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DAVID KAISER: Welcome, everyone.

This optional informal discussion for 8.225 STS.042, as hopefully you all know, we're just going to take our time, just very informally chat about really anything that's on your mind around the most recent material, but in particular things that might have been curious, or puzzling, or disturbing, or whatever.

Any of the above that might have been elicited in your mind upon watching the documentary film, The Day After Trinity.

I actually just watched the YouTube version with some of my family over the weekend.

I didn't realize how poor the video quality was.

I apologize for that.

If you were watching it on a small device, maybe you didn't notice.

But if you were watching it on a super big crazy large TV, you would have seen it was very blotchy visually.

But anyway, hopefully it was nonetheless clear enough to get the gist.

And I have no agenda for today, I'm really just happy to go whatever questions, or comments, or thoughts are on people's minds.

So anyone should feel free to jump in.

I expect we'll have a small enough group, we don't have to worry about breakout rooms.

We can just manage the discussion hopefully pretty informally with the group this way.

So I'm curious.

I mean just the floor is open.

Were there things that surprised you from the film things, that surprised you the film didn't broach or cover, anything?

The whole topic is open. Really interesting question.

That's a juicy one.

And I should also say, by the way, even more than usual, I invite the TAs to jump in as well.

Please don't be shy.

But let me give you my first crack at that. I think a lot of people who were convinced to work on the project, and the film gives a little hint of that, they really were not given very much in advance to go on.

They had to make a fairly snap decision in the middle of very dislocated times.

And often because of secrecy, they couldn't be given a kind of full briefing ahead of time.

Some of them didn't have much idea of what was coming.

And my sense of it, there was a lot of the folks who did volunteer then to join the project, really were deeply concerned about developments in Europe, especially around what looked like the kind of unchecked military progress of the Nazis.

So I think there was a sense that they wanted to find some way to contribute to the defense effort, to the war effort.

Now, that raises other questions, which are broached at least briefly in the film.

If many people's principal motivation had to do with Nazi Germany, what happened between so-called V-E Day, the ultimate defeat of the Nazis in April of 1945, and the remainder of the project, let alone the use of the weapons against Japan?

So we should come back to that.

But nonetheless, I think people felt strongly they wanted to do something.

Many people did, even very young people.

And this was a decision formed without full information, because often they literally couldn't be briefed.

We talked last time about these, the so-called indoctrination course, that Robert Serber gave once they actually arrived at Los Alamos.

For some of them, he had to tell them, oh, we gathered you here to build a bomb.

Like he first had to say that, because it might not have been obvious to everyone yet when they gathered.

I just find that extraordinary.

There's a larger question though, a larger thing that actually a good friend of mine, a historian Michael Gordin has written a really interesting short book about.

The book is called Five Days in August, which comes to another aspect of your question, which is how did many people, scientists on the project, military officials, political leaders, journalists, and other policymakers-- how did many different kinds of people come to think about the bomb once they learned about it?

And Michael's argument in brief, let's see if I do justice to it.

Again, some of the TAs know this book very, very well.

So they should correct me.

But my recollection of my friend's book is more or less the following.

That the bomb was treated by many, many of these folks as not particularly unusual or special prior to its use.

And my favorite parts of Michael's book actually have to do with the mechanics of how the weapons were literally put together, and then armed for use against targets in Japan.

So on the island of Tinian, there's some footage in the film of the staging grounds on Tinian.

And my understanding is it's not that President Truman, the US President Truman, gave direct orders every time to say drop a bomb now on Hiroshima, drop a bomb now on Nagasaki.

There was no such order given, not that specific.

The decision was made to use the weapons when they were available up to the discretion of the field commanders, just like every other kind of weapons, every other kind of bombing.

Again, as there was some footage in the film, and others, you might already have known, there had been campaigns of what was called incendiary bombing, using certain kinds of conventional explosives that were especially likely to cause ground fires against some cities in Europe, but many cities in Japan by the Allied air forces, US in particular.

And those weren't separately ordered from on high.

There was a chain of command in the field, so to speak, and up to their expert judgment-- were the conditions right, is there a storm coming, should they launch a series of bombing raids or not.

That was not a presidential level decision, or even necessarily a general's level decision.

That was kind of outsourced to the ranking officers in the field.

And what astonishes me, what Michael found, is that in the earliest stages the nuclear weapons were treated like that.

They were plugged into an existing system of local decision making about when to use them, under what circumstances.

And that Michael suggests shows that they were not treated as a separate category early on.

They were treated like another weapon.

There had been many other kinds of weapons developed and deployed from scratch in the course of the war.

And that these were treated at least logistically or kind of bureaucratically like yet another weapon to be deployed largely at the discretion of the local field commanders.

And that to the extent there was a standing order at all, it was to use them when you got them.

It wasn't like drop one, wait three days.

There was no such coordination of that level.

And in fact, there was no third bomb ready.

The two were dropped.

The bomb dropped against Nagasaki was, and you get a little bit of this in the film, was the schedule was pushed up by the local field commanders because there was a worry about severe weather, a typhoon coming that would have threatened certain kinds of aircraft runs.

And in fact, Nagasaki wasn't even the original target city.

There was a decision made by the pilot in mid-flight to change paths, I think largely because of things like changing conditions in the weather and so on.

So these were not highly staged, or these were not highly carefully thought out and vetted individual decisions.

The decision was load them into the planes, and drop when you got them.

And they had two, the makings for a third not yet compiled weapon were literally on a boat, making their way to Tinian at the time that Japan surrendered.

So the idea was drop them one after the other, much like the incendiary bombing raids have been, one after the other.

And what Michael and others have argued, what made the atomic weapons seem special was the fact that the fighting stopped, which was not necessarily predicted.

No one thought you drop one, and they'll stop.

Or at least no one seems to have thought that.

No one thought if we timed the other one very carefully that'll convince them.

There it was no such calculation for the timing of the second bomb that was used in this case against Nagasaki.

And they were prepared-- they were preparing to drop a third one, and they would have dropped a fourth if they had one.

They just literally didn't have the parts.

So Michael argues that it was actually in response to the fact that unlike other military campaigns, there was at least a coincidence in time this time around that Japan did surrender within days of the second bombing.

That then in kind of a post hoc rationalization, according to Michael, made people think that the atomic weapons were now somehow in the category of their own, or different, or special.

