Transcript of Freeman Dyson Internet Talk Show

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Center for Instructional Innovation
Western Washington University
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Scott Brennan: Hello and welcome to the first ever broadcast from Western Washington University's series of interviews with our distinguished guest lecturers visiting campus this year. My name is Scott Brennan and I teach environmental studies at the Huxley College of the Environment here at Western. And I'm thrilled to introduce to you, and to welcome here to Fairhaven College and to Western Washington University, Professor Freeman Dyson. Many of you I know are familiar with Professor Dyson's work in the sciences and humanities and philosophy. And I know many of you here on the Western campus have spent some time with Professor Dyson over these last couple of days. And some of you attended his guest lecture last evening.

And I'd like to tell you a little bit about our format today. We have been receiving questions submitted from many of you online and will be sharing some of those questions with Professor Dyson today and also taking questions that are published during this live webcast. So, if you do have questions and are watching us on the internet, do feel free to post questions based on Professor Dyson's work or conversation here today.

Before we start I'd like to say a little bit about Professor Dyson and his work and recognition and accomplishments over a long and distinguished career as a scientist and a philosopher and one of the more important thinkers of the last half of the twentieth century and now the early years of the twenty-first century.

Since 1953, Professor Dyson has served on the faculty of the Institute for Advanced Study where, at one time in the past, Albert Einstein was a faculty member and taught as well. He's also worked for the RAF bomber command as a civilian statistician, as a research fellow at Trinity College at Cambridge and was a contemporary friend and person who influenced the work of many prominent scientists including Hans Bethe, Richard Feynman, Robert Oppenheimer, and many others. Among the many awards that Professor Feynman **[should be Dyson]** has received, he received the Lorentz medal of the Royal Netherlands Society, the Hughes Medal of the Royal Society, the Max Planck medal of the German Physical Society and most recently the Templeton Prize for progress in religion.

And I'd like to begin our discussion with Professor Dyson today by sharing something that the Templeton Foundation said when they gave him the 2000 Templeton Prize for progress in religion. Professor Dyson joins some rather distinguished company in receiving this award in 2000. The first recipient of the Prize was Mother Teresa for her work in furthering religion and it's relevance to our daily lives. Billy Graham was also a recipient of the award as well as Stanley Jaki, a scientist and Benedictine monk who has

done a great deal of work integrating science, culture and faith. In their announcement of Professor Dyson's award, they said about him that, if there were one word to define him, it would necessarily be a scientist. It wouldn't be a philosopher. But it would be that of the optimist.

Professor Dyson, I'm curious. Knowing that you have worked in many capacities—in the cold war, in the RAF bomber command—you have seen the human capacity to use science towards some rather destructive purposes and I'm wondering what it is that has enabled you to maintain the sense of optimism that the Templeton foundation saw and that we have all seen in your work.

Freeman Dyson: Yes, it think comes mostly just from having grown up in a very, very dark time. And I grew up in the 1930s when things—I was in England—when things were really grim. I mean England was going through a terrible economic depression which went on and on and on and there were millions of unemployed. The kids in the slums were just badly fed and badly educated. And the country was just in bad shape. Also the industrial pollution was terrible. England had the industrial revolution before anybody else so we had the worst pollution in those times. You'd go into London your shirt color was black by the end of one day. And the Thames of course was so filthy that no fish could swim in it.

Well, in addition to all that we had Hitler to deal with. We had the prospect of another world war which we all expected, in fact, would destroy us. We knew about anthrax bombs. Aldus Huxley had already written Brave New World which started out with the anthrax bombs. So we expected, in fact, that the coming war would spread plagues all over Europe and we would probably die of plague rather than dying of bombs. So that was the prospect that we faced. As a teenager that was what I was looking forward to.

