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63A

00:14:48:23
Antonello: Can you tell me what technology is all about? Come on let's talk about what we have been discussing.

Technology is an idea. And nothing more than idea. Uh.. it's an invention of very recent vintage, a few centuries. The term wasn't used the way we use it now until the middle of the nineteenth century. And it was invented in its modern usage to mean the unification of Science and the Arts. And to some extent that's useful. But the way technology has come to be used, is as the subject of sentences of historical causation. Technology brings about freedom, technology makes people happy, technology causes changes in social relations. That is just an idea, it's a fiction. And I've spent a lot of time trying to figure out exactly what technology is, in the concrete. and I've looked at it as knowledge; I've looked at it as skills, techniques, books, things, artifacts. But the term doesn't make any sense unless you also talk about people. That is, knowledge , skills , techniques don't exist anywhere; they're just in people. Things that are made don't just come out of the sky, they're made by people. So when we talk about technology, what I would suggest, is that we talk about people; in that way we can give technology a historical, an accurate historical meaning and also a name, an address and perhaps a telephone number. So we can find it when we need it. On the other hand, technology is a useful abstraction. Useful if you want people to forget about people. To forget about the role that people play in shaping they're own lives and shaping other peoples' lives. Technology, in that way, in that form is one of the most pervasive forms of mystification that we now have. So, I don't know if that helps you; I warned you it would be abstract.

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David Noble

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Antonello: Let's try to say something about the difference in what is called now technology..last century and this century.

NOBLE
Well let's just say this whenever someone says to me, starts talking about
technology, as a subject of a sentence, because of changes in technology we blah blah blah. I always try to get them to make it concrete and also, not personify technology, but make it clear who they're talking about. Who brought this

particular device into being, who is using it, who is ug, ug being
used by it and that helps somewhat. And what I have done in my work is I've tried to identify people, like engineers who have identified themselves as this abstraction technology. We are technology, we are the revolution. Revolution is an abstraction, technology is an abstraction. Identifying with
it gives momentum and legitimacy, legitimacy to your notion of
historical destiny. And you say, Why are you doing that? And they say, look it's not me; it's technology. Why are you doing that, it's not me; it's history. Used to be called God. That's the kind of concept we're talking about. And just as a few centuries ago people tried to de-mystify God, and concentrate on human beings making their own history. We have to do the same thing with this version of divinity, no that's technology or science, the two are often used inter-changeably.

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David Noble

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Antonello: OK so in this case let's try to talk a little bit about machine tool in the last century and how the machine tool and the people who have been using the machine tool effects the change in society. Can you put it in this way?

NOBLE

Well, I'd rather do it another way, and that is look at how..... as I said before, to try and confertize technology by making it, translating it into human terms. The engineers identify themselves as technology and we can identify the engineers. Not everyone is an engineer, it's a finite number of people. And we say they are technology, what they do is technology. And then we say who are they, where do they live , who do they work for? Up until the end of the nineteenth century, there weren't any engineers. I mean, there were military engineers, but they weren't professional engineers, identified as such. It was a relatively new breed of person identified with abstraction technology. Another historical force appeared, in addition to the engineers, which was the corporation. And the corporations identified themselves as technology. General Electric didn't say, we are producing electrical equipment, General Electric said, we are producing progress. GE is technological progress. Stand in the way of GE, you're not standing in the way of a particular firm, you're standing in the way of a historical force... Technology. The development of engineering professions and the development of the corporations went hand-in-hand. The engineers flocked to the companies and the companies also tried to corrall the engineers as a way of gaining control over haphazard scientific and technical discovery and invention. So starting, I would say, at the end of the nineteenth century it becomes easier to identify, in human terms, who technology is. And I've been trying to convince people that

we should maybe just jetison the word, okay, because it's no longer useful and it mystifies more than it explains. So when people say technology is changing I say, well who is it that's changing these things. We can actually identify who it is: which companies, why they're doing it, who in the companies, for what purposes, what interests. Another way of looking at the same phenomenon is to say technology is political, or technology is social, or technology is cultural. And it's an indication of how far we've gotten, in this mystification, that it's necessary to do that. That technology has been so lifted from it's moorings, has become such an abstraction, that now we have to somehow remind ourselves that it's a social phenomenon that is created by people because we forgot it.

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David Noble

00:24:09:16Þ
Antonello: So what about the social implication of the birth of the engineers. Of this switch of this birth of the engineer becoming himself technology.

NOBLE

Well if you look at the beginning of the nineteenth century as compared to the end, there's a noticeable decline in popular learning of science. Science was a religious phenomenon. from the sixteenth and seventeenth centuries people were trying to-it was a new liturgy-and also a new means of understanding God. And at different times in the United States, certainly in the beginning of the nineteenth century, a lot of people were getting into it, it was a popular obsession (Science, okay). In part for religious purposes, what science meant, is that you could learn about God without having to rely on the clergy and therefore fueled radical PROTESTANTISM, and reflected it also. It wasn't until the end of the nineteenth century that it was professionalized, that is, this... these new bodies of knowledge in scientific professions and also engineering professions. And what that meant is the people who knew about certain things, the people who embodied this force became fewer and fewer. And so, for the historian, it is actually easier to identify; so now when we say technology is and I say,well who are we talking about; I usually say, you mean we talked about my mother? No we're not talking about our mother, okay scratch my mother off the list, when we say technology. And we start scratching people off the list and we find out we scratch most people off the list and then there are only some peoples' names left on the list-so let's talk about them. What is their political agenda? And of course it's complex, there are many different political agendas within that realm, but we can actually be a little more specific, concrete, and make sense when we talk.

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David Noble

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Antonello: So let's talk about these people and the social implication from the point of view of the workers, the majority of the society. What about these people? The other people are decided, they are doing something
in technology.