That was a long answer.

It's a very complicated question.

I think a bunch of the scientists who worked for example on Los Alamos, scientists, engineers, I think they thought this was different early on.

And some of their concerns which we hear about less so in the film and other reminiscences and interviews and so on, memoirs have been published, is that they were often quite concerned that some of the army figures, military figures, who also witnessed for example, the Trinity test, were not as shocked as the scientists were.

I think I mentioned very, very briefly in my previous lecture that for the Trinity test in Alamogordo, New Mexico, one of the things that really, really seems to have left a visceral reaction to many of the folks who then were able to inspect what would soon be called ground zero, was that the heat and especially pressure of the blast had fused desert sand into glass.

And that at least, as some of these scientists later recalled, that gave them a kind of visceral sense of the forces at play.

And then some of them report being equally viscerally upset that the generals weren't impressed by that.

So some of the scientists seem to think we are playing with the forces that power the sun.

We're dealing with extraordinarily powerful physical phenomena.

And so at least in their later recollections, they seem to have treated this as different, not just another TNT bomb souped up.

And therefore, they were concerned that others didn't treat it with a similar kind of differentness.

But I'm pretty convinced by Michael's argument more broadly.

If you look at the political, high level political apparatus, and the military planning war department apparatus, this was treated at least bureaucratically in terms of standing orders as such, much more like the next thing in the arsenal to drop, as opposed to some total separate category in itself.

I don't know if anyone else has any thoughts on that.

But that's my not very brief take on that very juicy question.

It's a good question. Right.

Thank you, Steven.

That's also a really hard question.

It's a important question, but it's a hard one.

And I talked a little bit about this in a previous class session.

But it's worth revisiting.

So the short answer is many of these folks were aware, as I say, the scientists and engineers, let's say, were definitely aware that there was going to be associated radiation and fallout.

And that would not be good for people.

They knew there was an inherent clear danger that was not like TNT or other conventional explosives.

That really did strike many of them as being importantly different.

They did not have anything like the sophisticated large-scale statistically powerful controlled medical experimentation type results or body of knowledge that would develop later.

So we shouldn't expect them to have had the same knowledge about the human biological implications of fallout, as the community would later acquire, largely from the use of these weapons and from other kinds of tests.

So they didn't know what would later be known.

They knew something.

They knew enough to treat it very relatively carefully.

It is.

Yes, thank you.

They're aware that that's at least a likely possibility.

On the other hand, they were pretty cavalier, even with their own personal safety.

So for example, I think I mentioned briefly.

One of my college professors who had just retired before I started college, 10,000 years ago approximately, he had served as a very young kid on the Manhattan Project.

I mean he like a kid.

He was basically like a first year grad student.

So even our TAs are more advanced than this kid was, when he joined the project.

And he would say, they would carry little radioactive sources in their jacket or vest pockets to calibrate the local machinery.

So they would put alpha emitters next to their gut.

I don't recommend you do that today.

So there was a kind of cavaliness about radioactivity in general for a lot of these folks.

Partly, oh there's a war on.

We don't have time to be all special and careful.

Partly they didn't know what would later be better known.

And then partly for people who were working on the project who weren't themselves scientists or engineers, there was a really I think very significant lack of effort to better inform those people about appropriate safety procedures that based on the knowledge that even was in hand at the time.

See what I mean?

And that's just for radioactive emitters generally.

Then we come to the question of fallout specifically from the use of these weapons in a large human population.

And that, again, they knew enough to start studying long-term effects.

They figured this would not be good for people.

They didn't have detailed information about which cancers at what rates, what kinds of demographics, young children affected differently than older people, a role of preexisting conditions, the kinds of things that kind of biostatisticians would come to study much more carefully later.

So again, that was a pretty long answer.

But they were not entirely ignorant of the dangers of radioactivity, in general, or some of the likely implications of radioactive fallout from the use of these things in a city.

And they didn't know what other people would learn in more detail later. That's a great point.

I'll just add again quickly, thank you, Tiffany on that point too.

Coming back maybe to Steven's question more directly.

Meaning more directly from me, than I [INAUDIBLE]..

There was a long-term study of people who were in Hiroshima and Nagasaki at the time the bombs went off.

Long-term longitudinal study largely under US auspices.

So Japan, as you may know, was occupied by the Allied forces, mostly the US, but the Allies of World War II for the better part of a decade, starting very soon after surrender.

So there were a lot of US-based long term studies of the effects of the weapons on site, including a lot of these biomedical epidemiological type studies.

And yet it still remains deeply, deeply controversial how many deaths to attribute to the bombings, partly because of different definitions about who was exposed in what way, partly to the usual difficulties statistically of saying would this many people have gotten lung cancer even if they hadn't been exposed to this kind of basically pathogen for lack of a better word radioactive source, and also because a lot of the stuff remains classified or remain classified for a long, long time anyway.

So one of the themes we'll come to a bit in this class, we've already got a little hint of it, is the role of classification in making it difficult to draw certain kinds of conclusions from otherwise very complicated scientific and technical projects.

In this case, it was a lot of the stuff was subject to boring classified strictures, which didn't help with independent statisticians redoing the stats, and stuff the stuff that we would kind of take for granted in peer reviewed scientific studies today.

So literally today, I'm sure I didn't look recently.

But I'm sure if anyone goes on Wikipedia, and says how many casualties from the bombing of Hiroshima, there will probably be one of these like warning comment signs.

People are flaming each other.

The editors don't agree.

Because to this day, 75 years later, asking what sounds like a countable seemingly straightforward question, how many people were affected, killed, injured whatever, is remarkably straightforward to very well intentioned experts, let alone people who are operating from further away from the original information.

So it gets really tricky to assess literally how many people were killed.

The immediate blast damage that actually was counted up pretty compellingly clearly.

There's not much argument about who died within the first week.

But all these kind of long tail, more epidemiological type things, remain actually quite tricky and can inspire some real earnest debate. Yeah, it's a great point Lulu.

And it's again, it's tricky.

I find it tricky myself.

And just biologically, I'm closer to those times than most of the rest of you, but not that much closer.

I mean I grew up during the Cold War, and thinking about-- I didn't have to do duck and cover drills during like h-bomb raids, but like my parents did.

