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Date : 9/1/1990
Tape N# : 33A, 34A, 35A
Time code : 00: 00: 56: 12
Subject : Technology

Antonello: Can you tell me something about the period before the WWII, when you were a young scientist in California?

00: 00: 56: 12 In the thirties, the late thirties in California I was a graduate student in physics, theoretical physics. Every close group of people about a dozen of us who worked and listened to the lectures and ideas of mostly Robert Oppenheimer. Who was the leading theoretical physicist of the university at that time in California. We were a very close community, very concerned about our work and also quite political, of course the whole campus was. We were, I think I would say, activists, to a degree, as much as we could be, with our hard work. So we're very concerned about the growth of Fascism in Europe, its strength and we felt pressed seriously by the rise of the Third Reich. And of course the crisis came in '38, at the time of Munich and the famous speeches of Hitler, at Nuremberg. And I remember as often as they happened, I would stay up all night. Because when Hitler spoke at noon in Nuremberg, that was four o'clock in the morning in California. And the only way to know what was going on, to feel part of it, was to listen to that threatening, raucous voice in the middle of the night.

00: 02: 20: 08 And it was a hard time, it was a hard time for us, because we're trying to think through the nature of particle physics and we were trying hard to via our profession at the same time, we felt very concerned about the future of the world as well. We might have been because, by '38 we saw that war, most of the group I think saw that war was inevitable. It was pretty sure to come. And of course it was into that particular sense of tension that the discovery of Fission fell, which changed my life and nearly every young physicist of the time, in the next five years. And of course this had such an impact on the world since.

00: 03: 04: 21 About certainly the most dramatic kind change I can recall. I could also say how it seemed very different before that. In those days I would have to defend myself to my friends who were not physicists, but who were rather students politically aware, concerned about the world. To defend myself against their charges, that what I did was entirely irrelevant to humans. That it was Ivory Tower material, who cared about the center of the atom, and the nature of the physical particles. What bearing could that have on anything? When there were so many grave problems in the world. To which I responded quite reasonably, but one of those problems will be energy.

00: 03: 47: 06 Always, the use and maintenance of an energy supply for a human activity and we know that the sun, we just recently knew, that the sun made its energy by nuclear reactions.
And we must find out more about that, then someday we might perhaps be able to do something like that, at least learn something from it, to improve the situation. I was not farseeing enough to imagine when first comes a weapon, but the idea was quite clear. So I'm afraid that the lesson I learned from that was, science which is called pure in our times, science which is far from applications may or may not turn out to have very important consequences. Rather quick consequences, in the time scale of history. I still think that's true, therefore I'm not

very sure you can divide these things as much as people like to divide them.

--- Philip Morrison Antonello: Were you in favor of intervention in the war?

00: 04: 51: 06 Yes I tried very hard to get the Americans to become concerned with the rise of Germany, in Europe. Strong supporters of the Roosevelt tack, in fact pressing Roosevelt to do more or more rapidly, especially about Spain. He remained neutral, with respect to Spain for the entire time, which we thought was a grave mistake. But as that war went on and as the victory of the phelange, became clearer and clearer, Roosevelt and the American public as a whole, began to move a little towards sympathy towards Britain and France. And then when the war was actually engaged and after 1940, was pretty clear the US would be in sooner or later.

--- P. Morrison Antonello: What happened after the bombing of Pearl Harbor?

00: 06: 58: 00 I remember very clearly now, the afternoon, the Sunday afternoon of Pearl Harbor when the attack was made on the American fleet, in Pearl Harbor by the Japanese. I was then a young instructor freshly at the University of Illinois, in the center of the US, my first job really. And it was a quiet afternoon and I heard noises from the campus, we lived a block or two away. I heard people talking, shouting, whatever it was, nothing clear and so I went outside to listen and somebody came by and said, listen to the radio. I turned on the radio, it was about dusk, and they were reporting the attack at Pearl Harbor. And from then on we were in war, the next day we declared war. That time of course came as a great relief to me because I'd been hoping that the Americans would take a part in the world war, which was coming. And here it was.

00: 07: 58: 16 And then as probably you may have heard, in the next year, the campuses changed tremendously. An enormous mobilization went on the campuses.
Within the matter of a few months, most of the students were in uniform and signed up in a special, the men, signed up in a special program to take engineering or similar courses of practical application, technical courses, remaining on the campus twelve months of the year. There were no more summer vacations, no more long Christmas vacations and so on. Of course the faculty was also engaged to do that, so we were all working much harder than before.
We felt we were somehow part of the war effort, that we were at a distance from it.

00: 08: 47: 23 It happened that a very original physicist at that university had only half a year before, before I got there, come across the idea of a new accelerating machine.Which made very fast electrons, very high energy electrons, at that time the highest in the world. And in talking we realized that such a machine would make x-rays of great energy. And in wartime you probably need to take pictures, x-ray pictures through steel parts.
We knew nothing about guns or ships, but we knew they had big steel parts in them. And we imagined that taking x-ray photographs through thick sections of steel, was indeed an important part of ordinance manufacture. So then we checked with the engineering people, they said

yes that was true. We said, okay we have a new means of taking x-rays that no one has ever investigated before, no one has ever had such radiation available before. It's not obvious that it is good, but it's obvious that it should be looked into. So we began to work on that. It was quite new to me, but I was prepared for it, it was in my view and several of us worked quite hard and made some progress, in that process. A kind of voluntary work for war, you might say, but of course then our chief went to Washington and got money for it, the whole thing was then arranged and regularized. But still we were doing in the context of the university, our laboratory was there. We gave our classes, we were so immersed that I imagined that Urbana, Illinois, which you have probably never heard, was in danger from German attack, by air. I became an air raid warden and a certain time during the week, I would go on the roof and watch for airplanes dropping any firebombs, somewhere in our little town. Which was of course a bizarre probability. But we thought well we could imagine how it could happen.

--- P. Morrison Antonello: How did you get involved with the Manhattan Project?

