Communicating Controversy in the Mass Media

Appendices

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A submission presented in partial fulfillment of the requirements of the University of Glamorgan/Prifysgol Morgannwyg for the degree of Doctor of Philosophy
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List of DVDs

Credit List


Appendix 2:

Program Scripts
Project One:

The Quality of the Evidence
FRONTLINE: Prisoners of Silence. [60’].
PBS/WGBH: Boston.
First broadcast October 19, 1993.
FRONTLINE investigates facilitated communication—the theory, the practice and the controversy.

PHIL WORDEN: God, it's really true. This stuff is bogus. You know, it's just so clear and so unmistakable as I was sitting there watching this.

ANNOUNCER: Tonight on FRONTLINE, "Prisoners of Silence."

CHILDREN: [singing] If you're happy and you know it, clap your hands / If you're happy and you know it, clap your hands / If you're happy and you know it--

NARRATOR: Every American child knows this song. They can feel happy and they know what it is like to feel happy. But to children growing up with the strange condition of autism, like these at the Boston Higashi School, the words may not mean much at all. Something has gone wrong with their developing brains. The children have a faraway look. Generally they shun human contact.

The mysterious condition of autism affects close to 400,000 Americans. Most have little or no speech. Eighty percent are mentally retarded. While the condition can be treated, there's no cure.
Until three years ago, this was the generally accepted theory of autism. But then a radical and controversial new technique called "facilitated communication" took America by storm. Today, thanks to facilitated communication, Jeff Powell, once written off as profoundly retarded, sits in class doing algebra.

Profoundly autistic Ben Lehr can't speak, but can type his thoughts to an audience of people.

**Dr. DOUGLAS BIKLEN, Director, Facilitated Communication Institute, Syracuse University:** [reading Ben Lehr's words] "Feel like you need patient friends like Michael. They fight for me."

**NARRATOR:** Professor Douglas Biklen of Syracuse University thinks it is the most important breakthrough in autism ever and is promoting it enthusiastically. The theory of facilitated communication claims that many, perhaps most autistic people, are not retarded, but have intelligent minds imprisoned in bad bodies.

**FACILITATOR:** Are, either, for-- good. Go ahead. Delete. Did you want to delete that?

**NARRATOR:** Biklen argues that autistic individuals like Ellen have many things to say but are unable to say them because her body will not do what her mind wants. But with a little help, or facilitation -- holding her hand, wrist or elbow -- her body's often jerky movements can be smoothed out, allowing her to type letters on a keyboard.

**FACILITATOR:** --TALK-- I, N, G--

**NARRATOR:** When Douglas Biklen discovered the method during a visit to Melbourne, Australia, he realized that everything known about autism might be wrong.

**Dr. BIKLEN:** I knew that I had seen something terribly important. Here was a means of expression for people who lacked expression and here was a way that you could find out what people were feeling and what they were thinking. And, you know, these were people who had a disability the very definition of which suggested that the people might not have feelings and certainly no ability to empathize with other people's feelings. This was a disability the very definition of which was that people lacked imaginative ability. Well, I mean, you know, how do you do higher order mathematics without an imagination? How do you write poetry without an imagination? So it was quite clear that this was a means of expression that was revolutionary.

**NARRATOR:** The O.D. Heck Center for the Developmentally Disabled in Schenectady, New York, runs a large autism program. Before facilitated communication, the staff never imagined that any of their nonverbal clients might be of normal intelligence. But then speech pathologist Marian Pitsas heard about the new technique being promoted at Syracuse University. Together with her colleague Jimmy Maruska, she went to find out how it worked.
MARIAN PITSAS, Speech Pathologist Facilitator, O.D. Heck Study: Three of us went for the training first and we rapidly trained everyone in our program, all three shifts, and had many, many clients typing at varying levels and with varying degrees of success but it spread very, very quickly.

I thought it was wonderful. At last we were going to— we were going to help these people communicate. We would find out what they really understood.

JIMMY MARUSKA, Facilitator, O.D. Heck Study: Before, they were just another person that I was helping with and teaching them some basic skills to help them survive out there, but then here along comes a person that can share their thoughts, that can talk to me. I can talk to them. We can have a conversation that's relevant. It was great. It was really super. I mean, you couldn't ask for anything more. All of a sudden, these people that we always treated as low-functioning were right up there with us.

NARRATOR: Ray Paglieri, the director of the autism program, realized the enormous implications of the typed messages his clients were now producing.

RAY PAGLIERI, Director, Autism Program, O.D. Heck Center: I was thinking that certainly a large number, if not all of the folks that we were working with may, in fact, have normal intelligence. I mean, we had people typing sentences, paragraphs, alike. We were thinking here we were going to redefine the whole notion of what autism is all about. We trained the rest of our staff, okay? We literally were encouraging people to work with everybody in the program. We were training as many people as we could, training people out in the community. I mean, we were excited. We looked at it as literally a breakthrough technique.

NARRATOR: So did the media.


DIANE SAWYER, ABC News: And now a story about hope. For decades, autism has been a dark mystery, a disorder that seems to turn children in on themselves, against the world. Tonight, however, you are going to see something that has changed that. Call it a miracle. Call it an awakening.

NARRATOR: Word of the new miracle of facilitated communication spread rapidly. Parents told teachers and teachers told parents. Many schools embraced it. At Edward Smith Elementary School in Syracuse, children previously thought to be retarded now sat in classes with their peers, receiving age-appropriate instruction, studying math, studying biology.

Dr. BIKLEN: Maybe you can say what you want to point to.

NARRATOR: A large group of individuals had, in Biklen's view, been greatly
underestimated simply because they could not speak or control their bodies.

Dr. BIKLEN: Why don't you show us and then you try to say it. That's good.

I had always believed that it was important to treat people as competent, even though they didn't give off the signs of it. To me, that was just the-- the humane thing to do. That was the sensitive thing to do. The wonderful thing about facilitated communication is that once a person begins to communicate, you can ask the person, "What's going on here?"

NARRATOR: The words that emerged from the electronic communicators and letter boards spoke of loneliness, of being trapped in a prison of silence, of slavery and of freedom.

("Autism held me hostage for seventeen years but not any more because now I can talk.") For Biklen, a simple technique had redefined an entire group of disabled people. Jeff Powell, for example, is no longer seen by his teachers and peers as mentally retarded. He has become a celebrity at Baker High School in Syracuse. They stress he's an academically gifted student who writes poetry for the school yearbook.

But some people had their doubts about facilitated communication. Dr. Howard Shane has devoted his life to helping disabled nonverbal people to communicate. At Boston Children's Hospital, he runs a center which finds technological solutions enabling disabled people like Tony Bonfiglio who has cerebral palsy, to communicate independently.

Dr. HOWARD SHANE Director, Communication Enhancement Center, Boston Children's Hospital: We have this saying in our center that no person is too physically disabled to be unable to communicate. The slightest movement, winking of an eye, moving of an eyebrow, sipping and puffing on a switch-- on--on a straw would control a switch-- finding that subtle movement is all you need to be able to control the technology.

VOICE SYNTHESIZER: Yes, I have made many good friends.

NARRATOR: Thanks to computers, thousands of nonverbal people can express themselves independently. With such equipment available, Shane questioned, why should autistic people need another person to hold their hands?

Biklen says autism is special.

Dr. BIKLEN: Last week, I had conversations with several people. One person said, "It slows me down. It helps me by slowing me down. When I'm not slowed down, I get garbage. I get unwanted words. I get a lot of letters strung together that don't make a word. When I'm slowed down, I can type what I want."

NARRATOR: But critics like Shane were amazed at the sophisticated output.
Autistic children of 5 and 6 produced perfectly spelled sentences. ["I cry a lot about my disability... It makes me feel bad when I can’t do my work by myself."]
Andrew, age 6] Where had they learned to read and write? [Please heed my need. I need to heed others. I think the world they need heed like we heed brothers."] Manny, 2nd grade]

A difficult question had to be faced. Was the typing coming from the autistic individual or from the facilitator? ["Am I a slave or am I free... Am I trapped or can I be seen... As an easy and rational spirit... Am I in hell or am I in heaven."]

Dr. SHANE: The outcomes that were being reported were just so far out of line with what anyone had ever found. They’re communicating in grammatically complete sentences. They’re marking the tense correctly. Their spelling is accurate. They have insights that go far beyond their years.

Dr. BIKLEN: [reading] "Understanding is so hard. I long to see it real. I just hope, really hope, it’s not a lost ideal.

As I said, many of the accounts coming from people with-- who are using facilitated communication as their means of expression have to do with loneliness.

I think it’s rather obvious that the way in which these children learned to read was the way that most of us learned to read-- that is, by being immersed in a language-rich environment. You go into good pre-school classrooms and you’ll see words everywhere, labeling objects, labeling pictures. You look at Sesame Street. We’re introducing words. We’re giving people whole words. We’re also introducing them to the alphabet. On the other hand, having said that, it does seem to me that there’s something unusual going on here when you see a number of children with autism who seem to have precocious ability. That is, they know a lot of words and very often, you know, quite long words. You know, how is this? Is there something about the disability that allows them to focus in on language and to be able to put together words? ["I greatly fear for the ruin of the Earth unless humans jointly find a cure."]

NARRATOR: A very small number of autistic people, "savants," have spectacular abilities in narrow areas.


SAVANT: That was a-- a Tuesday.

EXPERIMENTER: The 10th of June, 1917.

SAVANT: It-- it was a-- a Sunday.

EXPERIMENTER: The 1st of March, 2044.
SAVANT: It-- it will be a Tuesday.

NARRATOR: Noel only needs to hear a tune once and he's able to play it.

TEACHER: Try it. Try it now.

NARRATOR: If such astonishing abilities existed for music and math, why not for literacy, as well?

To parents and professionals, facilitated communication had given hope where there was none. They flocked to Syracuse by the thousand to learn from Douglas Biklen and his staff at the newly-founded Facilitated Communication Institute.

DR. BIKLEN: Welcome to the 1993 conference on facilitated communication in Syracuse, sponsored by the Facilitated Communication Institute at Syracuse University.

NARRATOR: Many parents had longed to know what their silent autistic children were thinking, had longed to have conversations with them. Facilitated communication appeared to be a dream come true.

JAN KOCHMEISTER: She had been tested in the past and they said she had an I.Q. under 10 and I believed it was a little higher than that, but not much higher. And when I heard about facilitated communication, I said, "Granted it might work with some people, but I doubt that, and I'm sure it won't work with her." It was a college student who started it with her and I watched her twice and I couldn't believe what I was seeing. Since then, Sharisa's typed 120 poems, 9 short stories. She talks about everything she feels.

KATHY HAYDUKE: This past year, in October, '92, a wonderful person came into her life who had gone through Doug Biklen's program here at Syracuse University and she believed in facilitated communication and she said, "Do you know Stacy can write?" And I just-- I-- I cried. I couldn't believe it. I said, "No, no. You're wrong. This is my kid. She's learned six signs her whole life. This can't be true." But she kept-- she kept at it and she said, "Kathy, she's telling me this and she's telling me that and you've got to see it." So one day she came over to the house and she said, "Stacy, I know you're excited. After all these years, you must have something you want to tell Mom." And she said-- and Stacy types out, "I love you, Mom."

NARRATOR: Speech pathologists, social workers and teachers felt just as passionately that F/C had changed everything.

COLLEEN DELLES, Teacher: It's changed the theory of autism alone, and that's pretty significant because what we've known as autism is almost completely different. It's almost like the label or term itself needs to be redefined because there are certain words that are under "autism" under the DSM III -- there's this, this, this and this -- while we find that once we open this world for
the kids, they are social now. They are appropriate. They do have language. They do understand.

NARRATOR: And, advocates claimed, F/C didn’t just work for autism, but for Down Syndrome and other forms of mental retardation, as well. By 1993, thousands of parents, teachers, speech pathologists and care workers had been trained as facilitators, the foot soldiers in a new social movement.

But some families had their doubts about the new miracle technique, like the Gherardi’s from Pike, New Hampshire, whose 17-year-old son, Matt, is autistic.

CATHY GHERARDI: It was about two years ago when someone mentioned that Dr. Biklen was giving some seminars on this facilitated communication. The speech and language teacher at Matthew’s school was there and she just couldn’t wait to get back and start with Matthew.

NARRATOR: Matt, who could then only recognize about 50 words, went to school and his teachers began using F/C in the classroom. Almost overnight, his academic work improved dramatically. Cathy Gherardi became suspicious of his new academic achievements.

MRS. GHERARDI: He was taking all kinds of Shakespeare literature, Romeo and Juliet, and he was in algebra class, although he didn’t fare that well in algebra, but English, diagramming sentences-- the work that he was coming home with was absolutely incredible. Incredible. I mean, getting A’s in some of these classes that I know I would have a hard time getting A’s in.

NARRATOR: What seemed especially odd was that Matt wouldn’t facilitate with his mother.

MRS. GHERARDI: At that point, I was frantically trying to communicate with him at home. You know, I’m saying, "Gosh, if he’s talking to these people, why isn’t he talking to his mom? You know, he and I have been best friends, bosom buddies. I mean, I’m his life and he’s mine. You know, surely we can be able to communicate," and absolutely got nothing. As a matter of fact, he would take his board and bring it and put it in his bag and put it in his closet and say, "Finished."

