

Lincoln, the Smithsonian, and Science Transcript

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Codes:

BG = Brent Glass

HR = Harry Rubenstein

TA = Thomas B. Allen

RA = Roger MacBride Allen

MR = Marc Rothenberg

JH = John Holdren

RK = Richard Kurin

[music plays during the video]

BG = Well, good evening everyone. I'm Brent Glass, Director of the National Museum of American History. I'm very pleased to welcome you to tonight's program: Lincoln, the Smithsonian, and Science. I hope you enjoyed that little introduction and you'll hear a little bit more about the patent model that Lincoln received in 1849 in just a few moments. I'd like to welcome everyone to tonight's program here in the auditorium and also online viewing through a live webcast. Tonight's program is being held in conjunction with our exhibition, *Abraham Lincoln: An Extraordinary Life*. And I hope all of you have a chance to see this wonderful exhibition which is located on the third floor of the Museum. If you are patient and walk through and wait on line for the all the people who are coming to see the exhibit, I think you'll be rewarded by having a chance to see this wonderful collection that we have on display. I'd like to acknowledge the sponsors of the Lincoln exhibition: the Ford Motor Company Fund, the Richard Lounsbery Foundation, and the History Channel. I'd also like to thank the sponsors of tonight's lecture series, the Lincoln lecture series, the Gilder Lehrman Institute for American History and the National Endowment for the Humanities. All the programs at

National Museum of American History are put together by wonderful teams, interdisciplinary teams, and the Lincoln exhibition. Tonight's program is a good example of the teamwork that is necessary for us to accomplish what we do here at the museum. I want to acknowledge Chris Wilson and James Zimmerman who are principally responsible for the Lincoln Lecture Series. I'd also like to acknowledge other members of the Lincoln exhibition team: Nanci Edwards, Lisa Kathleen Graddy, Stevan Fisher, and the curator for the exhibition and the project director Harry Rubenstein. Now I'd like to ask Harry to say a few words about tonight's program and about the Lincoln patent model. Harry.

HR = Thank you very much and thank you all for coming. The model that you saw just a minute ago is one of those curious pieces in our collection. When we began to work on the Lincoln exhibition, we knew that we would include his model for lifting boats off of sandbars and shoals, but you know we never really understood how it worked or in fact if it did work or what this had to say about Abraham Lincoln. All we kept saying over the years was, of course, this was a national treasure that we should all consider seriously. Once we began to think about the model and treat it seriously, I think it's one of those objects in our collection that really tells us a lot about Abraham Lincoln and his time and what it meant. Lincoln is the only president to receive a patent, but it's wrong to consider him an inventor. If anything, he's a would-be inventor, like the army of individuals who in the 19th century you know sent their models to the patent office with the hopes and dreams that they would be another you know: Cyrus McCormick, Eli Whitney, or Samuel F.B. Morris. That their name would be etched in, you know, the history books as one of those great inventors. But what it tells about Lincoln is that he really shared that spirit of invention, of commerce, of hope of the 19th century and he saw himself trying to fit into that world. You know, from his early training in New Salem to become a surveyor or to his days as president and having as his science advisor Joseph Henry, the first Secretary of the Smithsonian Institution, you can begin to see the influence of those ideals both in his individual life and in his presidency. And that's what we'll be discussing today is the relationship of Lincoln and science and the science community, the role of science advisors and the meaning of that both then and today. For this program, I should say that this program is a series of programs that we are

sponsoring here at the National Museum of American History as part of our bicentennial commemoration of Abraham Lincoln. We have had series' on race and we'll have another series similar to this on presidential power. And tonight, as Director Brent Glass mentioned, tonight we're talking about Abraham Lincoln, the Smithsonian Institution, and Science. For our evening, our panel includes Thomas B. Allen who has written numerous articles for the *Smithsonian Magazine*, *The Washington Post*, *National Geographic*. And most recently and I see that there are books out in the lobby, he has co-authored *Mr. Lincoln's High-Tech War*. He wrote this with his son Roger MacBride Allen who also happens to be with us tonight as well. Roger Allen, along with his work on Abraham Lincoln, has written over 20 science fiction novels, which means that he must have figured some time warp system through all of this so that he was able to produce so many works. The two of them are currently working on, or continuing to work on, their work on Lincoln and Civil War technology. We also have with us Mark Rothenberg who is the historian of the National Science Foundation and is a long-time member of the Smithsonian community. He has been the editor of the Joseph Henry Papers for many years and is the one individual when I think of who do I need to contact about Joseph Henry and science, it's Mark. So, thank you very much for coming. We also have with us this evening John P. Holdren. He is the assistant to the president for science and technology and is the director of the Office of Science and Technology Policy in the Executive Office of the president. In other words, he is the Joseph Henry of today. Prior to accepting this position, he was the Theresa and John Hines professor of environmental policy and director of the program on Science, Technology and Public Policy at Harvard University's Kennedy School of Government. And finally to moderate this program, we are honored to have Richard Kurin who is the Smithsonian Institution's Undersecretary for History, Art and Culture. So, thank you all for coming. Thanks to the panelists, for all willing to participate, and if you would all like to come up to the stage. Welcome.

RK = Well, it's great to be here. It's great for me to be here because I live and work or it seems like I live but I work over in the Smithsonian Castle where of course Abraham Lincoln was a visitor, where Joseph Henry lived and worked. And I kind of really get a, I've come become kind of my own amateur historian in terms of looking at that

relationship. So, I'm really buoyed by tonight's session. I guess I like to start off and ask maybe Thomas, Tom, about what Harry Rubenstein said what did Lincoln think about the role of science and technology generally in American society. What was his role was he enthused was he interested.

TA = It covers a long or rather large span because I mean what's often, because he was a wartime president we think of all the technology on the battlefield but he is also... He signed the law that created the Department of Agriculture and in the preamble to the law that creates the Department of Agriculture the word "science" appears two or three times, because he saw that even in agriculture there wasn't just the farmer with the plow there was something else going on. He is looking at the seeds. There are provisions in the law to get new seeds that produce new crops. So, he has that. We also came across something about Joseph Henry. The, one of Lincoln's advisors overheard a conversation between Mr. Henry and the president. And they had met by chance in the office of one of Lincoln's appointees and they suddenly start talking about what kind of oil ought to be put into the lighthouses. And the Confederates were destroying navigational aids along the coast as a way of conducting themselves toward the blockade. There had to be some repairs and so here is the president of the United States and Mr. Henry talking about the fact that maybe they should be using some more whale oil or some other kind of oil in the lamps of the lighthouse.

RK = John, I'm not going to ask you whether you have discussions with the president over things like that. That's one of the particular things that Lincoln was interested in but he was interested in a lot of very particular things as we saw. I mean the model of the boat. What else besides lighthouse oil and navigation? Roger any big thing other things in addition to agriculture and...?

RA = Well, in one of the things I was fascinated by, he was very closely involved with the Monitor. There was one point, there is a, it's a long involved story it could take the whole hour on how the Monitor gets to be built but one of the things that I just found fascinating. He, at one point, holds a paper and cardboard model of what will become the Monitor (it hasn't been named at this point) in his hands and he says to the people

in his office he feels like the western gal did when she looks into her boot. She thinks there might be something in it. And he fights this war by, on paper, by having meetings and by talking with people and he very rarely actually any contact with the actual fighting. Through a long involved series of circumstances, Lincoln actually personally directs the retaking of Norfolk. He is on the scene and he is telling ships where to go and so forth. At one point he draws alongside on another ship alongside the Monitor after she's had the battle with the *Virginia*, can see the cannonball dents in her side. This is the ship he's called into being and he actually orders the Monitor go over there and perform reconnaissance. And when he had the opportunity, he was that hands on. He was, there were a number of occasions he more or less had to be pulled out of the line of fire because he wanted to see what was going on. He was that closely involved with the war and with the technology and the new machines and so forth that were called into being by the war.