NOBLE

It's a process like this... on one hand the companies which grew out of a haphazard development, um. ug I'll use the word scientific and technical discoveries, achievements (but haphazardly), reach a certain point where they try to consolidate their own position and to do that they had to get control over this haphazard process. And to do that, they didn't only have to get all the books in their libraries, they had to get the people into their firms. And through process of standardization and patent control and formalized research and also education, we're sitting in a prime example of an engineering school designed to specifications of industry; they corralled all of these people. Part of the habituation of these people had to do with their relationship with the rest of the society. The engineer was told you are a professional, you're not a worker, stay away from unions. The engineer was told you have technical problems to solve in which there are various parts or components and one of those components is people. If you design a machine you are also designing what a person is going to do. But you don't understand that person, as a person you understand that person as a unit of production, as part of an engineering problem. So what happened is all the engineering schools, all the education of engineering, is essentially management training. The way people are taught to perceive the rest of the world. They are not saying, "You by birthright are a member of royalty and therefore you can run society," because that was out, inheritance and dynastic monarchy, aristocracy. Instead they said, "You are Science. You are reason and therefore you know more and so you can design the world." And a lot of engineers believe that. They're wrong. But it's one way that they are seduced into doing what they're told. The reverse side of the engineers subservience to the firm, is his or her derivative power over those over whom the firm has power.

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David Noble

TAPE 64A

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NOBLE

What we're really talking about is the habits of thought of the engineer. The engineer believes that he is solving technical problems using the scientific wisdom that he has accumulated in school, in the techniques. And that the solution to these problems is for the species that he embodies the technical rationality and what he does will

help people. And I've taught in engineering schools most of my career and I'm convinced by the earnestness of the engineers that they really believe this. They might also be out for themselves in a way, like everyone might be out for themselves, in terms of getting a job and what have you. But they really believe what they do has a social benefit; it's a very important motivation. It's not their motivation that might have dire implications on other people, because they don't want to put anyone out of work, or otherwise hurt people. That's what makes the system work so well, okay, it does not need conscious participation, and this is on the part of scientists as well; they can believe that they are searching for the truth, and still end up contributing directly to mass murder. Not because they're murderers, engineers are habituated very early in engineering school, to think of technical problems as management would. For example, labor-saving technology: an engineer has a friend and decides for her birthday he will build a machine, and it's his girlfriend, and he decides that this is a very special event and loves her very much, so he's going to build this machine, to dedicate their relationship. He spends hours and hours in the basement of his house trying to perfect this machine, this is the most perfect machine he's ever built, drawing upon all the knowledge and skills at his call. Finally he finishes the thing, it's perfect, it works perfectly, he ties a ribbon around it, goes to the birthday party and gives it to his girlfriend. He says, "My darling, here's your Happy Birthday, this is the most perfect machine I've ever designed in my life. It is so perfect, it can be run by an idiot". She's very upset and she says to him, "You know I'm not an idiot, go back and do so it can be run by not an idiot". Then he goes back and he gets his schoolbooks, and he looks through them and he finds no clue on how to design something for not an idiot, because the best way to design a machine is to reduce as much as possible, the so-called labor input, to reduce as much as possible the cost of labor running that machine. To make it idiot-proof. That is what is a perfect machine and if he takes that machine and tries to sell it anywhere in the industry he'll be hailed as a genius. But when he tries to give it to his girlfriend as a gift, she reminds him, that the people running machines are not all idiots. Then he has to go back, figure out how to do it , hasn't got the slightest clue, and of course, the best suggestion anyone could give him is for him to try to design the machine for himself. And if engineers had to run machines for fifteen years, the machines that they design, there'd be a revolution in technology, in machine design over night. Now the anecdote illustrates this management orientation.. the perfect machine, the assumption that the machine is going to
be run by someone else first; the assumption is the machine is going to be run by someone who's knowledge, skills, creativity are beside the point, and in fact, a danger. To minimize this as much as possible any chance for unit error, which doesn't mean error by the engineer and his friends, but error by the people who run the machine. Even error as a very jaundiced view of human capability. And this is never anything that's thought out. The engineer doesn't say, "Okay I want to design this machine now, let's see, how shall I

design it? Who's going to be running it? Am I going to be running it?" It's understood,that's what an efficient design is. Reduces much as possible the labor, cost and the possibility of human intervention, on that level.
That is so inbred that it has to be articulated. So when that engineer
goes out into the world to design, no one has to tell him what to do. He understands that all he wants to do is build the best machines. And that's how the best machines are designed. I once told this other story, its not really true, but an engineer goes into a room full of people, I usually tell this to an audience and I say I've got a great scheme here for a technical system, socio-technical design for the production of widgets, and it's the best system in the world. One of the operating principles of the system is that everyone has to do what I say for as long as I say it; and people start (??????),"Oh come on, give us a break." And I say no look, I know...I know. Just trust me. This is the latest state-of-the-art,the latest components, I really understand this technology. If you would only just follow my instructions, it will work.
Now, depending upon who the
audience is, most audiences if I insist and start really getting a little dramatic about it, they'll usher me to the door, maybe offer me some help or maybe buy me a beer or something like that, because it's absurd. If I take that same design to a manager in a firm, he might hail it as a brilliant innovation, the same design. What's the difference?
Well, the manager in a firm can provide me the
context in which people will do what I say. That is, within all businesses is an authoritarian rule. The design becomes magically viable, in the authoritarian context. If I take it back into the other room and let's say, people convince me that I'm kind of crazy trying to tell everybody what to do, because I won't be able to tell everyone what to do because the power isn't there for me to get people to do what I say and they say the best way to do this is why don't we change this design a little and make a democratic design out of it. Much more difficult, multi-variable, but let's try and do that. We work real hard together, we come up with a different design, in which all the people in the room have some input into the way it's going to work. We'll call that the democratic design and I take that design to the manager in industry. And he kicks me out and he says, "What are you a saboteur?"

