Open-Ended Problems: A Future Chemical Engineering Education Approach. J. Patrick Abulencia and Louis Theodore.

34

Term Projects (4): Miscellaneous Topics

Term Project 34.1

Standardizing Project Management

Three problems in the project management chapter (Part II, Chapter 13) were concerned with the attempt to "standardize" project management. The two key players and corresponding publications are ISO 21500:2012 *Guidance on Project Management,* and ANSI's *A Guide to the Project Management Body of Knowledge* (PMBOK).

Elam [1] recently compared ISO 21500:2012 with the 5th edition of PMBOK. His comparison is presented in Table 34.1.

Table 34.1 Comparison of ISO 21500:2012 and PMBOK

	ISO 21500:2012	**PMBOK 5th Edition**
Process Groups	1. Initiating 2. Planning 3. Executing 4. Controlling 5. Closing	1. Initiating 2. Planning 3. Executing 4. Monitoring & Controlling 5. Closing
Knowledge Areas for PMBOK Subject Groups for ISO	1. Integration 2. Scope 3. Time 4. Cost 5. Quality 6. Human Resource 7. Communications 8. Risk 9. Procurement 10. Stakeholder	1. Integration Management 2. Scope Management 3. Time Management 4. Cost Management 5. Quality Management 6. Human Resource Management 7. Communications Management 8. Risk Management 9. Procurement Management 10. Stakeholder Management

After carefully reviewing both documents, provide the methodology employed by both groups, highlighting the differences. Also, speculate on what changes can be expected in the future due to recent developments in terrorism, health and hazard risk assessment, nanotechnology, energy policies (or lack thereof), water policies (or lack thereof), etc.

Term Project 34.2

Monte Carlo Simulation: Bus Section Failures in Electrostatic Precipitators

Theodore et al. [2] employed Monte Carlo methods in conjunction with the binomial and Weibull distributions discussed in the Probability and Statistics Chapter (Part II, Chapter 19) to estimate out-of-compliance probabilities for electrostatic precipitators (air pollution control particulate control devices) on the basis of observed bus section failures. The following definitions apply (see Figure 34.1):

Chamber. One of many passages (M) for gas flow
Field. One of several high voltage sections (N) for the removal of particulates; these fields are arranged in series (i.e., the gas passes from the first field into the second, etc.)
Bus section. A region of the precipitator that is independently energized; a given bus section can be identified by a specific chamber and field.

Thus, an M x N electrostatic precipitator consists of M chambers and N fields. A precipitator is "out of compliance" when its overall collection efficiency falls below a designated minimum value because of bus section failures. When several bus sections fail, the effect of failures depends on where they are located. To determine directly whether a precipitator is out

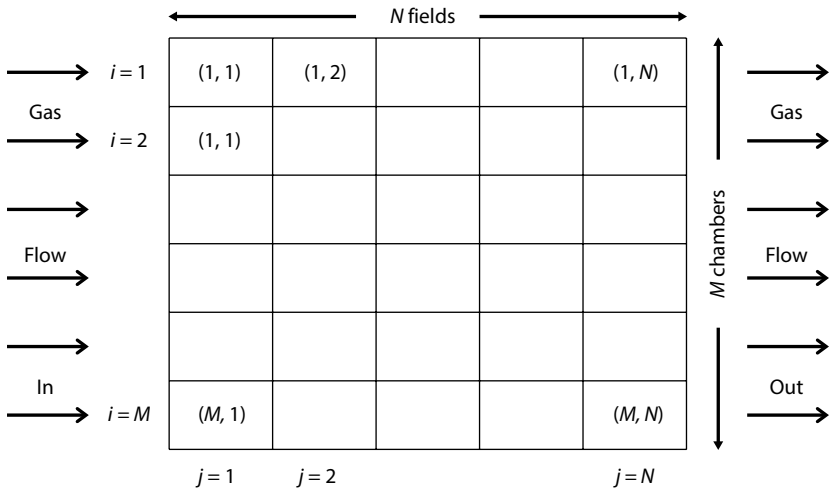

FIGURE 34.1 An M x N precipitator.

of compliance after a given number of bus sections have failed, it would be necessary to test all possible arrangement of the failure locations. The out-of-compliance probability is then given by the percent of arrangements that result in overall collection efficiencies less than the prescribed minimum standard. The number of arrangements to be tested often makes the direct calculation approach impractical. For example, Theodore et al. [2] were requested (as part of a consulting assignment) to investigate a precipitator unit consisting of 64 bus sections; if 4 of these were to fail, there would be 15,049,024, possible failure arrangements [3,4].