RK = So, if Lincoln was so heavily hands on and involved in these things on oil for lighthouses, on the Monitor why did he need Joseph Henry? Why did he need a science advisor? It seems like he would do all right on his own.

RA = Well, he needed technical advice, technical advice, which fed into making a policy. To give you a quick example: in 1862, a man who had the concession for coal mines in northern Columbia (now part of Panama), offered the mines to the United States to set up a coaling station. And this is just before the Emancipation Proclamation and the thought is, well this might be a good place to settle the free slaves. [inaudible] in fact ship the slaves, the ex-slaves out of the country but the question was were these coalmines really going to be able to support a community? So, Henry is called upon to provide a technical evaluation. He gets the leading geologist in the United States on coal, a guy named J. Peter Lesley, to evaluate the coal and Lesley says, "It's trash. It won't burn very well in ships. Forget about it. It's not worth digging up." Henry tells the cabinet this and expects that to be the end of it. Unfortunately, he's shocked to learn that Lincoln's still talking about it. And here's the one flaw the Secretary of the Interior had gotten his own scientist who produced a counter report saying the coal is very good. So, one of the issues that Lincoln has to confront is when you have scientific experts who

are contradicting each other how do you decide? In the end actually, the decision was made on a political basis. There was great hostility to setting up this colony among the Central American countries, particularly Costa Rica, and Secretary Steward said, the Secretary of State, "Don't do it. You'll upset the international community too much." Lincoln drops the idea but it wasn't based actually on the technical advice because the technical advice was contradictory.

RK = That's interesting because I think now in that area that's Northern Columbia, I think that's the area where Smithsonian scientists actually just discovered Titanoboa; these large snakes and dinosaur things. So, maybe it was good that they didn't dig. Well, that was it, I think about in general with Lincoln didn't he do a speech or paper on something young America and old fogy? The idea of the importance of America is a young country in its faith and science. And I guess you know the natural question is to wonder well, what does President Obama think about science and technology? What's he particularly interested in and why does he need a science advisor.

JH = Well, I guess I start by saying that President Obama (when he was still running for the office when he was campaigning) already made very clear that he viewed science and technology as crucial to addressing the whole panoply of major challenges that the country faces today and that the world faces. And he said very clearly in the campaign that he saw science and technology as crucial to the economy. to generating the innovation and the new businesses that would contribute to growing the economy, and raising the standard of living of the country. He was very clear that he saw science and technology as crucial to addressing the big issues in health that America faces. What the president said in the campaign about that and he says it still today is, he wants Americans to live longer healthier lives and have healthcare costs go down at the same time. The only way that's going to happen, among other kinds of reforms, is using science and technology more effectively in the healthcare domain. He sees science and technology as crucial for addressing the challenges we face around energy and environment and particularly in the environmental side around climate change. And he has a rather sophisticated appreciation of how complicated that set of issues is and how important science and technology are going to be to addressing it. He also made clear in

the campaign that he sees science and technology education as an absolutely crucial dimension of what we need to get better at. Not only to have the scientists and engineers in the future that we're going to need to build and run a prosperous economy in ways that don't wreck the environment but also to have a democracy in which the voters can function in relation to issues that increasingly have science and technology in them. And so, we didn't even have to wait for him to be president to understand what he thought about science and technology. He said repeatedly that he intended to move science and technology back into the center of what his administration says and does and thinks. And he's been doing it.

RK = I'd like to hear from other members of the panel because it strikes me a little, I mean is that, would Lincoln recognize that Obama platform as something that he thought would be the role of science and technology in the mid-19th century? Making life better or improving the economy? I mean...

MR = One of the things he did before he got into politics is he decided he would be a lecturer. And he would go around and he didn't do too well at it and he didn't make much money at it but one of his speeches goes into a very elaborate view of the future in which there will be inventions and there will be change that will have been drive. He really felt much more about invention and he also made sure at some point that invention was not merely mechanical that there would be also a quest for answers to things. He was certainly, I think, the president with the most curiosity that we've ever had.

RK = Did he see really...?

TA = And you really need that in a president.

RK = Did he see it as a driver of commerce?

TA = Oh yeah, absolutely. I'm fond of saying that he was one of our greatest peacetime presidents. In the midst of the Civil War, he finds time to found the Department of

Agriculture. He establishes land-grant universities. He sets in place what will happen in Grant's administration, the transatlantic railroad. And he's doing a lot of things. He accomplishes a number of things in the area of establishing commerce of connecting the country together. He is a very big, tremendous big user of the telegraph. We compared his use of telegraph to Obama's use of the BlackBerry, but he's absolutely seeing this as a driver of the economy.

RK = How about quality of life? I mean did he see invention, technology as a driver of quality of life for example? Improving, I guess improving education with land-grant colleges?

MR = The, we were just talking about you have politics and then you have rationality.

RK = I think John could tell us a bit about that.

MR = But he did see the creation of the land-grant colleges was a way to (in the message about it he mentions) that it's a way to take what seems to be focused in around cities and in the existing nation at that time and push it westward. His idea of the transcontinental railroad and the land-grant colleges and the Homestead Act was to create places where people were going to live. Now getting that all put together with Congress was another story but he does sign the legislation for all of that. And it's extending the idea of a vibrant country. It's not just that the people who are going to make money are going west, but that a lot of ordinary people are going to find new homes and new way of life as they move westward.

RK = Okay, and Henry how does Henry end up as Lincoln's science advisor?

RA = Well, it's an informal relationship. And in fact Henry is not merely, it's really the Lincoln administration because one of the aspects of science advising at that point it's much of it is through the cabinet as opposed to the president directly. The issues were usually cast by a cabinet officer who had the actual problem. But Henry had been in Washington since 1846, had very strong relationships with the political community.

Unfortunately, for his reputation during the Civil War, much of it was with the South. Jefferson Davis is one of his best friends. So, there were always rumors of Henry actually being a traitor during the war. But, he also had an interesting attitude. He learned very quickly that politicians: he once said politicians should be pitied because that even when they see what the right answer might be, the practical realities might prevent them from carrying it out. So, he understood the difference between what should be done and what could be done. And one of the things he always admired about Lincoln was that balance between getting things accomplished without losing sight of what the great ideals are and understanding you always had to have that balance. And that to him was Lincoln's great strength. But Lincoln brought to the administration a sympathy for the practical political issues at the same time he was the leading scientist in America and could bring to any problem the finest minds that were available.

RK = John does that ring true today? I mean how does that ring in terms of your job at the White House?

JH = Well, I'd say a couple of things about it one it's still true that many issues involving science and technology originate in the cabinet departments. And in those cabinet departments the Department of Defense, the Department of Energy, Health and Human Services with the National Institutes of Health, Department of Commerce which has NOAA, the National Oceanographic and Atmospheric Administration. Tremendous amounts of science, tremendous amounts of technology are done in those departments. And one might ask then so what does the science advisor do? One of the reasons the president has a science advisor is to have a source of independent science and technology advice that is not tied to the agenda of a particular department. Because of course, it still happens from time to time that scientists and engineers disagree with each other about either what the best science is telling us or about what's possible technologically. And because sometimes those views might become entangled with the agenda of a particular agency and be colored by that agenda, it's been thought for a long time that the president needs somebody who is the president's scientist, the president's engineer and who has an office of science and technology policy in support which can bring to bear resources and insights in the larger community. That is, the OFTP has a

staff actually at full strength of about 60 even that's not nearly enough to deal with the full range of science and technology issues that affect policy and in which cabinet departments might come up with arguments the president might want an independent view about. And so, one of the things the office does is it reaches out to the wider community, to the academies of science and engineering, and the Institute of Medicine, the major professional societies, and the wider community. One of the most important things about having this job is having a good Rolodex to be able to call somebody who knows what you don't know and the president does need to know.