NARRATOR: While the Gherardis got on with their life, reconciled that F/C didn’t work, at least for them, Matthew’s school continued using it enthusiastically.

One day at school, Matthew and his facilitator, special education teacher Susan Rand, had a conversation, but it wasn’t about Shakespeare. ["dad herts me .. (what happens) his balls next to mine make me feel very horny"] Later that day, Susan Rand wrote down the conversation and reported it to the authorities. ["(when was the last time this happened) Thursday. Dad give love to my ass and dad give love to my c--k with his mouth. (what happens next) the bastard eats c--k in mouth then kneel over and-- you know."]
Mrs. GHERARDI: She handed me a piece of paper -- actually, two pieces of paper -- and said, "These are the things that he said." And I just scanned through the paper and I was just in shock at some of the language that was on the paper. And I said, "It's impossible. It's absolutely impossible." And it was at that point she made it very clear to me that this was real. It was real, that they had a warrant for my husband's arrest and they were going to send Matthew to the hospital for an exam. They were telling me that Matthew may have to go to a home and-- a foster home. And I told them, I said, "There's no way he's going to go to a foster home." I said, "He hasn't been anywhere else except our home. There's no way he's going to go to a foster home." And I was told that I may have no choice in the matter, there may be no choice. And it was at that point that I realized I had no control.

NARRATOR: Gerry Gherardi a pharmacist at the veterans' hospital, was working late that day and knew nothing of this until he arrived home.

GERRY GHERARDI: I got home about 9:30. I pulled into my driveway and Cathy came rushing down the driveway and started to talk to me. She immediately told me not to go into the house, that there was a warrant out for my arrest, that allegations were made that I had sexually abused Matthew and I was not allowed near Matthew and I was not allowed near Matthew, nor was I allowed to go into the house.

NARRATOR: Forced out of his home, Gerry Gherardi spent the next six months living at a friend's house, his family life destroyed because of the letters on the board. Despite the fact that there was no other evidence of abuse, the school, the social services and the police all believed that the words had come from Matthew, yet Gerry Gherardi protested complete innocence.

Mr. GHERARDI: I told Cathy, "There's got to be something wrong. It has to be happening somewhere else. We have to call up the Autism Society in Washington and find out if they had any literature on facilitated communication and allegations of sexual abuse." When she called them up, they immediately sent us materials and in these materials it showed that it was happening all over the country.

NARRATOR: There were cases in California, in Texas, in Georgia, in Indiana, in Oklahoma, in New York. ["I hate my dad."] The accused included parents, teachers, care workers. ["-fucks me with a dildo"] Some, like Gerry Gherardi, had been forced to leave home. Some ended up in jail. Some parents had their children taken away. ["One afternoon the police arrived at my house to inform me that my daughter had [said through F/C] that she had been molested by my husband. They put her in foster care. Of course I couldn't know where because we were now a threat to her. I was frantic with worry. During her stay in foster care, she lost 10 pounds and suffered two black eyes. She had a severe ear infection which finally burst. Does it make sense that she never communicated to anyone [through F/C] that she was in pain?"]

This is what happened last January to a family in southern Maine. Betsy Wheaton, a 17-year-old autistic girl, began using F/C at school in 1992. One day, using a letter board, Betsy and her facilitator wrote that everybody in her
family -- her father, mother, grandparents and brother -- were sexually abusing
her. ["He f--ks me and and he f--ks me and he makes me hold his penissss."]
Betsy and her brother were immediately put in foster care while the case was
investigated.

The court appointed a local attorney, Phil Worden, as Betsy's legal guardian.
Worden realized that this was more difficult than the usual abuse case. Before
considering whether the allegations were true, the court had to decide a more
fundamental question: was Betsy the author of the allegations or had they come
from her facilitator? ["It looks like ... a ... a slimy and ... white. I'm afraid. I am
afraid. My father and my moth ..."]

PHIL WORDEN: I was most worried in my heart about were we going to do
justice in this case? If the communications were real and she was being abused,
the idea that on a legal technicality we might send the children back would be
just absolutely horrible. On the other hand, if these were not real
communications, the idea that all this would happen to this family and these
children on a bogus idea was also unacceptable. So to my mind, the stakes were
extremely high on both sides and it was very important that we reach a quality
decision based on the truth. And so I-- you know, what I was looking for was a
clean, simple and fairly quick way to just solve that one narrow question: Were
these communications coming from the children?

NARRATOR: All the parties agreed to invite an expert in communication to
come and assess Betsy. They chose Dr. Howard Shane from the Boston
Children's Hospital. Shane had devised a double-blind test, like this, to
objectively determine who was authoring the messages, Betsy or the facilitator
who transcribed the allegations. He showed both a series of pictures and asked
them to type what they saw. When both Betsy and her facilitator saw a picture
of a key, the letters K-E-Y were typed. But Shane wanted to discover what
happened if each saw a different picture. When Betsy saw a cup, she didn't type
"cup," she typed "hat," what the facilitator saw.

Dr. SHANE: Here we go. Now take a look at this one. I want you to tell me
what you see, okay?

NARRATOR: When Betsy was shown a picture of a dog, she didn't type
"dog," but "sneakers," what the facilitator saw.

Dr. SHANE: Okay. Want to take a look at that one?

NARRATOR: When Betsy was shown a boat, she didn't type "boat," but
"sandwich," what the facilitator saw.

Dr. SHANE: Okay, here's the next one.

Mr. WORDEN: It was just devastating to watch because what you saw was
that words being typed out were the words the facilitator had seen. And, you
know, it was just-- it was just so clear and so unmistakable. I was sitting there
watching this and saying, "My God, it's really true. This stuff is bogus."

**Dr. SHANE:** What I found was that whenever the pictures were different, I always received the typed message that was seen by the facilitator, so that was pretty strong evidence that not only was Betsy not communicating, but the messages were being absolutely, totally directed and authored by the facilitator.

**NARRATOR:** Shane then tried a message-passing test. He took Betsy out into the corridor and showed her an object out of sight of her facilitator.

**Dr. SHANE:** Betsy, now I'm going to show you something. Take a look at this. You take this. Now, what is that? Give it back to me. We're going back in. I want you to tell everybody what I showed you.

When we went back into the room, she was unable to type the word "key." I then took another key out of my pocket and said, with the facilitator present, "What is this?" and she immediately typed, "key." So again it suggests that when the facilitator is aware of the information, we get the answer, but when the facilitator is unaware of the information, we don't get an answer.

**NARRATOR:** The only logical conclusion of the test was that the terrible accusations had been authored not by Betsy, but by her facilitator. The Wheatons are now reunited. The facilitator, devastated by the test results, stopped using facilitated communication and persuaded Betsy's school to stop using it, as well.

After using F/C for over a year, the O.D. Heck Center in Schenectady began discussing whether they should do their own test of facilitated communication.

**Ms. PITSAS:** My first reaction was, "Why would we ever want to test it? It's working." We— there were things that people— that individuals who typed with me typed that I didn't remember consciously being aware of, so I thought, "Well, that's proof enough. Why should we need to test these people? It's their communication."

But just in thinking about it, I— then I wanted the research to be done because I thought it would prove once and for all, without a doubt, that it was these people communicating and that we were not influencing them in any way, shape or form. I was convinced that it would prove their communication.

**NARRATOR:** A team of psychologists and facilitators led by Doug Wheeler devised a rigorous double-blind test.

**DOUG WHEELER, Psychologist, O.D. Heck Center:** Well, this is what we had in mind. It's just a simple T device. The table's split down the middle. Myself, as the researcher, I can stand back here and I'm pretty much out of view of the--

**NARRATOR:** The facilitator and autistic individual sat side by side, with a
screen dividing their visual field. Sometimes they were shown the same picture, sometimes different ones. They tested 12 clients facilitating with 9 staff members, many who were trained in Syracuse. They ran dozens of trials. The results were shocking.

Mr. PAGLIERI: We literally really didn't get one correct response. I mean, it was unbelievable, really, given-- given, you know, our prior belief systems about the whole thing.

Mr. WHEELER: We had-- we ran 180 trials. There were 180 trials where valid communication could have been demonstrated and none-- none did. We had overwhelming evidence for facilitator control. That was the main finding. And it began to dawn on us that the impact on the facilitators was going to be traumatic. Their belief had grown to such an extent and was continuing to grow at that point where it really had become an essential part of their belief system, an essential part of their personality, and people would use phrases like, "F/C is my whole life." "F/C is my life." These people were dedicated. They spent their own money doing training. They spent their own money to buy communicators. The dedication was phenomenal. And we-- and we had evidence that these people were all controlling the typing and we were-- we knew it was unconscious. We knew these people had no idea they were controlling it. That was clear. So, yeah, we began to be very concerned.

Ms. PITSAS: It was devastating to see the data just there in black and white in front of you. It was mind-boggling. There was no arguing it. It was clear-cut. To see the look on Doug's face, seated across the table from me, someone who I work with, whose opinion I trust, whose work I trust-- I knew you couldn't argue-- I could argue with those results. It was-- it was devastating to look at it and see it there in black and white in front of me.

Mr. MARUSKA: It's like taking your best friend and going out and they're getting hit by a car and they're dead. It had the same effect. It's just like going through the death process. I mean, all of a sudden, you're slapped with this thing. It's not there. It's a belief. It's something that's ingrained in me. I believe this. This is-- I-- I centered a lot of things around this and now, all of a sudden, "No, it's not."

NARRATOR: Life at O.D. Heck returned to the way it had been before facilitated communication. The clients learned the life skills they would need to survive outside. No longer were they expected to express their thoughts and wishes in complex sentences.

Ms. PITSAS: It was like something had been taken away very, very suddenly and I didn't know what to replace it with. It took-- it took me, I think, months before I could talk about it with some people without breaking down in tears.

NARRATOR: A copy of the O.D. Heck report was sent to Douglas Biklen in Syracuse.

Dr. BIKLEN: I think that test has severe problems. I mean, one, you're putting
people in what might be described as a confrontational situation. That is, they're being asked to prove themselves. As I pointed out, confidence appears to be a critical element in the method. If people are anxious, they may, in fact, freeze up in their ability to respond. They may lose confidence. They may feel inadequate.

**Mr. PAGLIERI:** If there was a bias, it was a bias in terms of proving that it was real. I mean, we selected cards that people experienced in their everyday lessons. We ensured that the individuals participating were paired with the facilitators they had the most success with. We tried to make the setting as natural as it could be. We encouraged people to bring the reinforcers that they use in their normal, everyday lives, turned total control over, in terms of saying to the 3 facilitators, if the person wasn't comfortable that day, they could stop it whenever they wanted to.

**NARRATOR:** More studies came out.

**1st STUDY:** The results of this case study demonstrate quite clearly that the subject was not able to communicate using the facilitated communication techniques. [Hudson, et al., "Journal of Autism & Developmental Disorders," March 1993.]

**2nd STUDY:** No client showed unexpected literacy or communicative abilities when tested via the facilitator screening procedure, even after 20 hours of training. [Eberlin, et al, "Journal of Autism & Developmental Disorders," September, 1993.]

**3rd STUDY:** Considerable evidence was found of the facilitators influencing the attempts at communication. [Moore, et al, "Journal of Autism & Developmental Disorders," September, 1993.]

**4th STUDY:** None of the 23 participants demonstrated authorship. There has been no instance in which a participant has successfully identified an object through F/C. [Szempruch/Jacobson, "Research on Developmental Disabilities," July/August, 1993.]

**5th STUDY:** These results suggest that the communications previously reported from individuals with autism may have been influenced by facilitator co-activity. [Smith/Belcher, "Journal of Autism & Developmental Disorders," March 1993.]

**NARRATOR:** F/C had claimed to unlock expressive literacy in nonverbal autistic individuals. Under controlled scientific conditions, that literacy vanished. To date, over a dozen studies, involving hundreds of children and researchers in three different countries, have reported negative findings.

But Biklen remains unconvinced.

**Dr. BIKLEN:** A number of these studies have asked people to name objects or name pictures. It turns out that, for people with autism and some other
developmental disabilities, a number of people experienced very severe word-finding problems such that you ask people to label an object and they can't do it. They may be able to describe the object, even state what it's for but, quite typically, they, in fact, come out with a different name of a different object.

NARRATOR: But, researchers asked, was it possible that a child who can write poetry and do algebra would be unable to label a cup? ["I want people to understand. I know its hard to do. I think they can if they try understand won't you?"] And they questioned why autistic individuals who had appeared on national television and addressed crowds at Syracuse conventions would all be so nervous that none of them would get a single answer right.

Despite mounting evidence, most supporters of facilitated communication, especially parents like Marianne Kallen, who wrote this song about F/C, were undaunted. They had invested their hopes and dreams in F/C and had their own proof that it worked, at least for their children.