So I heard about it.

Anyway, but nonetheless it's hard to get my mind back to a time of total war.

I mean, thank goodness, right?

But if you look at the casualty counts, the fatality counts from the incendiary bombings of Tokyo and Dresden, they very likely exceeded at least the short term casualty counts from the bombings of Hiroshima and Nagasaki, at least they were comparable, meaning there were cities where hundreds of thousands of people were killed by dropping of weapons from aircraft multiple times in just the weeks, let alone months, before these to our eyes new kinds of weapons were used in August of '45.

So the scale of the human costs of civilian of total war where it's not people in uniform fighting on a battlefield but anyone who's within some geographical territory, is suddenly considered fair game as a target.

That wasn't invented with the use of nuclear weapons.

And the difference that sometimes people would articulate soon afterwards was it took 1,000 aircraft to level Tokyo.

And it took one to level Hiroshima.

So some people would start saying these really are different.

Let's be careful.

Let's think about this carefully.

Others would say 100,000 people dead.

That's like last Thursday.

It's just remarkable what's the comparison class.

Let me put it that way.

What are you comparing it with, and how do our own individual sensibilities shift compared to what many folks' were immersed in, at the time?

And I don't say that to say there's no culpability.

I'm just saying it's astonishing to me that might have seemed unremarkable in its day, given 3 and 1/2, 4 years of this really devastating heavy civilian law, so-called total war.

So I just find that-- I mean thankfully, I don't think we have that kind of experience in any of our lifetimes of that kind of civilian loss of life in wartime.



There's been plenty of bad things happen since.

Yeah, anyway so just the scale of civilian human loss, where you were deemed a legitimate target if you happen to live in a city, let alone if you were drafter, let alone if you volunteered, or whatever. Yeah, and again, not to get ahead of ourselves, but for this coming Wednesday's class session, we'll talk about, and you get a hint of this in the film as well, the next step that happened to have been taken in this thread of discussion was the development of hydrogen weapons.

Which are, roughly speaking 1,000 plus times more destructive by any parameter you choose to measure, than the weapons that had already been used. Right, right.

On the question of Niels Bohr, it's a great point, Lucas.

And I think it's a lot like something we talked at least briefly about in a class session maybe two classes ago, on Einstein's very famous letter to President Franklin Roosevelt as well.

These for a long time were held up by scientists as examples of these Nobel Prize winning architects of modern physics were also geniuses of the human condition and political wizards.

I wish any of that were true.

And it's not to take away from either Einstein and Bohr to say that those stories are not wishful thinking.

Boer very earnestly tried to serve in exactly the capacity you mentioned, because you're quite right.

And the fact is he was completely and kind of predictably ineffective at it, no one had any reason to listen to this mumbling Copenhagen guy who didn't seem to know anything about how governments work.

So his entreaties, his efforts were-- he did make the efforts.

Let's give him credit for that.

He did see ahead.

He was predictive, as many people were, of a an arms race unless there was this narrow window of opportunity to try to avert an arms race, mutual suspicions, and distrust growing.

But I think there was very little chance of him having any actual success.

And it turns out he had approximately zero success.

So it's not to fault him for trying or for recognizing this as a likely scenario.

But we tend to hear about these stories by like biographers of Niels Bohr, who are enamored of the many extraordinary things that Bohr was able to do during his lifetime.

But if we ask the same question of historians of US foreign relations they'll say, Niels who?

Because it had literally zero impact, at least from where they're sitting on the very, very complicated relations between US and Britain, let alone US and the Soviets, or anything else.

So guess I take these episodes as examples that some of these physicists were indeed trying to think one or two steps ahead, and they were not-- maybe they misjudged their own likely influence.

So they get credit in my mind for thinking about it at all and trying, but not much of a track record in hindsight. It's a great question.

Thank you, really interesting.

So the first impact was it was not very many from any given campus.

So it wasn't like one department was emptied out.

And in fact, there was at the time, a very, very strong concern on many, many, many university and college campuses in the US to keep as many physicists on site as possible, because they were involved in teaching what we would now consider basically classical physics, blocks, sliding down planes, and elementary circuits and radio, which was often done in physics departments, not a separate electrical engineering department in many, many places.

So there was this huge concern about, literally they talked about rationing and stockpiling physics instructors to teach canonical college students, but also to teach huge numbers of navy and army special students who were drafted sometimes often straight out of high school, were not yet college students, and were sent to many, many campuses around the US for crash course study, very accelerated schedules, to learn basically rudimentary physics, like for radio communication or like sighting or sound ranging.

It really was like classical physics.

And in fact, physics departments were admonished not to waste their time teaching quantum mechanics or nuclear physics, because that's not going to be of any importance during the war.

That makes me smirk.

And they should put all their efforts teaching classical E&M and Newtonian mechanics.

Whether it's for how do you measure air pressure, what's a barometer, how do you measure angles with a handheld of sighting device.

So I find that really fascinating.

So the term that's often used you might have heard, the Second World War has often been called the physicists war.

And that term has usually been taken to mean, oh, we know what that means.

It was all about radar and exotic weapons projects, like the Manhattan Project.

And so I actually wrote about this recently.

It turns out the phrase was introduced before the attack on Pearl Harbor, before there was Los Alamos laboratory, at a time when radar was still deeply classified.

The usage of the term, if you do one of these Google Ngrams, all these fun things we could do now searching in English language corpus, the phrase physicist wars use, it spiked in 1943, at which time anything about the Manhattan Project was deeply, deeply classified.

They were not printing editorials about the nuclear weapons in the op ed pages.

So the term physicists war was used to respond to the fact that more and more young people, mostly men, mostly boys, had to be trained in crash course settings on what we would call classical physics for practical purposes on the battlefield, by which they meant barometric pressure, measure angles, use sighting on a gun, and elementary electronics, and circuits.

So the physicists war, the meaning of the term actually changed quite dramatically after this dramatic revelation about these new previously secret weapons projects and the kind of impacts they had.

So the physics classrooms were bulging faster than ever before.

They weren't getting drained out.

There were more people rushing to study physics, more people who were put into physics classes, whether they chose to or not.

And more and more people teaching physics, not just for math and chemistry, but for music.

Anyone who had any kind of quantitative skills, political science, you know any statistics?