RK = And I don't want to put, embarrass you or put you on the spot but this is a heavy, I mean this is a very important job especially now. What brought you to it? Joseph Henry was sitting there in the Castle on the Mall, there was no other building on the Mall. He knew a lot and there he was. But what brought you to this both in terms of training and maybe even temperamentally?

RH = Well, I think a lot of things. I was trained originally in aerospace engineering and space science, space physics and then went into plasma physics with applications in trying to control nuclear fusion as an energy source. And I was particularly interested in the various ways in which science and technology interact with the human condition. I was always interested in these broader dimensions and fairly early in my career I broadened out from just doing engineering and science to doing work looking at the interactions of science and technology with society. And I had a lot of good mentors doing that early in my career including some of the people who were science advisors to our presidents. George Kistiakowsky, who was Eisenhower's science advisor, was one of my mentors.

RK = Oh, good.

RH = Jerry Wiesner who was the science advisor to Kennedy and to Johnson was another mentor.

RK = I just had a conversation about him in New York this afternoon, someone who knew him pretty well.

RH = In fact, I think I've know seven or eight science advisors well, before I became one myself. And in the Clinton administration I served on President Clinton's council of advisors on science and technology, who are people who keep their day jobs but come to Washington periodically to help with the process of advising the White House on science and engineering. And so, I learned a fair amount about how the process works and what the opportunities are to make a difference. For somebody who's as interested, as I have been my whole adult life, in the interaction of science and technology with the human condition, with questions of development, of environment, of national and international security, of space, it's a dream job. Nobody with those interests wouldn't jump at having that opportunity, and then the question is how did I happen to get it? I first met the president when he was a senator early in his term and he gathered some people to have dinner with him and to talk about climate change. And I happened to be one of the fortunate people invited to that dinner just a small dinner around a table in a Washington restaurant and we talked for three hours about the issue of climate change. What the science is telling us, what the technology can do for us, what the options are. And at that point, from that point on, I occasionally was asked by the president or his staff to offer some advice on a speech or on an idea. I subsequently joined another one of those roundtables. One of the things the president loves to do is arrange around a table six or eight or ten people who he has reason to believe know some interesting things about a topic and they don't have to agree with each other and they don't have to agree with the president. And I've been around now a number of those tables and most of them have Republicans, as well as Democrats sitting around them and the president just asks questions and probes. And at the end of the session, which is usually two or three hours, he invariably sits back and produces a synthesis that's considerably more than the sum of the parts he's been provided and great person to work for.

RK = How did Henry think about Lincoln? He admired Lincoln didn't he?

RA = Yes, very much so. He was actually in New York when Lincoln was assassinated and he immediately made plans to come back to Washington because he very much. He wanted to attend the funeral. I'd say he admired the man greatly. He... They met in the White House informally on a number of occasions for conversation. And Lincoln would accompany Henry when they would go, when they were testing some of the signaling equipment, including one time on the roof of the Castle.

RK = Now, did that really happen? Tell us, tell people about that story because they might not know.

RA = Well, there actually, you're talking about the treason story?

RK = Yeah, the treason story. Carl Sandburg did a thing...

RA = There are three different versions of this the historians can't ... Henry, what we're positive is that Henry was accused in the White House in front of Lincoln of being a traitor, of sending secret signals to the Confederates from the Castle. And there are three versions: one which Lincoln, which Henry tells which is that he's at a reception in the White House and someone there, another accuses him of this crime and he defends himself in front to president and that's the end of the story, not very dramatic. A story one of Lincoln's staff tell is that Lincoln and Henry are sitting in the White House chatting when a citizen comes in and asked leave to have an audience with the president and accuses Henry of sending these secret signals not knowing that the man sitting in the chair next to Lincoln is Joseph Henry. So, according to the version Lincoln turns to Henry and says, "Professor Henry what have you been doing?" And then they get up, Henry explains. He's up there with a lantern reading his meteorological instruments every evening.

RK = This is in the Smithsonian Castle.

RA = On top of the room.

RK = The north tower.

RA = In the tower, yeah so, very interesting.

RK= Now, did Lincoln go up with him or?

RA = Lincoln and Henry were up there, they would send signals between the Old Soldier's Home on North Capital Street and the Castle with military signaling and on at least one occasion Henry and Lincoln were up there together. Now, that's the third version. That's the Sandburg version which has a soldier dragging Henry into the White House and accusing him of treason because of these signals that have been seen from the Castle. And Lincoln is you know is just sort of hysterical about all this because it turns out that it was Lincoln and Henry who were up on the, up there and they were observing these signals.

RK = Committing treason together.

RA = Committing treason together. But they had a very, very close relationship. Henry was not a great admirer of the war. He in fact hated the war. He had desperately hoped that they come to a peaceful settlement and but felt that Lincoln had no choice in the matter.

RK = But didn't Henry as science advisor help Lincoln in terms of the conduct of the war, Tom or Roger?

TA = Roger's specialty is

RA = Well, one of the stories that comes to mind it's again it's a wonderful story I could tell the long version it would take the rest of the evening but there was one of the things that the Union had going for it was observation balloons that the Confederacy did not have. One of the gentlemen who was in, working on those was a gentleman by the name of Thaddeus Sobieski Constantine Lowe a wonderful name. He had no particular reason

he was named that it's just his parents decided to do that. Thaddeus Lowe had various communications with Henry and one of, before the war Thaddeus Lowe wanted to fly across the Atlantic in a balloon and there were very elaborate plans for doing this. And his basic point, and the other balloonists were talking about this, was that what we now know as the "Jet Stream" was constantly blowing west to east from America toward Europe. So, that no matter what the winds were doing down to the ground you could, if you could get to the Jet Stream you are on your way to Europe. And he, Lowe had actually made various plans to attempt this crossing. And he was getting ready to make an attempt. Lowe was advised by Henry that he should do a test run from well inland to see that this worked. Part of the reason being if he got halfway across the Atlantic and was never seen again there wouldn't be any proof but if he started well inland and manage to make this work and then landed he would have established his point. And so, he basically with Henry's advice Lowe decides the thing to do is wait till the winds are blowing close to the ground in the wrong direction. And when there is a good wind blowing toward the west he should get into his balloon go through those winds and catch the winds going east. He tries this. It works perfectly. He leaves from Cincinnati. He heads basically east and a little bit south. He winds up off the Virginia coast. He drops down by releasing some gas and heads back. Unfortunately, he lands in what is suddenly the Confederacy because he'd tried to do this four days after Fort Sumter. There are all sorts of elaborate adventures. He crashes or lands in South Carolina and is at gunpoint several times before he manages to talk his way back to the North. Lowe is then, gets a basically an entrée to the White House from Henry. And basically as more or less as a publicity stunt Lowe's balloon is hung in the sky next to the Smithsonian Castle and then at some point is towed to the White House and they send the first telegraph signal from a balloon to the ground and it's sent to the White House. And the last thing that Lowe gets from Henry is, as a government scientist he does the right thing, he writes a very long elaborate memo saying all the things that Lowe should be given credit for. So, he was in just in that little thing Henry was very involved in about three key points in the development of ballooning.