And, amazingly, we survived and, amazingly, things aren't as bad as we thought they would be. And the anthrax bombs never materialized and the Thames now is so clean that the fish are back and the soot has disappeared from London. The economy of England is prosperous. So many ways things have turned out better than we expected. And so I just—my feeling is if we survived that then the problems we have today are not all that bad and there's absolutely no reason we should feel gloomy.

Brennan: Were you an optimist at the times as a teenager during those early years?

Dyson: No. No, certainly not. I mean, no, we were really quite depressed and miserable at that time.

Brennan: What advice or what insights could you offer to students here at Western or students elsewhere who are struggling with that question of whether we should be optimistic or pessimistic? Is it simply because once in the past things weren't as bad as we thought or is there more to it than that?

Dyson: Well, I would say that there is more to it than that. The human species has shown itself just amazingly resilient in all sorts of ways. I think, of course basically, that the ice ages probably had a great deal to do with the human species as it now exists. We are the creature that survived these terrible changes in climate, which were far more extreme than anything we're facing today, when the whole world got cold. And getting cold is really much worse than getting warm if you're a creature huddling in a cave. And we survived that. We were built to be capable of dealing with all sorts of crises. And so it is in our nature to recover. That's, I suppose, the fundamental reason for looking on the future of humanity with some degree of optimism.

Brennen: Ok, you mentioned last night briefly during your remarks and it came up during the question and answer session that the challenges that we're facing around the world today, that most recently came to a head on September 11, are an example of—in the scheme of things—not the greatest crisis that we've ever faced. What advice do you have for people who are trying to understand what happened and understand how we can move on and begin to progress from that point.

Dyson: Well, of course I'm not an expert on the culture of the Middle East where these terrorists came from. But I think it's quite clear that the most important thing for us is to understand the Muslim culture and to understand the historical roots which led to this kind of terrorism. And if we don't get into contact with the hearts and minds of the people there, then we've no way to deal with it. It's not a military problem. It's a problem of understanding the despair that leads to this sort of terrorism. And I think that the first thing we should do, probably, is all learn Arabic and then—at least, I'm a bit old to start fresh learning Arabic, but there are many students that could do that. And travel as much as possible. Get an understanding of what the rest of the world is like. That, to me, is the primary requirement. Of course the United States has been terribly inward during the last ten years and I've been appalled by how little interest there is in what's going on in the rest of the world and how unwilling people are to learn from the rest of the world. So that, I think, is fundamentally what we have to do.

Of course the immediate problem is civil defense. We have to defend ourselves against attacks. And that's a serious problem; it's not trivial. But it does work and I remember very vividly that one of the things that made us feel good in the years leading up to World War II. In the year 1938, which was one year before the war started, the British government, with astonishing efficiency, manufactured 50 million gas masks and supplied every man, woman and child in the country with a gas mask and we had to carry them around. And so I went to school carrying my gas mask and that made us feel good. We were prepared and we had the feeling the government was actually doing something to deal with the problems. And that was civil defense. To me that is something very sound and healthy and I wish there were more of it in this country. We have, I mean, we have the spectacle of rich people going to department stores and buying gas masks, but there's not been any move to supply the whole population. I think that's the direction one has to go. It has to be something that applies to everybody, not just the rich.

Brennen: So, specifically our instance today, what type of civil defense actions could the US government take or should the US government take that would be equivalent to the gas masks in Britain during the war.

Dyson: Well, gas masks are very good and there's nothing wrong with that. The other thing you can do, which is cheaper and more effective in the short run, is to put positive air pressure into buildings. If you maintain a building with positive pressure inside and filter the air that comes in, then it's proof against biological weapons. That means anyone who can get indoors to such a building is safe. And I think we should do that with all the public buildings in the country. That would not be very expensive.

Brennen: Ok, thank you. One of the questions that we received, from a person who was at your speech last night and has submitted a question online, speaks to a couple of the themes that you just mentioned. One of the themes that you emphasized last night was the importance of bottom-up solutions to problems rather than top-down and you used the example of—well, you used a number of examples. You also made mention of the bombing that's occurring in Afghanistan right now as a top-down attempt at a solution in the truest form. And the question was: How could a bottom-up approach work in dealing with the terrorists?