Good, now here's your crash course to relearn calculus, and you're going to teach Maxwell's equations next week.

And again, anyone who was caught poaching, that was their word, stealing legitimate physics instructors from one campus were subject to public shaming.

So there was an effort to keep more and more physics instructors in the classrooms, not to teach fancy, fancy nuclear fission, but rather these other topics.

And that meant that when a couple slipped away, it was I think lost in the noise I have a feeling.

Because there was so much tumult about huge kind of throughput.

MIT'S campus switched to basically 12-month instruction and we had I think at the height of this three times more-- or not three times-- it was like a 3 to 2 ratio.

It was like a 1 and 1/2 times more so-called special students, meaning full-time army and navy students assigned to MIT for six week terms than MIT students.

So the MIT's own campus was taken over, was put into high gear.

And that was very common in many, many other liberal arts, tiny liberal arts colleges, big universities, and everything in between, these very, very intensive short term crash course things.

In fact, if I can find it in time, I'll put it in the chat.

One of my favorite photos is actually of 10-250.

I don't know if it's your beloved or your hated, a room many of you will probably know, one of our big, big lecture halls, 10-250 filled with young men in uniform taking one of these crash course classes in probably elementary circuits.

And it's just a sea of faces that all look the same, in all the same uniforms, just 400 people filling 10-250 all in their khakis.

That's what campus at MIT was like.

That was the predominant thing as opposed to, hey, where did all these people go?

They must be doing something top secret.

Gary, you're up.

And then Alex.

AUDIENCE: I just wanted to share a movie suggestion, because you mentioned Dresden.

And it's a chilling movie, but it's about how things can get normalized.

Bob McNamara, who was the Secretary of Defense during the Vietnam War, but was very involved in World War II with regard to the bombings in Tokyo, the Tokyo fire bombing.

I got to know Bob very late in his life.

And I thought I'm going to hate this guy.

I grew up just hating the whole idea of who this Secretary of Defense and the Vietnam War might be.

And he was reflective about it.

And he made this movie when I knew him.

But it's really worthwhile to watch, The Fog of War.

DAVID KAISER: Yes.

AUDIENCE: One other story about normalizing, my father was a corporal, never went to college.

And he was in Tinian.

DAVID KAISER: Yeah.

AUDIENCE: And so the day after Nagasaki, the general said to him, Sammy, you want to go up and see what we did yesterday?

So my dad flew over Nagasaki literally the day after.

30 or 40 years later, if I'd asked my dad about it, and he was a good man.

I love him to this day.

But he would say-- I'd say, what do you think?

He said, Gary, we did what we needed to do.

He was just a corporal.

He was a radio mechanic.

DAVID KAISER: Yeah.

AUDIENCE: But it got normalized.

I have a question for you David.

Do you know why Jacob Beser was the only man on both?

I don't know the answer, but I knew his son.

I knew Jerry Beser, his son.

But Jacob Beser was the radar man on both flights.

And why did they do that?

He's the only person that was on both flights.

DAVID KAISER: That's fascinating.

I didn't know that, Gary.

So my guess-- I'm just guessing, I'm speculating.

And Wikipedia might answer it quicker and maybe even more accurately than me.

My guess is that it was still, it was kind of a shoestring operation.

Tinian, I mean they were throwing this thing together.

They just barely had gotten the kind of airstrip to dry.

It was so last minute that my guess is it could as well have been short staffed as any kind of strategic reason, especially if it was a more kind of specialized role, like the radar operator.

It wouldn't surprise me if he was the person who had been trained and was available.

I don't know if it was any more than that.

DAVID: Yeah, so Gary, let's see something else you said, oh, yeah.

Yeah, so let me just say briefly, because it's something that the film didn't really get into.

A lot of the scholarship in the 40 years since even the film came out, let alone the 75 years since the events in question, has really gone around and around frankly, or has been a very vigorous debate, I'll put it that way, about basically were the bombs needed that's kind of a second guessing after the fact.

Or put a little more prospectively, what convinced people to give this standing order to use these weapons at all?

And soon after the war, I think it was 1947, then the person who had been Secretary of War during the Second World War, Henry Stimson, published a famous, famous article basically justifying the use of the nuclear weapons.

And he's saying it saved a million lives.

And then it became was it either a million fatalities or casualties.

But either way he said, if the United States had to actually launch this planned in-person invasion of the mainland of Japan, if there was no way to secure a surrender in an end of the war other than a fully armed invasion of the mainland which is what was indeed being planned by mostly US Allied forces, then the casualty count both among US soldiers and among Japanese civilians would have been astronomical.

And he mentioned the figure 1 million.

Well, where did he get the figure 1 million from?

It seems to have been invented in 1947.

It seems not to have come from any classified or since declassified military planning document ahead of time.

So then the question becomes, would an invasion have been necessary.

Were there other reasons to have thought, based on information available at the time, that Japan might or might not have been getting closer to a surrender even prior to the use of the bombs, alone would an invasion have been needed?

And if an invasion were needed, where do these casualty figures or these projected figures have come from?

So I'll just say, I don't know all the answers.

But I people who've pored over this very, very carefully.

And say each of those questions is subject to, let's say, many compelling and quite different answers. So many US military officials as later came out in declassified documents that were at the time quite secret, were already raising skepticism about whether a full invasion would be needed at all.

And then other people say, oh, but that was before the really quite horrible fighting in Okinawa, which was in June.

So maybe there was a concern that the Japanese troops would actually not surrender, even if they were clearly overwhelmed numerically.

So which military officials even thought the United States would need to mount an invasion, that's already actually pretty complicated based on the documents that have since much later become available.

Some people clearly wrote down Japan is on the brink of surrender anyway, prior to the use of the weapons, prior to any invasion.

Other people said, oh, we thought they might surrender, but now we're not so sure because of the really quite just horrific fighting, the kind of dug-in fighting, especially at Okinawa, not too long before the use of nuclear weapons.

Then there were all these questions like, were the weapons used to end the war or to secure the post-war?

So was it signaling vis-a-vis rivalries with the Soviet Union, which was a popular thesis, or other things?

Were they used for a kind of geopolitical strategy at least as much, if not more, than for direct kind of military strategy?

And again, there are very compelling arguments based on lots and lots of documents, on not just those sides, but the whole kind of spectrum of that.