Instead of the direct calculation approach that would have required the evaluation of more than 15 x 10^6 potential failure arrangements, you have been requested to develop a similar procedure to perform this calculation, e.g., using a Monte Carlo technique [5] for an M x N bus section electrostatic precipitator.

Generate solutions for various combinations of M x N systems operating at a given (specified) overall collection efficiency [6]. Comment on the results.

Term Project 34.3

Hurricane and Flooding Concerns

Hurricane Sandy was the deadliest and most destructive tropical cyclone of the 2012 Atlantic hurricane season, as well as the second costliest hurricane in U.S. history. Sandy was a Category 3 storm at its peak intensity when it made landfall in Cuba and a Category 2 storm off the coast of the Northeastern United States. The storm became the largest Atlantic hurricane on record.

Hurricane Sandy affected 24 states, including the eastern seaboard from Florida to Maine and west across the Appalachian Mountains to Michigan and Wisconsin. There was particularly severe damage in New Jersey and New York. Its storm surge hit New York City on October 29, flooding streets, tunnels, and subway lines and cutting power in and around the city. Gasoline shortages, reminiscent of the Oil Embargo of 1973, lasted for two weeks. One of the authors (located on Long Island, New York) had no heat for 11 days and no TV power for 17 days.

Damage in the US was estimated at approximately $75 billion.

On October 28, New York City officials activated the coastal emergency plan, with subway closings and the evacuation of residents in areas hit earlier by Hurricane Irene in 2011. More than 76 evacuation shelters were

open around the city. Mayor Michael Bloomberg ordered public schools closed the following day and called for a mandatory evacuation of areas near coastlines or waterways. Approximately 200 National Guard troops were deployed in the city. U.S. stock trading was suspended for two days. Amtrak canceled all Acela Express, Northeast Regional, Keystone, and Shuttle services for two days. More than 13,000 flights were cancelled across the U.S. on October 29, and more than 3,500 were called off October 30. Approximately 300 people were killed across the U.S., the Caribbean, and Canada, as a result of the storm.

Based on the above comments, obtain information on the following

1. What is the annual probability a Category 3, a Category 4, and a Category 5 hurricane will strike the New York City metropolitan area.
2. Estimate the damage (flooding, infrastructure, food and water shortages, and power failures) that can be expected with each Category hurricane.
3. Outline what steps can be taken to reduce and/or eliminate both the causes and consequences associated with each Category hurricane.

Note: The reader may choose to apply the above to any area of the U.S., including their own locale.

Comment: An urban planner [7] recently provided a real-world application that is of concern to administrators in the New York City metropolitan area. It was noted that Category 5 hurricanes strike the New York City metropolitan area with a 50 year recurrence interval. The analyses provided information on the risk that a Category 5 storm will strike in a 15 year period and investigated the recurrence interval that would be required to produce a 5% risk of a Category 5 hurricane striking in a 15 year period [8]. Interestingly, this "case study" has received little to no attention by city administrators. Discussion of this case study might explore what could be done to change this oversight.

Term Project 34.4

Meteorites

A *meteor* is defined as a small solid body entering the Earth's atmosphere from outer space. A meteor that reaches the Earth's surface before it is

completely consumed is defined as a *meteorite*. A meteorite has also been defined as a natural object that has come from elsewhere in space. Some refer to large meteors/ meteorites as *asteroids*, while others refer to asteroids as small planets. Meteorites can be large or small. Most are produced by impacts of larger asteroids. When meteorites enter the atmosphere, frictional forces cause the body to heat up and emit light, thus forming a fireball, also known as a *shooting star* or *falling star*. Meteorites that are recovered after being observed as they enter the atmosphere or impact the Earth are called *falls*. All other meteorites are known as *finds*. Finally, meteorites are almost always named for the place where they land, for example, Tunguska (Siberia) [9].