Ms. HAYDUKE: My validation that it was Stacy who was communicating came a few weeks ago. Now my husband has this attitude about her and he's found out that if he does this, it absolutely makes her laugh. She just goes crazy. He wiggles his nose. So now when they greet each other, it's like this. And so now she's in love with Dad and I've been trying to teach her how to type out "Dad" and I will admit that, yes, I am taking her hand and I am going, "D-A-D," and I'm, "Please, Stace, let's learn how to do 'Dad'." And she won't learn "Dad." But one day, Dad wasn't in the house and she came home and she's looking around, trying to find out where he is. And so she goes, "Uh! Uh! Uh! Uh! Uh! Uh!" And she gets her board and she starts pointing at the board. And I said, "What do you want to tell me? What do you want to tell me?" And she typed out, I-M-S-N-O-S." I said, "What are you saying?" And it's simple. It's shorthand: "I miss nose." We have been trying to teach her the word for Dad and she has created her own word for Dad.

ARTHUR L. SCHAWLOW: I don't need any more validation. My son has given me a lot of information, much of which I didn't know. A lot of it's been about what he wanted and it's turned out that that's what he did want. He asked even for a trip to Hawaii and he sat, good as gold, on the plane for five hours to Hawaii. And occasionally he tells me something I didn't suspect, like at the restaurant a few weeks ago, he said-- he typed out, "Look at her mane"-- M-A-N-E. Well, I looked and the waitress had a ponytail.

NARRATOR: Parents' attitudes to the scientific studies were summed up in a statement typed by Jeff Powell and read by his facilitator, Sue Harms.

SUE HARRMS: [reading] "Regarding the recent controversy about facilitated communication, we are extremely angry about the well-to-do critics who are giving Doug a disheartening review. We are the ones saying the words and we are questioning the expertise of you and your compassion for autistic students. And please encourage us and Doug to be able to become a part of your world and get the hell out of our world."
NARRATOR: But there was now too much at stake. Whether F/C was true or false had become a matter of great public interest. F/C networks had been established in 38 states. Millions of dollars of public money were being spent providing facilitators in schools and adult centers. Plans were being made for people to take their facilitators to college and even into the workplace. All this had happened without any public debate.

From public prosecutors to special educators, from social workers to parents, in their enthusiasm to adopt facilitated communication, they had chosen to overlook a number of things about F/C that simply didn't make sense. Skeptics wondered how thousands of autistic people could have taught themselves to read and write just by watching television. And why should disabled individuals who can point by themselves need someone to hold their hands to type?

And, most significantly, they point out, why is it that most of the time most of the autistic individuals are not looking at the keyboard? It's certainly true that a touch typist can type without looking at the keyboard. Connie Chisari, star graduate of the Katherine Gibbs school, can type 100 words a minute without looking. She has memorized the layout of the keys. But before starting, she registers her hands in a home position. This is her reference.

FRONTLINE wanted to see if she could type with one finger without looking. Despite her intimate knowledge of the keyboard, she can't. Nobody can. Without a reference, it's just impossible.

Dr. SHANE: You can't be a one-finger typist and not look at the keyboard. You just can't get oriented. You don't have a home position. And when you watch children who are F/C -- facilitated communication -- users, they may not be looking at the language board, but the facilitators are not taking their eyes off it. They're fixed on it.


NARRATOR: Doug Biklen admits that typing without looking is impossible. So what's going on in the Syracuse schools?

Dr. BIKLEN: It's not good technique. It's very sloppy and I think it really raises questions about that particular typing and-- as well it should. And what we need to do is to harp on facilitators to monitor eyes. It's-- it's a lot for people to manage but I think we have to do it.

NARRATOR: But does the Facilitated Communication Institute practice what it preaches? In the conference last May, Annegret Schubert, arguably the most expert facilitator in the world, gave a seminar on the importance of clients looking at the keyboard.

ANNEGRET SCHUBERT: Is there anything you want to share with me about
it?

NARRATOR: Yet minutes afterwards, she was in the corridor talking to a man with his eyes closed and a letter board moving around in the air. And even when Doug Biklen was present, we filmed Jeff Powell typing while looking at the ceiling, something Biklen concedes is impossible.

As Biklen admits, this is a serious matter. If the autistic individuals are not looking, then the facilitators are effectively putting words into their mouths. Scientists in Australia had warned Biklen of such dangers. This videotape especially concerned them. Rosemary Crossley, the founder of F/C, is facilitating with a head injury victim in a coma to make a very important decision about where he will live. Because the man is in a coma, his head pointer barely moves throughout the taping. By drawing a line on the screen it is easy to see that Rosemary Crossley is ever so slowly moving the board.

Dr. SHANE: I don't think they're doing it consciously, but they're absolutely manipulating these individuals and they're communicating for them. And I don't think that that's-- I don't think that's acceptable. I don't think that other people have the right to communicate for someone else.

NARRATOR: The scientific evidence suggested that, far from unlocking the minds of autistic individuals, F/C tapped the unconscious thoughts of the facilitator. The process, skeptics say, is not unlike what goes on with a ouija board. As letters are built up, hypotheses are formed about what comes next. The facilitator who attributes the output to the autistic individual is unaware they are controlling the typing. The autistic individual becomes so sensitized to respond to tiny cues that they become an amplifier for the facilitator's unconscious.

INTERVIEWER: Do you ever have a nightmare that, instead of liberating people, F/C might end up enslaving them?

Dr. BIKLEN: Yeah, that-- that worries me. That worries me, that people would be in some way-- you know, that people are being influenced. There's over-- there's interpretation of things that-- you know, we see that happening and it troubles me. It troubles me. I think it's terrible.

ATTORNEY: Did he fuck you in your mouth?

FACILITATOR: No.

ATTORNEY: Did he fuck your toes?

NARRATOR: But what explains the high number of facilitated abuse allegations? While most courts have refused to accept F/C as genuine communication, earlier this year a judge in Wichita, Kansas, allowed a nonverbal autistic boy to give testimony through F/C.
ATTORNEY: Did he fuck your butt?

FACILITATOR: Yes.

**Dr. Shane:** Why the facilitator is making these allegations on behalf of the child, I don't know. Whether they've been abused themselves—I don't have any—any sense of that. Maybe they've been persuaded. If you look at the literature from Syracuse University, they're suggesting that 10 percent of—make that 13 percent of the children in their initial study had alleged that they had been sexually abused. Now, if I attended a conference and I was told that 13 percent of the people in the initial study had been sexually abused, I'd go home and wonder, "Well, maybe my students are being sexually abused," so maybe this—maybe the idea is being planted.

**Narrator:** Syracuse University is now in the position of having an institute dedicated to researching, teaching and promoting a technique that all the scientific evidence says is not real. The University even has seven students doing research theses on facilitated communication.

A well-meaning social movement aimed at giving a voice to a group of disabled individuals has developed into a bitter controversy which some critics have dubbed the "cold fusion of human services." They ask why millions of dollars were spent on a technique without first proving it worked and, if unproven, why did thousands of autistic children waste precious years sitting in advanced classes instead of more appropriate education?

These are also the questions families like the Gherardis are asking, families whose lives have been turned upside down by F/C. After nine court appearances, social services carried out a controlled test of Matthew which proved he wasn't capable of authoring the accusations against his father. Last February the prosecutor dropped the case and the family was reunited to continue with their lives. The facilitator left the state, but the school continues to believe in F/C.

**Mr. Gherardi:** No one has ever apologized. In fact, to this day, we still sense that the administration at the high school will never admit that they were wrong. They want to continue to say that facilitated communication is successful.

If a new drug had just been discovered, it wouldn't be something that would be just thrown out into the market. It would take years of studies before this medication would be marketed. It's the same way facilitated communication should be treated. I mean, why should that be thrown out and people's lives devastated because they're trying it out on us guinea pigs?

I think a lot of parents are grabbing at straws and are hoping that facilitated communication is going to be the answer for them and I think they've been blinded by it. And I feel for these people, these parents that believe in it, because I certainly can understand where they're coming from. But until we face it head on and do more scientific investigations of it, then these poor parents out there...
are going to be— are going to be in the dark over what's actually happening to their child.

**Ms. PITSAS:** I know, for myself, I wanted so hard to believe that it was real, that I wasn't able to listen to objective thinking about it, because it grabs you emotionally right here and once you're hooked, I mean, you are hooked. It—you just—I don't think I was capable of rationally thinking about it because I had clues even before we did our study, that there was facilitator influence taking place in other places. People had done studies in Australia and I said, "Oh, we—that doesn't happen here. We aren't using the same—we aren't using it the same way. We aren't holding letter boards in the air. We have them down on the table, so therefore that limits the influence that could be taking place." Well, I was dead wrong.

**Mr. WHEELER:** It was amazing to me to see how willing people are to abandon their beliefs and adopt a new belief without verification and do that virtually overnight, because it happened to myself. And when I think back on it, if I had just thought about the literature on autism and thought about the studies I was familiar with, I would have known that the phenomenon of F/C was illogical, that it probably couldn't exist, but I was so caught up in the emotionality of it. And it just taught me a lot about human nature.

**NARRATOR:** Despite everything, Douglas Biklen and the Syracuse Facilitated Communication Institute remain committed to F/C. They believe that time will prove them right.

**Dr. BIKLEN:** I don't say I'll refuse to accept any amount of evidence. I never said that.

**INTERVIEWER:** What amount of evidence would you accept?

**Dr. BIKLEN:** What I've said is, we already have some evidence that this is for real. I think the challenge is, can we demonstrate it for, you know, each person who is using it. That's the challenge.

It's very easy to fail in one's attempt to demonstrate something. It's usually more difficult to be successful. So it almost doesn't matter how many instances of failed studies we have. What we need with any one individual are instances where the person succeeded.

**Dr. SHANE:** And when it gets to the letter that he wants, he hits the switch, as he just did.

**VOICE SYNTHESIZER:** I am hot.

**STAFFER:** I know. It's really hot in here, isn't it.

**Dr. SHANE:** Oh, thanks, Tony. And Tony just told us he's hot.
I've tried to find a middle ground. I don't know what the middle ground is. Either it works or it doesn't work. It doesn't work, so we have to abandon it. Abandoning it means that we just go back to-- come back to where we are, come back to reality.

NARRATOR: One day, the mysterious condition of autism will be understood and researchers may find a cure. Until then, as the evidence against facilitated communication accumulates, a painful question remains, whether parents and those who care deeply about autistic individuals are choosing to see them as they would like them to be, rather than respecting them for who they are.

ANNOUNCER: Next time on FRONTLINE, inside the Rocky Flats nuclear weapons plant.

NUCLEAR WORKER: I was the one who was contaminated. My hair, my hands, my sleeves-- everything was hot.

ANNOUNCER: FRONTLINE investigates 30 years of accidents, cover-ups and contamination at Rocky Flats.

CORRESPONDENT: After all the secrecy, it turns out no one knows what's here or what it may do.

ANNOUNCER: "Secrets of a Bomb Factory" on FRONTLINE.

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FRONTLINE: Currents of Fear. [60’].
PBS/WGBH: Boston.
ANNOUNCER: What is your daily exposure to electromagnetic fields? Should you be worried? Tonight, on FRONTLINE, find out, in "Currents of Fear."

NARRATOR: [voice-over] Imagine an environmental agent to which everyone is exposed day and night, an agent that is invisible, odorless and silent, an agent that affects young and old alike, at work and at play. Now imagine that this agent has been linked in dozens of studies to various cancers, but that the authorities have taken no action to protect their citizens. Some people believe this is what is happening now in America. The threat they see comes from the electromagnetic fields produced by the more than two million miles of power lines that criss-cross the country.

PAUL BRODEUR, Journalist and Author: I think there is a major public health hazard here. I think the evidence to date clearly shows it. I think it is unforgivably stupid public health policy to say that before we implement any kind of preventive measures, we should continue to study this for another five or 10 years in the laboratory.

NARRATOR: [voice-over] Omaha, Nebraska, like everywhere, depends on electricity. The Larm family never questioned it, until 1992.

JULIE LARM, Omaha Parents for the Prevention of Cancer: In February of 1992, my oldest son Kevin was diagnosed with acute lymphocytic leukemia. That very day, in tears, I wanted to know what caused this cancer, because I was afraid for all of my children.

NARRATOR: [voice-over] Julie Larm took Kevin to the Omaha Children's Hospital to be treated. There she encountered other children with cancers, like Jonathan Hendricks, and his mother, Dee. Dee was startled by the number of kids at the clinic with cancer.

DEE HENDRICKS: In going through the oncology clinic here in Omaha at Children's Hospital, I was blown away, in fact, I was in tears by the amount of
other children that were suffering from cancer. I could not get out of my mind the faces, all the other bald-headed babies. But I knew, instantly, that this was not a normal thing going on. I wondered what it was in my neighborhood or in Omaha that could have possibly caused my son to have cancer. And driving home one night, I noticed that there were huge transmission towers that were scattered throughout the neighborhood.

NARRATOR: [voice-over] Julie and Dee became friends, and soon were contacted by other concerned citizens, like Adrian.

ADRIAN DENDINGER: I was diagnosed with purpura hemophilia, I was diagnosed with Addison's disease, I've had seven unexplained miscarriages. I have been diagnosed with cancer. I've had a complete hysterectomy. My parents lived 50 foot from a 160-volt line tower. We grew up, as children, playing, having tea parties, whatever, under that.

NARRATOR: [voice-over] Their suspicions that power lines had something to do with all these health problems were apparently confirmed when, a few months later, they saw a segment of the CBS News magazine, Street Stories, about the dangers of electromagnetic fields, or EMFs. The program featured a school in California where teachers had abnormally high cancer rates, and a landmark Swedish study showing that children living near power lines had up to four times the risk of childhood leukemia.