00: 10: 48: 19 One year later, in the latter part of 1942, I went to Chicago. It's only a two hour drive away, for the annual Chicago meeting of physicists there, and or any physicists. Of course, we knew that there was in the University of Chicago, a large secret project. Whose purpose we did not know, but we could surmise from the personnel what it was likely to be doing. We thought it was somehow investigating the Uranium project, which everyone knew about. Which I myself had written a long paper on, which I tried to sell to a popular magazine a year earlier, just to inform people and to get paid for it. But they turned it down, "improbable, " they said, "this is speculation." But it was a good piece, looking back on it, I was naive, but still pretty good. And in the course of that meeting, a good friend of mine, we had been graduate students together at Berkeley, only a year or two years before. Four years together maybe. Came to me and said, " I work at the Metallurgical(?) laboratory, University of Chicago, the secret project, you must see me tomorrow. I'll arrange that you can get in. So please as an old friend, I want to talk to you." 00: 12: 06: 07 Well, I was interested, so I came of course, and they let me in. I went to his office, he looked at me , and he said, "I know what you're doing and I can assure you what we are doing is much more important and much more relevant to the war. We must have everybody who can contribute." And I said, what are you trying to do, he said, "well don't you know? " I said, well I know vaguely, must be something to do with uranium. He said, " yes, we're going to make bombs." Just like that. And so he then told me more, I went home to think about it. I consulted my wife, we thought aboutit, but it was pretty clear that I was going to enter this thing. I was frightened of the possibility that those things could be made. And felt if the Germans, clearly in my view had a great headstart, if it would seem practical for us, it must be more than practical for them. And was therefore a serious matter. So I joined the project at the turn of the year, roughly. And was there from the end of '42 until the middle of '46.
Not even that old, let me think...yes perhaps I was 27.

--- P. Morrison Antonello: It's my idea that the bomb was made and built by a group of very young people?

00: 13: 36: 05 Yes that's certainly true....well, I actually caused a survey to be made for the benefit of the History of Los Alamos. My wife worked and my best friend was the editor of that history. And so, in discussion we said, let's make a, just what you said, an age census. And in May of 1945, that's three or four months before the bomb, the distribution of ages among the white-badge personnel, all those people who had access to secrets, who had the equivalent of advanced training in science, was exactly my age, to the month. I was just absolutely average. Of course our leaders were somewhat older. Oppenheimer, Bader, Ivan Boer, were men ten or fifteen years older.

00: 14: 35: 07 On the other hand, don't neglect the fact that the industry which was abetted, was very, very large. Had at the peak perhaps 200, 000 people working for it. Now those were all kinds of people. We tend to focus our attention on these heading little groups, because they're easier to understand.
And they did supply the primary ideas, but they didn't do most of the work. They were design, they represent design and origination, but not carrying out the work, which took huge factories.

--- P. Morrison Antonello: Were the Los Alamos scientists political?

00: 16: 04: 15 I believe that's true, but on the other hand I do believe that there was an enormous concern, commitment to the war, on the part of nearly everybody on the project. Just to the war, the war aims, to the fact that the Americans were involved, that we were fighting an enemy of perceived great strength and ruthlessness. And a sense of anxiety overwhelmed the laboratory. Which I must say was shared, perhaps even led by our European colleagues. Who also, I remember very well, this is what's said, I came in one day after the Americans and English and whoever it was, had landed in Sicily. And I said, Ferme, Ferme isn't it splendid we are now fighting for the....didn't get back. He said, the entire conquest of Sicily, he said, would not make up for the absence of the metric system.

--- P. Morrison Antonello: You discussed the project with your wife, started thinking about making the bomb..what happened next?

00: 17: 19: 19 Then I joined the project a couple of days later and was admitted to the project and got the books, and introductory material to read and study. A few weeks later, by the first of the year perhaps, I was working in Ferme's Laboratory, was very much impressed by the quality of leadership in the laboratory. And I began to do what I could, and began to fit into this, as you say, very complicated, very large scale enterprise, that was then going on. Trying to find out what I could best do.

00: 17: 53: 07 I was still working in Chicago, I remained working in Chicago for two years. Until I went to New Mexico in the summer of '44.

--- P. Morrison Antonello: What was the structure in Chicago?

00: 18: 19: 04 Each of the great research laboratories, which was university connected, having industrial purpose, so to speak, a programatic purpose and an industrial contractor firm, who were getting ready to make a plant, that would carry out the work pioneered and theorized about at that laboratory. Chicago's plant was to be in

Handford, in Washington. And it was to be a chain-reacting pile, which would make plutonium. And we talked and fought and calculated everything about that process, that we could think of. We had nothing to do, directly with the design of the bomb itself. We made the fuel for the bomb, that was our plan, of course the plant itself did not get underway until the middle of '44, but all the preparation, construction, design, testing, speculations, all those things were what we were suppose to do. And we worked with a great chemical firm, the firm of Dupont, who actually constructed and ran the plant, in Washington state.

--- P. Morrison Antonello: Was this a completely new experience for you?

00: 19: 30: 20 It is quite true for the first time we saw something about engineering, about production, about contracts and that sort of thing. Schedules was not something we had much to do with before. I knew a little about it because I was, to some extent, I had an engineering interest. I was the graduate of an engineering school, after all. Though I studied physics at that school. And I was a quite experienced radio amateur in many constructions, and built things, and bought things and so on, in a fairly responsible way, when I was an undergraduate. So I knew a good deal about that, but only in passing. You're quite right, the whole tone was much less academic than it had been before. And we brought to that a certain freshness and originality which was different from what the engineers who had practice to go on. Of course they had no practice in this field, they were complete, they didn't understand the first thing about it. They had never heard neutrons before, most of them. So it was a very special situation, we became somewhat daring engineers. I would say that was what the physicists were. They were engineers without much practice to go on, innovative, perhaps a little imprudent. Doing things that there was no justification for, just hopeful(?). But there was no practice. So it went much faster for that reason, than it might have gone had it not been pressed by the academic physicists. I think that's true.

--- P. Morrison Antonello: Were there security problems in the early period? How was security enforced?

00: 21: 19: 23 Well, the security was serious, we had of course, a secret laboratory and secret documents which you couldn't take out, we couldn't copy them and so on. We had to work in the laboratory a great deal, we had badges which must be cleared on and off, we could not talk to anyone about our work. But inside the laboratory we talked pretty freely, group by group. The whole Chicago enterprise was related to the plutonium project and we knew a good deal about that project, we knew nothing whatever about the bomb-making, where it would be, when it would be, none of those things we were very sure of, at all. I heard simply that, about at that time of the formation of a new laboratory, didn't know where it was, but I knew it was out west somewhere. And had a code name Cite Y, we knew that Cite Y would be the place in which the plutonium would eventually be shipped. And I vaguely knew that my old thesis supervisor, Robert Oppenheimer, would be the scientific director of Cite Y, was the scientific director of Cite Y. In fact, once or twice I wrote him a technical letter, to tell him something that I thought might be relevant to their work, which we had found out in Chicago. But I didn't write him in the most direct way, I wrote through channels.

--- P. Morrison Antonello: Earlier you said that most of the campus was in uniform, was it the same in Chicago?

00: 22: 49: 03 Most of the students were in uniform. The faculty was never in uniform, the students were draftable, so they were drafted, if they were lucky they'd be sent back to university to become engineers, if they were not, they would go off. So...

--- P. Morrison Antonello: Was the military pressuring you to move the work along as fast as possible?