It gets pretty murky pretty quickly.

So there are waves of revisiting these questions of what military role do the weapons play.

And I'm not saying one or the other.

I think it's complicated, right?

But you can get these really interesting studies based on a lot more than what was publicly accessible in 1955 or even 1965, with much more passage of time and much more active use of Freedom of Information Act and declassification and so on.

It's pretty complicated.

And so again, we go back to an earlier question.

Do the bombs end the war?

Were they somehow special that incendiary bombings that leveled cities were not capable of ending the war, but these special weapons were?

That was a popular interpretation very soon after the war, when these things were revealed in such a dramatic way.

And then generations since have gone back to the question.

And I think it's more complicated, more subtle, than some of the early pronouncements, either pro or con.

And if people are interested, I'd be glad to share kind reading lists of lots of things that have dug into that since then. I think the answer is neither.

And here's my understanding, Alex.

But again, this is my-- I think it was raised as a serious question long before the test, and settled to everyone's satisfaction before the test.

So I don't think it was only a joke.

I think by the time of the test date, people weren't worried about that the way they once had legitimately sat down and calculated.

They didn't just say, gosh, I wonder.

Let's try it.

So I don't think it was a joke.

But I also think it was no longer a live debated scientific question by mid-July of '45. My understanding is Enrico Fermi was the one who articulated that question, but not like the morning of.

I think there was enough time for enough people to sit at that and check each other's calculations, and not only physicists, actually people who know stuff like chemists, and other people who had relevant expertise.

I think there was a vetting of that question well before the test date.

Yes.

So the short answer is yes.

But again, but you phrased it very well.

Was there any indication?

The answer is yes, not definitive indication.

That's why it's still-- you hear the phrase war is hell.

Like it's hell for information as well as for all the more obvious reasons.

So here's what I mean by that.

It has come to light since then that, first of all, some countries had cracked the Japanese encrypted cables, and was leaking that information to Washington, and London, and probably Moscow as well.

So some elements of the Japanese government, which at this point was highly fractured and not really functioning very easily because Tokyo had been leveled, some parts of the Japanese government were sending out feelers to try to see if a neutral third party could begin peace negotiations or negotiations to end the fighting.

It's not clear that they had the authority to speak for the emperor, who was refusing to step down, and that was part of this unconditional surrender and so on.

So it's not clear if that represented what fraction of the then existing Japanese government that represented.

It's also not clear how far that ever got.

But there indeed was some evidence that some highly placed members of the Japanese government before the bombings of Hiroshima and Nagasaki were seeking to start basically negotiations.

They were seeking a third party who might broker them.

And again, that doesn't mean they were on the verge of surrender.

What seems to be more clear than anything else from these other scholars, not my own work but I've learned from other people who've looked at this much more carefully, is that it was just complete disarray.

I mean Washington DC was not subject to that kind of bombardment.

And so there was something like a functioning chain of command, and something like a fractious but still functioning series of decision makers who could disagree, but nonetheless act on behalf of a functioning government.

I think not much of that was functioning the same way in Japan by that point in the war, because of things like the enormous disruptions from the incendiary bombing.

There were different factions, as one might expect.

There were different factions in the US and in Britain.

There were different factions within Japan.

And it wasn't just military-civilian.



There were different kind of complicated-- different loyalties and groups.

So it's not clear who was speaking for whom, and if they even were capable of having the equivalent of like a full cabinet meeting, the way we might expect in a US context.

So it's a great question, Alex.

And unfortunately, the answer, again, is like oh gosh, it's complicated.

So with the fullness of time, evidence has come out that there were some parties looking to do some things.

What's not at all clear and maybe it wasn't clear even at the time, was in a sense, would that have carried the day.

Who were they speaking on behalf of?

Who had the authority at the time?

Because I think that had gotten very, very again, let's just say non-trivial.

So it's a great, great question. Sure.

Yeah, no great question.

A lot, lot, lot, lot, lot, lot has been written about the Oppenheimer affair, let's say, the Oppenheimer hearing.

Over the years, again, people keep revisiting it as more and more it becomes declassified, more people are interviewed, and there's a lot.

The 100th anniversary of Oppenheimer's birth was 2004.

And over the 12 months of his centennial birth year, there were 12, like one per month, 12 full length biographies published just in that year, at least 12 that I counted.

There could have been more.

So I mean when I say there's like an Oppenheimer industry poring over this that's what I mean huge, huge amount of study of this.

So let me just say briefly therefore, instead of going on for hours, and again we'll talk a little bit about this also in Wednesday's class.

Oppenheimer ended the war really seen as the person who built the bomb, which is not historically accurate.

The Manhattan Project had 125,000 people.

And even the so-called inner circle was many, many people, not just one or two.

But he really became the kind of face of it.

And that became both for good and for ill.

I mean he was treated as a hero for many people who thought that the bomb had ended the war, and therefore saved lives, which was a dominant interpretation soon after the war in the United States.

He was seen as this kind of wizardly philosopher king, like the film says, who had made it happen despite all the odds.

On the other hand, that also made some people think that he was uniquely dangerous.

If there is a single mastermind or a single set of secrets with which these things can be made, then that invites extra scrutiny, right?

And this is something we'll talk a bit more in Wednesday's class.

So there was a lot of scrutiny as the political assumptions and fortunes and groups in or out of power within the US and elsewhere shifted after the war.

Oppenheimer had made a lot of enemies along the way, because he was very smart, and never, ever, ever shy about letting everyone just how smart he was.

He could be terrifically cutting, I mean just mercilessly mocking of people whom he considered intellectually inferior, sometimes of students, often of people who were outside of his immediate circle.

So he was mean to physics students.

He was horrible to people like the Secretary of the Air Force, which is not a smart thing, by the way.

If you're ever in a position to mock the Secretary the Air Force, let me advise you not to do it, whether the person deserves it or not.

So that Oppenheimer kept making enemies, basically.

He was in the spotlight, and that gave him the opportunity to shoot his mouth off a lot.

And much like Galileo, a couple of centuries earlier, he was often adopting positions that one might find perfectly reasonable defensible, but defending them in an often very aggressive and kind of mocking way.

Galileo and the Pope, Oppenheimer the Secretary the Air Force, right, not actually so dissimilar in some ways.