Dyson: Yes, I can't answer that of course, because I've never met a terrorist, I don't know what they're like. But obviously what we should try to do is to establish personal contacts as far as is possible. That's why it's so important, it's not Arabic in their case, I guess we have to learn Farsi and various other languages. But anyhow, that's what bottom-up means, it means getting to know people as individuals, finding out what their grievances are, and trying to understand what we should do differently. It's certainly not quick and it's certainly not easy, but that's what it means. And I'm not saying it's going to solve the problem, but it's certainly an essential component to solving the problem.

Brennen: Well, thank you. The next few questions that we received from our viewers relate to your work in the scientific field and your work with technology. And one of those questions—and this is something that I was told appeared in, I believe, OMNI magazine in the late 1970's, 1978 or so—in looking back on your career at that point, you said something like that some day all your serious work would be remembered as footnotes in textbooks, perhaps. But you would be more broadly known for what you did on the side. And I was wondering if you could tell us a little bit about that.

Dyson: Yes. The fact is I'm trained as a mathematician and everything I do in the professional level as a scientist is essentially mathematics. That's my skill—scribbling equations on bits of paper and trying to understand the problem I'm working on in terms of mathematics. So the professional work for which I'm best known is, in fact, a sort of a mathematical cleaning up job which I did. I never created any ideas. I took physics as it had been established in the 1940s with ideas which were mostly created in the 1920s and I cleaned up the mathematics inconsistencies in the theory which were hindering progress. So, the theory was physically quite correct, but it was just mathematically a

mess. And so my particular skill turned out to be useful. So I cleaned up the mess. I managed to make the mathematics consistent and usable and user-friendly.

So I made the theory accessible for people who wanted to do calculations. And so that's what I became famous for. Well it is true if you go 100 years into the future the methods are standard—the methods I introduced—which are essentially mathematical tricks. And those are in the textbooks. And it will be a footnote in 100 years time. It's not something that's going to be particularly memorable; it's just part of the machinery that people use.

On the other hand, the things I've done as a writer on the outside, involved much more imagination and those things I might be remembered for. They're the kinds of things that get associated with your name. And then for example this joke which is called the Dyson Sphere--which really has no substance whatever—but it got onto Star Trek and as a result I'm well known to the Star Trek crowd. And that's the kind of thing that happens—that you get remember for something that actually was just done as a joke or as a sideline.

Brennen: Which would you rather be remembered for?

Dyson: I don't think I particularly care. I think, because I would be happy. The one thing I've done which maybe in the end I'd like to be remembered for is writing a book about the origin of life--that's a hobby of mine, to try to understand the origin of life—and that is on the borderline between real science and science fiction. I have an unorthodox view about the origin of life which none of the biologists believe. So from their point of view I'm just an outsider who doesn't really understand biology. I think that my book may in fact have some substance to it. And so we shall see. And I would be very happy if in 100 years from now I might be remembered as having advocated this unorthodox view which, in the end, might turn out to be right.

Brennen: Very good. You mentioned an interest in explaining science, the origins of life, also weapons systems and things like that to a general audience. And in your most recent book you describe yourself, among other ways, as a person who tells stories to help non-scientists and non-experts understand the science and it's implication. And I'm wondering if—among scientists who are not story tellers, who are not working to increase public understanding and awareness of science—is there any animosity, you think, toward people who are story tellers and try to make science accessible?

Dyson: No, not at all. I mean I've never felt that at all among my scientific friends. I mean most of them, they consider what I'm doing to be quite useful and certainly have no problems with it. And it's particularly advantageous of course, if you're a theoretician like me, to have something else to do besides science because we don't compete with the young people. I mean I'm 77 years old and I'm surrounded by 20 and 30 year olds. I don't compete with them; they are very smart and they write papers faster than I can read them. *laughter* So I've got to do something else. What I do is write books for the public and it's better than becoming an administrator, which is the alternative.