What are we talking about? We're talking about,
what is a viable design. A viable design is determined socially not technically. So, engineers are not stupid people, they design systems that assume authoritarian control. When they say we don't want any human error. Well who's going to control for it? Who's going to tell if you try to get into this system, we're going to fire you. You go into factories like GE factory I remember down in North Carolina another one ( Lockhead?), you go in there and if anyone was caught with the key to the cabinet, which had the program in it, they were fired on the spot. It's like having a xerox machine and it says it's run out of paper, you go to open it to put more paper in, you can't. That's pretty much

the analogy, and if you try to get in there, you're fired. The authoritarian control is internalized and engineers want their dreams to be realized. And the way their dreams are realized is simply, they are imposed on other people. How do I realize my dream? Situate myself in such a context where other people have to go along with it.
So there's a long round about way of saying, that engineers in the very way
they formulate technical solutions to problems, the very way they conceptualize the problems, presuppose this authoritarian stance, which fits them perfectly within a management structure.

Let me say one other thing, I once taught in the engineering school at M.I.T., we had a project which lasted
a half a year on the health and safety of distributing liquified natural gas, around New England. The assignment was to study all the regulatory agencies and how to make it most(the safest way)of distributing this.

Liquified natural gas is very volatile substance, it's shipped over from boats from Algeria. If the boats break, if a plane crashes into them, if they have an accident it would go to the air and disperse over the city and you'd have (...??) it would ignite, very volatile. So, this is a serious question facing Boston. So the students spent six months studying this, they divided up into teams to study every aspect of this. Turns out, that the boats come in through Everett(?), they unload the liquified natural gas into storage tanks and the tanks unload them into trucks . And then the trucks carry the stuff throughout New England, the students talked to everyone in the regulatory agencies.and the federal government, on state level, municipal level, they talked to the shippers, they talked to the trucking companies, they even called Algeria which was a supplier. But the only people they didn't talk to at all, were the people who drove the trucks, the people who drove the bombs. Whom I think would have the most immediate interest in the health and safety. Why didn't they talk to them? And I posed that question,

they were very embarrassed, because
they had done all of this work. And I said why didn't you talk to them? And they sort of looked sheepish and they said, "well you know it was easy to call the regulatory agencies, you know, but we didn't know how to get a hold of them,truck drivers." I said did anybody think of it, they said no, but even if we did. And I said well you know what happens if the truck drivers are organized? And especially in this part of the industry, into two unions- and I went across the hall and got a telephone book and I looked up the names of the unions and they were in the phone book. And here was the name and here was the phone number. I said it wouldn't have been very difficult to talk to them and they made up some other excuses,well they wouldn't have known about it. And I said they probably would have known quite a lot about it, it being their lives at stake, but even if they dint.t then you would have had an opportunity to alert them to some of these things.

The reason they wouldn't talk to the truck drivers is because the truck drivers live on another planet. That all the contacts that engineers are given are with management and industry, with officials in the military, of course, with their brethren in the profession and they are cut off utterly from the other class. For those engineers who have just moved from the working class into engineering, and in the United States and perhaps this is the case in Europe, as well, increasingly since engineering is a four year professional degree, it's a quick way out of the shop, then you're a professional, boom, you don't have to go to professional school you just go to college and you're done, you're professional, so it has a great attraction. And so for some people coming out of like the working class, they become engineers and they don't look back.

But the point is, engineering is not by ideological habit and training, but also by a complete divorce between them socially and this other world are habituated to the world-view of those who run the society.

I wrote this book on the history of machine tool automation and it was a project at M.I.T. that lasted a decade. I spent three four years looking through the archives of files, rooms full of file cabinets, thousands and thousands of pieces of paper and I found not the slightest shred of evidence, not a memo, not a note of a phone conversation of any evidence of communication between any of the people on the project and we're talking about staff, faculty and hundreds of students who came through that project between any of those people and anyone working in the metal working industry that they were revolutionized other than managers of the firms, and aerospace firms,and military people. And if you think about it just abstractly, it's outrageous- it's impossible, in fact,

here are people skilled and trained to think critically about things, try to understand all the dimensions of a problem, and they rule out as a matter of course unreflectively the national population, who incidentally know about machining. This can be explained in the same way, as one of my students wonderfully put it, last week, they have a placement office in this university, where it's essentially a hiring call, where the companies come and pick up their new employees, and the students are constantly saying to me, I couldn't come to class last week because I was in interviews with companies. And so I said, listen have you taken any interviews with labor unions while you're down in the placement office? They just looked at me like I was crazy. Saying,what do you mean about labor unions? And I said why not? And we want to do a little history about placement offices and stuff. But his answer was this, he said, "Look here at Drexel we specialize in the management field." For him there were two fields, labor and management. The class struggle came down to sort of a curriculum choice. And they chose management. And I had to remind them that they really didn't choose management, that there wasn't any other option.

So, the point of all of this
is that the working life and the education of engineers, the people who self-consciously embody this abstract historical force technology weds them in heart, mind and of course pocketbook to a relatively few members of the society, a few citizens. The ones who run the company. And that's why when they go about doing their work, like designing machine tools, without any thought about it, without any malice, certainly without any conscious political objective, they do exactly what is required to enhance managerial authority and power. And at the expense of the power, dignity, what have you, of other people. Without instruction, they do it.

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David Noble

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Antonello: Can you talk now about the result of this situation from the workers' point of view. The de-skill of the workers.

NOBLE

Given this world view,.... the... worker is not viewed as a citizen, as a colleague, as a fellow human being. The worker is viewed as other, another species. In part, because there's been so little social contact. The students didn't get a hold of the teamsters union because they were afraid, to do it really. They didn't know what they would find on the other end of the telephone.
The worker is viewed as an unnecessary, ultimately, unnecessary
obstruction, to rationality. Where rationality means complete management
control. When the worker does what he or she is told, she becomes practically invisible. You desire a machine to be run at optimum speeds and feeds, and if the worker runs it at optimum feed and speed, the worker almost becomes invisible, it's irrelevant, the worker. The worker is simply part of the apparatus. The worker becomes invisible, except, except in so far as, the worker is a mark on the account books, how
much the labor cost of this part of production work, in other commodity labor. But the worker becomes visible when the worker does not comply with the specifications. When the worker doesn't run the machines at optimum feeds and speeds, when the worker has ideas of his or her own, then the worker becomes a problem to be solved.

