

## Case study on Waste Management

Stakeholders			
<u>Waste Management/Recycling Company</u>	<u>Scientists and Engineers</u>	<u>The General Public</u>	<u>Government Officers</u>
Chief Executive Officer, CEO	Principal Investigator 1	Water Treatment Plant Worker	City Mayor
Director of Finance	Research Scientist 1	Teacher	City Dept. of Sanitation
Public Outreach Director	Principal Investigator 2	18-Yr-Old College Student	City Dept. of Environmental Protection
Director of R&D	Research Scientist 2	Textile company worker	City Dept. of Public Health
		Fish Market Owner	
		John Regular, own stocks in textile company	

### Introductions:



**REVOLUTION:** A Waste Management/Recycling Company

**CEO** – “At Revolution, we specialize in the research and development of waste management and removal. All our developments and products have been tested and approved by the United States Environmental Protection Agency. We have extensive experience in managing waste in many major cities around the United States and Great Britain. The Mayor of your city recently showed interest in hiring our company to develop a method to keep drinking water safe for his citizens.”

**Director of Finance** – “My role in this company is to keep track of the monetary funds that are distributed to each one of our 113 on-going projects throughout the United States and Great Britain. We want to make sure that our projects are well-funded and are sustainable once they are developed and released for our customers. I also determine the appropriate funds for new projects that are presented to the company.”

**Public Outreach Director**- “My staff and I are responsible for educating the public of what goes on in our company. We present our major findings at community meetings, organize outreach activities, and conduct tours of our facilities for school groups and the general public. We also are responsible in marketing and advertising our products to the public in various forms, from posters and brochures about our company to our company website.”

**Director of Research & Development** – “My department is in charge of all the scientists and engineers who work for our company. We oversee more than 100 different teams of scientists working together for one common goal: Creating a Cleaner World! We test and analyze new ideas and inventions developed in our world-leading, state-of-the-art research facilities. Our products go through a stringent process of testing before its introduction to the public. We test

every product with the highest standards to ensure the safety and well-being of our customers. We also oversee the submissions of patents of all our products so that once patents are obtained, it will be most profitable to our company.”

#### **SCIENTISTS AND ENGINEERS:**

**Principal Investigator 1** – “My group at Revolution is in the process of developing a novel method to ensure the cleanliness of our drinking water. Recent studies have shown that our nearby textile companies are using color dyes that may be harmful if leached into our water reservoirs. These color dyes are chemical compounds that are too small to be filtered out by conventional filtration systems that are currently used in our cities water treatment plant. The most recent project that my group has been working on involves the use of electrospinning liquid polymers into thin nanofibers. Unwoven mats of these fibers may be small enough to filter out or degrade the color dye molecules from the textile companies that may be leaching into our waters. The liquid polymers that we are using for electrospinning are all biodegradable to begin with, so it will be least harmful to the environment”

**Research Scientist 1** – “I have been working for Revolution for 8 years now. I use to work for the city’s department of environmental protection. I still keep in touch with some of my co-workers in that department. But I am glad I switched over because, at Revolution, we are fully funded to get supplies and equipment to pursue our ideas. The PI I work with is not limited by grants. This is research at its best! Electrospinning is what I do all day. We basically use electricity to spin liquid polymer solutions into tiny fibers that land on a collector. The fibers collected are then characterized in terms of fiber length and diameter, fiber arrangement, etc. We are still testing all the optimal parameters to produce these nanofibers that can eventually be used in filtration. This is especially important because these new textile companies are making all these synthetic dyes and fabrics. Eventually, we want to start incorporating different enzymes into the fibers so that can degrade certain color dyes that are too small to be filtered by the city’s water filtration system. These textile companies are just not researching enough on the long-term health and environmental effects of them.”

**Principal Investigator 2** – “My group at Spool Fabrics is part of the Colors Department and is currently developing new color dyes that are vibrant and multi-functional. For example, one of our goals is to produce color dye molecules that can show good color and are fade-resistant. In our lab, we use various chemicals to synthesize new color dyes. I have already obtained patents for 4 synthetic color dyes produced in my lab. Our color dyes undergo many tests before it is incorporated into actual fabric that is sold at our company. Our research also ensures that all our products are safe for consumers to use. However, the chemical compositions of our color dyes are confidential.”

**Research Scientist 2** – “I have been working in this lab at Spool Fabrics for 4 years now. They’ve treated me pretty well so far with a good salary and excellent benefits. They even gave me stocks of the company! I was recruited by them when I was finishing my doctorate degree in materials science. I am glad that my training gave me background in both organic and inorganic chemistry since this company is big on synthesizing new dyes and fabrics that have so many practical applications. However, there hasn’t been much research on the long-term effects of

these new amazing products. I guess there's just not much funding from the company for that part."