Brennen: *Laughter* Very good. A number of the students who have responded to your remarks with questions have expressed an interest in the combination of science and writing and one of those came from an English major here at Western who is interested in futurism and mentioned life extension, externalization of consciousness, artificial intelligence, things like that. What advice do you have for a person coming from an English background who would like to try to make a living writing about those topics?

Dyson: Yes, well my advice is to learn as much as you can ___ about the science before you begin writing about it. It's so easy to be deceived by the hype that surrounds a lot of these subjects so a lot of the popular literature about science is sort of based on misconceptions that the author gets just by believing the hype. So it's very important to be able to tell the difference between genuine science and hype. So I would say that's my main advice, that whoever is doing the writing should have a feeling for what's real and what's propaganda especially in those fields which are sort of on the borderline between science and science fiction like consciousness and radio telepathy and things of that kind. There are a number of popular science books which are really quite misleading because they propagate these pseudo-scientific ideas.

Brennen: Whose work do you read in this field—interpretive science for the general public? Whose work do you find to be the most interesting and informative?

Dyson: Well, I don't read a great deal. I mean, I'd rather read science fiction which is sort of real fiction rather than something that's pretending to be something else. But, no one person I do read is Lee Silver. Lee Silver is a biology professor at Princeton who has written an excellent book about biotechnology applied to humans, which is called Remaking Eden, mostly about what goes on in fertility clinics. So it's a book really based on facts but he's exploring the present activities of fertility clinics and possible future activities, which of course are very scary. So I think this book is first rate. It's written by a real biologist who is also a good writer, and he has actually taught a course on biological ethics at Princeton—that's how this book originated. He was teaching the course and he had to find out what's going on in order to teach it.

Brennen: do you think there is anyone who writes well in the field who is not primarily trained as a scientist?

Dyson: Yes. There are people who do that and I think—I don't know many names—Gina Kolata is somebody who I a little bit-

Brennen: The Times?

Dyson: She's a correspondent for the Times who wrote a book called Cloning, which is quite good and quite factual, about the cloning of animals and the cloning of humans.

Brennen: One of the questions relating to this theme of technological advances that someone posted after hearing you speak last night was specifically about the green technology, biotechnology, genetic engineering. Their reaction to hearing the story about

the ground nut or the peanut in Africa and the story of biotech in Africa was to ask: What is the difference? How can we be sure that our biotechnology efforts in Africa don't end up with the same result, the undesirable result the ground nut did when it was produced?

Dyson: Well, of course it's a question of whether it's done by competent people and whether they know the local circumstances. The Africans would like to have this biotechnology; that we learned in Davos at the meeting where I was—the Africans came in order to plead the case for developing biotechnology in Africa. They want to do it themselves. They don't want us to do it for them. That makes a big difference. And in addition of course it should be done on a local basis by people who understand the local agriculture and what the needs of the soils are, what the needs of the climate are.

I mean groundnuts are grown in Africa very successfully in all sorts of places. There's nothing wrong with growing groundnuts in Africa. The trouble was they were trying to do it in very unsuitable places. And if in the future you have biotechnology being done by the Africans for themselves, it will probably make a mess of things in some places and have great success in others. You can't guarantee success, it all depends, but at least if we have several groups of Africans in different places trying this out it's much more likely that the thing is going to work.

Brennen: So the more attempts we make the more failures there might be, but the greater the odds that we will succeed.

Dyson: Yes. And the failures will be on a small scale and you'll learn from the failures how to do it right.

Brennen: And this was another one of your lessons last night, that we should practice experiments that we can learn from and be willing to learn from.

Dyson: Precisely, yes.

Brennen: Why do you think that that is something that is not as common as it should be—learning from experiments and failures? Why don't we do more of that?