And over the last hundred years, there have been many different ways to solve that problem, there have been whips, we should say throughout history. And the carrot and the stick, incentive schemes, individual incentive schemes, group incentive schemes to get the worker to identify his or her interests with that of the firm. That it is in your interest to run this machine at full tilt. But all these schemes, however elaborate, only gave the appearance of it being in the interest of the worker, ultimately and people would figure out usually very quickly what the limits were of this new system. And they'd

start working around it.

The interests of the worker and the manager and the engineer serving the manager are different, that's all. The dream which became full blown in the last fifteen years was of the automatic factory. Andrew Jure at the dawn of the modern industrial era talked about the factory as an automaton, Charles Babitch, also. There was a fellow who worked for IBM, who in the 1950's would go to the factory and said it reminded him of a vast computer. Whatever your metaphor is, the important thing is, an automaton, a computer doesn't contain people. And of course, all of these factories were populated, heavily populated. The dream was to eliminate the problem and the potential problem. And it wasn't until really, the middle of the twentieth century that in one industry after another the effort was made to actually realize the dream. Again, the dream, in the mind of the engineer, was the dream of a more perfect society, more leisure, less toil, less human drudgery, greater efficiency of production, who could object to this? And the concept, labor saving technology, was understood by the engineer to mean it would be less work for people. The translation of the concept, labor saving, into management terms is the reduction of the labor bill. It wasn't that workers were going to be relieved of labor, it was that managers were going to be relieved of labor. And so you had this double meaning in the phrase that still confuses a lot of people. When you talk to engineers who design machines that put people out of work, they see it as an act of liberation. Although, in the short run they might hurt some people.

So the effort to achieve reason, to achieve rationality, to achieve efficiency, achieve progress, to achieve technological sophistication and elegance, these are the concepts that are always used. And also sometimes to achieve economies, to achieve greater productivity.

All of these phrases are devoid of political content. And, I have to say, that most of the people who actually design the machines, that put people out of work, believe in these phrases and don't do it for political reasons. But the political content is there in the social relations of production. So that the engineer rationalizes the system of production eliminates as many workers as possible to achieve what he thinks is greater productivity or helping the species, but in reality he's concentrating management control over the means of production. Is this too abstract?

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David Noble

65A

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Antonello: progress for who?

NOBLE

The idea of progress begins in the Enlightenment, meaning social betterment and human fulfillment in human perfection. By the nineteenth century that had been pretty much abandoned and the focus was on industrial development. And because of the very visible human calamity of industrial development in Manchester and other places, that was given up also. By the end of the nineteenth century people began to focus on this thing called technology.

How do we know society is getting better? What's the indicator, are people

better, more perfect, is society more harmonious? We don't use those indicators. How many tons of steel do they produce? Okay, that's one indicator of progress. but not very satisfactory. Technology has become emblematic of progress. And when I confront my students with this, I say, how can you that the twentieth century is the end of progress, that's the most barbaric age in at least a millennium. There've been more people killed in wars in this century than ever before. We have the capability of destruction of the entire planet. Either in a few flashes or a little slower, destruction of the environment. How by any stretch of the imagination can be that this be seen as progress? And they become baffled because they've never thought about it before, because it's never been posed to them before. And then when it is,they say well, and they look around for something, and they say, "technology, what about technology?" That's always what people point to.

Why is the twentieth century better than the nineteenth, better than the eighteenth, better than the seventeenth etc, etc.?. Because today we have microwave ovens, we have VCR's, we have equipment like this? That's why. So that, it's the ultimate justification of the idea of progress. When all other measures fail, and have failed since the idea was first really put forth, two three hundred years ago,

so I think we can distill the idea of progress down to technological progress. And then you start asking about technology and the question is as we said before, technology is political, technology is social, who are you talking about, progress for whom? And the age of automation which we can date from the 1950's to the present, the term automation was coined in 1947, at Ford Motor Company. People started forecasting by the 1950's, mass leisure, people were worried about the problems of people having too much time on their hands, how will they spend their time. Whole forests were destroyed in that inane discussion about leisure. The shorter working day was talked a lot about.

What has been the real result? In the last thirty years real wages have
deteriorated. Relevant to output, workers in the United States, I'm talking about the US, are now working more for management than for themselves, their proportion of the return on their output has diminished, in the last thirty years.

Secondly, the hours of work have increased, not decreased. The average work week in the US is now somewhere between forty and forty-five hours. We just had a big strike at the Boeing factory in Seattle, and the issue was compulsory overtime. What's compulsory overtime? It means a lengthening of the work year, mandatory. I talked to some people at a GE factory up in (?) Massachusetts, I said, so what's a new demand? What would be a radical demand? They said the forty hour week, would be a radical demand. That is the work week has increased, in part because of new machinery,and the need to optimize it's utilization by twenty-four hour new types of shift work.

And the third thing, is leisure, people have in fact gained leisure but not voluntarily, it is compulsory leisure known as unemployment. The manufacturing work forces has been depleted by a third, in the last thirty years, and if you look at what happened to the people who lost their jobs, very few of them ever got employment that paid anything near what they had been making. This is the fruit of the age of automation.

On the other hand, about three or four years ago the managements of Ford and General Motors and Chrysler announced bonuses for their top managers, part of the fruit they said of automating a lot their factories, of millions 9of dollars a year. So, when we say progress we have to say; what is progress, what are you talking about, and for whom?

My own mother who worked as a secretary, all of her life, a legal secretary was sixty years old working in a legal, a law firm, they introduced a computer system to routinize some of the activity, and she was deemed too old to be re-trained so she was given two days notice and thrown out of there, on her ear. And the miraculous thing about that experience, which is repeated in households throughout the world with an alarming regularity,is that my mother rather than fighting this, accepted it saying, "  well, I guess that's progress."