## THE GENERAL PUBLIC

**Water Treatment Plant Worker** – "I've been working at the city water treatment plant since I graduated high school. I am the fifth member of my family to work in this treatment plant. The city is very serious about keeping the water clean. However, we noticed that more recently that even with our state-of-the-art filtration system, we are seeing slight changes in the coloration of the ground water as it enters the system. I think we're going to have to sample the water more often now to see what is exactly causing this. We have some potential suspects, but I don't want to release any information at this time without my boss's approval. As of now, the water is perfectly clean to drink and will not cause any harm at all. Once the water gets filtered, it is crystal clear!"

**Teacher** – "I teach chemistry in the local high school in this city. I was very excited when the mayor announced his interest in hiring a waste management company to deal with cleaning up our waters. I am already in the process of planning field trips for my students to see where their waste end up and how it is treated to in a way in which it will cause the least amount of stress for the environment. Students are always taught how we are causing pollution, but there is very little emphasize on what we do to deal with the pollution. The partnership between the city and the waste management plant will be an excellent opportunity for the young citizens of this city. "

**Textile Company Worker** – "I am a technician at Spool Fabrics who oversee some of the machinery in their factories. Whenever a machine breaks, I fix it. Whenever a new machine arrives, I help install it. I also help start machines whenever, there a new product that is incorporated in the fabrics. New things get added into the fabrics pretty frequently. I make sure all the machines are running smoothly. But there is no doubt in my mind that we produce waste...and there are LOTS of it! However, to my understanding, they're all "water-soluble". So when they get dumped in the nearby lake, it will dissolve in the water anyway. If people are concerned, and they shouldn't be, just go fishing in the lake! I go fishing with my son there every weekend. The fish look healthy, so the water must be fine."

**Fish Market Owner** – "We go out on our boats almost every morning to get the freshest products for our customers. However, times are tougher now. We use to go out at least five times every week. Recently, we're just out there waiting most of the time. I don't know what's going on. We are beginning to order our fish from other places to keep our stock up at the market. The quality is never the same. Frozen is never as good as just-caught. Sometimes we see some pinkish run-off coming out of one of those textile companies on the other side of the lake. Maybe that's the problem, but nobody's saying anything about it yet."

**John Regular** – "I own stocks in 4 different companies. My most recent investment is in a company called Spool Fabrics. Based on research I have conducted on this company, it makes some amazing products that will be very promising. I have looked into their annual financial reports for the last 3 years and they have consistently increased their funding for R & D. This

shows that they are serious about their business. They're at least financial stable enough to support a group of scientists who produce their new products. I have a feeling their products will be the next big trend in fashion! All the famous clothing designers will be using their fabrics and dyes in no time. It seems like their ideas are the best ideas since the discovery of cotton. I've made pretty good choices in my other companies, so this will be no different."

**18-Yr-Old College Student** – "I am currently a sophomore at the City Institute of Fashion. I recently took a class called "Textile and the Environment" and the professor made us memorize all the different types of color dyes that any textile company would use in their fabrics. It was torture! However, there have been recent concerns about our how the textile company across the lake might be leaching out some of these color dyes. Finally, there's something I learn that is actually applied to real life! I wonder if our Mayor knows about this. Maybe he does...that might be the reason why he recently wanted to hire that waste management company I read about on Facebook the other day. I'm so glad my parents voted for this Mayor. Re-election is coming up soon! This could be the perfect time to exercise my voting rights."

## **GOVERNMENT OFFICERS**

**City Mayor** – "I am proud to be the Mayor of this city and there's definitely a lot at stakes right now. The most important concern is the health of my citizens. I think it is important that we manage our waste properly. This is the reason why I have recently partnered with Revolution, a waste management company. One of the major things on my agenda as Mayor is to deal with the waste products that we produced as a society. My campaign when I ran for this position was heavily emphasizing the importance of educating our citizens the proper way to reduce, reuse, and recycle. This is a moral mission that we should all take part of as citizens of not only this city, but citizens of this Earth. This will continue to be a mission for my administration, even during my re-election campaign coming up next year. If we want past this wonderful city to many future generations, we need to take the initiative to take care of it first."

**Department of Sanitation** – "We understand some of the recent concerns about waste coming out of one of the textile companies nearby. We are currently looking into the matter. We have arranged meetings with the president of that company and their top scientists to discuss this matter. There's no doubt that we will determine whether these companies are properly disposing of their waste so that it will cause no harm to the citizens of this city. Our current water filtration system at the city water treatment plant is one of the best systems in the world. We have just installed it three years ago and are constantly making updates to our system to ensure that our citizens drink the cleanest water. I am 100% positive that our water is safe for consumption."