00: 23: 14: 08 Oh, yes, we knew that we were working for General Groves and his project. We had a lot of tension between us, but on the whole I was not one of those people who felt the worst about General Grove. The more I got to know about him, the better I thought he was. I didn't like him, I didn't agree with him at all on the general view of the world, but as a hard- boiled, schedule-keeping, priority-arranging officer, he was good. And I came to work, rather closely with his office for a variety of special reasons. During the war I acquired that feeling. He thought the only most important thing in the world was getting his project done, which was more than what physicists mostly did. They would do anything, but they also recognized there was a larger issues, not General Groves, he saw his own task as the main task of the world.

--- P. Morrison Antonello: Why was there tension?

00: 24: 13: 19 Two reasons.. In the first place, there were people in Chicago especially, who really strongly disliked General Grove and they couldn't manage him at all. And the second place, probably more important, we had an ingenuous view that we were going slowly, that we were not cutting enough corners. And we should cut corners and take chances and take risks and expose people to greater dangers in order to be sure to anticipate the Germans. I no longer think this is wise, at the time I thought it was wise. And so we conspired a bit, to try to speed things up, to try to talk Dupont into cutting corners, to try to talk to Generals, but they would not listen. They knew about it better than we did how hard it was to move a big enterprise, to do things that are not done by the book, so to speak.

--- P. Morrison Antonello: So in reality, it was the scientists not the General who were pushing?

00: 25: 16: 08 Absolutely.. well the scientists invented the project. Even, say, Einstien if you like, that's the paradox of the whole thing. The military did not come to us and say, "Look, in exchange for lots of money and prestige, will you please make a bomb for us." Which we reluctantly undertook to do, not at all, it was the other way around. We said you the military must take over and organize and get the money, so we can make this bomb, before the Germans do. And that was the general feeling and that role was not really understood by many people. And it's really true.

--- P. Morrison Antonello: And this push, sense of urgency was because of the Nazis?

00: 25: 58: 00 Because of the war in Europe and because of the historical truth, that quantuum-mechanics is a German subject, in many ways nuclear physics were excellent there. Eisenberg is a great leader. The Germans were organized for war, clearly, several years before the west. And so Fission was discovered in Germany. So we all felt, I think, now it appears to be wrongly, that the Germans would be way ahead, a couple of years ahead. And a couple of years to be fatal, it only took a four or five years, the whole thing.

--- P. Morrison Antonello: So everyone was putting in more than they were supposed to..

00: 26: 36: 15 Yes...the long hours, six day weeks, overtime, plenty of work on Sunday as well.

Antonello: What happened when you went from Chicago to Los Alamos?

00: 26: 53: 04 The origin of that change which was not just for me, but for hundreds of people, hundreds of technical people from the rest of the project, went to Los Alamos. Because a crisis had arisen at Los Alamos, a technical crisis. At the same time, the work of the other parts of the project outside of Los Alamos, was declining, it was nearly done. The plants were getting ready to work and after the plants were working, the physicists were in a very similar position. Their job was the initial calculation, the initial measurements and so on. Once the plant was routinely operating, twenty- fourhours a day, they would shoot for trouble, you know they would do trouble-shooting and worry about, but they would not have so much to do. And that was clear in the laboratory as a whole. After what I did everyday for the first year or so, was do something directly contributing to the Handford plant design. Just how it was going to be built, what materials, what sizes. We made measurements, neutron measurements on all of those details, over and over and over again. In a typical engineering way, but it was directly contributing to the plant. Once that was all decided and cast in concrete we had nothing much more to do.

00: 28: 06: 10 So the absence of work in New York, Berkeley and Chicago, and the crisis that arose at Los Alamos, when it became clear in the late spring, early summer of 1944, that plutonium could not be used in the way that uranium was used to make gun-like bomb for Hiroshima. You can't do that with plutonium, which was a very simple thing to do, you can't do it. Therefore it was a crisis, they couldn't use this most abundant, highly expensive fuel until they figured out a way to use it to make an explosion. Indeed, as you know, the implosion, they made the implosion from plutonium. And the idea of the implosion had just been settled upon in the middle of '44, as the one way Los Alamos could go to work.

00: 28: 56: 04 So they wanted to double the technical staff to try to make that feasible. And therefore they sent the leading people to allthese laboratories, to recruit appropriate persons, the right sort of chemists, physicists, mathematicians, whatever who would fit into the work, of implosion. And my group had become quite expert at making measurements of critical mass, I'd say somewhat in an indirect way, but it's a fair way to describe that. And we knew that was an important step they would have to begin to do at Los Alamos. So they said wouldn't you come and do that, and it was clearly much more important then than continuing sort of the winding down work in Chicago and of course I, felt was good to be back again where many of my friends were , where the

director of my laboratory was my thesis supervisor. So I said I must go to Los Alamos, and we did. But not alone.

34A 00: 00: 41: 03 But not alone. Los Alamos Laboratory was a peculiarly united and attractive place to work. Everyone, almost everyone, was committed to the work of the laboratory, Robert Oppenheimer's leadership was very pervasive, he was everywhere. No important decision happened without him, no difficult experiment in the middle of the night went on without his coming around just to watch and show his understanding of the importance of the thing. And there was an enormous esprit, sense of accomplishment, sense of, and of course it' very close to this terrible thing the explosion of the bomb. We were the ones, behind us were all those hundred of thousands of people and all those billions of dollars. In front of us, we're just making this little thing out of that, would it work we didn't know. So we felt heavy responsibility, and all the time the papers were telling us about war in Europe and Asia, and what was going to happen.

00: 01: 46: 23 I was particularly concerned because I believed during summer and fall of 1944, the Germans would start using atomic weapons on Britain. Because we could see no other reason for the great effort they had a spent in V2. V1 perhaps was not so expensive, but V2 was very expensive. And it was clear that it would not pay, unless it had nuclear warhead. Which case, just as today it would have been a disaster, because it could reach right across the land and sea from France to London quite easily. And when it blew up there, it just took out a block, that was not worth the cost. But if it blew up there and took out ten square miles it would be worth the cost, it would probably knock Britain out of the war. Exactly at the time when the invasion was being supported and so on. So we're very concerned, it turned out that was wrong, the Germans were in no position at all to do that. But I didn't know that I believed just the contrary. As I was an old radio amateur, I had a short wave set, which really was not very common, but I had one. I kept it tuned to London frequency. Whenever I got up I turned it on, when I came home for lunch, when I came home for dinner and so on, just to turn it on and make sure the station was there and turn it right off again. I didn't care about the program, I wanted to know was London still operating at that second. Because I had expected there would be quiet at some point, and then we would hear.

--- P. Morrison Antonello: When did you start doing Intelligence work?