So Oppenheimer started collecting a slew of really quite emboldened political enemies.

And he started giving advice on strategic steps for the nuclear arsenal that many of them didn't like either.

And again, we'll talk a bit about this, and there was a hint of that in the film as well.

So in less than a decade, he had then made a long series of quite powerful people who were pretty ticked off at him.

And so in some sense, his hearing was, I don't know if it was overdetermined.

But it wasn't actually such a shock.

The fact of the hearing, the fact that people wanted to get him.

What was left out of the film, and this largely came to light in more recent scholarship since the early 2000s, is that Oppenheimer frankly was trying to hold on for a long time. As we now know from since declassified documents, he often sold a bunch of his own students out.

He was very desperate to protect his younger brother, Frank, who does feature a lot in the film.

Frank had been an explicit card carrying member of the Communist party in the '30s, not active, but he joined the party as many, many, many, many academics did in the US, in the '30s.

That wasn't so unusual.

But that made Frank an easy target.

And so it looks like not infrequently Robert Oppenheimer would try to cut these deals.

He thought he could control the situation.

Don't bother my brother.

He's actually no harm.

But you know what?

Those guys, they're reds as well.

And often those guys he'd point to were some of his own former PhD students behind their backs.

So he was doing a lot of these things, as we now know, that paint a more complicated frankly human picture than the saintly martyr that often comes up even I think in this film actually.

So his own political skills were not quite as sterling as he often thought.

His way of coping with fast changing political winds were not what I think any of us would hope we would do within that situation.

I don't know how we would do, but it didn't always look great, as we now know.

And it comes off as almost a kind of grasping, at least in some of these scenarios.

So Oppenheimer becomes, frankly, more interesting and also just much more human.

There was a reason to write at least six of those 12 biographies in 2004.

There's a lot of dimensions to this person, and a stand-in for larger fast moving currents certainly within the US, and I think beyond that as well.

So I'd be glad to talk more about Oppenheimer.

But let me shift to Teller.

Teller was also a very early recruit, very active at wartime Los Alamos.

And already a very accomplished theoretical physicist, that generation they all knew each other.

It was a small community before then.

He was an emigre.

He was a Hungarian Jewish person who fled fascism.

He'd been studying in Germany like many of them.

So he had very good reason to come to the United States in the '30s and was hired here in that wave that we talked briefly about.

And he was very accomplished, and in particular very accomplished in nuclear physics, ahead of the curve on that.

He also, I think because of his experiences with these very short lived communist and socialist governments in Central Europe after the end of the First World War, a bunch of these emigres like Teller had experienced what they considered just really scary chaos in their reckoning right after the end of the First World War, when they were basically late teens or early 20s.

A lot of them from self-proclaimed communists, or other socialists, short lived.

There was a huge back and forth, the far left, the far right, the far left, far right, militias in the streets, hopefully nothing that any of us will experience soon or not so soon.

So Teller was a devoted anti-communist before he landed on the US shore, from I think really not because he read Marx and was horrified.

Because he'd seen these blood in the streets kind of fights in the 19-teens. And many of the folks who came with him from that era shared those sentiments.

So he was very, we might say jingoistic.

His adopted home really should develop the most significant weapons.

We really should keep all these other kind of bad people at bay was a rough paraphrase.

Now he spent the war years at Los Alamos trying to argue that a fission bomb was small potatoes.

And why are we wasting our time with this.

We should actually be going for a fusion bomb, of the sort we will talk briefly about on Wednesday.

So he kept butting heads with leadership, because he thought they had the wrong priorities.

This was at a time when there were still like micrograms of plutonium on the planet, no working device had been developed and tested.

And he's like, that's such a trivial task.

Give me all the resources.

I want to build a hydrogen bomb.

He didn't quite say it that way.

He had very big strong fights about resources and priorities.

And so more or less, to appease him, because he was a smart contributing member he was given a small little study group even during the war to work on fusion weapons.

And I think even by his own reckoning, they got nowhere.

But it was a study group to lay the seeds.

In fact, even before there was a Los Alamos Laboratory, he was arguing from literally the very first discussion on Berkeley's campus with Oppenheimer and the rest that fission bombs were trivial.

We should be going right now from summer 1942 into fusion.

I mean, that was his *idée fixe*.

And after the war, he's more and more listened to by the folks who are getting more and more impatient with Oppenheimer.

He seems like he has answers that many of the Air Force leadership after the war actually does want to hear.

They want to hear about bigger bombs that would be under the control of the Air Force, that would be the reason the Air Force would be the most important service branch.

And all of these things get tied up in kind of rivalries within the US infrastructure.

So Teller's star rises basically, or at least he has more people listening to him after the war, including-- he's very influential, not him alone, but he was a big mover in getting a whole second weapons laboratory established, the Livermore National Laboratory, which opened its doors in September of 1952 with the express purpose of working full tilt on fusion weapons, this kind of thing.

So he's moving in that.

He did testify, as you heard in the film, at Oppenheimer's security hearing in a way that really when the transcript was published, was seen as really devastating by many, many members of the physics community.

He doesn't come out and explicitly call Oppenheimer a communist or directly a security risk, which other people were calling him, fairly or unfairly.

But he says, Oppenheimer is a complicated person, which was not meant to be a complement.

And the famous line, which I'll get pretty close, Teller says under oath, I wish that these big important tasks were in hands I understood better, so therefore could trust more.

He says, I basically don't trust Oppenheimer, because he is this kind of complicated maybe scheming kind of person.

And so Teller gives this basically damning, what's seen as damning testimony.

For decades he outlived Oppenheimer for decades.

For decades, people wouldn't shake his hand when he'd come to give a physics colloquium.

It really had a generation long impact on how people thought of him.

Nonetheless, in other circles many others couldn't get enough.

And so he continued to have influence among certain US administrations well past the '80s, I mean really decades after the '40s and '50s.

So much like it's easy to venerate people like Niels Bohr, oh, world government, if only he could have carried the day.

Like well, I don't think it works that way.

Teller is I think often vilified often by the same people who want to see heroes like Einstein, Bohr, and Oppenheimer.

All these people are complicated and the world is complicated.

And I don't want to leave the impression that Teller was somehow like a masterful demon, which he's often been cast as.