Dyson: Well, I think we do. In fact almost all the good technologies grow that way and I think we are doing that, with drugs for example, on a very large scale. There's a huge variety of different drugs being developed for all sorts of medical problems and it is a process of trial and error and everybody's aware of that. Many of them go to trial; some they fail and then you try something else. So I think the drug industry understands that and it's done on that basis; you have to develop 100 different drugs and you hope that two or three of them actually work.

Brennen: Excellent. A couple of the other lessons that you mentioned last night, we've talked about the bottom-up approach rather than the top-down approach. Another one that relates to the trial and error, perhaps, is the idea that we should be more willing to

heed bad news and to learn from that. Is there a current example that's relevant broadly today of people ignoring bad news that we should we heeding?

Dyson: Yeah, that's an interesting question. I don't know what off-hand.

Brennen: Well, we can come back to that.

Dyson: Yes, I think let me pass on that, yes.

Brennen: We'll have a quiz at the end of the hour. Alright, we're getting a lot of questions online, I'm trying to track some of those. Ones of the things—I realize this is something we discussed earlier—your interest in popularizing science. We have a question from a parent who is asking how they might encourage a ten-year-old son's interest in science.

Dyson: Yes, of course, my view is politically incorrect. I mean my view is 'don't try to teach science to kids who don't like it'. I came through my whole education really, up to college, without ever really having to learn science in school. What I learned in school was mostly Latin and Greek. I came through the old English classical education so we didn't get science and I think that's why I became a scientist. I wasn't turned off by having it all forced on me in school. So I would say be careful with the ten-year-old. Don't try to push him into science; that's much more likely to turn him off. And, I mean, give him a chance to visit museums and read books. I learned much more from museums than I ever did in school. I think museums are wonderful because kids can go there and take their time with whatever they're interested in and it's much more fun than sitting in class. The idea that you can become a scientist by sitting in class of course is absurd.

So I would say to this parent, it of course depends entirely on the child, some childs love discipline and others don't and so it's absurd to make rules that apply to all children. But, in case of doubt, just leave the kid alone and let him decide himself what he wants to do.

Brennen: Excellent advice. You said you can't make someone a scientist in the classroom. What can you make someone in the classroom?

Dyson: Well, of course it depends on the age. One thing that's very important you can do in the classroom is teach languages. And kids ought to be learning foreign languages from the age of three or four when it really comes easy. And that you can do very well in the classroom with audio labs and audio equipment. I mean, my kids were lucky enough to learn French in the public schools in Princeton and they came out of those classes talking better French than the teachers because they listened to tapes and they got quite a good French accent, which the teachers of course didn't have. You can also learn the essential skills—reading and writing and arithmetic—everything that has to be done with drill and discipline, you can do in classrooms, and the younger the better.

But when it comes to more imaginative and individual subjects it's generally much better to be let free. And you have to know where to draw that line; it's not easy. I'm not a teacher myself; I only see what happens to my kids and my grandchildren.

Brennen: Excellent. Just a question about how that would apply to the university—here at Western Washington University there is a requirement that students will take a certain number of science classes and I'm wondering if you think it's appropriate at the university level for that to be required of students.

Dyson: I don't think so. I mean, of course, it's good for students and certainly those courses should be available—I don't think that they should be forced on anybody. But that's mostly my own prejudice because I would have found it intolerable myself.

Brennen: Can we make a note of that as an official recommendation to the curriculum people here at Western, that we decrease that?

A number of questions coming in relate to the broader implications of science, not just teaching science or understanding it, but its role in shaping society, being shaped by society. And one of the key questions people were asking last night, and that you've done a great deal of writing on lately, is how technology and science can advance at the same time that social justice becomes more widespread. And a question that relates to that—cultural and technology—comes back to an earlier theme that we mentioned that a lot of people are interested in right now is whether or not modern technology, capitalism and democracy can live side by side with Islamic culture. Can you think of a place or a case that would answer that question for us?

