Handout 2: The TMI Accident

Previously, we considered three questions

> **Q1:** How can we avoid error, decrease the number and seriousness of accidents?
> **Q2:** With a fairly high degree of forethought and inquiry, can we anticipate *all* of the *serious* accidents that might result from using technology?
> **Q3:** What is the *primary cause* of accidents?

We offered two answers to Q2.

> **A1 (Optimism about Risk)**: Yes. We **can** anticipate ***all*** of the *serious* accidents that might result from using technology. Human beings can work toward preventing dangers associated with accidents and ultimately we can prevent all serious accidents that result from our use of technology. **A1** implies that human beings are capable of knowing nearly everything, that the world isn't so complex that it is beyond our practical capacity to understand and anticipate future events, that reach of technology does not extend beyond the reach of science.

> **A2 (Pessimism about Risk)**: No. We **cannot** anticipate ***all*** of the *serious* accidents that might result from using technology. Human beings can work toward preventing dangers associated with accidents but these can never be fully prevented. **A2** implies that human beings have a limited ability to know/anticipate events in the world, that the world is so complex that it is beyond our practical capacity to anticipate *some important* future events, and that the reach of technology extends beyond the reach of science.

The complexity of technological systems and system errors seemed to suggest that **A2** is true and **A2** seems to suggest the following argument:

ARGUMENT FOR ABANDONING CATASTROPHE-PRODUCING COMPLEX TECHNOLOGIES

P1	If some complex technological systems are likely to produce unpredictable catastrophic events, then we should abandon their use (or, if we cannot, then we should begin an aggressive search for alternatives).
P2	Complex technological systems are likely to produce unpredictable catastrophic events.
C	Therefore we should abandon the use of these complex technological systems (or, if we cannot, then we should begin an aggressive search for alternatives).

On the one hand, we might reject **P1** by saying that while complex systems are likely to produce unpredictable catastrophic events, the *risk* is worth the reward.

However, before we consider that argument, it is worthwhile to consider **P2** more closely by considering an example. Today we will examine a *near catastrophic accident* of a complex system, namely the Unit 2 nuclear reactor at Three Mile Island (TMI) near Harrisburg PA on March 28, 1979. In 1979, the TMI accident was the most serious nuclear power plant accident in the United States to date. Prior to the TMI accident, there were several accidents (some with no serious effects) and after TMI there are two examples of catastrophic accidents. Nuclear accidents are classified by the International Nuclear and Radiological Event Scale (INES) on a scale that considers three factors[1]: **negative impact on people and the environment** (e.g. release of radioactive material), **breakdown of radiological barriers and controls** (e.g. meltdown without radioactive

[1] See http://www.iaea.org/Publications/Factsheets/English/ines.pdf

material escaping), **degradation in the defense of depth** (failure of some safety system, but no breakdown of barriers). These factors are used to scale the seriousness of accidents/incidents:

INES RATING

Accidents	**Major Accident** Level 7
	Serious Accident Level 6
	Accident with Wider Consequences Level 5
	Accident with Local Consequences Lever 4
Incidents	**Serious Incident** Level 3
	Incident Level 2
	Anomaly Level 1
	No Incident Level 0

It is sometimes thought that nuclear accidents/incidents are "rare". But let's put TMI in context by considering a variety of incidents/accidents that occurred before and after it.

