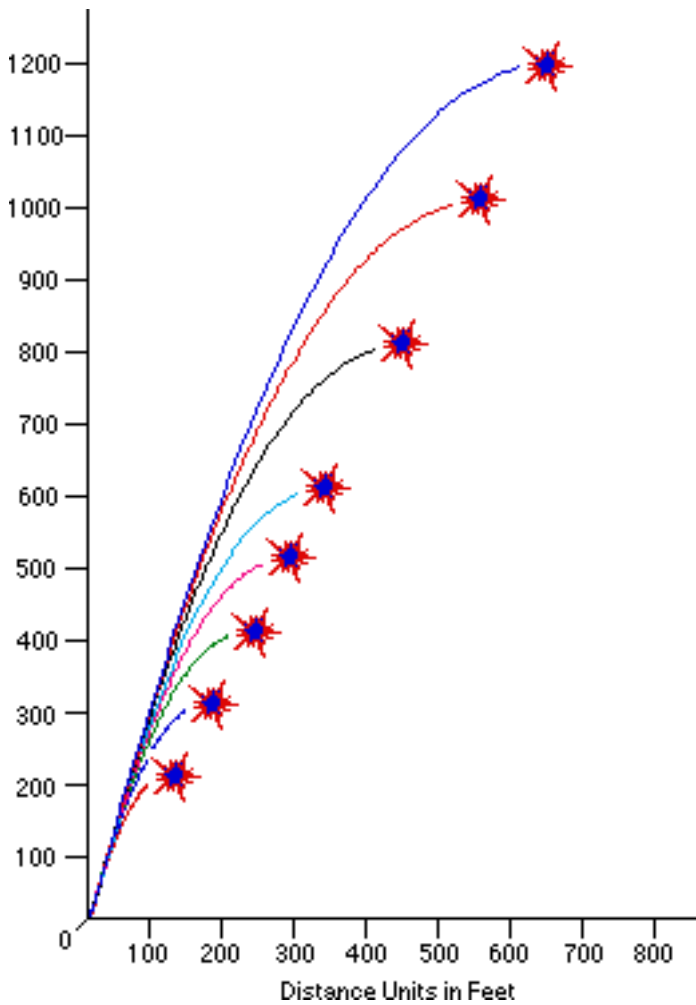
*(THE TEXT BELOW WILL BE INCORPORATED INTO THE DIAGRAM)*

- Stars – Produce pyrotechnic effect
- Black Powder - Bursting charge; also helps ignite and disperse the stars

<http://science.howstuffworks.com/innovation/everydayinnovations/fireworks1.htm>



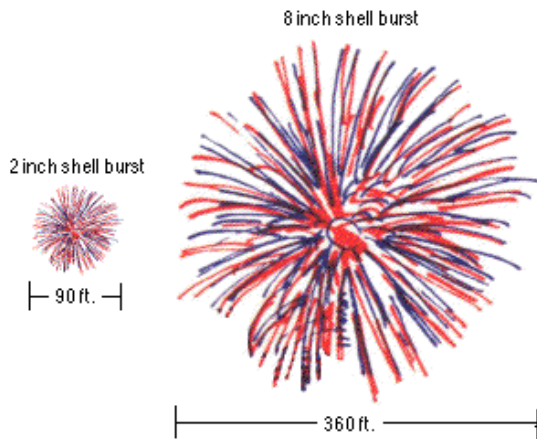
## Learning to Launch



### How High

- Shows the flight paths of 2", 3", 4", 5", 6", 8", 10" and 12" shells fired at 75 degrees

<http://library.thinkquest.org/15384/physics/>



### How Big

- Shell burst sizes are usually about **45 feet in diameter for every inch** in shell size, depending on how tightly the shell is packed.

<http://library.thinkquest.org/15384/physics/>

Initial Shell Velocities	
Shell Size	Initial Velocity
(in inches)	(in ft/sec)
2"	117.5
3"	144
4"	166
5"	186
6"	203.5
8"	235
10"	263
12"	287.5
24"	393
36"	481

### How Fast

- Commonly used shell sizes and their corresponding initial mortar velocities - the speeds that the shells are traveling as they are fired out of the mortar

<http://library.thinkquest.org/15384/physics/>



## Witnessing the Wonder

### **NYC: Macy's Fourth of July Spectacular 2012**

- How much: 40,000+ shells launched from six barges over the Hudson River, avg 1,600 shells/min
- How long: 25 minutes
- Estimated cost: almost \$6 million
- Spectators: 3+ million and has a TV audience of 8+ million.
- <http://www.foxbusiness.com/personal-finance/2012/06/27/explosive-costs-big-fireworks-displays/>

### **DC: A Capitol Fourth 2012**

- How much: 33 tons of pyrotechnics; 3,000 "high-end" fireworks
- How long: 18 minutes
- Estimated cost: more than \$250,000
- Spectators: 500,000 at the National Mall, + more than 11 million PBS viewers
- <http://www.foxbusiness.com/personal-finance/2012/06/27/explosive-costs-big-fireworks-displays/>
- <http://americanprofile.com/articles/top-10-fireworks-displays-in-america/>

### **Boston: July Fourth Boston Pops Fireworks Spectacular 2012**

- How much: 15,000 shells fired from seven barges
- How long: 21 minutes
- Estimated cost: over \$2.7 million
- Spectators: 500,000, 7 million people tune in on TV
- <http://www.bloomberg.com/consumer-spending/2012-06-26/the-real-cost-of-july-4-from-nyc-to-nashville.html#slide11>
- <http://www.foxbusiness.com/personal-finance/2012/06/27/explosive-costs-big-fireworks-displays/>

### **Nashville: Let Freedom Sing! 2012**

- How much: 25,000 fireworks (or 7 tons) containing shells as big as 10" in diameter
- How long: 23 minutes
- Estimated cost: \$500,000
- Spectators: more than 100,000
- <http://www.bloomberg.com/consumer-spending/2012-06-26/the-real-cost-of-july-4-from-nyc-to-nashville.html#slide14>
- <http://www.nowplayingnashville.com/event/detail/441607819>



### **Seattle: Seattle's Family 4<sup>th</sup> 2012**

- How much: 2,400 shells
- How long: 21 minutes
- Estimated cost: \$550,000
- Spectators: 250,000 + 200,000 TV viewers
- <http://www.bloomberg.com/consumer-spending/2012-06-26/the-real-cost-of-july-4-from-nyc-to-nashville.html#slide13>

### **Addison, Texas: Kaboom Town! 2012**

- How much: over 1,500lbs of fireworks
- How long: 30 minutes
- Estimated cost: \$220,000
- Spectators: population of only 15,000 people draws in half a million spectators
- <http://www.travelchannel.com/interests/holidays/photos/best-us-fireworks-displays>
- <http://www.forbes.com/sites/bethgreenfield/2012/06/27/top-10-best-july-4th-fireworks-displays/>