RK = And that helped observation of Southern troops.

RA = Absolutely, yeah.

RK = Of Confederate troops.

MR = One of the things that happens is that three, in three areas Lincoln makes the discovery that you can't put some new thing into the army. And so they develop a civilian telegraph corps, a civilian run military railroad. And when he starts looking at weapons (weapon systems such as a repeating rifle), he takes charge. I mean one of my favorite stories is he meets the inventor of the repeating rifle and they go out behind the White House and put up a target and Lincoln shoots seven rounds into the target. The target exists; he doesn't do too well at it. He says to the inventor, "Well, you're younger than I am you've got better eyes." And then, so Lincoln really likes that rifle but it's very, very hard for the army to like it because they've made a big investment in flintlocks.

RA = Well, percussion lock.

MR = Percussion, yeah. And actually Lincoln investigates this and as you said there's some reasonable elements in all this. I mean first of all big investment has been made factories are turning them out, training manuals have been printed, soldiers all over the army are operating the same weapon, and then a moral issue starts to creep in do you really want to have a machine gun. There's a Gatlin gun that also comes up into the picture that would rapidly kill a lot of people and it just doesn't seem to want to happen. Some of them get into the army but it never becomes a mass weapon. But he's discovered that practicality, again, doesn't necessarily always win.

RK = Doesn't he call on Henry to separate good ideas from bad ideas for the war.

RA = The Permanent Naval Commission, Henry, Alexander Dallas Bache who's head of the co-survey and Admiral Davis, Charles Henry Davis make up a three member commission which is set up to evaluate inventions to sort of. The American people respond to the war effort with tremendous creativity and imagination. And someone has to decide which of these ideas make sense. So then these, and they can go through

in an evening eight, ten, twelve inventions. Submarines, underwater demolition cannon, all sorts of things trying to figure out which ideas are worth going to the next step in R&D (in research and development) and which ones. And they look at things like how practical they are. I mean one of the issues for some of the inventions is well, are sailors who are going to be using them going to be able. This maybe look wonderful on paper, but do you have the technical expertise on board ship? Can you do it cheaper with what or what, or the kind of technology you already have? Is it even going to work? And every once in a while there is an invention that they decide they recommend that the government invest a little more money in to develop models and to test. One interesting thing is Henry is usually often accused of course being too theoretical. Because one of the rules he does apply to all this is the laws of physics. I mean if it defies the scientific law then the inventions crash. And some of the inventors thought, "Why are you talking about the mechanics at this point?" But yeah he would, he estimated he saved the government huge amounts of money by eliminating the real trash before it got any further.

RK = Yeah I think that committee met like three times a week at the Castle. I mean it was a pretty robust operation. I, John I don't know how many ideas you get up at the White House but some of this kind of rings... I mean our wars, our war, way of doing warfare has changed of course and yet you know there are global conflict, regional conflict, the US is involved and things. How does, without of course violating any confidences or anything, how do you, are you called upon to deal with science and technology with regard to warfare and kind of how does that work?

JH = Well, basically the science advisor and the Office of Science and Technology Policy have the responsibility in statute for advising the president on every issue that's on his plate in which science and technology play a role. And that obviously includes national security, homeland security, as well as all these other issues across health, environment, energy, the economy, and so on. So yes, we do advise on those matters. The government of course employs very large numbers of scientists and engineers in the Department of Defense and its various divisions to work on science and technology related to military purposes. The nuclear weapons enterprise of the country sits in the

Department of Energy. There's a lot of science in the intelligence community in terms of making observations and analyzing them. And again, to the extent that the president needs independent advice on those matters I and my office have to provide it. And that's not the bulk of what we do but it is part of what we do. Now, this particular president has made again his views very clear in the course of the campaign and in speeches since in respect to nuclear weapons, he would like to reduce the role of nuclear weapons in US national military policy. And he would like, ultimately, to work toward creating the conditions where the world would be able to get rid of nuclear weapons all together. There's science and technology in that as well. That is, the technologies by which we can determine whether other people are developing and testing nuclear weapons would be very important in a circumstance in which you're trying to reduce drastically the numbers of nuclear weapons in the world. The capacity to detect nuclear weapons being smuggled onto your territory would be very important, is very important. And so, when you talk about military science and technology you're not necessarily talking about offense, you're also talking about defense and we have to look at both.

RK = You have a tough job.

JH = It is a tough job. One of the things that could be said about Abraham Lincoln and Joseph Henry by the way is that they together established the National Academy of Sciences. And they established the National Academy of Sciences with Joseph Henry, the most prominent scientist in the United States, and Lincoln, the president, and not as an honorary society which it also is but as a body which would advise the government of the United States on science and technology issues where again it needed an independent opinion. And the Academy still serves that purpose today. There are many questions that are too large and too complicated to be answered in the day-to-day mode in which the science advisor and the Office of Science and Technology Policy necessarily operate. And so, very often the administration or the Congress will, down to this day, call upon the National Academy of Sciences to undertake a study to inform government decision making, policy making, about these kinds of issues. Indeed the Academy today, through its operating arm the National Research Council, which now encompasses the National Academy of Engineering and the Institute of Medicine, as well as the National

Academy of Sciences, issues something in excess of 200 studies a year. Most of which are a year or two in the gestation but which end up influencing policy across the same wide domain in which my office has the shorter-term day-to-day responsibility.

RK = What's that then I mean with what you said about the establishment of the National Academy of Sciences, how did that go down in Lincoln's time? I mean was this a quirky thing? Was this an idea of establishing science that was I guess government supported? Was that, I mean we have the example of the Smithsonian, which what only took nine years of debate in Congress to put together and there was still a tremendous debate over whether science being done even at the Smithsonian, which was not quite the federal government, was problematic?

MR = There is a funny exchange when, again one of the recollections by one of Lincoln's appointees happening upon this conversation I mentioned. When Lincoln remains in the office and Henry leaves and so now Lincoln is talking to the man who recollects this and he starts talking very frankly about the Smithsonian and said, "I'd been told that there was an awful lot of talking that went on down here and these guys don't seem to really do much. But I just met someone who really knows what he's talking about. And if we have a few people like him in the United States we're going to do all right." So, he really did size up Joseph Henry man-to-man and he was pleased with what was welling up at that point in the nation. I mean, there was a feeling that we got to sort of get things on a more modern level. Modernity was certainly part of what Lincoln was looking at.

RK = Yeah I mean there is the Franklin Institute in Pennsylvania, a few other societies but that occasion any big debate in society over government support for science?

TA = Well, in a sense that, it was I would say almost more technology than science and where Lincoln came from was he was a Whig before he was a Republican. The Whig party basically collapsed for various reasons and he was part of the nascent Republican party. The Whig's were all about internal improvement, which meant building lots of canals, building roads. When the railroad came along, they were very big on that. As

drivers of internal development, the viewpoint there was progress and you were going to move forward and you're going to do the next thing. And everything was going to go onward and upward because of technology was the idea of progress was very much coming out of that tradition. Lincoln, I would say that that was perhaps more the viewpoint than you know improving the standard of living is that wasn't really what, the way they thought.