00: 03: 28: 10 That's correct, somewhat before that. Yes, it must have been first six months or s that I was on the project, maybe it was later, I'm a little mixed up now. I got the idea, I was so worried about the Germans, and I looked in all our literature, and we discovered we knew nothing about them, we said nothing they were doing in the classified library. So I said to myself, surely we can find something out and I preceded to imagine thing that we ought to do. Which it does take work to do. LIke read the literature and talk to people and look at maps, and lists, and photographs and so on. And I wrote a long letter to that effect, to General Groves. And it happened by chance, that another young physicist, actually a physical chemist in NY, whom I didn't know at all, never heard of. But in a very similar week, he wrote a very similar letter, to General Groves. And this coincided with Groves' own concern and so Groves acted. And he set in motion a big intelligence effort, to do what is called, positive intelligence against the Germans.

00: 04: 37: 17 Up till then Groves' concern and major concern was negative intelligence, keeping the Germans from finding out about us. But now the question is can we find out something about the Germans. And I took some part in that and went to Washington quite frequently, I saw many documents and many photographs, and talked to many people, some directly from Europe, some more technical people who just had photographic and mineral surveys and thing like that. And the whole variety of things, was there any sign of a German mining effort? Purification effort, building a reactor on some river as we had a reactor on the Kwambia(?) River, and so on? We made all kinds of pretty outlandish and expensive schemes to try to find that out.

--- P. Morrison Antonello: Were you doing Intelligence work full time?

00: 05: 38: 22 No, not full time, I always did my work at my desk, but then in the evening or on the weekend I would think it doesn't take much to do intelligence work at a planning level. I didn't go out in the field an talk to the prisoners of war.
But I would sit down and say, We must talk to the prisoners of war, get all the ones who have served in chemical laboratories. I would got to the library and make a list of the twenty biggest firms in Germany, who might be involved.
And I would send that in, that kind of thing, and then we'd go to the organization and do that. And after that we just go and listen to what they are doing and try to advise them.

--- P. Morrison Antonello: Did you have any success in this work?

00: 06: 13: 16 At the time, we thought so. But I think now not. Intelligence is extremely self delusion, that's its main issue. Because in a complex situation like that you get all kinds of news, some bad some good, some true some false. You can't tell the truth from the false, you don't know and therefore, what you tend to do and we did, was to assume the worst case as we say, if you say, well the good news is true and the bad news is false, then you do nothing. That's dangerous, we felt. Let's assume the bad news is true and the good news is false, then you have a very different position. When some sort of balancing in between, we say well maybe it is more dangerous to neglect the possibility the Germans are acting. Than it is assume the possibility they're acting and do too much, so I'm afraid we erred on that side.

00: 07: 11: 08 We always made the mistake, of overestimating their progress.
And we had all kinds of things defeated, amazing, not at this date. But later on say by late 1944, we had many tens of thousands of German officers, were prisoners. Many trained engineers, architects, pilots and so on, at that time we got fantastic information. For example, I have read an account, six months before any explosion or eight months before any explosion, of a man, an airplane pilot, who was flying over (? ?); in some routine operation, and saw a mushroom cloud rise from thesurface, huge mushroom cloud glowing violent and he said that must have been an explosion of an atomic bomb. That was before any atomic bomb was ever exploded. He just guessed what it would look like, he knew more about it than I did. Surmised more, and of course, already toward the rest. He never saw such an explosion, of course it's now true, high explosives also make mushrooms. You just have to exaggerate a little bit, and that's very easy to do. He was sitting in some French

prison camp, very boring, every day as he kept this going, some nice officer would come talk to him in German, and sit him down and give him cigarettes and he'd sit in a pleasant, quiet office for a few hours. And he would tell these titles, well of course he told, the more you ask, the more he told.

--- P. Morrison Antonello: During this period you also learned something about Intelligence?

00: 08: 46: 22 Yes I did, I learned a good deal about it I think. And I acquired a feeling that it is very unsatisfactory way of working. I would not trust it as a guide to policy of any kind and never since done so. Because they say it is this terrible problem, noise and sigma are the same. You can't tell them apart. So how can you judge what to believe? You have to believe, you believe what satisfies your preconceptions or I'm afraid for the professionals , the preconceptions of their bosses, whom they wish to please.
It's very easy to get into that position.

--- P. Morrison Antonello: Was it an Intellectual challange?

00: 09: 28: 20 Yes, it was a heavy intellectual challenge, can we penetrate this, it isn't important. Well the success of this kind of fiction, shows how many people have this feeling, it's very easy to have this feeling. And of course many ingenious things are done in this purpose. We do so me strange things ourselves, they're not that ....
We did improbable things.
We tried to get airplanes to fly low over the cold rivers of Germany and Austria, dragging wicks of cotton along the river to get a sample of the river water. I don't think it ever worked, but if we could get a good sample we could then detect the presence of a nuclear reactor anywhere for hundreds of miles upstream. We practiced in Washington state on the Columbia River downstream, two hundred miles. We could detect the presence of the Hanford reactor.
1944-45..just before

--- P. Morrison Antonello: Were there political discussions at Los Alamos about building this new weapon?

00: 10: 59: 14 Well we did , but on the whole we perhaps might have had more. We were enormously impressed by the fact that our responsibility was to find a wooded work.
And that was what we had to do, the leadership had to decide how to make it work, how to use it. But they depended on us, and nobody else to find out if it could be made to work or impossible. The favorite invasion of the Los Alamos physicist from this issue, was to raise the question that maybe it can't be done. Some unknown property of the nuclei would prevent it. But you can't know that until you try to measure those properties, which step by step, one after another gate appeared open, but any gate could have closed us away from it an that was our main feeling.

00: 11: 44: 23 Then in the spring of '45, things were different. When the German war came to an end, then everything was quite different. Because we no longer had this fear of preemption. Nobody believed the Japanese would preempt us on the bomb. Most people believed the Germans had a good chance of doing so, until the last days. Clearly for me

until Dec-Jan of 44-45, when we captured some of the good Nazi physicists, and looked at their notebooks and diaries and all those things. And it was clear they were not going to be anywhere near completion.
And unless we had the wrong people, we could see they were doing nothing, and important. They were spending twenty million dollars whereas we had spent two thousand million dollars, ... you couldn't do it on that scale. They were smart, but they didn't get very far. And we were so sure that we had people who were close enough to being the center of competence and also trustworthy for the Nazis, that we couldn't be far wrong in what we knew what was going on. So that began to change our views, and by January, maybe I would no longer believe they would be a German bomb. I wasn't too sure there'd be an American either at that point. But then when the war came to an end in Europe, by that time we were heavily engaged in the last organization of the test of the first bomb and our whole concern was, will it work.

00: 13: 24: 12 Oppenheimer, and Boer, especially had given us a point of view towards the whole thing was our responsibility to see will it work and the responsibility of the government, in which we trusted, was to use it as wisely as possible if it did work. And the most important thing was to make sure that the war did not come to an end with the bomb still secret. Still unresolved and still secret, because that would make the construction of the peace very, very difficult.