So progress which is tied in with this idea of technology is a very powerful ideological weapon, used against people. My mother had to believe that she was fired for some social good. Again it's a religious idea, Why am I suffering for the higher good? My suffering has a purpose in the scheme of things. I don't by any chance know what it is. But if there wasn't some larger good, then my sacrifice would be meaningless. And that is too much for my dignity, so I hold on to the idea of progress. So yes I lost my job, society is getting better, if I try and fight for my job, I'll be standing in the way of social benefit.

It's what I call an irrational idea, in one sentence it says you can't stand in the way of progress even if it kills you, and

that is heralded as the epitome of rationality. And we have to understand, is why something as absurd as that on its face is so universally accepted. And that's a question not only of psychology but of history.

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David Noble

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Antonello: Would you like to talk a little bit about women, technology and
science?

NOBLE

If we understand that technology reflects social relationships between people. whatever is designed just like
this engineer and his friend, he designs this for her as if she were an idiot, she reminds him she is not an idiot, the relationship is changed, the technology has to be redesigned. The engineer and the audience try to get them to do what he wants, they refuse, technology has to be changed.

The technology fits and reflects the social relations between people and particularly we are talking about class relations , management , worker. The history of automation is a history of the development of technology reflecting a relationship between capitol and labor.

Where management wants to control production and eliminate as much as
possible labor. And technology would look different if that relationship were different, if the machine designer and the machine operator were friends, or brothers or sisters, the machinery in production would look different. If that's true and I suggest it is, what do we make of the relationship between man and woman? How is that relationship reflected in the design of science and technology?

One of the things I've spent a lot of time doing is showing that technology is in social terms when we look at it concretely,an activity of a select group of people in society with particular interests,needs, ends, with dillusions, illusions, and fantasies.
When we look at the history of science and technology, we see that it's also the product of one half of the species, namely man.

I've been trying in recent years to understand how that came to be,in the west. There's some effort now to
recruit women into science and engineering and this is episodic. It happens when there's a need for more technical labor. But people are talking about recruiting women into these traditionally masculine fields, so one question before us, is how do they become masculine in the first place?

My own historical explorations have led me to see it in terms

of the history of the church, and the creation of a celibate homosocial culture, clerical culture which gave rise to science. as I said again a relgious phenomenon .

Technology is really, if you want to use the definition of the wedding of the useful arts and science, sort of the imperialism of the clerical culture of science outward to appropriate for itself all the knowledge of the useful arts, much of which resided in the heads and hands of women. Formalizing it and codifying it into the hands of science and technology. So the point is that this whole development has been the result of one half of the species,well then how in what ways can we say that the imprint of this relationship has been left upon science and technology? It's a very hard question to answer.

When I used to work as a museum curator down at the Smithsonian, I used to ask people, tell people that we should correctly label the exhibits and when we're talking about a laser, we're talking about a lave(?), we should say that this is a male laser, then everybody would laugh because it seems so meaningless, what are you talking about. But there's meaning there, the most vivid example I can give is the development of reproductive technologies-

I'm writing a book now called A WORLD WITHOUT WOMEN, which is this celibate culture, that gave rise to science in the west.And I don't have time to elaborate, but it was an ongoing struggle over the last two housand years, it wasn't something that just automatically happened and was finally really in place by the twelfth century. But throughout this period you see these men, celibate and fearful, dreading um, ug.. women. Identifying women not only as evil, but as a danger.

At the same time these people are preoccupied with reproduction, generation. And they experiment, artificially simulating life, much in the same way that man in so called primitive tribes artificially appropriate the birth process in the Kubar(?) ritual, act out giving birth. At your puberty rites appropriate birth from women. The creation of automata, which increases in sophistication through the Middle Ages through the Seventeenth Century and eighteenth century to industrial automation today,I would consider, say this is the Kubar(?) ritual of modern society. When we talk about reproductive technologies define experiments with spermus theories of generation, that is that the little child is in the sperm and all you have to do is get an incubator. And so you have people in the fourteenth century burying, taking semen and putting it in horse dung for thirty days and watering it with blood, or some other things to create a homoculus,that is a child born only of man. And the leading scientists of the day Von Levonhok(?),the first to use the microscope, in a

sustained way, discovered as he looked under the microscope and there he was a little kid in the sperm.

The infatuation as it continued with this attempt to create, what I call the motherless child, continues in our own day. And if anyone suspects that reproductive technology are a work of people
concerned with infertile couples, they are I think, profoundly mistaken. It has a long history, it is a history in large part of the unconscious, underlying compulsions. And if underlying compulsions of men,who can not naturally have babies,

so I suggest that one imprint of this complete, until very recently, male domination in science and technology, is this very strange obsession. Mary Shelley, who wrote Frankenstien, I think said more about the scientific community than anyone before or since. If we imagine Dr. Frankenstien going to such heroic measures, to create this living thing, we imagine Dr. F. as a woman, the book loses all of its meaning and power. So this might be one of the more obvious pieces of evidence, but it's one way, now we can talk about embryo transplant, it gets very concrete,talk about the move towards developing artificial wombs,talk very concrete about different techniques, I would suggest you can't understand this whole development unless you understand that the relationship between men and women, and how that science and technology reflect that. That it's all men doing this and the last obstacle to a world without women, is motherless child.

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David Noble

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Antonello: The influence in technology in the shaping of society by education

NOBLE

The history of American technology is the history of the military. If you look at the development interchangeable parts and the beginnings of mass production, it's rooted in the ordinance department of the army. The production of steel is rooted in the production of ships for the navy. The development of scientific management that's also mostly the navy. If you look at the development of automation, computers, transistors, micro electronics, mostly the air force. And I haven't found much evidence about the marines, but now we have the army, navy, and the air force. And there is very little you can point to in the array known as high technology, that did not have its origins in the military.