CBS NEWS CORRESPONDENT: ["Street Stories," CBS News] Immediately after this landmark study was released, the Swedish government and the power companies accepted the connection between electromagnetic fields and cancer.

NARRATOR: [voice-over] Also interviewed was a senior public health official, Dr. David Carpenter.

DAVID CARPENTER, Dean, School of Public Health, SUNY Albany: ["Street Stories," CBS News] I feel very strongly about this issue, because I really feel people are dying from exposure to magnetic fields that could easily be avoided.

JULIE LARM: So I called the health department the next day. They told me I had to gather the names and diagnoses for as many children as we could before they would start an investigation. So we began a telephone line of calling parents that we knew, and then they would, in turn, call parents, and we got a list of 11 children, that lived within one mile of the substation, that had been diagnosed with cancer within the last seven years. So then we called the health department back, and they, in turn, then did an investigation.

NARRATOR: [voice-over] While they waited for the health department, they began plotting cancers on a map, and reading everything they could find on the health effects of magnetic fields. One author that caught their attention was pioneering environmental journalist Paul Brodeur. He had written about similar EMF cancer clusters in Connecticut and California.
PAUL BRODEUR: My name is Paul Brodeur. I've been a staff writer at The New Yorker magazine for the past 35 years. I was the journalist who first alerted the nation to the health hazard posed by asbestos.

NARRATOR: [voice-over] For Brodeur, EMFs were simply the latest of a series of environmental toxins that industry and government had tried to conceal from the public.

PAUL BRODEUR: It's pervasive. You literally have millions of unsuspecting men, women and children exposed to power frequency magnetic fields that have already been associated in dozens upon dozens of studies conducted and published in the peer-reviewed medical literature, levels that are associated with the development of cancer. Never before has there been this much epidemiological evidence of the carcinogenicity of any agent, and that evidence subsequently declared to be invalid, and that agent subsequently declared to be benign.

NARRATOR: [voice-over] By the time Julie, Dee and Adrian met with the Nebraska health department, they had become convinced there was a serious problem with the power lines in their neighborhood, and they were in no mood to be patronized.

JULIE LARM: We used your map to put our dots on. These are the four ZIP codes, outlined in yellow. These are substations, okay.

DEE HENDRICKS: Something's going on in this neighborhood. There's too many dots that represent families that are being torn apart by cancers. There's too many 17-month-old bald-headed babies in the neighborhood, and we're going to scream until someone figures out what's going on in this neighborhood.

BRYAN RETTIG, Nebraska Department of Health: You know, the truth of the matter is, is that almost without exception, cancer cluster investigations don't come up with anything. They don't find a risk factor or, you know, a series of risk factors that might be responsible for-- for what-- you know, for the increase in the number of cases of cancer.

NARRATOR: [voice-over] When the head of the health department failed to turn up to this meeting, Adrian became angry.

ADRIAN DENDINGER: Those are people. My sister, dying of brain cancer. I've watched her rot in Mayo Clinic for a year. And then a head of a health department doesn't come to the meeting. That's baloney. We get lied to, we get ignored; we have to go get our own information, we have to make our own maps, we have to find out about substations. That is not what our elected officials are for. We're getting screwed from both sides.

NARRATOR: [voice-over] The Omaha mothers' concerns are shared by this man, Dr. David Carpenter, dean of the School of Public Health at the State University of New York-Albany. Carpenter has been convinced for almost a
decade that EMFs pose a genuine risk.

Dr. DAVID CARPENTER: In my judgment, they are dangerous. Up to 15 percent of all cases of childhood cancer might be attributable to exposure to magnetic fields from the power lines in the street.

NARRATOR: [voice-over] But not everyone agrees that power line magnetic fields are dangerous. The group most skeptical of Carpenter's claims are engineers and physicists, who argue that the laws of electricity and magnetism, discovered a century ago, are among the best understood theories in science--

MUSEUM STAFF MEMBER: So those sparks are being produced by about 1.5 billion volts of electricity, but I can touch the inside, run along the inside with my bare hands.

NARRATOR: [voice-over] --so much so that museum staff entrust their lives to those principles every day, demonstrating them to children.

ROBERT ADAIR, Ph.D., Yale University: There's probably nothing on earth, or in the universe, that we understand as well as electromagnetic fields, and the interaction of electromagnetic fields with matter, including biological matter. All of chemistry and almost all of biology, excepting a few gravitational effects, are electrical.

NARRATOR: [voice-over] Bob Adair and his colleague, Bill Bennett, are professors of physics at Yale University. A few years ago, they became interested in this area, and the more they studied it, the more skeptical they became. The notion that power line electromagnetic fields could cause disease seemed, on the face of it, to be scientifically impossible.

WILLIAM R. BENNETT, JR., Ph.D., Yale University: The thing that struck me as most puzzling about it is that the fields these people are dealing with are absolutely minuscule. They're talking about fields of two or three milligauss, fields that are 1/200th or so of the earth's magnetic fields.

NARRATOR: [voice-over] Magnetic fields are measured in milligauss. The fields recorded in most homes are of the order of a few milligauss, at most. Yet, as every school child knows, we live in a magnetic field, the earth's magnetic field, which causes a compass needle to point north, and this field is hundreds of times larger. In America, it is about 500 milligauss. The earth's field, physicists argue, would totally dwarf those from power lines.

PAUL BRODEUR: There is absolutely no reasonable biological comparison between the earth's magnetic field, in which we evolved as human beings and which, as some people think, is responsible, at least partially, for the way our brains and central nervous systems develop, and the power frequency fields, which have only been with us, really, in a meaningful way for 50, 60, 70 years.

The magnetic field given off by power lines alternates to and fro, 60 times a
second, to the rhythm of a 60-hertz alternating power. When you're standing underneath a power line, every cell in your brain and body is entrained to the rhythm. Well, that rhythm is going 60 times a second.

NARRATOR: [voice-over] But physicists have calculated the force this oscillating magnetic field could exert on moving charges in the body, and the electric currents it could induce, and concluded they are tiny, thousands of times less than the effects of the body's own heat bouncing molecules around.

ROBERT ADAIR: It's completely lost in the noise. The oscillation from the magnetic fields is absolutely minute compared to the general thermal oscillations. They would be a little like, let us say that you have a windstorm, and an erratic windstorm, where the wind's blowing all over the place, and somebody calls -- your neighbor calls up and said, "Your cat is breathing on my tree. Since he breathes in and out, that causes the tree to be pushed in and out, and that might damage the tree." Well, you wouldn't take it very seriously.

NARRATOR: [voice-over] Physicists found it even harder to see how such a tiny field might cause cancer. Cancer is usually caused when very energetic radiation or some chemical agent directly breaks or rearranges DNA. Adair calculated that power line fields were millions of times too small to do this.

John Moulder is a radiation biologist, a specialist in how radiation can cure or cause cancer.

JOHN MOULDER, Medical College of Wisconsin: Certain types of electromagnetic sources, the high energy ones -- x-rays, cosmic rays -- are capable of actually breaking bonds in biological material and cells, and it's that breaking of bonds, specifically breaking of bonds in the genetic material, that can cause cancer.

NARRATOR: [voice-over] This kind of radiation, ionizing radiation, lies at the high end of the electromagnetic spectrum. Vibrating at very high frequencies, 10 billion trillion times a second, ionizing radiation like gamma rays from radioactive fall-out, cosmic rays from space, and medical x-rays can all cause cancer. But at lower frequencies, the radiation no longer has the energy to break DNA.

JOHN MOULDER: Within the optical frequencies, the photons have enough energy to excite electrons and molecules, and that's the basis of how flowers grow and of how we see. Once we get down a little bit lower, down to lower frequencies now, into infrared and then into the microwaves and radio frequencies, the photon energy isn't even enough to do that, but it can heat, and that's how a microwave oven works. It works by heating molecules. As the frequency gets a little lower, we now pass through the frequencies used for cellular phones, then television and FM radio, and then ever lower, the ones used in broadcast AM radio. Somewhere around where AM radio is, the frequency is so low, the photon energy is so low, we don't even get heating.

NARRATOR: [voice-over] Twenty-four hours of every day, we are bathed in
electromagnetic energy from all parts of this spectrum. Right at the low end, one million times less energetic than AM radio, are power line EMFs. The fields from these lines vibrate only 60 times a second. This frequency is so low, and the energy in the field so tiny, that all other natural sources dwarf it. Physicists have calculated a person standing under a power line at night would get some 10,000 times more electromagnetic energy from moonlight than from the power line. Such arguments led the 45,000-member American Physical Society to release a report last month saying that cancer fears were "unfounded."

PAUL BRODEUR: Who says that the lower frequencies don't operate in another way to cause cancer? Who says that they all have to act in the same way? Who says they do? Ludicrous. I mean, what kind of mind set is that? Well, I fear it's the mindset of the American physicist. The fact that the physicists don't want to believe that should not, in any event, be the engine that drives public health policy in the face of all this epidemiology, which is the only valid tool we've ever had to take preventive public health measures. It was through epidemiology that we learned that cigarette smoking was hazardous, through epidemiology that we learned that asbestos inhalation was hazardous, through epidemiology that we've learned that virtually every one of the environmental carcinogens that we know today, and against which we've taken action, has come to light through epidemiology. So the physicists are going to tell us "No, forget epidemiology, let's go into the lab"? Give me a break. You know, when have they ever discovered anything about biology?

INTERVIEWER: Do you think they should stay out of this debate?

PAUL BRODEUR: No. I think everybody should get in to the debate, the more the merrier. But I think it's ludicrous for physicists to try to pretend that they know about biology, when they don't. And the example I gave, that the last time they got involved in a major public health controversy, it was to assure the American people that no possible hazard could come from radioactive fallout, goes to show you how stupid and wrong they were about ionizing radiation.

NARRATOR: [voice-over] Traditionally, epidemiologists studied epidemics. Working back from an epidemic, usually an infectious disease, they tried to find a cause. Great successes of epidemiology include the major infectious diseases, and modern plagues like AIDS. But increasingly, epidemiology has been used to link environmental toxins with disease, and this has proved more controversial. Here, where the effects are strong, most scientists concede that epidemiology alone is sufficient to prove a serious public health risk. In heavy smokers, for example, the risk of disease, the so-called risk ratio, is 10 to 20 times that of a nonsmoker. Similarly high risks were found in studies of asbestos workers. These findings were so striking that even before there was supporting laboratory evidence, many public health officials were convinced that such toxins endangered the public, and advocated preventive health measures.

So if magnetic fields pose similar risks, one might expect that electrical workers exposed to very high fields would get cancer at a significantly higher rate than average. EMF activists like Brodeur claim this is, indeed, the case.
PAUL BRODEUR: The clear preponderance of the occupational studies show that workers exposed to power frequency magnetic fields at home and at work, are developing cancer at statistically significant higher rates than non-exposed people.

NARRATOR: /voice-over/ But Brodeur's interpretation of the dozens of epidemiological studies isn't shared by many scientists.

JOHN MOULDER: The first thing you ask is how strong are the correlations when you see them, so my favorite analogy is to cigarette smoking. Cigarette smokers have 10 to 20 times the incidence of lung cancer of nonsmokers. That's a strong association. In the power frequency studies, where we find associations, they've tended to be pretty weak.

NARRATOR: /voice-over/ In the EMF studies that found an elevated risk of cancers, risk ratios of only 1.5 to 2 are typically seen.

JOHN MOULDER: The second thing you would look for is, is it consistent? Does everybody find the same thing? All studies, for instance, of smokers showed elevated lung cancer. But with the power frequency occupational studies, you don't see that. Some studies show leukemia elevated, some studies don't. Some show brain elevated, some show that they're not.

NARRATOR: /voice-over/ Three recent very large occupational studies produced quite inconsistent results. One found elevated levels of brain cancer, but no leukemia. A second found no brain cancer, but did find a suggestion of a link with leukemia. A third found nothing at all. Many epidemiologists think this inconsistency, combined with such low risk ratios, raises serious questions as to whether there is, in fact, a real risk, or whether all the studies are picking up is statistical noise.

PATRICIA BUFFLER, Ph.D., Dean, School of Public Health, University of California, Berkeley: If it's a low-level risk, you have to be very careful. Epidemiology is not sufficient in and of itself unless you have a situation where you have an overwhelming disease response, and we have a few examples like that. The vinyl chloride monomer story, where a small number of workers developed a very rare malignancy, angiosarcoma of the liver, and were identified as having very high exposures to vinyl chloride monomer in the process of cleaning out some of the reactors. There we had a risk ratio which exceeded 200.

NARRATOR: /voice-over/ There were also issues about whether all of the workers in these studies had really been exposed to magnetic fields. While serving on the Oak Ridge panel investigation into EMFs, Bill Bennett read dozens of epidemiological papers, and found some were quite misleading.

WILLIAM R. BENNETT, JR.: There was one report published that referred to an epidemic of male breast cancer among telephone linemen in New York State, in the phone company. When you look at the data, you find that although this produced at a relative risk of something like 6.5:1, there are only two cases
that were recorded, and they weren't linemen at all, they were actually office workers. So that somehow, on the basis of these two cases, one is led to believe that there was a serious problem involved.