00: 13: 54: 15 Because all the diplomats and all the generals would slowly learn about this possibility, after all, all over the world people were doing it. But the people would not be told and masses of the people, the public would not understand what was going on. A secret arms race would be worse than the one we had. And that was Boer's main point, so we felt organizing a test was the most important thing. Of course, didn't ' think far enough to see that the test would not only be a secret test but also would be a test on the Japanese cities.
I don't know if we imagined that would happen, we thought probably it would, I think we have to say that.

00: 14: 38: 04 From our point of view the cities were being burned every day and it was just one more. The difference is not so much on the ground than as in the air, as I constantly tell people. If your house is hit by firebomb, and your family is burned up, it's about the same as if your house is knocked over by a distant blast from an atomic bomb and your family is burned up, which is the principle cause of death in both cases. But the difference is in the incendiary it takes a thousand big bombers, and that's all there are in the world.
In the case of the A bomb it just takes one. So it's a thousand times cheaper, roughly. Say a hundred times cheaper, and that makes the difference. And that's what happened, statesmen have never come to realize that maybe just recently now, that war destruction is a hundred times cheaper, a hundred times easier. They prepare with the same vigor as though it were the same price as 1945. And that's why they threaten us with hundred time more disaster. That's the simplest explanation I can give. And it became rather clear to us even in that summer.

--- P. Morrison Antonello: After the German defeat did your personal position change?

00: 16: 02: 01 No, probably it should have, but it didn't. As I say, we no longer thought it would be anticipated, but we still felt that nobody knows if the bomb will work, and the bomb remains an untried

secret. And that was the thing we were trying to get to end of. For Los Alomos project, the climax was not the attack on Japan, the climax was the test in New Mexico for most of the people on the project. That was what they did, they made that test. They found how and they succeeded in making a nuclear explosion, the first one ever.
And they found out in fact it was relatively easy. And then that was the end of their work, not the end of my work.

00: 16: 47: 01 I actually went on to take part in the use of the bomb in Japan. I went out to the islands, I flew out and so on. But that was only a small number of people, maybe 50 people in all from Los Alamos. And I did that mainly because I realized at one point that I was in a position to be a witness to the entire process, I thought that would be interesting and valuable in the future. From the very beginning right to the end, and not many people could do that. Because the way I had gone first through Chicago, and then to Los Alamos, and then got into the making of the center of the bomb and so on. It was clear that I could easily do that, and that I should do that as one person to, so to speak, experience the entire process.

--- P. Morrison Antonello: When did you fly to Hiroshima?

00: 17: 39: 10 Twenty eight or twenty seven days after something like that early in September. Of course it was all but incredulous, see we've seen on the flight, we saw many Japanese cities burned from the air. That was the great thing, it always looked the same, we saw this enormous disk of red rust, that was the characteristic result of the fire. All the roofs were broken, all the Japanese cities were all grey and green from the air. Grey tiled roofs and green trees and gardens. And then hear even the very closely packed, it still has the color. But then here it would be a very bright red spot, it was true in Tokyo, it was true in Mangoya, that was true in many places. Because the fire had taken the whole city and burnt that down, and left this oxidized iron rubblle, rust red, over the whole of the center of the city.
And Hiroshima looked exactly the same. But one airplane, not a thousand airplanes or as in Tokyo several thousand, but one. And that was when it became very clear to us. At that point we didn't quite appreciate the entire human side of being there on the ground, which I came to be after I was in Hiroshima for a while. I was only there a few days.

--- P. Morrison Antonello: Were you already aware of the presence of radiation?

00: 19: 08: 23 Oh yes, we were to a degree. I think where our numbers were a bit optimistic, but not a great deal. See it's still true that most of the people who died of Hiroshoma, even to this very day, of course every body will die eventually, but say ascribable to the attack, most of them 80-90 percent died from fire and blast, and not from radiation. The Hiroshima bomb set a fire storm, like Dresden, like Tokyo. And that' why it had such tremendous damage on the city.

--- P. Morrison Antonello: How did you feel on the ground at Hiroshima?

00: 20: 03: 11 Well, even from the first time I saw Tokyo, my feeling was clear, that war is definitely not tolerable anymore, because it's barely tolerable when you just have firebombs. We saw the Japanese destroyed, when you multiply that by a hundred or a thousandfold, we

understood that you were not going to be able to do it anymore. And then it was worthwhile to tell that story, and that was why I had come there and saw and I commented on that , we said at the very beginning by August, late August, we were already saying, there was no solution but some kind of agreement to prevent the use of these bombs.

--- P. Morrison Antonello: Why do you believe the bomb was dropped? Since Germany was already defeated. Why were two bombs dropped?

00: 21: 16: 05 Well, of course, you can discuss this question in great length, I can hardly answer it in a moment. We know exactly the origin of that idea, we know its validity the people though it had. It's not very important, it shows how when you're in this set of mind you do things you might regret if you looked at it more broadly. A certain Admiral Purnell invented that, he said, he was in the appropriate committee, they said what we'll do, we'll drop one bomb, no he said you should from the beginning plan to drop two. If you drop just one the Japanese may think there are just only one, they'll endure that, it took five years to make one. It will take five years to make the next one and so on. So dropping two at least shaped that point of view.

00: 22: 02: 03 It is also true and that's all these decisions happened because many interests coincide, more or less by chance, about a single decision.
For example, there are two kinds of bombs, they're absolutely different construction and different materials.
And so to use them both is part of the purpose of several technical and military groups inside the project, as well as Admiral Purnell's proposal that two will make the Japanese feel it's an uncertain number coming, and not just one. One and then cessation would not do that. I myself argued quite strongly in the little committee I was in, I was not responsible, I was technical advisor to the committee, which discussed targeting. And I said, look you must make a warning, that's the most interesting and important thing to do. To tell people, a new kind of warfare, one bomb one city, and they said no you can't do that. If you do that said the military pilots to me, "I'm flying the airplane, you're not. It's very dangerous. You say there just one bomb in one airplane, they'll look for every airplane. They see a lonely airplane, they won't attack it. It would be very difficult." Well I didn't know enough about the situation to rejoin, but I know now that was not a very good argument. First place, it's an unimportant point compared to the major questions involved. second place, none of our aircraft in my group that I was connected with, the 509th group, flew thirty planes, B29's over Japan repeatedly, practicing. Only once with the bomb, but repeatedly otherwise with ordinary bombs. And they never once received any damage from any Japanese source. Though they flew in big raids and small raids, in day and night, every which way. The Japanese had almost no resistance left.

--- P. Morrison Antonello: Do you believe the reasonings was that since two bombs were built they both nedded to be tested on human beings?