Dyson: Well, we know that in the Middle Ages when Europe was essentially stagnant, from the point of view of science and technology, the Muslim world was racing ahead. In the 10^{th} and 11^{th} centuries, before the Mongol invasions, the world center for science and technology was the Muslim world. They could do it and they did it very well. There's no antagonism between Muslim faith and science. One of my good friends is a very famous physicist called Abdul Salam who was a pious Muslim, a very devout believer in Islam faith. And he, all his life, was doing first rate science. He's a native of Pakistan and he had no problems at all with reconciling his science with his religion. So I don't see that there's really a problem there. It's sort of a historical accident, as far as I can tell, that the science developed much more rapidly in the Christian part of the world than in the Muslim part. It was partly as a result of these Mongol invasions, which essentially destroyed the Muslim civilization as it existed and had consequences which, of course, lasted to this day. And Europe fortunately escaped, that is most of Europe did.

Brennen: Now, following up on that, a lot of your recent work has dealt with theological questions and I read a bit lately about an argument that tells us that the conflict today is not between a particular religion and science and technology and social justice, but between fundamentalism, literal interpretation of texts and the isolation that comes with fundamentalism. Do you think that fundamentalism and these views are sometimes in conflict?

Dyson: Well, of course they are sometimes, but I think lass so than people imagine. I have a lot of respect for fundamentalists and I remember—I mean, two years ago I taught a girl three months in Minnesota at a small college and several of my students they were fundamentalists and they were very capable and talented—mostly pre-meds—and I think they'll do well in life and there's really no contradiction between being fundamentalist and being a good physician and maybe even a research scientist.

To my mind it's one of the glories of human nature that we are able to believe two contradictory things in the same mind. As Alice in Wonderland said—I forget who it was, the red queen in Alice in Wonderland—but when I was your age I used to try believing ten impossible things before breakfast each day. So we're capable of that.

So I had big arguments with these students about the genome, I mean one of them was saying that if you cloned a human being we would be producing things that looked like human beings but they actually wouldn't be human because God—it says in the bible—only gives out one soul for each set of genes. So I said I couldn't find that in the bible.

Anyhow, we had friendly arguments. I mean, there are of course contradictions, but somehow we're quite good at living with contradictions and there's no reason why we should get to the point of hating each other just because we disagree.

Brennen: Indeed. Another question about this connection between science and more universal ideas—the questions just come in—as a physicist do you believe the universe is a random happening or that there is a creator?

Dyson: Well, that's of course a question of what you mean by believe. I don't believe anything. And so in that sense I don't believe in religion as a set of beliefs. For me religion is a way of life. I happen to be a sort of practicing Christian who belongs to a Presbyterian church. I go to church; I love the community; I love the music; I love the literature; and to me that's what religion is.

In a way I'd be a better Jew than I am a Christian because the Jewish religion doesn't involve so much belief. It's much more a matter of how you live. But I think that's true of most of my Christian friends as well. So that I would say, I don't know what 'beliefs' means. I don't have any firm belief that the universe has to be so. To me those are questions about which one can never really believe; essentially you are hoping and still always living with uncertainty. Living with uncertainty, to me, is what science is all about. It's also what religion is all about. Both areas are living with uncertainty; you never know if what you think is true, you never know what other people say is true, either.

So for me, I think the universe is to a great extent random. That's a scientific fact, in effect, that quantum mechanics tells you that most events in the universe are random. So the universe is governed, certainly, by random chance to a great extent. That doesn't

mean that there isn't a creator. The creator may be using randomness for his own purposes, and that's, I think, quite likely. So there's no contradiction there either.

Brennen: On a related topic, things that we may or may not believe in or have definitive knowledge of one way or the other—maybe a little lighter questions than some of the topics you've been pursuing so far—this is a pretty straight forward question about extraterrestrial life: Why haven't we discovered it yet?