NARRATOR: [voice-over] And Bennett realized there were other occupational categories that epidemiologists seemed to have virtually ignored. Going down to the Amtrak station, he measured a 50-milligauss magnetic field, even with no trains, and he decided to do an experiment.

WILLIAM R. BENNETT, JR.: I took data coming from Washington to New Haven at two-second intervals with a gaussmeter, and what I noticed in that result was that the magnetic fields were enormously high, compared to most of the epidemiological studies.

NARRATOR: [voice-over] On his journey, he measured peak magnetic fields as high as 600 milligauss.

WILLIAM R. BENNETT, JR.: There hasn't been a major epidemic of leukemia among electric railroad commuters, to my knowledge, or among workers on electric railroads who would be exposed to the fields even longer.

NARRATOR: [voice-over] Last year, one Norwegian study did investigate electric railway workers. It found no effect. But there are other problems that make interpreting the occupational epidemiology difficult. While workers in a substation are exposed to about 40 milligauss, the fields from home appliances can be quite large, as well, especially six inches or less from the appliance.

While these appliances are only on intermittently and the fields fall off quickly with distance, some, like electric blankets, can give long-term exposure. All of this makes the EMF issue far more complex than most epidemiology. As we live in an electric world, with appliances and with overhead and underground cables, virtually everyone is exposed, at home, in the workplace, even in the park. Even the epidemiologists who believe there may be a link with disease fear it may be impossible to prove.

DAVID SAVITZ, Ph.D., Epidemiologist, University of North Carolina, Chapel Hill: The key mode of exposure in the workplace is not notably higher than the key mode of exposure from outside the workplace. So if you have someone who's working, let's say, as an electrician, and look at how much exposure they accrue over their workday, if they go home and use an electric blanket, or perhaps live near certain kinds of power lines, they may actually get an equivalent amount of exposure at home.

PAUL BRODEUR: So much for the claim of the electric utility industry that this is, quote, "junk science."

NARRATOR: [voice-over] Paul Brodeur passionately disputes that the epidemiological studies are flawed, and in a recent book argues that the truth is being concealed from the public. The coverup involves government and
industry, notably the Electric Power Research Institute, which funds much of the research. Moulder thinks this far-fetched.

**JOHN MOULDER:** First of all, they would have to know that a study was going to be negative before they funded it, and second, to repress positive findings in funded studies, I think, would be next to impossible, because you'd have to repress it in this country, you'd have to repress it in other countries, you'd have to repress publications by industry, by government, by academics. I don't think you could do it.

**INTERVIEWER:** Are you saying they're lying?

**PAUL BRODEUR:** I didn't say they were lying. I never said they were lying, and I have never claimed, nor do I believe, that anyone of these scientists, or any scientists who are being financed by EPRI or by the utility industries are falsifying their scientific data.

What they are doing, and let's be clear about this, is not lying. They are coming out and they're making public pronouncements about their opinions. Quote, "It is my opinion that there's absolutely no validity in any of the epidemiological studies that have been done so far." That's Patricia Buffler. Madam Buffler is not only a paid consultant of EPRI, she's a paid consultant of the San Diego Gas and Electric Company and has given an affidavit for them in court.

**PATRICIA BUFFLER:** I've worked with the U.S. Environmental Protection Agency, reviewing their document on EMF, and I've worked with the Electric Power Institute, putting in place their research program. Those are very important activities to participate in, and I think for someone to infer that by virtue of participating in those activities, I have a conflict of interest, is to attempt to intimidate me or others from participating in this public debate.

**NARRATOR:** [voice-over] Back in Omaha, Julie, Dee and Adrian, dissatisfied with the health department's response, joined a national activists' group, the EMR Alliance.

**JULIE LARM:** We do believe there is a coverup, and that they have known about the link with electromagnetic fields and cancer for quite some years. Certain individuals have the information and are able to protect themselves and their families. It is not fair that the rest of the public does not have it. They need to tell the truth.

**NARRATOR:** [voice-over] Last year, Julie got the chance to make her views known to President Clinton, when ABC invited Kevin to the White House for a special children's town meeting. In preparation for the program, ABC filmed Kevin in Omaha.

**KEVIN LARM:** I just think it's a big coverup. There's just too many kids getting cancer around here. There's 11 kids in this one-mile radius from the substation that have cancer, 11 of them.
JULIE LARM: The night before he was to appear with President Clinton, he became ill out in Washington and had to be hospitalized, so my other son took over for him on the show.

PETER JENNINGS, ABC News: Patrick, you want to talk to the president?

PATRICK LARM, Hometown Omaha, NE, Age 10: I want to ask you his question: "I have heard that recent studies have linked EMFs to childhood cancers. Other countries such as Sweden are passing laws to set standards. As our president, can you help lower EMFs, so hopefully some childhood cancers can be prevented?"

Pres. BILL CLINTON: That's something that we can do something about, but we had a study in 1990 which was inconclusive about it, but you're right, Sweden has concluded that EMFs do lead to higher rates of cancer. So I have asked the person who runs the Environmental Protection Agency for our government to do a review of this and to make a report to me in the near future. We just have to look into it and see whether we think there's honestly evidence there, and if there is, then we have to take action, and we're looking into it. And you tell your brother to hang in there.

Kevin, I hope you're watching this, and, we're praying for you and pulling for you.

NARRATOR: [voice-over] Five days later, Kevin, Patrick and Julie were invited to the Oval Office to talk further with President Clinton.

JULIE LARM: In my heart, I believe President Clinton is sympathetic to the children. After meeting with him, I believe he's sympathetic. But I believe, because of politics and large industries, his hands are tied.

NARRATOR: [voice-over] Two years before Julie's meeting at the White House, Congress had set aside funds, some $65 million, for research to try and resolve the issue. Because of the inconclusive epidemiology, research scientists like Gary Boorman were brought in to investigate EMFs in the laboratory. Perhaps with carefully controlled scientific experiments, biologists would be able to unlock the mystery of magnetic fields. Boorman realized that to get definitive answers, he had to attract first-class scientists.

GARY BOORMAN, Ph.D., EMF Program, National Institute of Environmental Health Sciences: You have to apply the same scientific standards to magnetic field research as you would to any other field. We're trying to get the best investigators we can to bring their resources and their intellect to bear on this problem. It's very difficult. A lot of scientists would rather work on AIDS, breast cancer, or other areas, and they're reluctant to get involved in this field. We're trying to get the best scientists involved, and we're having some luck in that regard.

NARRATOR: [voice-over] One large grant went to the Illinois Institute of...
Technology in Chicago. They built the largest rodent EMF exposure facility in the world, capable of exposing 3,000 animals at a time.

DAVE McCORMICK, Ph.D., ITT Research Institute: Our budget for this program is a little over $9 million. This building is constructed almost entirely of nonmetallic materials. All the wall and ceiling construction is wood. Temperature, humidity, noise level, light level are all controlled and monitored continuously. The earth's magnetic fields in all the rooms has been mapped very extensively. We monitor the ambient fields of the rooms continuously, so I think it's fair to say we've taken quite great pains to remove any potential confounders from the program.

NARRATOR: [voice-over] Two years ago, the center began a series of crucial studies to see if magnetic fields caused birth defects or reproductive problems, to see if they caused or promoted cancer, to discover if magnetic fields affected the immune system. Unlike humans, who are constantly exposed to 60-hertz magnetic fields, McCormick could ensure that one group of rodents, the control group, would be completely unexposed. Other groups would be exposed to different amounts of magnetic field from 20 milligauss all the way up to a massive 10,000 milligauss, thousands of times the average exposure in most homes. If anything could detect an effect, at least in rodents, these experiments should.

Another exciting possibility that interested Boonman was that the magnetic fields were subtly affecting cancer genes in totally novel ways, as Paul Brodeur had claimed. While power line magnetic fields could not break DNA, some unconfirmed studies had claimed that the fields might stimulate a certain cancer gene, increasing its activity and, presumably, its likelihood of causing cancer.

Jeff Saffer, a young molecular biologist, was intrigued by this possibility, so a couple of years ago he set out to try and validate the experiments. He placed identical batches of human cells into two test chambers. One batch of cells would be exposed to power line magnetic fields; the other would not. Saffer's job was to measure precisely whether this field affected the activity of a cancer gene called the MIK gene. If it did, it meant, in principle, there might be a mechanism by which EMFs could cause cancer.

Saffer knew that he had to be extremely careful. Temperature, humidity, noise and vibrations might affect the subtle changes he was looking for. His first effort failed. Undaunted, he continued systematically searching for something he might have done wrong. These efforts would take nearly two years.

By Spring, 1995, results from the different labs were beginning to come in. The EMF rodent exposure laboratory in Chicago had completed five studies. First, the study looking at whether power line magnetic fields caused fetal abnormalities.

DAVID McCORMICK: We evaluated a total of 3,000 animals. We did complete skeletal evaluations, evaluations of the head, evaluations of all the visceral organs, and that study was completely negative. We found no adverse
NARRATOR: [voice-over] A reproductive study involving 12 litters from three generations of animals bred under the magnetic fields was also over.

DAVID McCORMICK: The end points we looked at were number of successful pregnancies, number of litters which were actually delivered, number of pups per litter, birthweight, and a number of other parameters to assess the health of the pups once they're delivered, and again, the results of that study demonstrated no effect of the magnetic field on reproductive performance in either sex.

NARRATOR: [voice-over] Two cancer studies using specially bred cancer-prone mice were also finished. Did the magnetic fields promote an already existing cancer? Did the exposed animals get higher cancer rates?

DAVID McCORMICK: Again, we found no evidence that magnetic fields stimulated lymphoma production in either strain. The EMF exposure had no effect.

NARRATOR: [voice-over] Finally, the immunology study also came out negative. One big study is still going on, where rats will spend two years, essentially their whole life, under the magnetic field. This will test for a longer-term chronic effect. The results will be known next year.

Meanwhile, at the Pacific Northwest Laboratories in Washington State, Jeff Saffer had gone to great lengths to discover whether magnetic fields could directly influence the MIK cancer gene. Despite his best efforts, nothing had worked, but he refused to give up.

JEFF SAFFER, Pacific Northwest Laboratory: We went back and used different types of plasticware to grow the cells that were different geometries, different shapes. We tried some higher field intensities, we tried some lower field intensities, we tried different type of serum, we also tried different concentrations, and again, could not find any conditions under which the cells were responsive to magnetic fields.

NARRATOR: [voice-over] Finally, Saffer took an extraordinary step. He actually went to the laboratory of the investigator whose work he was trying to replicate.

JEFF SAFFER: We went to the laboratories in New York City that had done these experiments, used their cells, used their culture vessels, their exposure system, and again were unable to find evidence for change in MIK expression due to the magnetic field.

NARRATOR: [voice-over] Saffer's conclusion was that the effects reported were not real, but probably resulted from inadequate experimental controls. Last month, in the scientific journal Nature, a preliminary report of Saffer's work
appeared. The same issue carried a report from a team in Cambridge, England, who had also tried and failed to find any effect. Other studies have recently reported negative results. A study into whether EMFs affect melatonin levels in humans, a hormone that's been linked to breast cancer, found no effect. A large study of pregnant women using electric blankets was also negative. While other experiments are still underway, so far, things don't look promising.

GARY BOORMAN: As you refine your studies, if there really is an effect, the effect should, should increase, it should become stronger, it should become more focused, and if you cannot, with repeated studies and with better studies, you continue not to find an effect or find only marginal effects, then it becomes obvious that there's really nothing there.

NARRATOR: [voice-over] When completed, these studies will help Congress decide what, if any, action to take, but Paul Brodeur doesn't believe laboratory studies should drive health policy.

PAUL BRODEUR: Laboratory studies are not going to be the criteria upon which we base preventive public health measures. We have used the epidemiology as the only viable tool for implementing preventive public health measures. It is the only viable tool.

NARRATOR: [voice-over] But in the face of so much negative laboratory data, can epidemiology alone prove that cancers like the one Kevin Larm has are caused by EMFs? One thing most epidemiologists agree on, even the ones who support a link between EMFs and cancer, is that the kind of lay epidemiology that the Omaha parents have done is unsound. They had identified four ZIP codes in Omaha which appear to have two to three times more cancer than average, and these ZIP codes are criss-crossed with power lines. It looks impressive but for two things. First, according to their map, only three of the cases actually live within 300 feet of a power line, and power line fields fell off to tiny levels within this distance. But there is a second, more crucial weakness to this lay epidemiology. Cancers do not fall evenly across the landscape. Even if there is no carcinogenic agent in the environment, just by random chance, some ZIP codes will get more cases than average. Others will get less. For example, this densely populated ZIP code a few miles away has just five cancer cases, less than half the expected number, and it, too, is criss-crossed with power lines.

PATRICIA BUFFLER: In many of the cluster investigations, where cases are taking place in time and space, these events most likely are happening by chance, and if you draw artificial boundaries around a cluster in time and place, it's like the Texas sharpshooter.

NARRATOR: [voice-over] Epidemiologists like to tell their students the cautionary tale of the Texas sharpshooter.