Some people point to this happily and look and see it as a sign of the benign fruit of war. That everyone hates killing but out of the activity comes this wondrous new things for people to use in their own home, to make life better. And this is known as sort of a spill-over, of military into civilian life.

What I would suggest in addition to the spill-over or with the spill-over is some carry -over. Carry-over of some of the characteristics of the military, that are reflected in the things that spill-over. One in particular is an emphasis upon authoritarian relations. The military is sort of the, someone said, the primordial command structure. The commander says and the subordinate does, without any ifs, ands or buts. So much of our technology which comes out of the military reflects its origins in this regard.

It's not an accident that whether you look at containerization on the west coast, which was a navy development, or automation, as we've been talking about which is an air force development, they reflect and re-enforce this authoritarian bias, in the way the systems are designed. Concentrating control at the top reduces control at the bottom. Reducing inputs at the bottom, reducing knowledge, intelligence at the bottom and concentrating it all at the top. There's a striking compatibility between management and the military and the reason is because they have the same origins.

Modern management comes out of the railroads. Railroad management was built explicitly on the military model. The line of staff model of the firm is explicitly military model. The creation of modern industry was explicitly, I say explicitly because people were quite explicit about applying military principles to production. So it's not an accident that modern management and the military look so much alike.

For that reason the technology developed in the military fits so well within the contours of the firm, the authoritarian firm. Now there are some other aspects of the military the consequences of which are a little different.... let me elaborate on that just a bit, okay?

Machine tools for example, are the guts of industry. Whether you want to make a tank, a missile, a submarine, or a fixture for a toilet you need a machine tool.The military needs toilets, they also need tanks and missiles, and everything like that, so ...concern about possible problems with the people running machines, has always been a preoccupation of the military. Because the efficiency of achieving a mission can be jeopardized by labor troubles at the machine, so it was not an accident that the air force would be so interested in automation, because it would eliminate the possibility of this obstruction. The navy, the same thing, I'm just elaborating; with containerization the navy was concerned about logistics and especially on the west coast during the Korean War. And the dock workers on the west coast organized into the ILWU, which was historically a very radical union, posed the danger of obstruction, and in fact the ILWU has taken various actions over the years, preventing the shipping of military equipment, say to Central America and things like that. Containerization was a way around that, and it was first proposed under the auspices of the military

and the National Academy of Sciences. And then only belatedly taken up at the encouragement of the military by the shippers, this interest of the military to reduce as much as possible any obstruction by labor,in a military mission meshed very nicely with the needs of management to eliminate their labor problems.

Now the other side of the coin is that, the dysfunctional side of it, is that the military's objective is to find in terms of a mission and the performance of the mission, whatever its cost, whether the aim is to illegally capture the head of state of another country, as you see lately, or to intimidate harass the population, whatever the objective the performance of the objective is paramount.

So the costs entailed in achieving that objective assume a secondary importance. Which is why so many engineers and scientists go to work for the military, because it's the biggest sandbox in town. They learn all of this fancy stuff in college and they want to be able to indulge all of their enthusiasms, they want to do so much that they would kill to do it, so they do kill to do it. They go to work for the military. And the military provides them with the resources, the largess that knows no bounds, so they can play in their sandbox, come up with all of their fancy things, without consideration of costs. And they do.

Then we have the spill-over, and what is spilled-over is not only all of the fancy gadgets, but the habits that went with them, that is, the habits of excess, of opulence which don't work very well in the commercial market place. And the habits are not only reflected in the things, the very expensive technologies, but also in the people who have been raised in the military environment. We're talking about a third of the scientific and technical personnel of this country.

There are students right here who are learning things that will have no application anywhere in the world except in the military. They will not be able to pursue their line of inquiry except in the military. And they say, "Look, this is really exciting, I'm learning all about this,the only place I can do it is in the military or with a defense contractor." And so they go to work not because they want to kill people, not because they're interested in the military, not because they believe in the military industrial complex, just because they want to do what they want to do. And they want to do because they were taught in college that this is going to be exciting, and they got caught. So they're hooked on the military drug. They continue to work for the military, doing all of the fanciful things and then something drastic and terrible happens , like, peace is declared. And these people have to go into civilian life, the commercial market place; and they can't function. They can't produce anything that is economically viable.

the machine tool industry is a perfect example. The

automation of machine tools in the US, under the auspices of the air force, led to a machine tool industry heavily dependent upon the military and unable to compete economically, on the international market. Fifteen years after the beginning of the air force funding of the machine tool industry, the US became a net importer for the first time of machine tools.

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David Noble

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Antonello: Let's see if you can tell me something about this new relationship between science and technology in the WWII?

00:02:34:24 NOBLE

World war 2 was a watershed in the sense that science and technology seem to have won the war. And even more than in world war 1, which was also an engineers' war, to some extent a chemists'war. In world war 2 the physicists with the development of radar and especially dropping of the atomic bomb, the prestige of the scientific community as people who were not just, again intellectuals,but people who could get things done on a big scale, was enhanced. The scientific community took advantage of that moment to create the post war research environment in which the tax payer became the major supporter of the scientific enterprise.

Before world war 2, research in science was conducted by industrial labs, that is private labs, foundations, private money also and within universities but on a modest scale, and again privately funded with very modest public funds. In WW2 there was a seat-change, a dramatic change in the funding of scientific research. And it began under the auspices of the OSRD during WW2, headed by Vannevar Bush who was known as one of the great architects in post war science. He was also a director of AT&T, Raythyon, and Murk(?), a man who embodied corporate science, and also representative of the largest universities, the elite universities. And they created , they invented the modern contracting system, whereby, private firms and universities could contract with the state, receive public monies to do work and it was a coup really of major proportions.

Because one of the reasons conservatives have always opposed, I would say, the kind of conservatives we don't see anymore, old fashioned conservatives, direct government supportive education, direct government support of research and science, was that the government would somehow control what is happening in science. And the same was the case with the universities, the direct funding by state, of the universities, people felt that would lead to government control of what was done in the universities. What happened in the forties, the system that was set up, was really miraculous, brilliant, that is, the scientific community

gained unprecedented access to the public bank with little or no public scrutiny. That is with almost total immunity from democratic controls. If this had been soy bean farmers, the lumber industry, textile manufacturers everyone would have gone crazy.