Most meteoroids disintegrate when entering Earth's atmosphere. Only 5 or 6 a year are typically recovered and made known to scientists. Few meteorites are large enough to create large impact craters. Instead, they typically arrive at the surface at their terminal velocity [10] and, at most, create a small pit. Even so, falling meteorites have reportedly caused damage to property, and injuries to livestock and people.

Meteorites have traditionally been divided into three broad categories: stony meteorites are rocks, mainly composed of silicate minerals; iron meteorites are largely composed of metallic iron-nickel; and, stony meteorites contain large amounts of both metallic and rocky materials. Meteorites have also been classified according to their size; for example, those smaller than 2mm are classified as *micrometeorites*.

It's early morning on February 15, 2013 near Russia's Ural mountains. A large meteor has entered the Earth's atmosphere at a speed of approximately 30,000 mph and exploded into pieces about 25 miles above the ground, creating a sonic blast with the power of an atomic bomb. Over 1,000 people are injured.

The explosion occurred about 3,000 miles west of Tunguska, which in 1908 was the site of the largest recorded explosion of a meteor plunging to Earth. The present blast could have produced much more serious problems since the area contains nuclear and chemical weapons disposal facilities as well as some 6,000 tons of nerve agents.

Should there be concern? You be the judge. Scientists believe that a meteor explosion 6.5 million years ago in Mexico's Yucatan Peninsula may have been responsible for the extinction of the dinosaurs. The impact could have thrown up vast amounts of dust that blanketed the sky for decades and altered the climate of the Earth. Interestingly, at approximately the same time as the Tunguska explosion, an even larger meteor went sailing by Earth approximately 15,000 – 25,000 miles away. This meteor could have produced devastating effects had it approached Earth's atmosphere.

As a result of the recent 2013 meteor episode, NASA, in conjunction with PAT (Patrick Abulencia and Theodore) Consultants have initiated a joint project that will address three key issues.

1. Determine the annual probability with respect to size and frequency of meteorites striking/affecting the planet Earth.
2. Develop a plan to reduce or eliminate the likelihood of (1) occurring.
3. Develop an emergency plan of action in case (1) occurs.

References

1. Adapted from: D. Elam, *Standardized Project Management*, EM, Pittsburgh, PA, March 2013.
2. L. Theodore, J. Reynolds, F. Taylor, and S. Errico, Electrostatic Precipitator Bus Section Failure: Operation and Maintenance, Paper No. 84-96.10, presented at the *77*th Annual Meeting of Air Pollution Control Association, June 24-29, San Francisco, CA, 1984.
3. A.M. Flynn and L. Theodore, *Health, Safety, and Accident Management in the Chemical Process Industries*, CRC Press/ Taylor & Francis Group, Boca Raton, FL, 2002.
4. L. Theodore and R. Dupont, *Environmental Health and Hazard Risk Assessment: Principles and Calculations*, CRC Press/Taylor & Francis Group, Boca Raton, FL, 2012.
5. S. Shaefer and L. Theodore, *Probability and Statistics Applications in Environmental Science,* CRC Press/ Taylor & Francis Group, Boca Raton, FL, 2007.
6. L. Theodore, *Air Pollution Control Equipment Calculations*, John Wiley & Sons, Hoboken, NJ, 2008.
7. G. Theodore, personal communication to L. Theodore, Interboro Partners, Brooklyn, NY, 2011.
8. L. Theodore and R. Dupont, "Environmental Health and Hazard Risk Assessment: Principles and Calculations," CRC Press/Taylor & Francis Group, Boca Raton, FL, 2012.
9. L. Theodore and R. Dupont, *Environmental Health and Hazard Risk Assessment: Principles and Calculations*, CRC Press/Taylor & Francis Group, Boca Raton, FL, 2012.
10. L. Theodore, *Air Pollution Control Equipment Calculations*, John Wiley & Sons, Hoboken, NJ, 2008.