PATRICIA BUFFLER: He takes his gun, shoots at the side of the barn, and then draws a bull's-eye around it afterwards, and then says "Aha, I have a bull's-eye."
NARRATOR: [voice-over] Drawing artificial boundaries in space and time, such as cancers occurring in certain ZIP codes during certain time periods, can create an illusion of a cluster. In fact, like the sharpshooter's bullets, cancers are usually scattered randomly throughout the landscape. Even scientists who support an EMF cancer link agree it's not valid scientifically.

Dr. DAVID CARPENTER: By statistics alone, it's very possible that there will be a number of cancers in one block and none in the next 10 blocks. And if one wants to try to identify sources of cancer, what one must do is study many, many children.

NARRATOR: [voice-over] That's just what a number of investigators did. Over the past 15 years, a series of residential studies, each involving thousands of children, have been done. The results have been controversial because, depending on how exposure from power line EMFs was estimated, epidemiologists either found or did not find associations with childhood cancer. Like the occupational studies of electrical workers, the typical risk ratios reported in these studies were low, around 2 or less, too low, most epidemiologists felt, to prove an effect.

But in 1992, a landmark study appeared from Sweden. A huge investigation, it enrolled everyone living within 300 meters of Sweden's high-voltage transmission line system over a 25-year period. They went far beyond all previous studies in their efforts to measure magnetic fields, calculating the fields that the children were exposed to at the time of their cancer diagnosis and before. This study reported an apparently clear association between magnetic field exposure and childhood leukemia, with a risk ratio for the most highly exposed of nearly 4.

The Swedish government announced it was investigating new policy options, including whether to move children away from schools near power lines. Surely, here was the proof that power lines were dangerous, the proof that even the physicists and biological naysayers would have to accept. But three years after the study was published, the Swedish research no longer looks so unassailable. This is a copy of the original contractor's report, which reveals the remarkable thoroughness of the Swedish team. Unlike the published article, which just summarizes part of the data, the report shows everything they did in great detail, all the things they measured and all the comparisons they made.

When scientists saw how many things they had measured -- nearly 800 risk ratios are in the report -- they began accusing the Swedes of falling into one of the most fundamental errors in epidemiology, sometimes called the multiple comparisons fallacy.

JOHN MOULDER: The problem is, when you do as they did, hundreds and hundreds of comparisons, something in the neighborhood of 800 different comparisons; by the standard way we do statistics, we would expect 5 percent of those to be statistically elevated and 5 percent to be statistically decreased. And now you have a problem. If you find, by one measure of exposure, that leukemia
NARRATOR: [voice-over] In the face of negative biology and contentious epidemiology, what should lawmakers do to protect people from a risk that may well not be there? Peter Vahlberg is an expert in risk assessment. One thing, he says, is certain. Even supposing there is a risk, the fact that it has been so hard to prove that power line magnetic fields cause cancer means that, by definition, any risk cannot be very large. Even assuming the Swedish study were true, the increased risk to children of getting a very rare cancer like leukemia is of the order of one in a million. Would moving them to another school make them safer?

PETER VAHLBERG, Ph.D., Harvard School of Public Health, Gradient Corp.: On the one hand, you might argue that if you believe there is an elevated risk from an adjacent nature of the power lines, that you could move the children out, but if this, in fact, involves putting them on a vehicle such as a bus and driving them a mile or so, we know from real actuarial statistics that being on a bus does carry some real health hazards, in terms of injury and death. The EMF risk is likely very small, it’s hypothetical on several bases, whereas the risk from getting in a car is very concrete, it’s very real, we can actually appreciate that, and we know how to calculate that. And to say that you’re going to incur these concrete risks in order to avoid this very low hypothetical risk doesn’t seem to make a lot of sense.

NARRATOR: [voice-over] And in fact, the Swedish authorities now agree. On reflection, they decided not to make any policy changes based on the 1992 study.

So should President Clinton follow the Swedes and do nothing? Not according to David Carpenter.

DR. DAVID CARPENTER: There’s too much smoke here. There’s got to be a fire. While I admit that the proof is not 100 percent, there is consistency in correlation between leukemia and brain tumors and exposure to magnetic fields, both in residential and occupational settings. So I do not believe that doing nothing is appropriate.

NARRATOR: [voice-over] Amidst the public controversy, for Dee and Julie there is good personal news. In a happy reversal of fortune, both Kevin’s and Jonathan’s cancers are in remission, and their future looks very promising. Thanks to major advances in childhood cancer therapy, nearly two-thirds of childhood cancers are now curable. But they have not changed their beliefs about EMFs.

DEE HENDRICKS: Our human body is very complex. It will be years before scientists understand it more, and they will never understand it completely, the way that God put us together. There is significant studies that do show that electromagnetic fields make changes, and that’s what I believe.

NARRATOR: [voice-over] And do they have any doubts they’re on the right
is up in a group of kids, is that real, or is that the result of just random noise in
the system?

NARRATOR: [voice-over] In their thoroughness, the Swedes had created their
own version of the Texas sharpshooter problem. Even if nothing is going on due
to power lines, if you measure hundreds of risk ratios, they will scatter by
random chance around a mean of one. Some will be above, and some below.
Risk ratios below one suggest that EMFs protect against cancer, above one, that
they increase the cancer rate. But the published article focused only on the
strongest positive risk ratios. The summary highlights a nearly fourfold increase
in risk of childhood leukemia. This is what the press picks up and the public
hears.

JOHN MOULDER: It is not scientifically reasonable to do all the
measurements, but then only pick out the ones that give you the answer you
want for publication. If I dredge through their original report, I can find
situations which, looked at in isolation, without looking at the rest of the report,
that if that was the only data I gave you, I could claim that that proved that
power lines protected children against childhood leukemia.

PATRICIA BUFFLER: It is analogous to the Texas Sharpshooter. What we're
searching for in any research is truth, and that search for truth argues for being
rigorous, having clearly documented your methods, and not withholding any
information, not using the information in a selective way.

NARRATOR: [voice-over] How many of the EMF studies commit this error is
unclear. Original contractors' reports are rarely available. Yet the issue is
fundamental. Outside of epidemiology, most scientists are unanimous. You
cannot confuse a study that tests a hypothesis with one that generates them.

ROBERT ADAIR: Epidemiologists should decide what they are going to look
for, and write it down before they make the search, just what they're going to
look for and just how they're going to look for it. Then, after they make their
analysis, they will find two sets of things. They will find answers to the
questions they have asked, and now we have a situation where one can analyze
properly the statistical significance of those answers. They will also have
answers to questions which weren't asked. Odd things may show up, and that's
very interesting, too, but we separate those in another category. We call those
hypothesis-generating experiments. And if you want to say whether that's really
a real result or just a fluctuation, then you must do a second experiment were
that is on your list of things to look at.

PAUL BRODEUR: Yeah, this may be a weakness in the album study. I'm not
familiar with it myself. And there are weaknesses to be found in all of the
epidemiological studies. You can take any given epidemiological study -- and I
saw the asbestos industry do this time and again -- as it comes over the horizon,
gets published, you can shoot it down with all kinds of stuff. They're trying to
shoot down the Canadian study now. But the totality of these studies suggests a
pervasive major public health problem that needs to be dealt with, and that I
believe will have to be dealt with, because the American people will demand that
JULIE LARM: No

ADRIAN DENDINGER: Not at all. I'm 100 percent sure.

NARRATOR: [voice-over] Rightly or wrongly, power lines are now part of a long list of environmental agents that the public fears. While unproven, these fears, once established, are hard to erase.

PETER VAHLBERG: Reducing anxieties is far, far more difficult than inciting anxieties. I think it partly hinges on a difficulty that people have with understanding numbers. I mean, you can say the risk is high, the risk is low, and so forth, but the quantitative differences are difficult for people to appreciate.

NARRATOR: [voice-over] But why would people fear power lines more than established risks, such as smoking and driving?

JOHN MOULDER: What are the big risks that people seem to be totally unafraid of, like driving a car, versus the small risks they appear to be very afraid of? The differences seem to be people are less afraid of risks they think they control, and they're less afraid of risks that they understand, so the things that people are most afraid of is things they can't control and don't understand, and certainly power lines fall right in that category.

NARRATOR: [voice-over] A society must pay a price for its fears, whether they are real or imaginary. The power line controversy is costing an estimated $1 billion a year, money, critics argue, that could be much better spent elsewhere.

ROBERT ADAIR: The total cost to our society with this nonsense, this unreasoning fear of electromagnetic fields, is a serious drag on our economy and, in some sense, on our civilization. And it's like the little boy who calls wolf all the time, and one of these days a real wolf is going to come, and people are going to be so used to the imaginary wolves that they're going to miss the real wolf.

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DAVID FANNING ................................................................. Executive Producer

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Breast Implants on Trial

ANNOUNCER: Tonight on FRONTLINE—

DEMONSTRATORS: Stop the lies and get the facts! Stop the lies and get the facts!

Attorney JOHN O'QUINN: We're going to win this fight. We're going to beat the Dow machine.

ANNOUNCER: Four hundred thousand women say they've been poisoned, but medical science says there's no proof.

JOHN O'QUINN: Dow's engaged at the present moment of buying science.

Dr. DAVID KESSLER, FDA Commissioner: The scientific evidence is simply not there.

ANNOUNCER: Tonight get the real story when FRONTLINE puts "Breast Implants on Trial."

NARRATOR: The operation you are seeing is rare and controversial. A few years ago, it was one of the most common operations, performed on more than a million women. Today in America only a handful of surgeons still offer it as part of a clinical study. The silicone breast implant — a bag filled with silicone implanted to augment or reconstruct breasts — has become the center of a bitter controversy involving nearly half a million American women. Is this a valuable medical device or one of the greatest health disasters in history?

Thirty-three years ago, when this woman, Timmie Jean Lindsey, had the first ever silicone breast implants, it seemed like a good idea. In March, 1962, Timmie Jean, then 28 years old, went into a Texas hospital to have some tattoos removed when two plastic surgeons came to her with a question.

TIMMIE JEAN LINDSEY: And they asked me would I like to have breast implants. What they were going to do would be enlarge my breasts. And, you know, after having six kids, it wasn't that flat, it was just they sagged. Of course I said yes.

NARRATOR: Almost immediately, she noticed an effect.

TIMMIE JEAN LINDSEY: Well, it was about six weeks after surgery and we were going to go out to a club, so we walked into this bar and all the men just went, "Wow!" you know, and whistled and wolf calls and everything, so I thought—kind of went to my head, you know? I thought, "Wow!" But the breasts standing out and enlarged made me—my waist look smaller and everything—accentuated the waist. It kind of built my self-esteem or my confidence or something like that because, really, I thought, after having six children, that no one— I just probably never would attract any men or anything. But it really did the trick.

NARRATOR: In the next three decades, many thousands of women followed in Timmie Jean's footsteps. For a few thousand dollars women could change their shape from the way they were to the way they wanted to be. In sunbelt states like Texas, as many as one woman in 50 had silicone breast implant surgery.
But there was another group of women for whom the new prosthesis offered a lifeline. In 1977, when Gladys Laas discovered she had lumps in her breast and would have to undergo a radical mastectomy, she was devastated. Then doctors proposed reconstructing her breasts with silicone, offering her a possibility of being whole again. GLADYS LAAS: I had to wait a month after the mastectomies to have reconstruction, so I knew what I looked like without breasts and so then a month later, once again, I have beautiful breasts. They were soft. They were supple. It was just impossible to tell that they were not real breasts. The surgeon, he told me that they were absolutely harmless and that they would last me a lifetime. He said, "Matter of fact, Gladys," he said, "if you live to be 80 and die, all your friends are going to be very envious because when you're in the casket, you may be an old woman, but you'll have beautiful breasts." So that sort of has stayed with me! NARRATOR: Gladys was one of many thousands of women with breast cancer or fibrocystic disease who, following radical mastectomies, had their breasts reconstructed with silicone implants in the '70 and '80s. For 13 years Gladys was happy with her implants, but then she began to experience a litany of bizarre health problems. GLADYS LAAS: I started having problems probably around 1990. My shoulders would freeze up. Had to have my shoulders injected and then I had to take physical therapy and then I would go three or four months and the first thing you know, they would start freezing up again. And so this kept happening.

And then I would have a stinging sensation in my face that would come like someone just drew a line right here, just exact, nowhere else. And it would sting, sting, sting like bees were stinging me. And that would come and go.

I had double vision. The tip of my tongue would go numb like I'd been to a dentist. I could not remember things. And I would drop things or I'd knock things over. I would have terrible spasms in my legs. They would just draw up under me. And my arches would curl up and my husband would have to hold my feet on the floor in the evenings a lot.

BOB LAAS: I saw a lot of these things before she would realize them. I didn't know what was causing them and I knew that there was something wrong. And when she would go to sleep on the couch right after supper and sleep till time to go to bed, that was not my wife. That was this person that had a big problem.

NARRATOR: Gladys wasn't the only woman with breast implants having health problems, as Connie Chung told millions of viewers later that year.

CONNIE CHUNG: ["Face to Face With Connie Chung"] Most of us know little about breast implants. We've seen the ads. We've heard the rumors about which celebrities have them and which don't, but we don't know anything about the dangers. Since the early 1960s—

NARRATOR: The program told viewers that many women with silicone implants were reporting patterns of illness from breast cancer to autoimmune diseases like rheumatoid arthritis. Since roughly one million women had implants, a huge public health crisis might be looming.