00: 24: 16: 12 No, I don't think that's the case. You say two bombs, but in fact we had a schedule. I went out there and my schedule was to stay out there for six months. And then I was to come back home, and my partner who shared my group would go out for six months. Our plan was a one year, we planned one year of dropping bombs, at a certain rate. Not everyday, but certainly every month or a few a month with a big one

every once in a while. That was our plan, it was perhaps naive but that was the view we had. We were continuing the war, we didn't see it as any different. The air force had been doing just that, they'd been dropping ... they made... I think they dropped a couple of hundred thousand tons of bombs during the summer, and they would go ahead and do the same thing. We would add the same equivalent more, with our infrequent bombs once in a while, we would double it. Now they're running out of targets, we didn't know that at the time. When I made these plans, I was sitting in New Mexico, I had no idea what the war was like in Japan. I was just told, plan for a year. I don't know if I thought it would last a year, but we didn't know.

--- P. Morrison Antonello: Can you say something about the huge escaltion that started with strategic bombing?

00: 25: 49: 17 I think that's the case, I think that strategic bombing, was born as an idea in the first world war. Where US and English aviation people had a solution to the WW1 problem, which as I understand it, you send all the young men in Europe to one place in Belgium or France, year after year nothing happens.
It just moves back and forth a little bit, and you immolate an entire class of people in the trenches. And everybody in Europe tried to think of some other way to make war that would be different from that. And the airplane people said, we fly over it and we attack it before it gets on the ground. It's much opener, it'll quickly end the war.
There'll be no great production of guns, year after year. It maybe bad for the first month but that's the end. That was their view, and they invented that.

00: 26: 41: 05 And in Japan they had, the first time, they had an ideal case. In Germany it didn't work very well. Because the cost of the bombardment was as great as the cost of the damage they inflicted, maybe more. THey took civilians and got them out of their houses and killed maybe half a million people. But they killed 50 or 75 thousand English, mostly and American airmen. Each of those men was trained and had an expensive airplane and everything else. So you can say, and the whole industry was busy producing those bombers to be burned up over Germany. So people analyzed that, so you could hardly tell who was ahead. But in Japan, it's true, we built all those things, but they worked so to speak perfectly. The air force was triumphant. They never had any damage, and they burnt down all the cities one after another without opposition.
And then they had the atomic bomb on top.

00: 27: 43: 18 And the atomic bomb was the answer, the strategic bombardment theory had been looking for. When they talked about it in WW1, they were talking about raids. They dropped in WW1, the American forces dropped only pounds of bombs on the enemy. They talked about it as 60 thousand pounds or 80 thousand pounds, not tons. They had to talk about pounds to make the numbers larger. Right? They had no means, they had the aircraft, pine and canvas aircraft, just can't do it. And then even in Germany it didn't work, on Europe. And in Japan it was working. And then when the atomic bomb came, it seemed to be the apocalypse. And that era, I think, which was enormously powerful in American strategic thinking, dominated from 1945-70 or 75, when it became clear it was not a one sided proposition. And if you did that the other guys did..we never worry about the Japanese bombing Los Angeles. Had we worried about that, we would not have been in that frame of mind, it makes a big difference.

--- P.Morrison Antonello: Do you think the decision was also made because they were japs?

00: 29: 04: 15 I think that public support for it, had that quality, and I can't say I don't know. I don't think that Roosevelt and Stimpson had that view at all. I don't know about Mr. Truman, I'm not sure. But I think Roosevelt planned the whole thing, and Stimpson actually carried it through. And I think he would have rejected very much that approach. But maybe subconsciously he would have recognized that the American people had more anymosity towards the Japanese, partly on old ground having to do with racist attitude. And partly on newer ground having to do with the terrible hostilities in the beginning of the war. And the Bataan march and all those things.

00: 30: 00: 19 There's no question that the behavior or Japanese fighting men and civilians during WW2, made an enormous impact on the American mind. They told us repeatedly in Saipan, which was just next to the island from which the bomb was launched, that thousands of Japanese civilians committed suicide rather than surrender at the end of the attack on Saipan. And that's true, I've spoken to eyewitnesses of that, men and women would go to the edge of the cliff and jump into the sea. No firing, no anything, that's what they would do rather than surrendering. Every kind of method was made to convince them that they would not be mistreated, I don't say be made to be happy, but they would not be mistreated, they would not be tortured, they would not be shot, they', be given food and house until they could be sent back to Japan. And there were some in that condition, but war's a terrifying institution on every side, and I'm not able to judge how sift out the motives. I'm sure that played a role. But it certainly didn't play a role among the physicists on the project not at all.

35A 00: 00: 52: 00 The most conspicuous names and personalities that are associated with the development of the bomb, are a and handful of physicists for the most part. We think of Ferme, Oppenheimer, Compton, Boer and so on, and they played an important role, you could not deny that. But it's a very mistaken view of the entire project. It's not centered in a little esoteric group of people on top of a mountain, in New Mexico. They have some overplay, it is even indispensable , but it's only part of the drama, which as you know is, a gigantic enterprise with a couple of hundred thousand people working on it.

00: 01: 32: 02 Before WW2, the physicist, and chemists used to separate isotopes. It was very interesting to separate isotopes, each isotope has a different nuclear physics property, even some inseparable Perhaps the biggest plant would consist of fifty glass tubes along some laboratory bench, with a graduate student, and a laboratory technician, and a professor attending them. And they would work for six months and make a little tiny sample. And the isotope separation plant at Oakridge, one of three different ones, completely different principle but just like to describe only one. Consisted of fifty-five wings, each one of which, was like a normal oil refinery in complexity, number of pipes, number of pumps, smokestacks and cracking towers and all that sort of thing. One after another lined up for a mile, each building a couple of a hundred feet wide, and a whole U oing around.
And the technicians would ride bicycles from one end of this place to another, doing exactly the same thing as had been done, say, three or four years before in New York, Berlin or in some other laboratory. By a few people with glass tubes as a model. It's just an enormous

difference, it just became a huge industrial effort. And of course, many engineers, technicians, workmen involved in that far outside the view of a physicist. You could explain it in money, but money, we don't think of money wild enough. The project cost two billion, two thousand million dollars. And in those days you had a physicist working for a year easily for five thousand dollars. It would be like twenty billion dollars today, which is a big industry. Like the Apollo Project, like going to the moon. All carried out in wartime, inside of a three year time.

--- P. Morrison Antonello: Did this project change the relationship between science and technology?