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NOBLE

The question is, how were they able to pull this off? This coup. Massive public support, no public control. The answer has to do with the prestige that came out of the war. Vannever Bush and his colleagues on the Manhattan Project, running the
scientific and industrial establishment during the war, had proved to the public that they could be useful. They did this by murdering many Japanese. And the political leverage that resulted from that was enough to catapult them into this post war system. Between 1943 roughly, and 1950, there was considerable controversy over the outcome. And there were some people; Harley Kilgore, a senator from West Virginia was very much opposed, as were the Roosevelt Administration, Truman himself, because of the anti-democratic nature of such an apparatus. Public funding without public control. The victory came in the late forties, and not surprisingly, in the wake of another war, that is, the Korean War. Korea actually, as some people said, saved the whole idea of the post war research establishment. That is, once again, in 1949,the scientific community could demonstrate its usefulness to war. The other aspect of science and technology and the government in WW2 was the development of a sort of a subvergence of the patent system.

When an industrial laboratory develops something, and patents it, they have essentially, taken the patent from their employees, and this is an earlier subvergence of the patent system. The inventor surrenders his or her patents to the firm. The firm justified this saying, look, we are providing the laboratory, we are providing the roof and the running water, we are providing the wherewithall for this discovery. Therefore, the patent should come to us, so the person as a condition of employment, should surrender the patent to us. This had become standard practice by WW2.

Now you have public monies fueling and underriding scientific research and development. Who gets the patents? The company can't say, look this is our money, that has funded this, therefore the patent should come to us. The patents come from the government, that is from the tax payer. This was another major controversy. What Bush was doing, V. Bush and friends, was essentially letting contracts to his friends at the elite universities and the large corporations, in a privileged way and this was highly contested.In addition, they were granting patent rights over the research to the companies. That is, research done at public expense was now being essentially captured, in the form of patents by

private firms. The rational was several, first if we don't allow the companies toget the patents the research is just going to lay there and no one is going to develop it, that was one argument. Another one, which was used during the war was, if the companies don't get the patents,then they're not going to play ball with us. That is, they're not going to go along with the war effort and this is a form of extortion. Now, if you or I tried that , we'd be thrown in jail without much discussion for treason. But in this case the companies got what they demanded. After the war this became very controversial, again to make it short, the issuing of patents on publically funded research, remained an inconsistent. Depending upon the agency and depending even upon the contract, who got patents.

In 1979, 1980 in the midst of another military build-up, under the Carter Administration, but also the build-up of a new sort of ideological propaganda campaign for competitiveness, the universities, the scientific community and industrial corporations together lobbied successfully to change the patent law. So that universities automatically get ownership of patents on federally funded research. This was another historic change, which has been little acknowledged. Because what happened is not so much that universities got patents, what really happened is that companies got the patents on federally funded research via the university. The university gets the money from the public, does the research, takes a patent on the research and grants an exclusive license to the firm. The firm thereby indirectly gets control over public research. So what began in WW2 was in a sense completed only a decade ago. That is the private control over the public resource of science.

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NOBLE

How do they decide which corporations? The universities have been integrated with the corporations. This has happened in many ways. The companies come to the universities and set up research programs and research projects.

A more important way, as far as I'm concerned, is the interlocking directorate between the university and the company, Up until ten years ago it was very common for corporate industrial people to sit on the boards and run the university. What has happened in the last ten years is people running the universities are now sitting on the corporate boards and not the local bank, but General Motors, Exxon, the biggest multi-nationals in the world. So what you have is this interlock at the very top of both institutions.

Then the question is, if you take all the corporations represented by the administrators of university, that is, the corporations of which they are directors,and you list those corporations. Then you take all the corporations that the university has research agreements, proprietary research

agreements with and then you take another list and all the corporations that have been granted licences on patents owned by the university, is there any crossover? Well we have found, I have this organization, I work with people called the National Coalition, the university is in the public interest and we've been investigating these things and in a less than scientific procedure, mainly suing universities, we have discovered very interesting crossover. But I'm happy to report the US congress has now begun a full scale investigation along precisely these lines. Trying to see which corporations, the major research universities in the country, the top grant recipients,the relationship between these three columns of corporations. And so we will know more specifically.

But I would suggest that we have as a process of insider trading,where for example, at MIT,there's a program called the industrial liason program. There are three hundred members they are all some of the largest industrial firms in the world. They're foreign as well as US owned. The president of the institute sits on Cabot Corporation which is a member of the industrial liason program, the chairman of M.I.T. sits on Kodak which is a member of the industrial liason program, the provost of M.I.T. sits on actually about seven or eight firms, some of which like the (latter?) corporation (owners?) are members of the industrial liason program.

The industrial liason program is set to give firms privileged access to a half a billion dollars of federal research annually. When I say privileged access, I mean, pre-publication access. M.I.T. publishes a directory which is like a catalog three hundred pages or so, of all the research done at M.I.T., every member company gets it. They look through it and they say I like this, etc., they call M.I.T.; there's a special person assigned to help them, to make M.I.T. accessible to them. They say, I like what's going on in this lab, would you send the person who runs that lab to my firm or can I come and visit that lab? Can I have the pre-publication material, the in-process work? This is routine as part of the industrial liason program.

Now the question is, given the fact that some of these companies are directed by the administrator at M.I.T., you have both the purveyors of the research and the receivers of the research being the same people. And remember the research is public, publically funded. Another thing of interest is that the firms that are represented are also the firms that M.I.T. as an institution is very heavily invested in. That is M.I.T. itself, owns millions of shares of stock in the same firms. Now the industrial liason program at M.I.T. has become the pattern throughout the US. There are programs all over the country, some called liason programs, Stanford has a big one, Penn State, but throughout the country. So, the appearance suggest that further investigation is required here.