Dyson: Yes, that I don't know, of course. I don't believe that extraterrestrials have to exist, but I don't believe they don't exist either. It's just an interesting question to try to find out. It's a fact that we've been searching for 40 years with radio, and for a much shorter time with other channels, and we haven't heard anything. So, the question is why not? It may well be that for some reason the aliens aren't interested in using radio to communicate. Or it may be that there aren't any aliens there in the first place. We just don't know.

So, to my mind, this is all very much an open question. I don't think it makes a great deal of sense to try to guess what the aliens might be interested in and this idea that they should be interested in communicating with us, I think, is probably wrong and they probably have quite other concerns. And so we shall find out if we ever do discover them. It's a little bit surprising—if you believe that aliens actually are spread all over the universe—it's a little bit surprising that they haven't shown up, but there may be many reasons for that. I think, myself, that the chance of finding aliens in the next hundred years is probably quite good. I take that as a serious possibility and so I'm very much interested in pursuing the search.

Brennen: You've been present during a lot of scientific discoveries that have larger effects on society, once they were publicized and became known. If we did, tomorrow morning, find out that aliens did exist and they landed at Fenway Park for a playoff game or something for instance, if they happen to be baseball fans. What effect do you think that might have on us, today? How would things be different for human society?

Dyson: So, this would of course make an honest difference, if you had real live aliens that landed on this planet and you could communicate directly, of course that would make a huge difference. I think it's completely unpredictable what we would do. It might conceivably pull us together in a way that would be enormously helpful—giving us a feeling that we all really belong together and that we have bigger concerns than fighting each other over trifles. So I could say that's a possibility.

I think it's far more likely that we discover aliens at a much more remote distance. So we'd detect them—we'd discover evidence that they exist—but we would not be face to face. And of course that's very different. It would then be a much more prolonged and slow process of learning about them and so the immediate impact would probably be much less. But even then it might make quite a big difference knowing that they're there. I think the chances are that the way they show up will probably be so unexpected that any guess as to what effect it might have is really quite absurd.

Brennen: Last question on aliens then, before we move on. You said you don't necessarily believe in them or disbelieve, but you do hope and you put hope in the title of at least one of your books, I know. Do you hope that there are aliens out there that we might be able to communicate with?

Dyson: Oh, indeed, yes. I mean the universe would be far more interesting if it's full of aliens than if it's just us. So, definitely it makes for a more colorful universe.

Brennen: Okay, a question just came in about, we could call it unexpected outcomes of technology. Someone writes in and says, 'My video doesn't work. What are the consequences for learners at schools like Western Washington University when technologies fail to produce the outcomes they were designed to produce and that we desire them to produce?'

Dyson: Yes, of course, well that's very much a part of learning how to deal with technology—that most of the time it doesn't work. So I think it should be one of the most important things for kids to learn is how to fix things. And I was talking at breakfast with a lady who teaches classes for single mums and—I forget her name—but she happened to be sharing breakfast with me this morning. And she teaches a class here in Bellingham for single mums teaching them computers. And she said the important thing is not to use the latest computers, which is what most of these courses do.

When they're teaching people computer science of course they have all the latest stuff. Then they go home and what they have at home of course is some antiquated machine and none of the software works and they're lost. They don't know what to do. And so what she does for her classes is she actually has the most antiquated machines there in the class and the first thing that the women have to do is take them apart and put them back together again so they know what's inside. So they can actually fix the machines that they have at home. And I think that that's a brilliant idea and it should be pursued. And most, of course, most computer science is not taught that way but it should be. And every child, I think it would be very useful if they were taught how to fix the toilet and do the plumbing and take the toilet out and put it back and my wife can do that and it's a very useful skill and it teaches you a lot besides fixing toilets.

Brennen: So we can have two kinds of relationships with our technologies: they can be mysterious black boxes, almost supernatural, or we can understand them. And you're saying those are the two approaches, is that right?

Dyson: Yes, and to understand them you have to be able to fix it yourself. I think that the emphasis should be very much on that when you're teaching kids technology.