LIST OF NUCLEAR REACTOR ACCIDENTS/INCIDENTS

WHERE	WHEN	LEVEL	WHAT HAPPENED
Chalk River, Ontario	12 Dec 1952	5	
Mayak Russia (USSR), Kyshtym Reactor	29 Sept 1957	6	
Windscale, Cumberland (UK)	10 Oct 1957	5	Release of radioactive material
Vinca, Serbia (Yugoslavia)	25 Oct 1958	?	
Santa Susana Field Lab, California	26 July 1959	?	Partial core meltdown
Westmoreland County, PA	3 April 1960	?	Core meltdown, 2 million gallons of contaminated water
Richmond, RI	24 July 1964	?	
Monroe, MI	5 Oct 1966		Partial meltdown
Lucens, Switzerland	21 Jan 1969	?	Explosion (underground)
Greifswald, Germany (East Germany)	7 Dec 1975	3	Disabled cooling
Jaslovske Bohunice, Slovakia (Czechoslovakia)	22 Feb 1977	4	Release of radioactivity into plant
Middletown, Dauphin County, PA, TMI Unit 2	28 March 1979	5	Partial core meltdown
Orleans, France	13 March 1980	4	
Tsuruga, Japan	March 1981	2	
Buenos Aires, Argentina	23 Sept 1983	4	Radiation exposure
Prypiat, Ukraine (USSR), Chernobyl Reactor	26 April 1986	7	Complete meltdown, explosion, release of radioactive material, 50 dead
Goiania, Brazil	13 Sept 1987	5	Radioactive contamination, 4 deaths
Tomsk, Russia	6 April 1993	4	
Ishikawa Prefecture, Japan	June 1999	2	
Ibaraki Prefecture, Japan	30 Sept 1999	4	
Paks, Hungary	10 April 2003	3	
Sellafield, UK	19 April 2005	3	
Braidwood, IL (USA)	Nov 2005	?	
Erin, TN (USA)	6 March 2006	2	
Fukushima, Japan (two reactors)	11-March 2011	7 & 3	Partial meltdown, release of radioactive gas, explosion, evacuation,

*This is a partial list of accidents at nuclear facilities (does not include accidents relating to nuclear-powered ships, aircraft, etc.)

In examining TMI, we won't be looking at as an example of the *actual* damage that occurred. Rather, what is important here is that it serves as an example of a complex system that (i) has the capacity to produce *catastrophic* accidents and (ii) the fact that these accidents appear to be unpredictable. Of course, dealing with radioactive material is dangerous and there are a number of accidents involving individuals becoming sick or dying from exposure, e.g. in the early development of nuclear weapons or the first reactors, individuals being exposed to radioactive waste during the disposal process. But, our focus is not on incidents that happen to single individuals but *catastrophic* accidents, one that could threaten many lives (both living now and the future) and destroy ecosystems permanently.

General Questions to Consider While Watching TMI

*Questions about **P2** of the argument:*

1. How would you rate the ability of the individuals involved in the TMI incident to accurately diagnosis what was going wrong: 1 (guess) – 10 (certainty).
2. What sorts of things about the TMI reactor and its workings did the individuals know, not know, should have known, could have known, could not have known?
3. What was the primary cause of the TMI sccident?

*Questions about **P1** of the argument:*

4. What psychological effects did the non-catastrophic incident have on the people living nearby the reactor? Do any other technologies besides complex technologies that are capable of producing catastrophic effects have this effect?
5. What are some other negative effects that could have resulted if the TMI reactor melted down or exploded?
6. If you were to ask the people living near TMI *before* the TMI incident if they thought the risk of the reactor was worth the reward, what do you think they would say?
7. If you were to ask the people living near TMI *during (or after)* the TMI incident if they thought the risk of the reactor was worth the reward, what do you think they would say?
8. What people would be put the most at risk if the TMI reactor melted down? Do we have any *special* obligation to these people?
9. Are the risks worth the reward?

Specific Questions to Consider While Watching TMI

10. What happened at Three Mile Island Unit 2 near Harrisburg, Pennsylvania on March 28, 1979?
11. What was Metropolitan Edison's (the utility company) initial response to the problem at Three Mile Island? (video: 8-10minutes)
12. What was one disastrous effect that could have occurred at Three Mile Island?
13. What was the attitude of the Nuclear Regulatory Committee (NRC) concerning before the Three Mile Island accident concerning those who raised concerns about the safety of certain power plants? (video 18:30-19:10)
14. What sort of reaction does William Scranton III have to visiting the Three Mile Island plant? How does he see the plant as having a double significance? (video 19:20-20:20)
15. Which people in particular were recommended as evacuating Three Mile Island? And what was the reaction of the general population to this limited evacuation? (video 28:30-30:30)
16. When it was initially discovered that there was a hydrogen bubble in the reactor, what was the general state of *knowledge* that government officials, media, engineers, clergy, and members of the NRC had of the potential danger? (video 33:00-43:30).
17. What did President Jimmy Carter do after hearing about the two different explanations about the hydrogen bubble in the reactor at Three Mile Island? (video 43-45)
18. Ultimately, was the hydrogen bubble in the reactor a threat? (video 45:30-46:30)
19. Was there a meltdown at Three Mile Island? (video 49-50)
20. How many reactors have been built in the United States since the accident at Three Mile Island? (video 50-50:30)