Many celebrities had silicone breast implants and some of them, like Jenny Jones, had also experienced health problems. They used their television shows to warn other women of the dangers.

1st AUDIENCE MEMBER: ["Jenny Jones"] I've got fibromyalgia, chronic fatigue syndrome. I've got— I've been tested for scleroderma, lupus, rheumatoid arthritis. I'm 25. I taught aerobics and I can hardly get around.
2nd AUDIENCE MEMBER: I had my first heart attack at 44. I'm on heart medication. I have undifferentiated lupus, Sjögren's, arthritic condition. I'm too young!

JENNY JONES: What kind of implants?

2nd AUDIENCE MEMBER: I had the same—the silicone—

JENNY JONES: Silicone?

2nd AUDIENCE MEMBER: —breast implants.

JENNY JONES: Silicone.

Raise your hands if you've had problems. That's just about everybody.

NARRATOR: As the media devoured the story, fear spread among American women with implants. When, they wondered, would they get ill?

Dow Corning, the largest manufacturer of breast implants, had heard some of these complaints before. In the 1980s a few women had claimed that the silicone contained in the bags had leaked out, damaging the immune system and causing it to attack their own tissues, which led, in turn, to autoimmune diseases like rheumatoid arthritis.

Some, like Mariann Hopkins, had even taken the company to court. In 1991 she sued Dow Corning, arguing that silicone leaking from a ruptured implant caused her autoimmune disease. Her case was based on hundreds of pages of internal memos and reports that her lawyers obtained from Dow Corning suggesting that the company had been aware of problems with the devices, but had continued to market them anyway.

READER: [Dow Corning memo, 5/13/75] "We are hearing complaints from the field. The general claim is that the units bleed profusely after they've been flexed vigorously."

READER: [Dow Corning memo, 6/8/76] "I have proposed again and again that we must begin an in-depth study of our gel envelope and bleed phenomenon. Time is going to run out on us if we do not get underway."

READER: [memo to sales force, 5/16/75] "The new implants have a tendency to appear oily after being manipulated. Wash with soap and water in nearest washroom, dry with hand towels."

READER: [Dow Corning memo, 4/29/80] "To put a questionable lot of implants on the market is inexcusable. I don't know who's responsible for this decision, but it has to rank right up there with the Pinto gas tank."

MARIANN HOPKINS: I will tell you, during my trial I was just absolutely appalled by the information that I heard. I felt that the manufacturer had a social, moral and ethical responsibility to the consumers and that this product should not be on the market.

NARRATOR: The jury agreed. In December, 1991, they awarded Mariann Hopkins a stunning $7.3 million, claiming Dow Corning was guilty of negligence and fraud.

Hopkins's victory served as an inspiration for other women. All this activity had caught the attention of the FDA which, after years of doing little, had finally gotten around to asking breast implant manufacturers for comprehensive safety data.

Commissioner David Kessler, who was appointed in 1990, felt that the FDA had let women down. Kessler was concerned by a series of case reports by physicians suggesting a possible association between breast implants and autoimmune diseases. Then he received a package of Dow Corning documents from Mariann Hopkins's lawyer and he was disturbed by what he read.

Dr. DAVID KESSLER: There were a whole set of internal Dow documents that raised concerns. They were reporting areas of thinness and thickness to the outer envelope. They were talking about increasing bleed rates. They were saying that there were problems when the devices were flexed, that they would bleed profusely or that they would rupture.
And when I saw those quality assurance problems and I saw that those devices had been implanted, my first concern was, basically, to say "Time out. We need to get a handle on this. We need to get certain questions answered. And I can't continue to allow this device to be implanted until we have the answers to those questions."

NARRATOR: On January 6th, 1992, Kessler made a dramatic announcement that caught the attention of the nation.

Dr. DAVID KESSLER: I am asking that physicians cease using silicone gel implants. As physicians, our first obligation is to do no harm. We do not know exactly what material—

Dr. MARCIA ANGELL, Executive Editor, "New England Journal of Medicine": I don't think Kessler could possibly have foreseen the consequences of his action.

WOMAN AT TALK SHOW: Walk in my shoes! You want a study, study me!

Dr. MARCIA ANGELL: He said, "Look, I'm going to remove breast implants from the market. I know that one to two million of you already have them. Not to worry. Don't get them taken out. Nevertheless, I'm removing them from the market so that other women can't get them."

And I think women who had breast implants quite rightly were terrified by this. And there were women who were so frightened that they did desperate things. There were a few women who tried to carve out their own implants with razor blades because they couldn't afford the surgeon's fee to have them removed. This is a measure of the fear, the alarm, the desperation that his action caused.

NARRATOR: Dow Corning, the largest implant manufacturer, found itself under attack from an outraged media.

KATIE COURIC: ["Today"] Let me read a couple of the particularly disturbing quotes. One salesman said putting these implants on the market was — quote — "inexcusable" and had to "rank right up there with the Pinto gas tank." An internal document instructed salesmen to wash off the oily film off the outside of the implants, ostensibly, I'm assuming, so doctors wouldn't realize that they, in fact, could leak.

ROBERT RYLEE: Oh, no.

KATIE COURIC: You said that this is a P.R. nightmare, but isn't it much more than that? Doesn't this show some sort of unethical behavior by your company?

ROBERT RYLEE: Not at all. Not at all. Both those documents are very interesting. Both of them related to the complaint of a salesman back to his sales manager and they had to do with the appearance of the product, okay? It was not an issue that involved the safety of the product. It had to do with the appearance.

DEMONSTRATORS: Stop the lies and get the facts! Stop the lies and get the facts!

NARRATOR: Kessler's moratorium had turned the concerns of individual women into a political movement.

KATHLEEN ANNEKEN, RALLY SPEAKER: I am appalled that the American public has not called for criminal charges against these manufacturers.

NARRATOR: Thousands of women were frightened, angry and looking for help and there was no shortage of people ready to help them, like the legendary Texas attorneys John O'Quinn and Rick Laminack, who some called "the kings of tort."

Attorney JOHN O'QUINN: There were thousands and thousands, tens of thousands of women who reported being ill and so only common sense tells you, with that many women that are ill, something's wrong with this product.

NARRATOR: And those women, O'Quinn argued, needed expert help.
JOHN O'QUINN: These women cannot possibly get justice without highly experienced, capable lawyers who are actually willing to put up the money to fight these companies. To do one of these cases, you got to spend probably a million dollars to get knowledgeable enough to present it. Most lawyers cannot afford to spend a million dollars to take a case to court.

NARRATOR: O’Quinn could. Later that year he convinced a jury to find for his client, Pamela Johnson, against implant manufacturer Bristol-Myers-Squibb, awarding her $25 million.

With such huge sums, a flood of women came forward asking O’Quinn and Laminack to sue manufacturers on their behalf. As the number of clients grew, O’Quinn and Laminack began holding regular meetings to brief clients and boost morale in what, for most of them, was going to be a long and bitter fight with corporate America.

JOHN O'QUINN: They are so scared of Rick Laminack and John O'Quinn that they put us on the front cover of their most famous magazine, Fortune. This is what all the executives of Fortune 500 read. And of course, the point of the article is to demonize us, so they call us "the lawyers from hell." We're the lawyers that give them hell.

Make no mistake, we are engaged in a holy war. We're going to win this fight. We're going to win it because we're right and we're going to win it because, like no case I've ever worked on, this is the champion of all of them. I've got the greatest clients who ever lived. And if we're going to beat the Dow machine — and they got a lot of help. 3M is not a small squirt itself, nor is Bristol and Baxter. Together, these companies are worth in excess of $50 billion — it will be only because of a united effort and your voice, your voice saying, "No, we're not going to take this."

NARRATOR: All over the country, cases were filed. Fueled by lawyers' advertisements, media publicity and reports of enormous verdicts, women came forward— first dozens, then hundreds, then thousands, all wishing to pursue cases against Dow Corning and the other manufacturers. Soon it was clear that this would become the largest mass tort in history, eclipsing litigation for asbestos, Dalkon shields and Agent Orange. There were so many cases that they threatened to choke the legal system.

The growing litigation crisis quickly attracted the attention of specialists in mass tort litigation like the Cincinnati lawyer Stan Chesley. Chesley realized that something had to be done, and quickly, otherwise there would be total chaos and women might not get anything.

STANLEY CHESLEY: The average federal judge or the average state judge is not going to spend the rest of their judicial career trying only breast implant cases. "Oh, hi. I'm Judge Smith and from now on— I'm 40 years old and from now on until I retire, I will try nothing but breast implant cases."

NARRATOR: Chesley saw the opportunity to create a massive class action. By amalgamating thousands of women into a class and representing them all at once, their chances of getting compensation were much better.

STANLEY CHESLEY: The class action was a means to put some order in this because the key was to build a united front and go after the defendants. And if everybody was going off on their own— one might sue Dow Corning, one might sue 3M, somebody may want to go after the raw manufacturer, the raw product manufacturer. There were certain defendants that we already knew were bankrupt or almost bankrupt. And so my view about the class action was more a procedural case management tool. It was the means to put some order in this.
NARRATOR: But lawyers like O'Quinn and Laminack thought Chesley was trying to take control of perhaps the most lucrative litigation of the century. They urged their clients not to join Chesley, who had a reputation for settling quick, but stick with them and perhaps get multi-million-dollar settlements.

STANLEY CHESLEY: Well, a lot of lawyers thought I wanted to take over the litigation. My view was this litigation was big enough that we needed all the help we can get. And the other rap that I get is, "Oh, Chesley settles quick." Well, I don't settle quick.

NARRATOR: Dow Corning found themselves under attack on two fronts: Chesley's class action, on the one hand, and thousands of individual cases brought by trial lawyers like O'Quinn on the other.

Located in Midland, Michigan, Dow Corning had built its wealth on mass producing a single, very versatile and useful product. They took silicon, the second most abundant element on earth, and transformed it into a polymer, silicone, which they found possessed an incredible set of properties. It can form a liquid, a rubber, a putty and a solid. It could act as a de-foaming agent and as a water repellent. Today silicones are found everywhere, from glues to shampoos, deodorants to gel tabs.

Today everything from automobile parts to hose pipes are made from silicone. It has become a crucial raw material for American industry. Founded in the 1940s, Dow Corning had prospered as a traditional manufacturing industry, producing one basic product. Now they found their future threatened by an industry of the 1990s, mass tort litigation.

At Laminack and O'Quinn's Houston offices, armies of paralegals toil away, managing the cases of thousands of women. Success depends on winning lawsuits, a service for which they reportedly charge 40 percent.

RICK LAMINACK: The deluge of paper that comes in every day is so extensive that we have half a dozen people that do nothing but file all day, every day.

NARRATOR: Laminack and O'Quinn have mechanized litigation every bit as much as Dow Corning mechanized production of silicones. Their team of staff that even includes a full-time nurse prepares all the groundwork for the ultimate courtroom battle.

Remarkably, they even have their own courtroom to rehearse expert witnesses and their own video studio to record performances. The aim is to prepare a formidable case, so formidable that a corporation is willing to make a settlement to avoid fighting them in court.

RICK LAMINACK: These files contain the deposition testimony of about a million pages. Every corporate executive, every technician, every internal employee of Baxter, Bristol-Myers, Dow Corning, 3M that had anything to do with breast implants have been deposed thoroughly. And this is probably the most complete library in the world of the sworn testimony of the bad guys. Now, the explanted implants themselves—

NARRATOR: But the most unusual archive they have is this room, full of hundreds of silicone implants removed from their clients' bodies.

RICK LAMINACK: It's probably the most complete collection of used implants anywhere in the United States and that is of great scientific significance.

NARRATOR: But they weren't the only game in town. Back in Cincinnati, Stan Chesley had not only established the class action, but had also succeeded in having Cincinnati chosen as the main depository for the nationwide litigation, which now involved hundreds of lawyers and tens of thousands of women plaintiffs in every state. Depositions and documents relating to litigation against all the companies are stored in a huge Cincinnati warehouse.

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Litigation on this scale, in Chesley's view, needed organizing so that other lawyers perhaps not as experienced as O'Quinn could participate. His law firm prepared and sold a "do-it-yourself" guide to suing breast implant manufacturers.

STANLEY CHESLEY: We can have an army of trial lawyers all over the country and we can arm each one of those lawyers with a briefcase of ROM discs and be prepared to go try their case.

Attorney DIANNA PENDLETON, Waite, Schneider, Bayless & Chesley: The CD holds roughly 20,000 to 25,000 pieces of paper, so we have a total of three million pieces of paper on CD right now.

We put together these trial notebooks. This is one of the notebooks that's involved with the Baxter company. And if you look at it and you open it up, you can see by the tabs, you can literally take this notebook and prepare for a case, starting from the beginning of a case to the end. You can see "jury selection" followed by "opening statement," "witness list," "deposition designations," motions that you can file or respond to, the exhibit list, jury instructions and then all the way to verdict forms and post-trial briefs.

NARRATOR: By the end of 1994, some 20,000 individual lawsuits had been filed against Dow Corning and countless other women were considering legal action. In desperation, Dick Hazleton, the third CEO since Kessler's moratorium, began negotiations toward a global settlement plan masterminded by Stan Chesley to pay a fixed, one-time amount into a fund against which the women could claim. But if they were innocent, why did they want to settle?