Brennen: And, about fixing it yourself, we're coming close to the end of our time here I think. There are those who have studied these matters who are not as optimistic as you are. And I don't know if you know the work of Thomas Homer Dickson on ingenuity and systems thinking. But I was just reading this morning just a short statement that counters

some of what you say, but there's maybe some similarities and I'm wondering what your reaction is to this, and then I have a specific question.

"Looking back from the year 2100," he's making a prediction, which we know is inherently dangerous, "we'll see a period when our creations—technological, social, ecological—outstripped our understanding and we lost control of our destiny and we will think, 'if only we had the ingenuity and will to prevent some of that.' I am convinced that there is still time to muster that ingenuity, but the hour is late."

What do you think of that?

Dyson: Yeah, well, I think it's an illusion, but I'm happy that people disagree. I mean, when I'm writing books it's not to make people agree with me, it's just to present a point of view. They may or may not agree with it but at least it gives them some stimulation for thought. So, in this case, what this fellow is saying could be right. But I think, in fact, technology is so much a matter of trial and error it's inherent that you make mistakes. I mean you can't develop technology without making mistakes. So the idea that you could somehow foresee the consequences and avoid mistakes, I think, is an illusion. And that's roughly what he's saying.

So I would say let's blunder ahead, that's what we've done in the past and we're pretty good at muddling through one way or another. But I could be wrong. There might be mistakes which we could be wise enough to avoid. You never know.

Brennen: What advice do you have for students who are facing such levels of complexity in their studies and also as they look around the world and see environmental systems we're now influencing on a very large level, research has shown us; social systems, the sheer number of people and the relationships among them are greater today, you could argue—and this is something you're written a great deal about in your studies of the internet and that your son George has also written about in his book Darwin Among the Machines. For someone who is just now becoming aware of the complexities of these systems, and doesn't yet have the perspective that you do, what advice could you give them or what principles could they keep in mind as they move forward into this evermore complex world?

Dyson: Yeah, well, I only think of my own kids who have all found interesting things to do with their lives and we don't have to understand everything to do something and the world has always been incomprehensible and it always will be. That's the beauty of it. But there's so much more going on than we can ever hope to understand. In spite of that, you can do a lot to ameliorate things. I have six kids who are all in different ways trying to improve the world. And two of them are medical doctors, one's a veterinarian, one's a minister of religion, and one's a venture capitalist. And I think they all have found useful and exciting and interesting lives. That's one reason why I'm in optimist, is they're not gloom, why should I be?

Brennen: If today you were choosing a career for the first time—say you're teens or twenties at the university, and you're trying to choose which field is most promising, most exciting—would you stay the same course that you have thus far, or would pursue something new, perhaps Arabic?

Dyson: Well, it's difficult to say. I think the main point with me is that my skills are rather narrow, but my interests are very broad. My skills happen to be mathematics, essentially, and writing. Those are my two skills. And so I was sort of—it would have been foolish not to use the skills that I have, but my interests of course are much broader and so I have dabbled in many other things. But basically what I do is either mathematics or writing.

And I think that's true of the young people today: that they should first find out what their skills are and try to make use of them in as many different ways as possible and, particularly, think of your fourth job rather than your first job if you're a student. Expect that your first job will probably be a bust. Don't imagine that you'll immediately find the right career. Think in terms of the fourth job. After you've tried out a few things, you'll finally find out what you're good at, find out where you can make a contribution, so that the process of education should be a preparation for switching careers rather than for one particular career.

Brennen: Alright, well thanks very much. It looks like we're out of time and those of you that have joined us on the web, on behalf of Professor Dyson, the University, the Center for Instructional Innovation and Fairhaven College, I'd like to thank you all for tuning in and to let you know if you joined us late that if you revisit this site later today, and everafter, this video and the audio will be available online and we will, with Professor Dyson's help, iron out those technological glitches. So thanks very much for joining us today. And thank you.

Dyson: Thank you.