



AMERICAN COUNCIL OF ENGINEERING COMPANIES
of Colorado

**NATIONAL ENGINEERS WEEK 2005
"THE PERFECT STORM" EDUCATION PROJECT**

Designing the Perfect Storm

Purpose of Project

The week of February 21, 2005 is National Engineers Week. Overall, in the United States, there has been a decrease in the interest and enrollment of students in engineering and science studies. The American Council of Engineering Companies of Colorado (ACEC/CO) is concerned about the growing trend of fewer engineering majors at universities across the country. Each year, ACEC/CO has embarked on a community outreach project to increase the awareness in school age children of how engineering plays such a crucial role in all of our lives. ACEC/CO, along with one of its member companies, HDR, has designed an educational project entitled "Designing the Perfect Storm" to be used by broadcast meteorologists during their school visits.

The purpose of this project is to provide educators with an instructional tool, utilizing a meteorological event such as flooding, to make the connection with science and problem solving through engineering. HDR has designed an award winning program, "Designing the Perfect Storm" as an engineering analysis tool for the City of Boulder to determine the best approach to responding to the potential flooding threat in Boulder. We have adapted this project to make it suitable as an educational presentation for young students so that they can more easily see the correlation between science and engineering.

This presentation is targeted for earth sciences or related classes. A Power Point program including video clips demonstrates what type of weather causes floods, the effects of such floods and takes a look at how engineers respond to solve the problem. Our hope is that this program increases interest in meteorology, geography, hydrology and engineering as a potential career. A teacher resource guide to additional information and classroom activities is also included. Involve the students, explain the problem and then ask for their solutions.



AMERICAN COUNCIL OF ENGINEERING COMPANIES
of Colorado

**NATIONAL ENGINEERS WEEK 2005
"THE PERFECT STORM" EDUCATION PROJECT**

Educational Resources for Designing the Perfect Storm

There are numerous resources available to enrich your student's experiences with this project. The following are some of the more relevant sites that relate to engineering, meteorology, science and education:

Helpful weather information and instructions- How the Weather Works:
www.weatherworks.com

National Science Teachers Resources: www.nsta.org/91

The Weather Channel: www.weather.com

Colorado State Department of Atmospheric Sciences: www.atmos.colostate.edu

Community Collaborative Rain and Hail Study, aka CoCoRaHS:
<http://ccc.atmos.colostate.edu/hail/>

Forecast information, radar and satellite images from Denver National Weather Service:
www.crh.noaa.gov/den

NOAA Flooding information:
www.nws.noaa.gov/stormready

Guide to engineering education and careers:
www.allengineeringschools.com

How to make a cloud, a tornado or fog- Web Weather for Kids:
http://www.ucar.edu/educ_outreach/webweather/activities.html

MESA-Math, Engineering, Science and Achievement
A Colorado educational resource for students and teachers: www.cmesa.org

American Council of Engineering Companies of Colorado (ACEC/CO)
www.acec-co.org



AMERICAN COUNCIL OF ENGINEERING COMPANIES
of Colorado

NATIONAL ENGINEERS WEEK 2005
"THE PERFECT STORM" EDUCATION PROJECT

Designing the Perfect Storm PowerPoint Script

(Slide 1)

Sometimes Mother Nature has a way of letting us know whose boss. She can do this by producing earthquakes, hurricanes, tornadoes and sometimes floods. Have you ever watched it rain so hard that, before long, the water turns into a small river running down the gutter next to your sidewalk? Think about when the water runs down from the mountain and flows so hard and fast the ground can't absorb it. How do meteorologists and engineers deal with this problem? In this presentation, we'll take a look at how The Perfect Storm develops and then give you a chance to think about the best way to respond to it.

(Slide 2: Jeffco Flooding Vid)

* Thunder Sound FX*

What started as a peaceful Sunday afternoon on June 27, 2004 turned into a day of heavy rain for parts of Jefferson County, Colorado. Dozens of basements were flooded by as much as six feet of water. Flooding also closed off roads around the Ken Caryl Ranch area. As much as 4 inches of rain fell on the City of Golden in a 3-hour period. Torrents of water ran down the spillways engineers had designed to channel some of the floodwaters.

(Slide 3: The Perfect Storm: Defining a flash flood)

1. So how do you define a flash flood? It's a lot of rain in a short period of time that results in too much water running off the land.
2. In Colorado, this is usually caused by a weather condition called upslope, which can produce a larger thunderstorm.
3. The heaviest rains tend to fall between 3PM and 3AM.
4. Flash floods can happen anywhere, in the city, in the foothills or in the mountains.
5. Meteorologists can determine how much rain is falling with Doppler radar.
6. Many areas monitor stream and river flows with flood detection networks.
7. The National Weather Service, along with TV and private meteorologists forecast and monitor the weather.
8. When flooding is imminent, the police and fire departments and other emergency response agencies spring into action.

(Slide 4: When do floods happen?)

Most of Colorado's floods occur from late spring to early fall, with the best chances during May, July and August. Spring snowmelt and runoff can also increase the chance for flooding in May and June.