RA = You know the, there was always a struggle about how you justify support for science which is after all an elite activity understood by a very small percentage of the population, in a democracy, which is supposed to represent the views of at least the majority of the voting population (white males at that point) but nonetheless much broader than those who understood science. And after saying that, science was never held up as an endeavor for the sake, as something seeking knowledge for its own sake. It was always, there was some sense of a payoff. I mean the National Academy some of its early investigations were into counterfeiting, how to protect compasses on metal ships, and very nuts and bolts sort of things. A lot of funding went into geological surveys in terms of mineral resources. And once when Henry was attacked, because the Smithsonian supported a publication a systematics of seaweed, of algae, and he was attacked for that he said, "The only reason we don't understand why this is important, truly important, is our own ignorance because all knowledge is connected in some way." I think this is part of this whole looking forward into the future. Scientific research ultimately has a payoff. We may not see it yet and that was his argument. That was the argument of the scientific community more generally and that was the argument that the government has generally accepted.

RK = How does that play today?

JH = One of the things I would say about that is that it was really World War II which moved the scientific community into a degree of prominence and political influence that allowed it to argue for large scale federal support for science. It was the sense that science and technology had won World War II with radar, with the Norden bombsight, with the atomic bomb, that led government to start calling on scientists to a degree that

it never had before. The physicists were the most prominent in that period after World War II, when the scientists were really being called upon for their advice on a wide variety of questions. And the physicists took advantage of that to get government support for basic research ramped up (and particularly basic research in physics, which as a result leaped far ahead for a while of basic research in biology and other disciplines) but the key point was that the scientists were interested in knowledge for its own sake and expanding our understanding of how the world works and how the universe works and what our place in it is. But they took advantage of the sense of a payoff that you've referred to (and the understanding from World War II that there had been a big payoff) to get support for the more fundamental research. And today, I have to say that one of the things President Obama has been very clear about is that the strength of our fundamental research institutions, our research universities. (This refers, by the way, not just to the natural sciences but also to the social sciences) The strength of our research universities, our national laboratories, our independent private research laboratories is underpinning of our future success in technology and engineering and innovation that's going to pay off. You can't tell exactly when. You can't tell exactly how, but the president is determined to maintain the health of those fundamental research institutions because (as was already pointed out) it's all connected. If you want to have that basis in place, you've got to invest in the fundamental stuff as well as in the direct pursuit of the applications you're interested in.

RK = That's interesting about the role of war in the development of science and particularly

TA = Well, it's almost the inverse, the reverse of what you were saying. One of the things that stuck me when we were doing our book on Lincoln and the high tech wars, I had occasion to go through a lot of 1860s editions of *Scientific American*. Back then, it was basically Joe Zilch has invented a new gravistran it has four bolts in it instead of six. *Scientific American* was really closer to *Mechanics Illustrated*. It was all about the new device that was going to be a better invention or whatever. When the Monitor and the Virginia were coming at it each other, the executive officer of the Virginia recognized the Monitor because he had read about it in *Scientific American*.

RK = Well, if it seem *Scientific American* wasn't too impressed with the Lincoln's model either.

MR = That's a good point.

TA = Well, catching up a little time, if that was World War II you got research and development that produces RAND and it's the Air Force that discovers you can get an outside outfit to come and serve you directly. And it starts that, the whole idea of research and development inside the Department of Defense.

RH = And that's what RAND stands for R-and-D, RAND.

TA = But when Lincoln walks, I mean the one thing about which we hadn't really touched too much on was the telegraph which of course that Joseph Henry is very much part of. When Lincoln comes into the White House, the telegraph office of the War Department: somebody has to take a message, it's all written out on a piece of paper, and goes out to the commercial telegraph office in Washington, gets in line, and the telegraph people were famous for spiking. You know, "we'll get to your message in a few minutes." And that's what Lincoln walked into. And he gets a direct line to the, a direct telegraph line, to the telegraph office of the War Department and he becomes fascinated as Roger said about the idea that he can sit there and read messages. And there is on many occasions where he sees some general or officer even a major sending a message to the War Department saying, "Well, on Tuesday we're going to do the following and we expect we'll go six miles or something." And then he reads the next day they haven't done it. And a message goes back and it says "A. Lincoln" on the bottom saying "you didn't do what you said you were going to do." I mean he starts to really take on the war with the telegram.

RK = But that's a new form of communication.

TA = Yeah.

RK = I mean Barack Obama used that form of communication to mobilize millions of people. Is he still sending messages and signing it B. Obama.

JH = I said to a group of high tech executives who visited the White House not long ago, I was listing the various forms of evidence of the president's continuing commitment to science and technology and all the support for science and technology in the stimulus package and the increase in fellowships from the National Science Foundation and so on. And I said, "And not even the lawyers are going to get his BlackBerry away from him." They haven't gotten it away from him.

RK = Good to know. Well, you know this being Washington we've touched on it you know this being Washington it's hard to avoid politics in scientific advising both then and now. And I guess the, we've talked a little bit about Henry's advice and the role of politics as kind of inhibiting or in some cases I guess maybe enhancing or allowing some of that advice to go forward. That's true right?

RA = Yes, yeah.

RK = I mean I is that true now?

JH = Well, I guess what I would say is that you can't entirely avoid politics and you shouldn't in the sense that decisions about policy are never only about the science or the technical content. I've told my students for years that the scientific and engineering facts are never everything although they're almost always something. That is, it's not wise to try to base policy on incorrect understandings of what we know about the relevant science and technology, but at the same time you should not expect the scientific or technological content to dominate the decision in the end. There are going to be lots of other considerations. It's the responsibility of the scientists to tell the science to the decision makers as straight as they can tell it, as unvarnished as it can be, with all the uncertainties, with all the warts. "We understand this pretty well that not so well" and then it's the job of the policymaker to integrate that with all the other

considerations that have to enter policy. The values, the preferences, the stakeholders, and so on and decide what to do. And if you can't grasp that as a scientist, you don't belong in Washington. And you know I've been involved in science advice in one way or another since the early 1970s I sat on my first National Academy of Sciences committee advising the State Department on the US position for the Stockholm Environment Conference in 1972. (I was the token youth on that committee.) And I learned very early on that sometimes the science advice you offer will play a big role in the decision that gets made and other times the decision makers will say, "Thank you very much that's terribly interesting but we have bigger fish to fry and we're going to make a decision you're not going to like."

RK = I remember that happened I mean with the Smithsonian. I don't know if it was so much Henry but his assistant Spencer Baird, sending scientists, ethnologists, geologists, and others to Alaska. That had a big impact right.

RA = Right.

RK = I mean it was very much a 19th century illustration of the same thing John said. You want to tell us about that.

RA = Well, when the issue was raised about the purchase of Alaska, the Smithsonian did send out expeditions to gather specimens, evaluate the natural resources. Again, and I think this is what, it is, it was simply data which was part of the decision-making. Seward would not have, was not going to decide and the White House wasn't going to decide the issue based on this, but it was part of the data that was involved. The Smithsonian then pointed out the riches that were there.

RK = So the Smithsonian scientist actually went up the hill and testified to a Senate committee or...

RA = It doesn't operate that way I mean the Smithsonian issues reports. The Smithsonian has a tradition of trying to avoid going up the hill. After the 1850s, when

there was a Select Committee investigation about the Smithsonian and the Library after that we just

RK = So, they used to do that then to.

RA = We had, yes in the 19th century. Henry spent a considerable amount of time on the hill. I mean much of the influence might be said to be social. It wasn't formal. You didn't go up there and testify necessarily. You might, but you might be up there at dinner, have dinner meetings in the White House, have dinner meetings with the people on the hill. The tradition of the January 1st, New Year's Day, visits was part of the tradition. You visited every major member of the House and Senate. And every time a, again in terms of the Regents, every time a new Regent was named, Henry was there to say, "hi." It was a much more informal structure, much more personal structure. As opposed to sort of the more formal testimony, although occasionally for certain things you did write formal reports.