00: 03: 38: 17 No, I think it started in the first world war. I think the same thing happened then, but it happened to the chemical industry. And in WW2, it happened to the electrical and nuclear industries. Microwave radar, electronics, automatic computation, automatic control and nuclear energy, those are the technologies that came out of the second world war.
They're somewhat different, perhaps somewhat more expansive than the chemical, but not even sure of that. You see, we don't remember in 1915, the first year of WW1, the US was still neutral. You couldn't buy commonplace dye-stuff and drugs like saccharine or indigo in the US. They were all made in Germany or Britain. There was no American chemical industry on that scale to do fine chemical operation. And there was a famous occasion, the British had a blockade, so the Germans sent a submarine to the US, full of dye stuffs and pharmaceuticals. Which sold tremendously in 1915 and the outcome of that was the great American chemical industries.

00: 04: 53: 00 All the Standard Oils and Duponts went into the business not just for fertilizer, gasoline, but also the many, many chemicals that make up the modern product, the chemical industry. Then finally becoming the plastics industry and all those things. And that was the change that WW1 brought about. WW2, I think wasn't new in kind, perhaps it was new in degree and its impact was wider. And ever since then, as you say, the largest developments especially military developments, of the post WW2 were all foreshadowed inside WW2. The only change, a very important one, was the transistor, solid state electronics, which came about 1948, 1949. But if you think of it, computing which was digital but was in vacuum tubes, automatic control, that means feedback and all that sort of thing, radar, tiny electronics, they made electronic radio transmitters that fit into aircraft shells(anti-aircraft shells, tiny little ones). The beginning of miniaturization of that kind and then finally nuclear energy and nuclear weapons. All of those ambulistic missiles and cruise missiles, both had been pioneered by the Germans in 1945.

00: 06: 18: 04 What I was saying before is not totally wrong, it's just an error. The Germans did pioneer two very powerful weapons, but they were too early
They were too late in getting them and it was too early in the development of the weapons to make them decisive. Had they pioneered the atomic bomb, with the same energy they put into V1 and V2, they might have won, it's a possibility.
They could deliver those by airplane, but now of course, V2 and V1 turned into a hundred different missiles, are the main armaments of the great powers and even the lesser powers throughout the world. Both of them pioneered then by the Germans and improved with all the solid state

electronics and better circuitry and better radar, and all those things which we now have. But the ideas is inherent, isn't it?

--- P. Morrison Antonello: Did the relationship between science and the industrial military complex change during WWII?

00: 07: 29: 12 It changed for the physicists, but it had already changed for the chemists. I would say, that's the thing that was very clear to me. When I grew up I recognized that chemists were not like physicists. Most of them worked in industry not universities. Some worked in the university, yes, but they were not primarily there. They were much more conservative, much more related to industry, to business, to finance and so on. The chemical society was very much larger than the physical society, it had lots of interest in manufacturing. No physicist cared much about that at all, there were very few. Very few laboratories in industry, very few people working in industry. Physics was primarily university centered with some government concern. And chemistry was not like that at all. It was much bigger and much more related to everyday economic life. And that was clear to me as a physicist, one reason I like to be a physicist and not a chemist. But by 1950's, physics was in much the same relationship as chemistry had been before, but I don't think it was a brand new phenomenon, it was a shift. From one sector to the other...

--- P. Morrison Antonello: What about the creation of BIG SCIENCE..and the relationship between the govt, industry and the university? ?

00: 09: 34: 07 The description they give is correct, but the cause is wrong.I don't think it's so. There was big physics before the war. I was in it, that was Berkeley, it was very small part of physics. But it was very interesting, has the same look after the war. Of course, it enlarged, everything is enlarged. In particular, the military industrial, the university complex, what ever you want to call it, did become much more important. And the government did engage in more support of science. And they spread their support, away from the most programatic into a broader look, and all those things. That did happen, but I think it was already embryonic after the first world war and it was in the cards, it was going to come. You know, what I was saying when I was a student, I defend myself from my critical friends, who said, your work is not relevant, it's not of human importance. And of course the students in the seventies raised the slogan of relevance. But I thought they were quite wrong.

00: 10: 39: 24 The trouble with physics, is it became all too relevant. It's not that it wasn't relevant, it was the most relevant thing there was. It made possible the computer and digital industry, the automatic weapons, all those things.
And so of course it's relevant. It's still among the most important industry, the semi-conductor(?) industry, the computer industry, these came right out of the physics laboratories. And then pretty soon they set themselves free there. Now it developed better in the big firms than they are in the laboratories, probably.

--- P. Morrison Antonello: What is the relationship between war and technology? Does war bring innovation?

00: 11: 50: 01 again I have a slightly paradoxical view of this. I think war brings development, more than innovation. We have a common proverb

which says, "necessity is the mother of invention." I think this is absolutely false. The reason we have that proverb is, people who talk that way, think that it's an invention to place a book under the window, to keep it open when it slips and doesn't fall. That's the kind of invention they're thinking of. A stroke of ingenuity, taking some simple device and turning it to another purpose. That's a modelled invention, but it's a very poor model of important inventions. Take a really old one like the invention of iron, you imagine the king who said, "I have a bronze sword that doesn't work very well, it doesn't get very sharp. I cut off somebody's head and it becomes dull. Couldn't you go out and make me a sword of iron? Or some other material which will be much sharper and better? Do you think the king ever said that? Of course he never said that, he hadn't heard the idea of iron. He knew nothing about that.
He knew of no possibilities, save stone and bronze.And bronze is much better than stone.And he was content. How was iron discovered? First as beads, little beads, little shiny beads, a strange new thing that appeared in somebody's fire, some workman's fire. And then they worked and they made bigger beads, they began to hammer them and they thought maybe this is a stronger material. But first it was decorative. It came first out of as more playful element, then out of necessity. Because necessity is great when you see how to solve the problem. When you begin the problem, you don't see the solution. It's naive to think you see the solution when you recognize the problem, for most things you don't. For microwave radar they did, for nuclear weapons they did, that gave the people (?), but those aren't the biggest inventions.

00: 13: 54: 14 Things like fire and iron, and hydro- carbons, and all these big subjects. Didn't develop in five years time, they developed in centuries. And even now a days, in decades. The transistor, it's true, since the war, the conscious effort of big groups, firms, and nations to make technical innovation. Has changed that relationship somewhat, that was true before the war, but not so much. It became much truer. And when Bell Labs made the transistor, they knew it would be important for the telephone company.
But it still wasn't the necessity that led to it. It was the chance of fooling around with solid matter. You could make something like a vacuum tube. And then you said, "my goodness, maybe we can make things like vacuum cleaners that are much smaller." And even then it took them ten years to get to that idea. Yes, and in country also because of radar. Well I think I always believed that a scientist had a social responsibility. But what it is is a little hard to define, there's no record here.....