(Slide 5: Recent Floods)

Thunder SFX

1. August 1, 1985, 5 to 7 inches of rain fell in Cheyenne, Wyoming in 5 hours. This storm resulted in a 24-hour record rainfall, 12 deaths and \$65 million dollars in damage.
2. July 28, 1997, around 4PM, Ft. Collins weather turned cloudy, cooler and stormy. Nearly 14.5 inches of rain fell in the next 36 hours. A combination of intense rainfall rates, long duration and an urban environment all added to extensive flooding in Ft. Collins.
3. The Plum Creek Flood was caused by heavy thunderstorms dropping 14.5 inches of rain in 6 hours. To put that in perspective, Denver's average annual rainfall is around 15 and a half inches. That flood damaged 1200 structures, including 600 homes in Denver. As a result of that flood, Chatfield Reservoir was built by engineers to catch future floodwaters.

And the most destructive flood in Colorado was the Big Thompson Canyon Flood in 1976.

(Slide 6: Big Thompson Flood Vid)

On Saturday, July 31, 1976, it was a perfect day to enjoy summer activities in the mountains and canyons near Estes Park, Colorado. In the early evening, larger thunderstorms developed over the Rockies and moved very slowly over the foothills in Larimer County. These storms moved so slowly that they produced 14 inches of rain in only 5 hours. The heavy, rapid downpour caused an extremely high water flow down the Big Thompson River. As the water arrived near the east end of the canyon, in an area called The Narrows, the water piled up into a 19 foot wall filled with houses, car parts, propane tanks and other debris. The Big Thompson Flood caused \$35.5 million dollars in damage, destroyed 418 homes, 52 businesses and left 145 people dead.

(Slide 7: Flash Flood Impacts)

When water falls on the surface of the earth, it has to go somewhere. If too much water falls in too short a time, there may be a flood. The force of floodwater is extraordinary. 6 inches of fast moving water can knock you off your feet. Two feet of water can move a car.

Floods cause soil erosion and mudslides. They can damage or destroy homes and businesses, disrupt basic services like electricity, gas and water. Floods can close roads, destroy farm areas and they can kill people.

(Slide 8-11: How the Perfect Storm Forms)

The ingredients for a Perfect Storm in Colorado include a strong flow of very moist air, add lots of warm, unstable air, and, if the steering winds up high are not very strong, the Thunderstorms that develop will not move very fast. The result: well, it's a slow moving storm that will drop a lot of rain over a small area.

(Slide 12: What Else Can Influence a Flash Flood?)

If the ground is already wet and has a lot of water in it, we call it saturated and the new rain that falls won't be absorbed. So guess where it goes? Another factor is vegetation. Trees, plants, bushes and grasses hold onto the rainwater and keep it from running off. In an area like the Hayman Fire near Denver, vegetation is sparse and it is only slowly returning. Where there is heavy rain and little vegetation, the water runs down the hillside quickly, resulting in either mudslides or flash floods.

(Slide 13: Tools of the Trade)

Engineers, meteorologists and hydrologists use many tools to predict, monitor and respond to flooding. Some of these tools include radar and computer models. Hydrologists use these weather factors to design computer models, which tell them how big a flood will be and where it will flow. Engineers then take that information and design structures and flood proofing devices to lessen damage.

(Slide 14: Using Radar to Estimate Rainfall Patterns)

Here's what Doppler radar looks like. It show us where and how much rain is falling.

(Slide 15: WSR-88D Doppler Radar)

The radar can also tell us how big an area is being rained on.

(Slide 16: The Perfect Storm; this storm's 6-hr rainfall...)

Doppler radar can create a map that tells us exactly where the most rain has fallen.

(Slide 17: A Rainfall/runoff model provides a tool...)

The computer model can help us determine how much rain has to fall in a particular area to cause a flood.

(Slide 18: Define the Flood Plain)

A hundred year flood is defined as a type of flood that would only happen once every 100 years and it could flood the land with several feet of water. Any storm that rained about 5 inches in 24 hours would produce a 100-year flood. So a 100-year flood has a 1 in 100 chance of happening in any given year, even if it happens 2 years in a row. A 500-year flood has a 1 chance in 500 or .2% chance of happening in any given year.

(Slide 19: Flood Plain Model Prediction)

Using math, observations and computer models, here's where the engineers think a 100-year flood would go in the City of Boulder.

(Slide 20: Visualizing the Predicted Flood)

Okay, we've looked at what makes the Perfect Storm, how we predict it and how we measure it. But what do we think it will look like? There's our angry, heavy thunderstorm over the mountains. It has been raining hard for hours and here comes the floodwaters, down from the mountains, foothills and into the flood plain along South Boulder Creek. Pretty cool, huh? Unless you happen to live in its path.

(Slide 21: How do Engineers Protect People...)

Now you know what causes flash floods and what they look like. But how do engineers protect people and property in the flood plain?

1. Engineers look at a variety of solutions including putting flood detection devices in the streams and rivers. They could design and build a dam to trap a lot of the water before it reaches the city.
2. They could build levees, which are embankments that prevent a stream from overflowing. Another engineering solution might be to build flood detention ponds where water can hang out for awhile without bothering anybody. Would it be a good idea to move some buildings out of the flood plain? Can engineers design structures that won't be damaged by a flood?

If you were an engineer, what other ideas could you come up with to protect your town from floods?

If you live in or near the foothills of the Rocky Mountains, flash floods are of serious concern. It's not a matter of "if" a major flood will occur but rather when.