He certainly had very, very different ideas about the scientist's responsibility and about the geopolitical stature of the US, vis-a-vis changes in Europe, especially.

And he was just dogged, I mean he was just undeterrable with this focus on more and more bigger fancy weapons, and let's make them available more and more quickly.

So that became the kind of symbol of this larger split within the community, between the Oppenheimer camp and the Teller camp.

Ironically, Teller was being surveilled by the FBI just as much as Oppenheimer was.

They didn't trust this strange weirdo European Jew.

Who is this guy?

He came from places where there are communists.

I mean, the FBI was really in overdrive in this period, I say chuckling now.

It wasn't so funny.

And there are these amazing passages in his once classified, in Teller's once classified file, saying we don't trust this guy.

We don't know who he's talking to.

He's no more trustworthy than Oppenheimer.

So it's a-- I don't want to say it's a shell game.

But it wasn't like he was seen as unproblematic.

He was seen as someone who said the things that some other powerful people wanted to hear more at that time.

I think he was useful.

I think he earnestly believed that.

But he was also useful to frankly, other people who really did understand a bit more of the kind of hard power plays of Cold War politics.

So I think Teller is also, there's much, much less attention paid to him in the secondary literature, even though he lived a much longer life, he was involved in many more unusual events.

But I honestly think it's a lingering sense that he was somehow just the bad guy.

He's been cast I think in a kind of one dimensional role that I think there's just been less attention paid to the nuance that we might now get to try to do for someone like Oppenheimer. Yeah, yeah.

So we'll get a little hint of that.

It won't be the Chicago site.

But a little bit of that theme certainly comes up in the next film we'll watch, basically a week from now.

And I'm going to figure out a way to make sure you can all see it through the Canvas site.

The film's called Containment.

I think I mentioned it briefly, by my friend and colleague, and actually my former advisor, Peter Galison, and some of his colleagues.

So it's a much more recent view of some of the kind of nuclear legacies, in particular, environmental and radiological.

And not just of the wartime, but of the kind of Cold War period ever since.

It's in some sense still going on.

So how does one handle waste byproducts of civilian nuclear power, let alone above-ground nuclear testing, when some of these very, very deeply dangerous poisonous isotopes have half lives in the tens or even hundreds of thousands of years?

So the stuff isn't going away anytime soon, to put it mildly.

And so that's the kind of thing that the new film, the more recent film, grapples with.

And we'll watch that and we can have a similar session to talk about it next week.

I'll make sure we all have the details in an email.

But yeah, I mean again, it's one of these things where people knew better at the time.

They didn't know as much as we know now.

But the cavaliness, or even sometimes callousness, I think, with which some legitimately dangerous materials were handled in the '40s and '50s, it's still astonishing.

And it's not good to say the only place it was worse was some parts of the Soviet Union.

I mean if that's a competition, that's not great in terms of just the cavalier disregard for local populations that the only place more poisonous from nuclear efforts than Hanford is the corresponding site in, I forgot which one it is.

Tiffany might remember.

But one of these sites within the former Soviet Union, where they had also been doing enormously large-scale plutonium production and similar things like that.

Right, in fact, my understanding is that he was exposed because he threw himself on top of it, to knock him apart.

He basically threw, like a soldier would on a grenade or something like that, to save comrades.

That he literally threw his body on these now joined critical mass.

So my mentor that I mentioned who had served as a young kid in Manhattan Project, so the rest of his life my teacher wore Slotin's belt buckle.

They'd been buddies.

They were like totally young kids together at Los Alamos.

And so the accident happened soon after the end of the war, like weeks.

They were still working full tilt.

And Leonard Rieser was still there, my teacher.

And so Slotin died within days of the exposure.

It was a very, very intense exposure right in his gut, which is not a good place to absorb lots of these things.

And so Leonard, he got his belt buckle for the rest of his life.

I only know the name because I heard about it, starting when I was about 18.

But you're right, Alex.

It's an amazing story about talking about cavalier, anything like a just shop level safety standards, let alone treat these things with some level of awe and respect because of the forces of nature.

But just like don't prop stuff open with a screwdriver.

Like, come on.

Just basic level machine shop, let alone safe handling of nuclear materials.

So that's another great example.

Good.

Any other questions?

These are great topics, great questions. No, it was.

It was definitely after.

It's a good question.

Because I don't know the fine details.

Some of the TAs might remember better from recent readings.

The rough story goes like this though.



Soon after the end of the war, and I guess I'll talk about this briefly on Wednesday, it was signed into law I think August of '46, so roughly a year after Japanese surrendered, the US passed the Atomic Energy Act.

And that was a sprawling piece of legislation that established the successor agency to the wartime Manhattan Project.

Nominally civilian, it created what was called the Atomic Energy Commission, the AEC. Thank you, Tiffany.

But it also made all things related to nuclear power, born secret and subject only basically to military or official government control in the US.

So it had an unintended consequence of hugely stifling a private sector development of energy generation, reactors.

That was then amended, a big amendment to the Atomic Energy Act in I think '53, again, others on the call might remember.

I think was 1953.

Which began to make certain kinds of-- we might call it private-public partnerships, a kind of limited entrepreneurship possible in the power generation market.

It still wasn't a free market.

But it was no longer a felony to share certain kinds of documents of otherwise innocuous information, seemingly innocuous, with no direct weapons potential.

So you start getting a more active what's the word? Sorry, trying to build up a kind of working quasi-market private-public partnership with major industrial contractors like General Electric, like Westinghouse, building commercial power reactors by the mid to late '50s.

It doesn't take off the way other new technologies have done in history, because it still has a lingering period of not clear quite how to get this right.

So over the course of '50s, there were power reactors actually coming online, ShippingPort news I think was the first or among the most famous somewhere in Pennsylvania, for example.

So it didn't become ubiquitous right away, but they were coming into genuine civilian use in the outskirts of populated areas by the end of the 1950s.

For the submarines and things, that was again I think a mid to late '50s development.

Admiral Rickover, Hyman Rickover was I think the main moving force behind what was often called modernize the Naval fleet, including making reactor-driven submarines that could stay underwater much longer, for example, let alone armed with nuclear weapons.

Which could the power come largely from nuclear reactors on board.

For strategic reasons, it wouldn't have to surface as frequently or things like that.

So again, I think those were being developed largely within the military.