RK = But it was that work by Smithsonian scientists to point out the riches of Alaska that at least helped with the decision to acquire Alaska. So, the next time they're discussing that budget in the White House about doing research at the Smithsonian just remember that got us, that got the country Alaska and all its riches, as well as a vice presidential candidate, but.

JH = I will pass that on to.

RK = You will pass that on.

JH = To Peter Orsag the director of the Office of Management and Budget.

RK = Thank you very much John. I think it's time for some questions from the audience. We have two microphones set up on both sides. You can address a question generally to the panel or any particular person.

CW = Go ahead and raise your hands and we will bring a microphone to you. I want to start with one of our questions from an internet viewer. Someone watching tonight, Jeff Scurry from Chicago, Illinois who wanted to ask the panel, “What do we know about Lincoln’s feelings about Darwin’s work and his book *On the Origin of Species*?”

RK = Oh, good question.

RA = That’s a wonderful question I have no idea. Well, I can tell you that Henry thought Darwin was correct and that we know, we can document that Henry discussed *Origin of Species* with members of the House and Senate. We have no documentation that he ever talked about with Lincoln.

RK = Other questions?

TA = One thing I just wanted to mention concerning the telegraph that I think it’s one of the wonderful unintended consequence is because the telegraph was tremendously in use, all those telegraph messages had to be written down. All of those telegraph messages wound up in a, I can never remember the number it’s something like a 137 volumes of the Official Records of the Civil War which is a primary research tool for anyone looking at the Civil War. The Official Records and the Official Records of the Navy on both sides and a tremendous amount of that is simply the raw telegrams that are going back and forth. Because the telegrams are there because they put it on paper, they’re there for research.

RK = Which is great but what was Henry I mean that recalls another thing, I mean Joseph Henry as the Secretary of the Smithsonian was using the telegraph for kind of weather buddies across the United States. Yeah, that was an idea that I think Thomas Jefferson had as president of citizens, science people kind of taking weather measurements and rationalizing agriculture. And Henry would do those first weather maps in the Castle. There were telegraphs too. Did Lincoln’s use or the War use of the telegraph impede Henry’s work in terms of receiving you know weather observations and doing that?

RA = It destroyed it. Well, the Civil War destroyed it because you actually do this unless you had a wide enough net. And he lost everything to the South. And then when the Civil War ends and he tries to restore the system, the telegraph companies now realize you can make money with weather forecasting and they want to be paid. And before the Civil War they would do it for free. They would transmit the information, the data. They said, "Have the city governments pay if they want to know what the weather's going to be in New York." And that kind of threw, that just ended the Smithsonian program.

TA = But if we used all those clocks they won't like that because they were selling the time also.

RA = And he invented the Weather Channel.

P = I'd like to follow up the last question about Darwin. The question I was going to ask is we've been told that Lincoln was the most curious president and so I would like to know in terms of science what Lincoln read and what he knew in terms of basic science. It would be very interesting to know if we know what he read. Did he subscribe to *Scientific American*?

MR = I don't know if he did. I know there is one thing about what he read and I think it's an indication of how he operated. When the war begins, he starts to get an intense interest in exactly how does a war get fought. And he sends over (so there is a record of this) he sends to the Library of Congress for books of maneuvers, on war theory, anything he can get his hands on so that he can start to learn. And he puts, he starts applying this quite rapidly and then he sees that he has the instrument of the telegraph. And so he can become a Commander in Chief. For the first time we have a president in direct contact with the battlefield. So if you take that and you wonder what else did he read? I don't know what he would have read on science but he was curious about everything. And he got a lot of information by talking to people who possessed the information.

TA = I, when we were doing our book I did just a very cursory count. There were at least 30 occasions when Lincoln went out and observed or in some cases literally pulled the trigger himself on weapons tests. That he was very, very interested in seeing for himself how things worked on that level as well. He was forever going down to the Navy Yard in Washington and firing a few rounds into the Potomac to try out a new weapon. I really don't know much about his reading habits during the war. He was in love with Shakespeare and he read, he was fairly well read in history. He was self-taught in practically everything he did. I don't know that there was much in the way of science that he was reading about that didn't come, there could well be huge areas we didn't locate in our, when we were doing the book but, mostly it was during the war on a very practical level.

P = I have a question. I'm very interested in Edwin Stanton and his relationship with Lincoln. He was the Secretary of War. They had worked early on a law case on cotton, the reaper, the cotton gin, whatever. Stanton was very knowledgeable about railroads, movement of people, canals. He had done law and attorney, as attorney general for years with this. He and Lincoln were very close and Lincoln spent a tremendous amount of time with him. Stanton was also intermarried with the Tappan family. And it was Benjamin Tappan who began the Smithsonian the first to introduce the bill to Congress. So, what did Stanton, how did he influence Lincoln with respect to science do you know?

MR = I think that they had a meeting of the minds about so many things. I think the railroad, the whole idea of the railroad and almost as if the international space program was going through the current administration. I mean railroads were going through Lincoln's background and Lincoln saw the railroads again and again. When he has the idea of the transcontinental railroad is there almost in the war. The creation of a military railroad system lifts the whole idea of the railroads being an instrument of war. I know that Stanton would have backed him on this.

P = Well, I thought Stanton was the one who promoted that.

MR = Yeah but when the question comes it happens in both the South and the North who's going to pay when you carry soldiers and fodder and food for the soldiers on the railroads? And in the South, they never really come up with a policy. And what Lincoln does, and maybe with Stanton's urging I'm not sure of that, he they call the railroad people on. I mean they're kind of calling in the bankers today. And they say, "Look here is what we can do. We can get a serious, generous subsidizing of the railroads that will be carrying war materiel and soldiers or we can just take you over."

RK = Now we don't want to ask about those discussions in the White House today.

JH = Not in my department.

MR = And so that's what, I mean

P = Well, I thought they did nationalize them at some point.

MR = No.

RK = No.

MR = They national, they get an agreement that they will pay a very fair rates for the handling and it's all put out in you know great lists of what you're paying for what you hauling. And everything works smoothly.

RA = But what you may be thinking of there was the US Military Railroad which was hugely important but to vastly oversimplify basically that operated in the Confederacy. That was the Union building railroads to supply its troops in operational areas. That wasn't

MR = So they have to push the railroads.

RA = That was a separate thing from the civilian railroads which were still in operation.

P = Thank you.

RK = We have been talking a lot about science in a largely in terms of natural science but at the time of course you had Henry, when he put together the program of the Smithsonian named anthropology as one of the areas of science was very much involved in the discovery and ethnology of American Indians for example. There were a lot of discussions of, I would guess we call it now maybe pseudoscientific ideas of race and things like that. I know that at the Smithsonian Lincoln used to attend some talks of abolitionists. They gave talks at the Smithsonian. The Smithsonian had a wonderful auditorium. It was acoustically quite fine and there was a Washington Debate Society that basically said to Henry “we’re going to do these talks” and Henry I think said, Mark will correct me if I’m wrong, but “okay as long as they’re in keeping with the mission of the Smithsonian they’re fine.” And of course

MR = Nonpolitical.