**Department of Environmental Health** – "Here, at the Department of Environmental Health, our mission is to protect health of our environment and ensure the safety of the humans living in this environment. We take environmental concerns very seriously. We also work closely with the Department of Public Health to ensure the protection of our citizens from any hazardous pollution/wastes that may be released into the environment. We study the production, management, and consequences of any chemical substance that may be a hazard to human

health. We also are responsible in creating, implementing, and enforcement of guidelines that are required to ensure the health of the entire community and environment.”

**Department of Public Health** – “Our department is responsible in promoting a healthy lifestyle for our community. We also investigate and maintain record of cases of disease and pathogens that may cause harm to human health. During a few community board meetings, citizens showed increase interest in the cleanliness of our drinking water. We are working closely with the Department of Environmental Health to investigate our water reservoirs. Much of this concern may have been caused by our new partnership with Revolution, a waste management company recently hired by our Mayor.”

**Objectives:**

- Students will use role playing to demonstrate the complexity of waste management of a community.
- Students will learn about current research in materials science/electrospinning/nanotechnology that is being applied to solve real-world problems.
- Students will understand the use of enzymes to degrade chemicals produced by industry.
- Students will be able to generate a coherent claim to an argument based on textual evidence.
- Students will be able to gather evidence and data from experiments to support their claim.
- Students will be able to write an argumentative essay to support their claim for an argument.

**Materials:**

- Introduction Information Cards
- Extra Information Cards
- Role Playing Character Sheet
- Argumentative Essay Guide Sheet
- Daily Progress Checklist
- Jurors Information Sheet (Who’s Who?)
- List of Interview Questions

**Special Teacher Instructions:**

- Depending on your students you may designate specific students for certain roles. Have students place their own picture on the Introduction Information Cards.
- Students who are not designated for a role will serve as the jurors of the case.

### Additional Resources:

1. “The Environmental, Health, and Economic Impacts of Textile Azo Dyes:”  
[http://2014.igem.org/wiki/images/2/29/Goodbye\\_Azo\\_Dye\\_POSTnote.pdf](http://2014.igem.org/wiki/images/2/29/Goodbye_Azo_Dye_POSTnote.pdf)
2. Pereira, L. and Alves, M. “Dyes - Environmental Impact and Remediation”:  
<http://repositorium.sdum.uminho.pt/bitstream/1822/25109/1/Ch%25204%2520-%2520Dyes.pdf>
3. Chhonkar, P.K. et al., Journal of Scientific & Industrial Research, “Impact of Tannery & Textile Industries Effluents on Agriculture”:  
[http://nopr.niscair.res.in/bitstream/123456789/26583/1/JSIR%2059\(6\)%20446-454.pdf](http://nopr.niscair.res.in/bitstream/123456789/26583/1/JSIR%2059(6)%20446-454.pdf)
4. Cornell University, “Electrospinning Cellulose Waste into Fiber”:  
<http://www.sciencedaily.com/releases/2003/09/030911072323.htm>
5. Barker, E., Popular Science “The Problem with Indigo”:  
<http://www.popsci.com/blog-network/techtiles/problem-indigo>

## Introduction Cards

New York City Mayor

Commissioner  
New York City Department of  
Environmental Health

Commissioner  
New York City Department of  
Sanitation

Commissioner  
New York City Department of  
Public Health

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Principal Investigator  
Revolution, Inc.



Research Associate  
Revolution, Inc.



Principal Investigator  
Spool Fabrics, Inc.



Research Associate  
Spool Fabrics, Inc.



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Public Outreach Director  
Revolution, Inc.



Director of R & D  
Revolution, Inc.



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## **List of Interview Questions**

1. What evidence do you have to support that the color dyes your company uses is safe for the environment?
2. Tell me about your research.
3. What are you studying to become?
4. What is this city doing to protect us from pollution?
5. What did you notice that was different in the city's lake recently?
6. How do you know that the products you make are going to clean the city's lake?
7. How much does your company pay you for the job that you do?
8. What would students learn from the tours at Revolution?
9. How often do you test the water in the city's lake?
10. What kinds of tests do you do to make sure the city's lake is clean?
11. Who is paying for your research?
12. What do you know about the Spool Fabrics, the textile company nearby?
13. What do you know about Revolution, the waste management company?
14. How much money is Spool Fabrics, Inc. making on a yearly basis?
15. Why do you think Spool Fabrics, Inc. is a good company to invest in?
16. How does the color dyes used in textile companies affect human health?
17. Do you think our lake waters are clean? How do you know?
18. Who usually buys the products you make?
19. How do you decide which research projects get funded and which do not?
20. How long have you invested in this company?
21. How is your company planning to improve this city?
22. How old is the city's water filtration system?
23. What does biodegradable mean?
24. What types of items are considered hazardous wastes?
25. What will be your first step if we find out that Spool Fabrics, Inc. is releasing harmful chemicals into our lake?