00:19:23:05Þ

NOBLE

Whenever a reporter ask me about the social responsibility of engineers, or the ethics of engineers...a bridge falls down, and they say or you know....nuclear power plants or what have you, and some engineers speak out, then someone will call me because I've written about engineers and they'll ask me what do you think engineers should do? And what I usually ask them, is I say, what newspaper are you for? And they'll say I'm working for the Washington Post. And I say do you intend soon to write an article about how the Washington Post distorts the truth? And usually the answer is no. I say well you write that article and call me back and we'll talk about engineers.

The idea that engineers are any different from anyone else, they have a job, they have families, they do what they're told justlike anyone else in this society. And the expectation that they would be any different is romantic, why should they be? That is, why do people have expectations about this group of people that they don't expect even of themselves. And it takes no less
courage for a reporter to write truthfully about his own newspaper as it does for a GE engineer to blow the whistle on GE. This is what we're talking about. And it's serious business because it means people's lives are usually destroyed. The studies that have now been done on whistle-blowers, it's not a happy story. Whistle-blowers are not put on people's shoulders and paraded through the street. What happens is they are isolated completely, no one talks to them. And if they don't go crazy from that, their family is destroyed and of course economically they are in serious trouble. And this is even more so the case for engineers because it's a relatively a small community, it's very easy to blackball them. People are not engineers they are specialist, that is, they work in particular fields and to get other jobs they have to have references.in that field. And so, they're very easily blackballed. So, it sounds perhaps too flippant an answer, but this is what we're talking about.

Since what scientist and engineers do has dire consequences for people and therefore they should be somehow super-human in this regard. It's just simply a ridiculous expectation. So I think all the studies about, I mean, I taught in programs which were created to try to make engineers more responsible and more ethical, stuff like that. It comes down to this, you can be ethical or you can be an engineer, that's the choice. You can be a hero or you can eat. And it's the same in any field. Most scientists and engineers are enmeshed in a hierarchy just like anyone else,they don't have that much play. If an engineer wants to blow the whistle on something it usually means, he's fired. And
I don't begrudge a person for being very cautious about being fired. Because in this society, being fired means, you starve; you're in big trouble. So all the courses I taught in this one program and some of the students became very concerned about the ethical dilemmas and some of the social

consequences of their work that they didn't even understand. What choices do they have? Should they stop doing it? That's one choice. And then how are they going to eat? That's a difficult thing. Some people can handle that better than others. I had some students looking through the newspaper under the wantads for radical engineer, I said there are no jobs like that!

And that's the real dilemma,
these people want to do what they like to do, and know how to do. The positions available don't give them much leeway over doing something what we would call morally defensible. You could say, wouldn't it be great if all the engineers and scientists in the world, or in the US refused to work for the military like with SDI. Yes it would be wonderful except for them. There's nothing to eat.

The thing about a social
system that, it's been in creation for a century, is that it works, that is, to keep people in their places. And it works as other systems of domination in past eras, because you place yourself, your life or your livelihood at risk if you go against it. That's what makes a system work. And there is no more, no less courage in the engineering and scientific community than there is in any other community.

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David Noble

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Antonello: So what should be done to control somehow especially science and
technology?

NOBLE

Well then we're talking about politics. For example, I talked about the struggle in the 1940's, over the control over the scientific apparatus. Kilgore had ideas for democratic control of science.The scientists said this is outrageous, any intervention in science will somehow pollute it. Only scientists know the direction in which science should go in. And they won on this,a nonsensical idea, since all scientists do what other people tell them to do all the time.

But the ideology of autonomous science, of pure
science had it's intended political consequences. That is, immunizing this community from political controls by other people. Many of the procedures, the proposals put forth in the forties are still things that can be revived. We've been at work with this coalition, working with various congressional committees, to set up guidelines, so called conflict of interest guidelines for scientists and universities. It's a very hot issue right now in the US.

Should a scientist be allowed to do work on a drug at public expense,when he himself is a director or consultant or in some way
an equity owner or beneficiary of the firm that produces the drug? Or of the firm that will benefit from the research? How can we say that the scientist is disinterested? Well because of this congressional pressure put on the national institutes of health, some guidelines were proposed several months ago. This came out of these hearings in the summer, the Weiss Committee on Human Resources in the House of Representatives, and the guidelines were actually very timid but suggested or made it clear that people who had equity ownerships, or consultantships, or directorships in firms that might benefit from the research could not get NIH grants. It's very limited, they're not saying that scientists cannot have relationships with these firms, or own firms or benefit, we're saying they can't do that and get tax payer money. That's the difference.

Well since most scientist now are at the public troth, a suggestion like this is very serious business. And when the guidelines were
floated, proposed, the university and the scientific community went crazy. That is now not subsided, because we're still in the process, what happened about three weeks ago is the secretary of health and human services under the Bush Administration, eliminated the guidelines and said no we will not have conflict of interest guidelines. So it was done by fiat out of the administration to try and kill it, arguing that the universities and sciences were to important to industry and this would have an inhibiting effect if we regulate it for conflict of interest. I was just on the phone, just now and learned from this one congressional staff person that they are now putting forth some legislation, to try and do it. So there's a battle underway.

But the battle is a very modest battle. It just begins to chip away a little at the complete corporate and private control over the whole research effort, which is publically funded. We're not saying that you can't get any money, we're just saying eliminate the conflicts of interests. And that, just that is seen as sort of revolutionary. But the point is that it's one tiny little step along a path of gaining social control over science. And acknowledging that science and technology are social and political processes and the question is not are they becoming political, the question is they are becoming political by people other than the ones that have been controlling it up to now. So the universities say we don't want any intervention in our process, and they let the companies run the universities all the time. But when the environmentalists or the farm workers, or what have you, want to get some control then they say, no we're an autonomous pristine(?) institution. The truth is, they've always been political, the question is, whose politics.