RK = And it turned out as we would say now and it turned out it was Frederick Douglass, Ralph Waldo Emerson, Greeley, a whole bunch. And I guess and so I think Lincoln used to get up. Not Lincoln. Lincoln would attend these things and Henry would get up before these lectures and kind of do a disclaimer. “The Smithsonian does not endorse ...” And I think there’s reports, I’ve read you know Lincoln’s account of sometimes, “Poor Professor Henry had to do this and people laughed at him.” And so I guess my question to maybe Mark is you know to what extent did Henry or the Smithsonian get involved in advising Lincoln on, at least at that time, scientific theories of society or understanding humankind or understanding the whole issue of race? Was it absent? Was it...

RA = The Smithsonian was the leading center for research on anthropology at that time. I think you, not to hedge on this, Henry would be considered racist by our current standards. He definitely believed in the racial superiority of the Caucasian, in fact the

racial superiority of Anglo-Saxons over the French and the Italians. They were inferior as well. The American scientific community at that point had taken, was taking advantage of a mass, armies now being created to take measurements, physical measurements, of the soldiers through the Sanitary Commission. An astronomer, B.A. Gould, was running this. Of course, he had the statistical tools in order to analyze and they were actually doing some really important physical comparisons. One has to understand that the science of anthropology at that point was definitely a hierarchical. But that's why actually, interestingly that's why Henry could accept Darwin. Because he saw gradations in the human race and then argued well, if humans can create the gradations, then we could go continue the gradation down into the primates. It made a lot of sense to him. As a good Presbyterian who believed in the Resurrection and the Afterlife, it bothered him because the implications of Darwin, but he accepted his good science.

RK = And he had other people on the Regents who didn't buy Darwin who were opposed to Darwin.

RA = It was a battle you know he also had a fight with his Alma Mater, at Princeton where he used to teach about this issue. This was not a position held by the large majority of the people. One of the interesting things is one of the congressmen he actually showed Darwin to was an abolitionist because that individual was very interested in this whole question of the unity of the human race.

RK = Which many scientists, as you say, didn't believe in. There was a polygenesis there even.

RA = Yeah, with Louis Agassiz at Harvard being the great spokesman and a great opponent of Darwin arguing that the races had all been created independently and therefore were not related.

RK = And Agassiz was one of the regents.

RA = Yes.

RK = One of Henry's bosses. John, do you get into discussions of social sciences policy, as well, or is it pretty much hard science and natural science?

JH = Well, it depends on who the "you" is. I mean I can tell you every morning in the White House there is a lot of economics discussed. But

RK = That's a dismal science.

JH = You know there's a National Economic Council and there is a Council of Economic Advisors and of course, a Treasury Department and a Commerce Department. So, you know around the table, there is always a lot of economics. There is some political science, obviously. There is some sociology. But in the Office of Science and Technology Policy, the representation of the social sciences is relatively light. Most of the responsibilities of OSTP fall in the natural sciences and the engineering domain and the other social sciences have their representation more heavily in other White House offices.

RK = Question?

P = You have said earlier that Lincoln was very interested in the scientific field. Exactly how did this, did this influence in any way the Union's victory in the Civil War?

TA = Well I, tremendously I would say. One of the things that is if you sit down and look at the Union versus the Confederacy on paper, there is all sorts of statistics that show the Union should have won in five minutes. Obviously it didn't. But, the, I will say technology more than science. Science is finding things out technology is how using what you found out to build a better machine to oversimplify again very much. But the technology that the North had in terms of having more railroads, in terms of having more telegraphs, in terms of being able to, one of the most important weapons that the North had was the factory. They could mass-produce practically anything. They in, the

ability to make lots of stuff was a huge part of the way the Union fought. They manufactured so much stuff in effect they also supplied the Confederacy. A significant (I don't have numbers on this) but a significant way that the Confederacy supplied its troops was by in one way or another stealing Union supplies. They would do a raid on a supply dump. After a battle, they would go out and pick up the rifles from dead soldiers. They would take the clothing that they could steal. A tremendous amount of what the Confederacy was using was stuff they had grabbed from the Union. And so, the ability to manufacture everything in very large quantities was directly related to the Union's technological superiority and that was a, played a huge role in how the war was fought.

MR = And Lincoln makes a reference which is very hard to track down exactly what he was saying and how he was saying it but he talked about "the numbers." He said you look at "the numbers." And what he was really talking about very grimly was casualties. The North could handle more casualties than the South could. That you could have a battle and in that battle the South could not pour in as many men. Lincoln makes a reference to "the numbers." And he is so cryptic about it that it's people still discuss what he meant because it's kind of a delicate issue "Am I pouring men in?" And of course Grant was accused of this. But they did know that there was a massive industrial base. It finally does get put to good use by the Union, but it takes a little while. And then the South, I mean and one the incredible things is that they could even think about producing ironclads. I mean they had to go and find scrap iron they, in putting together the Virginia. It's a homemade ship. It's not really a functioning shipyard. It's people figuring out how to make do with what they have.

RA = Could I pick up on something you said earlier about the lighthouses. I mean here was Lincoln supported the efforts of the lighthouses, it's called the Lighthouse Board. The Confederate raiders had destroyed the whaling fleet. Whale oil was the main fuel for lighthouses. Without lighthouses, American commerce grinds to a halt. If you ever try to dock a ship in the dark in the coast of the US, say New England, you know the value of the lighthouses. Henry was chair of the committee on experimentation for the Lighthouse Board. His job was to come up with an alternative fuel. Something that was cheap would burn brightly and could be used instead of whale oil. He spent years and

lots of government money experiments on Long Island coming up with various forms of alternative fuels. Looking at the light they produce and also the temperature they would burn at because you don't want explosions, you don't want it too high. It's a field of applied thermodynamics and applied optics. This was a very important element in the winning of the war.

RK = What did he come up? with because you should tell John.

RA = Alternative energy.

TA = I believe the alternative fuel source was kerosene.

RA = Yes, it was.

TA = The byproduct of kerosene they didn't know what to do with was something called gasoline.

RK = Yes.

TA = So, they found uses for that and here we are.

RK = What was the furthest out thing that Henry think up for Lincoln? I mean was he thinking in terms of science? What was really at the frontier of scientific thinking in that day?

TA = That's a good question.

RK = Well, we give you time to think about it because then I'm going to ask John what his (inaudible) today. Yes.

P = Possibly related to that comment of yours maybe somebody will either corroborate this or provide some kind of commentary. It was my understanding that one of the

sciences of greatest prestige at the time was astronomy. And nations were competing to some extent, who had the best astronomers and such. And at the old naval observatory which is, now there I mean the property on 23rd Street downtown, that the astronomers who were there were irritated when congressmen would come by in the evening and bring hometown folks and show off the, want to have tours. Interrupt the scientists on their work and that one time the astronomer said he just wasn't going to do this anymore and he barricaded the place and the persistent knocking he found out later on came from Abraham Lincoln who said, "I couldn't sleep tonight and so I wanted to come and see the stars."

RK = That's a great story.

MR = Well, the charts that were used by the North were developed by Maury who was a brilliant genius for navigation. Unfortunately, he chose to go south. And he essentially became the most important figure for the naval strength of the South. I mean he was, he had a Roger knows about this better than I do.

TA = Well, I happen to marry one of his remote ancestors so.

MR = But he develops a what they called a torpedo, was really a mine

TA = Right.

MR = In his bathtub for instance.

TA = Yeah.

RK = That could be dangerous.