So it didn't have the same kind of public-private, same level of friction.

But those were being, again, I don't know when the first one came into service, probably by the early '60s at the latest, certainly under active development and testing by the '50s, late '50s.

And as we'll see in Wednesday's class, this also begins to coincide with growing concerns about fallout, so about above-ground nuclear weapons testing.

Concerns about safety or otherwise of nuclear power generation was not the first topic of real kind of public consternation or debate.

It really was about the fallout coming, back to the questions that Steven was asking earlier.

What happens when you blow a bunch of these things of these things up in the atmosphere and stuff comes down?

And so we will hear a bit about that in Wednesday's class.

So the first public efforts, first widespread anti-nuclear mobilizations were really also starting by the late '50s.

And they had these fits and starts of temporarily successful treaties that would stop, and then they'd go back.

And so a lot of the kind of official treaty space, as well as more informal political organizing against certain aspects of nuclear technologies, that's also growing over the course of the '50s into the 1960s.

They're growing up together. There were efforts, by the way, throughout the early and mid '50s to try to so-called modernize the weapons side, so to shrink down.

So both to make enormously humongous hydrogen weapons that were thousands, many thousands of times more powerful than the fission bombs of the Second World War, but also to miniaturize them, so that they would be more likely to be useful tactically, not strategically.

Strategically was the lingo, Lucas you might know from talking with the folks in Security Studies, strategic is the idea that is roughly speaking symbolic.

Would it be impossible for any enemy to attack you because they'd be assured of immediate annihilation?

Because you have city leveling megaton bombs.

So that was seen as strategic to have an unsteady balance of power.

Because no one would be dumb enough to trigger those enormous things for use.

Then there's tactical weapons that people might actually plausibly use on a battlefield, without the high-level hand-wringing about, oh my goodness.

It's mega-tonnage.

So people were making so-called Davy Crockett, basically like shoulder fired bazooka sized nuclear weapons, which were actually developed and deployed in the field, thankfully never used, but certainly tested.

So there was both a miniaturization to make these things more ubiquitous in certain kinds of tactical US military planning, not only US, but including US.

And then the enormity, the monsters that we'll talk a bit about in next class that were really just made the Hiroshima Nagasaki weapons look small.

It was both these kind of fronts of development on the more weapons technology side.

Those were actively under development throughout the '50s. Yeah, absolutely right.

And again, we think back to that.

And yet that was not sufficient to end the program, much is the fact that poison gas first deployed in the First World War.

Also, the winds would change, and you would not infrequently wind up gassing your own troops inadvertently.

So the competing calculations about what's going to be a worthwhile device to pursue, unfortunately that was not unique either.

Yeah. Yes, it's an idea that comes and goes.

As many of you may know, the US for the time being, is still subject to a limited test ban treaty, which suggests that there can be no-- I'm getting the wrong treaty, actually more recent treaty.

There was a more complete test ban treaty the US signed starting in 1992.

It was one of the last things that President George H.W.

Bush signed before the Clinton administration.

So the US presently, by treaty statute, is not allowed to test new nuclear weapon designs.

And that led to an enormous multi-billion project called stockpile stewardship.

So there was testing allowed, non-nuclear tests allowed to be performed to maintain the aging stockpiles of existing weapons.

Epoxies dry out and change.

All the kind of conventional materials don't have a shelf life of 10,000 years.

So stockpile stewardship is meant to enable laboratory style testing for materials to maintain the existing arsenal, not to develop and perfect new weapons.

And so some of these areas get-- some critics at least say there's a little gray area.

Some things that some people will say are being used for stockpile stewardship might actually have implications to help with new designs.

It's again, it's an area where there's ongoing debate and push-back largely away from full public view, because so much of it still remains classified. Yeah, Amanda.

I agree.

That is a chilling part.

And that as I said, those lists were made.

In fact, they were made I think by the so-called interim committee, which included Oppenheimer and a couple other physicists, as well as the Secretary of War, and other military leaders.

It was a group of maybe a dozen people.

And so for example, there was a decision made early on I think by that group or at least the recommendation from that group, not to bomb the city of Kyoto, either by conventional means, let alone with the newer weapons.

Because that was seen as too culturally significant.

It was a kind of millennium old city of art culture and kind of heritage.

And that wasn't a kind of nukes versus incendiary.

That was like, please don't bomb that city, the US committee advising the US military on that.

I think it was part of that same exercise to say what cities would be so-called legitimate targets for use with the nuclear weapons versus other kinds of attack.

And I don't know that means that they thought the bomb was special.

I think they thought it was new.

And I think that was the idea of, for any new element in the collection, so to speak, you want to understand, its parameters, its characteristics.

So I don't know that they thought it was somehow in a category unto itself.

I think my sense of that is that it's a new thing.

We want to learn about it, because we intend to use it a lot more.

At least we have the option open that this will become a more common element of the arsenal.

We'll talk a bit about that actually, again, on Wednesday as well.

That there were, even amidst the debates over whether or not the United States should pursue a hydrogen weapon so much more powerful, the debate was rarely as we now know nukes or no nukes.

It was fission versus fusion.

And one leading reason not that was put forward not to pursue fusion weapons, because it would slow down the production of lots more fission weapons.

Because the idea, at least among certain influential people, including Oppenheimer, was that the US should have hundreds and thousands of these things at the ready.

Because at the time, they were very, very few in a stockpile.

So the concern wasn't these things are so terrible we should never use anything in this whole category again.

People had that concern, but not these groups behind the fence advising we now know.

Their concern was making these things which might not even work anyway will interrupt too much making the things that we now know more about, because of these things like the usage against actual cities and the fact that they were not previously destroyed targets, environments.

So you could learn a lot from these post-bombing surveys. Yeah, anyway, so that's a bit of a preview.

We will talk a bit about that in Wednesday's class. Yep, yep, yep.

No, that's an excellent point.

Good, I think we'll pause there.

That was a really interesting discussion.

Thank you all for taking the time.

It was an option during a busy part of the term.

So I hope it was an interesting and worthwhile discussion.

If you have other questions, of course, please don't hesitate.

I'll have my regular office hours on Wednesday morning.

Feel free to email me to make a separate appointment, of course, at any time.

And otherwise we'll meet at our regular class time on Wednesday.

So stay well, everyone.

See you soon.