00: 15: 13: 21 I think it's clear science has a social responsibility. I think that the innovations science makes have an obscure but eventual impact on society. And the scientist is, especially in Democracy, is bound to try to explain and foresee, and talk about regulations and all those things to do that. And I don't see any way out of it. But I don't think the scientist will solve this problem themselves, I think that it's absolute wishful thinking on the part of the population. These ideas are usually not so individual as you think. Fission's in the wind, after all. If it had not been Han and Strassman, if it had not been for the war, fires(?) might have been found anyhow. There are half a dozen people who almost found it. That's quite characteristic of these discoveries.

00: 16: 10: 08 The technique and the ideas, they're lying there ready to be picked up, and somebody picks them up. Of course that always appears by accident, but indeed on the table there they are, and a few years

later, some other person in quite different ways would have done it. So I think we could not avoid fission. The bad luck is that it came in wartime. When the governments put all that money into it and collected all these people together. Where the physicists would be recruited to do it, they were in mortal fear of conquest, the outcome of the war. And that's what was the difference.

00: 16: 43: 03 But I don't think that war makes for rapid innovation, I think it makes for development, yes. And I think in the present world the conscious intention of firms and nations to make that innovation, has made a big change. That's the biggest change in the world. And that is going to be here for a long time to come. Now what it means is not perfectly clear, because they don't always succeed.
That's the biggest lesson. You have to gamble with these matters, you can't foretell the future. You can't solve a problem , as I said necessity is not the mother of invention, it's the mother of development. Invention comes from chance and play, and imagination and those things, it's very much harder to plan. And I think everybody who has tried to do it will agree with that.

--- P. Morrison Antonello: What is your idea of progress?

00: 17: 45: 23 Well I think the idea of progress is clear in this, that the species has become enormously more abundant in the last twenty or thirty thousand years. And it's going on very rapidly. And that means we impact on the world very heavily, whereas, we didn't before. And that is no question, that is the most objective part of progress. That says nothing about the values or the worth of the individual, whatever, none of those things, I'm talking, most in the coolest possible way. There are so many people. They do so many different things.
And their aggragate activity is such an important part, not yet a major part but an important part of the cycles, the physical cycles of the world. That we are different from what we were when we were small groups and that's the main thing we have to try to understand. I think we're not going to go back on that, I doubt it. The population will not go back down to, I hope, down to one million. It might go to half, but will not go down to factor of a thousand, five thousand. And therefore, we have to find out how to live in a world where we are so numerous and so, making such impact on the world. We can do that, it's not even very difficult, but we have to solve all the problem of national rivalry. And I think that is being solved today, at least hope solving it is on the horizon, as it was not five years ago.

--- P. Morrison Antonello: Can you talk about the difference in time from the Industrial Revolution until today...the electronic revolution?

00: 20: 31: 05 I think the most important development in the formation for thought, of human thought, on a large scale anyhow, maybe not individual great figures, but as for the climate of culture, is probably in the moving image. Which means film and video and whatever else will come. And they have this curious property that they simulate time, but they don't represent time. Perhaps the first time, the first occasion when this was encountered, is worth mentioning because it is very different but you'll see how it works. If I read a book, even earlier, if I listen to someone tell me a story, I'm reliving his experiences at a different time. But I dont think that I'm watching what he does. A man comes and says, " yes I went fishing and caught a fish this big." Well, I sympathize, I'm interested, perhaps he tells me

details, but I don't have the illusion that I'm watching him pull that fish out of the water and so on. Right? Because it is done symbolically, through words and gestures and whatever. But when you look at this television, you think you are seeing the running out of an event as though you were sitting in the room, watching this happen. But you know very well this is not the way this is done. It's clipped together, it has many times, it appears seamless, but it is not seamless, and yet it's impossible to get over the illusion, that what you see on the screen, especially, since you see so many real things on the screen, but everything you see on the screen is also real in time, and it's not.

00: 22: 15: 15 Theater was also a break with that. You go to the theater, you watch the people on the stage, you imagine you're watching a room and the people are fighting in that room, whatever, but you know it is illusory.. The (? ? ?) is there, the people are actors, but on television you don't know that. The news looks to you exactly like the simulated news. And it is so abundant that's the other story, I can only go to the theater with great luck, very hard for me doing it every evening for a week, it's very difficult, there's not that many plays. But in my home I have seventy-two channels of television. Mostly working sixteen hours a day. It's many lifetimes I could live in this vicarious way, that images go by looking as though they are real. And they are not. And I think this is something we do not understand, I don't understand it. I made television, I tried to pay attention to it, and it's extremely important, the nature's important, what will the outcome of all of this, I'm not prepared to say. I think that's the most important element of time, the illusory time that goes by on video image or film image, is the most important change in what we think of as human experience in time, that has ever happened. Because we now live another life in front of that screen.

--- P. Morrison Antonello: What are the social implications of TV?

00: 23: 48: 19 ....I'm in a quandary. But I believe it's extremely important. I believe the present world is dominated by this view of what goes on the screen. How to get out of that, whether it will last, whether other things will take its place. I don't know those answers, but I think it has to be addressed by every thoughtful person. You know, when writing was made popular, Plato wrote about it. Writing was old in his time was five thousand years old, so he never saw that.
But it was new enough so you could imagine the time when the Greeks didn't know how to write. Which was not that long before. He imagined it and he has a whole discussion, where he says, well, when you have writing people and reading, people will read, don't appear to be wise when they're not wise at all, because they repeat the wise opinions of others. And he felt that was pretty bad. Now you can see it's a kind of a parallel.

00: 24: 53: 02 But the trouble with television is not just the opinion of others that are repeated, it's the experience that is repeated or simulated. And it's reality, its impact is very great. You know the famous phenomenon called the docudrama, where they take real names and real events and reenact them , in front of a television. Usually in such a way they appear to some degree real. That's more important than reading a book, from many people that see it.
The history book, the letters will not be as convincing, they're just symbols on a page. But these things move in front of you and you think you're seeing the continual, but you're not. You're seeing something

that was cut together, pasted and arranged, had a different cause and a different effect, not atall what you see. And when many people have that repeatedly, and that's what television guarantees.
Most of the population has such experience and they have it not just once a week, once a month, but all the time. I think that the world is changing more than it changed with writing and more than it changed with print, and we just don't know what's going to come out of it.

00: 26: 28: 14 Even what they see, how selective it is. And the thing is, it produces this false experience. It produces another time.
You startled me by saying, it's not real time, it's true, television is only rarely in real time. But it makes a special real time for me, and I can't get back over that. I still think in my mind, I've seen that thing happen. But I've not seen it happen, I've seen the screen, I watched some images happen and maybe or maybe not, those images directly connected to the event. That's what I have to think out, that whole channel. When I read a book it doesn't impress me that way at all, the man says something, it might be true, but it's only words, it's only ink. It doesn't live in front of me. I have to be much more active to make meaning out of it, and television, I don't even get the chance to slow it down, to ask it questions, to make it repeat. I'm at the mercy of the producers.