TA = Well, the other when I tell that story to other of that part of the family. They said, "Yeah that sounds like a Maury to me." But Maury's charts were of ocean currents and those were extremely important to the whalers of the time. And these very elaborate

charts about ocean currents pertaining to whaling fleets, again going back to the whale oil thing. But Maury was involved in all sorts of remarkable things, he. There was this one little ship I'm fascinated by, a ship called the *CSS Teaser* which is just a tugboat but they found lots of uses. It was one of the consorts to the Virginia during the Battle of the Monitor and Virginia. It was the Confederacy's first and only aircraft carrier. It, there I believe there were two observation balloons used by the Confederacy. One of them was launched off it. Maury used it to mine the James River and it was captured on July 4, 1862 with his secret plans for a new ironclad, the Confederate's only observation balloons, and one of what it sounds very much like was one of Maury's mines on board. And they tested the mine in Baltimore harbor I believe and blew a ship to splinters with it so they knew it worked. But he was involved in quite a few things.

P = Hi, we're undergoing a geospatial revolution with Google Earth, GPS navigation. In what ways did the Lincoln administration utilize mapping technologies of the time for the railroad or you talked about you know building homes out into the country, moving people out westward? And in what ways is the Obama administration going to encourage this geospatial revolution you know improve, development of the geographic information science, technology, and perhaps leading towards a national strategy?

JH = Do you want me to start with Lincoln?

RK = Start with Lincoln and then (inaudible 87:51)

MR = Well, I think that they recognized the binding force that railroads represented and on a very low level practical thing the really started getting railroads not to just put the tracks at any width they happen to feel like putting them. So that the gauge of tracks got standardized. As they got standardized, so did the factory (and this was by the Union ordering locomotives from northern factories). The locomotives were told, the manufacturers of the locomotives were told how wide the wheelbase should be on the locomotives so that those locomotives could go on the majority of the tracks that the Union was laying. And it introduced the whole concept of there being a system in not

only the railroad but the whole idea of system was then developing I think at the same time.

TA = And two things sort of follow from them which one of them goes a little bit in a sense they both go over to mapping, literally the telegraph follows the railroad. When they're laying the railroad tracks the railroads have all sorts of uses for a telegraph. The telegraph goes right alongside it when they're building a railroad and the, and for civilian and for military uses. A little later one when you get to the Homestead Act and when you get to laying out where people are going to get to have their land, there was a whole elaborate deal about taking the railroad and you know basically almost a checkerboard system of putting huge tracts of land on either side of that railroad that had to be mapped out, that had to be surveyed. And these were people who were going to get their homesteads. And so in a very practical particular sense, the railroad where it went you know where the road is are where the towns spring up. That's always been true, but it was the railroad that created the railroad towns and the tracks of land that were granted to the railroad companies, that were granted to the homesteaders was a really hard-edged, very practical way. That's mapping.

RA = The war also led to tremendous infusion of funding in the Coast and Geodetic Survey. So one of the things in fact that happened that at the end of the war we have better maps, better understanding of our space. The Coast and Geodetic, although it's supposed to be the coast, I mean they're moving inland as well. The other thing I'd like to bring up because it's where technology and science have to yield to politics is that through most of the 1850s they argued about the transcontinental railroad, but couldn't build it because of the debate between the North and the South over what path it should follow. They sent out survey parties which were supposed to solve this problem based on technology and science; what should be the best route. Well, they couldn't decide what was the best route purely on science and the fight continued. When the Civil War begins and the southern politicians are no longer there to interfere, then they can lay out a northern route but science was not able to overcome the political roadblocks no matter what the logic was at the time.

TA = One of the mapping thing very quickly, at the very start of the war when Lincoln declares a blockade of the South all of a sudden they've got to find out what it is they're blockading. I forget the statistics but I believe that if you measure it all it's something like 3,000 miles of coastline. They've got to figure out what are the ports. Where are the potential ports and how big a ship can go into this port; how big can go into that one? They've got to do a tremendous, an inventory of the entire coast of the Confederacy and, of course, getting in and out of those ports is tremendously important.

RK = How are we using geospatial science then today?

JH = Well, if you think about what the geospatial revolution that the questioner referred to consists of. There are a lot of different pieces that have to come together. One of those pieces is having the capacity to look down from space and sense and observe a whole variety of conditions on the Earth. Another capacity that's immensely important is information processing, information storage, and high-speed computing that is capable of analyzing and rearranging all those data in ways that make them useful. A third component of that is very advanced software in order to actually be able to interpret those masses of data and make them transparent in ways that are useful. Another very important part of it is the microelectronics that enable everybody to have a GPS unit that you can hold in the palm of your hand. Yet another is having the broadband capabilities that enable people to stream into their homes large quantities of these data and various representations of the data that enable us to understand all kinds of things that we couldn't see or understand before. The Obama administration inherited a set of circumstances in relation to some of those capabilities that are less than ideal. In the space program, the looking down aspect had been badly neglected compared to the looking out aspect. There are a lot of things we have to do in our space program and in our constellation of satellites now to restore, and then maintain, the capacity to see everything looking down that we need even down to what we need for weather forecasting and hurricane tracking. Obama understands that very well and is simply going to have to find ways, notwithstanding the economic difficulties, to make the investments to strengthen, restore, and expand those capabilities. Broadband is another big priority for the Obama administration. The United States ranks actually low

among advanced industrialized countries in the capabilities of broadband available to the average citizen. We're determined to fix that and last weekend Obama announced the appointment of the first Chief Technology Officer, the first CTO, that the US Government has ever had. One of that person's responsibilities, that person will also serve as Associate Director for Technology in my office, the Office of Science and Technology Policy. Broadband and the information processing capabilities and the application of that to the geospatial revolution, to healthcare, to education are all going to be part of that portfolio. So, this is a big set of issues for the Obama administration.

RK = So that broadband is like planting that telegraph across the country.

JH = That's today's version, yeah.

RK = Okay, I think we have to, do we have one more Chris?

CW = We have one more question. In the brief amount of time we have left I just also wanted to remind our audience that Roger and Thomas Allen's book: *Mr. Lincoln's High-Tech War* is available for signing and for purchase in the lobby following the program and just one last question.

P = Yes, this is not entirely unrelated to the previous question. I've done much research on Massachusetts geologist Edward Hitchcock who wrote for the Smithsonian on surface geology around the late 1850s. I was wondering if either Lincoln or Henry displayed special interest in geology, especially geological surveys, which would be useful in locating coal resources, and anything particularly notable of their insights on the subject.

TA = Well, there was a story someone was telling just before we came out about in Colombia; the coal survey.

RK = Yeah, Mark had mentioned the coal survey.

RA = If Henry hadn't been a physicist he would have been a geologist. I mean that was his first love and he taught geology at Princeton. Always was very interested in geology and made sure the Smithsonian was supportive of it. But geology was something which was a huge amount of government investment because it was, in fact, practical. One of the things people forget when they talk about government support of science is the states used to take on a much bigger burden of supporting scientific research in the 19th century. That's one thing that's changed tremendously, flip-flopped, into the 20th century. The existence of mineral resources is a very important issue for the US government. The federal government had various surveys under Lincoln and his successors.

RK = Yeah in fact Powell who runs the Bureau of American Ethnology at the Smithsonian ends up, does geology and becomes the head of the US Geological Survey. So, and holds both posts simultaneously. Thank you it's been a very fascinating I think talk. Roger, Marc, Tom, John thank you very much. I think it's interesting how a lot of things from the 19th century kind of ring through our own times as well. The world seems like it's gotten more complicated in many, many ways but I think probably the job of the science advisor is still a pretty tough one and a job of the president is a pretty tough and humbling one. And yet, I think again has that, has obviously that purpose for the good of our country and I think the good of a larger world. So, thank you very much for joining us for the second Lincoln lecture session, thank you.

JH = Thank you.