DICK HAZLETON, Chairman and CEO, Dow Corning Company: For a company in a position like ours, faced with 20,000 lawsuits, the only feasible way for us to move out of that situation is to try to seek some sort of an overall resolution of the— of the case.

INTERVIEWER: A settlement?

DICK HAZLETON: A settlement of some sort. And that presents a problem because when we start to talk about that, the perception that's created immediately is that we're admitting guilt. Why would we spend money to participate in a settlement if, in fact, we believe our products are safe? Why don't we stand and fight? But it comes back to that fundamental economic calculation.

NARRATOR: Breast implants formed a tiny part of Dow Corning's business, but the ramifications of the mass litigation affected workers in all parts of the company, like Linda McInally, who now faced an uncertain future.

LINDA McINALLY: I think that what's happening to Dow Corning could happen to any company in this country. I mean, there's a product at every company that some lawyers are going to decide is the target and they're going to go after it with their mass torts. I don't think that what's happening is because of Dow Corning in any unique—did anything differently than any other company. I just think it's a decision that those lawyers made to go after this product.

NARRATOR: Workers rallied around management, giving them their full support.

KIM HOHISEL, Dow Corning Employee: I've never worked with a group of individuals, people, management or otherwise, that are so together on this thing and I think that, by continuing to work hard and keep focused and—and let the decisions be made in the courts, I think we will come through it. I—I don't know what the end, you know, results will be, but I think we will come through it.

NARRATOR: Back at the Food and Drug Administration, Kessler had watched in horror at the effects of his announcement. He had never said breast implants were unsafe,
he had simply called a time out to examine the evidence that had emerged in court cases. A few weeks after his moratorium, he had called the FDA’s scientific advisory panel together to consider all the data.

One of the special consultants to the panel was John Sergent, former president of the American College of Rheumatology.

Dr. JOHN SERGENT: Hello, Tammy.

TAMMY: Hello.

Dr. JOHN SERGENT: How do you feel?

NARRATOR: Sergent is an expert on autoimmune diseases which affect the muscles and joints, the so-called connective-tissues. Tammy, who does not have breast implants, has scleroderma, a very serious and sometimes fatal disease. Other of Sergent’s patients have rheumatoid arthritis and systemic lupus. If such serious conditions were being triggered by silicone leaking from the implants, then with one million women exposed, rheumatologists might soon be facing an epidemic, so Sergent was deeply interested.

Dr. JOHN SERGENT, Rheumatologist, Vanderbilt University: I went to the panel with the bias that there probably was something to it. First of all, I believed that Dr. Kessler probably would not have asked for the moratorium if he didn’t have real data, meaningful data. And secondly, I hadn’t, at that point, seen any— any rebuttal to what people had been saying. So I went to the panel expecting that there was something to it.

I came back from the panel very disappointed. There was no attempt to do any kind of scientific look at the population. And, as a matter of fact, there was almost no attempt to filter this material. It was a series of anecdotal reports from the two or three rheumatologists, from a neurologist, from others.

You have to understand that these diseases are not rare that we’re talking about and we had a million women walking around with breast implants. Therefore, we would expect to see 40,000 or 50,000 cases of these various diseases occurring over a period of time.

NARRATOR: Chairperson of the panel was Elizabeth Connell, a veteran women’s health researcher. She was also disappointed at the lack of hard scientific evidence.

Dr. ELIZABETH CONNELL, Chair, FDA General and Plastic Surgery Devices Panel: Although there were data on autoimmune disease, they were certainly not scientifically valid and it’s always been very, very clear you cannot make good value judgments based on anecdotal types of— of information. But that, you see, was— was our problem.

NARRATOR: So the FDA panel settled on a compromise, recommending that use of silicone implants could continue, but only for patients undergoing breast reconstruction, not augmentation, and only as a part of a scientific trial where the women would be followed.

Women wanting breast augmentation could still get saline implants. These did not feel as natural and had a tendency to wrinkle, but if they ruptured all that would leak out was harmless salt water.

By the end of 1992, there were several scientific studies under way, involving researchers from some of the world’s top medical centers, aimed at determining whether or not silicone breast implants caused systemic disease. But these studies would take time.

Scientific research moves slowly and methodically. Doing the research is just the beginning. Before it is taken seriously, a research report must be submitted to one of hundreds of medical journals and reviewed by other scientists. If it is acceptable, it gets published where other scientists can read and criticize it further. Only if it survives this
process and the results are replicated does the information become accepted into the
canon of scientific knowledge.

Dr. MARCIA ANGELL: We have to wait for the science. What was so startling to
me, in this case, was the disconnect between the science, which largely wasn’t there in
1992, and what was happening in the courts and what was happening at the FDA and
what was happening in public opinion. The disconnect was amazing.

NARRATOR: Marcia Angell, the executive editor of the New England Journal of
Medicine, had been troubled by Kessler’s moratorium and the ensuing panic. She felt
that the trial lawyers and the media had proclaimed the dangers of breast implants
without waiting for scientific proof. She urged women not to jump to conclusions until
the scientific evidence was in.

Dr. MARCIA ANGELL: I think a reasonable person has to be skeptical. I think a
reasonable person always has to be skeptical. History is replete with instances of health
scare based on claims, testimonials, anecdotes and we have to wait for the science.

NARRATOR: Being skeptical, according to Angell, did not mean doubting that
women like Gladys Laas and Mariann Hopkins were ill. The issue concerned whether
their illnesses were caused by silicone breast implants or would have happened anyway.

Dr. MARCIA ANGELL: You have to look at coincidence. About 1 percent of the
population of women have breast implants and about 1 percent of American women
have connective-tissue diseases, the most common being rheumatoid arthritis. So if you
do the arithmetic, you find that in this country you can expect about 10,000 women
will have both, just by coincidence.

Since connective-tissue disease can occur in women with or without breast implants,
the trick here is to rule out coincidence and the only way you can do that is by an
epidemiologic study which tries to see whether connective-tissue disease is more com­
mon in women with breast implants than it is in women without breast implants.

Only when you have done such studies and found the answer to that question can
you rule out coincidence.

NARRATOR: It was little comfort to women like Gladys Laas that controlled
epidemiologic studies were under way. Gladys had spent most of 1992 and ’93 seeing
doctors and racking up huge medical bills. Both of her implants had ruptured and she
worried that leaking silicone might have caused her illness. This was the view of the
physician who took major responsibility for her diagnosis and care, a Houston
neurologist named Dr. Bernard Patten.

GLADYS LAAS: I heard of Dr. Patten and I was able to get an appointment and have
a physical and then have a nerve biopsy done. And when he, you know, saw the nerve,
he immediately told the operating room nurse to go get my husband because he wanted
to tell us both at the same time that I was extremely ill.

NARRATOR: After telling Gladys her life was in danger and that her implants needed
to come out, Patten ordered a series of tests followed by aggressive therapy, including a
blood-cleansing treatment called plasmaphoresis.

GLADYS LAAS: I had six of those. About six weeks after that, then I had three
months of chemotherapy every day, just like a cancer patient. And before I had any of
that done, I had 12 weeks of I.V.'s of gammamune.

NARRATOR: Gladys was hit with a mass of medical bills.

GLADYS LAAS: You get a hospital bill for $30,000, $65,000. You get these lab tests
that are $1,500 and $3,000 a throw. The gammamune— the gammamune is $1,500 a
dose. I said, "No, uh-uh. This— this is not right." We were told that these would last
me-forever. We were told— and even if they didn’t, we were told that they were harm­
less.
Take all of that and set all that aside, how would you like to have to have your breasts removed again, even if everything else wasn't so? So it's, like, "No. No." We need to be compensated for this. And I told them — you know, Mr. O’Quinn and Laminack — "Those people owe us some money."

NARRATOR: Gladys joined thousands of other Texas women and put her faith in the skills of John O’Quinn and Rick Laminack. Only with their help could she hope to get compensation.

JOHN O’QUINN: How many of you women were told that they would last a lifetime? Raise your hands. That was a lie.

NARRATOR: At Dow Corning, shocked by this anger, executives were waiting anxiously for the results of scientific studies. They believed passionately that silicone was not dangerous and that, in time, they would be vindicated.

Medical products formed only 3 percent of Dow Corning’s business. They had begun using silicone in medical devices in the 1950s with hydrocephalus shunts. Then silicone found its way into cardiac pacemaker leads and catheters, even as a lubricant for syringes. Quickly silicone became a mainstay of the medical device industry.

Silicone was a natural choice for breast implants because it could simulate the consistency of breast tissue and because it was widely believed to be inert.

Dow Corning accepted that implants could cause local problems. Like any foreign body, the implant caused inflammation and a capsule of scar tissue formed around it. This fibrous capsule frequently became hard and contracted, deforming the breast, and surgeons often would have to break the capsule to restore the shape.

Dow Corning also accepted that occasionally implants could rupture inside the capsule, but claimed it was a very rare event. Others disagreed. Since Kessler’s moratorium, plastic surgeons had been besieged with women demanding to have their implants removed.

Some surgeons did hundreds of explantations. They removed the encapsulated implant from the breast, cracked open the fibrous capsule and looked inside. Some implants emerged looking like new. Others seemed to have disintegrated. No one was quite sure of the reason — trauma, age, weaknesses, surgical nicks. But a number of scientists argued that the true rupture rate might be much higher than previously thought. Some put it as high as 50 percent or more.

While most of the silicone stayed contained in the fibrous capsule, there was a possibility that some could escape into the body. The crucial issue, therefore, was not rupture, but whether silicone was truly biologically inert or whether it caused systemic disease.

Dow Corning had carried out a series of animal experiments which they claimed proved silicone was neither toxic nor caused cancer, but the FDA had found these studies inadequate, claiming that they do not predict how implants would fare in the human body over a lifetime of use.

Since the moratorium, a number of centers had begun controlled epidemiologic studies on humans. The Mayo Clinic in Rochester, Minnesota, had complete records on women going back many decades. They looked at every woman in the county who had often breast implants between 1964 and 1991 and compared them with a control group of their neighbors without implants, matched for age. They tried to determine whether the women with breast implants were more or less likely to contract connective-tissue disease than the controls.

The article was sent in to the New England Journal of Medicine in November, 1993, where it entered a long peer review process to check if the science was sound.
Meanwhile, in Cincinnati, Stan Chesley was putting the finishing touches on a global settlement deal. After intense negotiations, Dow Corning agreed to put up more than $2 billion into a breast implant victims fund. Other manufacturers brought the total to over $4 billion.

Women with implants were encouraged to register, not only those who were currently sick, but also those who felt fine, in case they developed symptoms in the future. The Alabama federal court administering the global settlement announced a deadline for women to join in with Chesley's plan or opt out and go it alone with trial lawyers like John O'Quinn.

ANNOUNCER: [television commercial] If you have ever had breast implants, this is an official legal notice from the U.S. District Court, northern district of Alabama.

OFFICIAL: Women must decide by June 17th if they do not want to participate in this settlement. To help you make this personal legal decision, the court has prepared this information package. All women with implants should call or write for this information. It's free and all names will be kept confidential.

NARRATOR: By chance, the same week as the deadline, the results of the Mayo Clinic study made it into print. They had looked to see if women with breast implants got more connective-tissue disease than women without breast implants. They found absolutely no difference. Investigator Sherine Gabriel announced the news.

SHERINE GABRIEL: It's my hope that these results can reduce some of the anxiety that many women with breast implants feel regarding their future.

NARRATOR: But far from reducing anxiety, Sherine Gabriel and her colleagues were roundly attacked.

STANLEY CHESLEY: Question: Who paid for it? Mayo didn't pay for it. And second study—I'm very suspect about any studies that are funded by the plastic surgeons. We took away their pet industry. I mean, their industry is in shambles.

NARRATOR: The Mayo study had received some funding from an educational arm of the plastic surgeons association which, in turn, had received money from Dow Corning. But was Chesley saying that the Mayo Clinic had been bought off?

STANLEY CHESLEY: I don't like the word "buy," but they love research grants. I mean, I was on a board of— at— chairman of the board of trustees of a university and I know how diligently they fight for research grants.

NARRATOR: Some lawyers even suspected that the New England Journal of Medicine was implicated along with the Mayo Clinic. Undaunted by the fact that the Journal is the most prestigious medical journal in the world, operating independently since 1812, they fired a warning shot across Marcia Angell's desk.

Dr. MARCIA ANGELL Executive Editor, "New England Journal of Medicine": I received a subpoena in the fall of 1994, growing out of the Mayo Clinic study, and then another one from the same people the following spring, asking me to produce all documents that indicated that the breast implant manufacturers had paid me. And they implied the New England Journal of Medicine had been paid by the breast implant manufacturers, an outrageous suggestion.

Attorney, STANLEY CHESLEY: So what? I got news for you. Let them be offended. Let me tell you something. I have seen doctors involved in research at my institution when I was chairman of the board and I asked questions. "Why did you take this study? What were— what were the ground rules?" And they got offended when I asked those questions because they want to hide behind their white coat.

I got news for you. Anybody who gets offended or easily intimidated by these kind of questions shouldn't be in that business because guess what? They are not sacrosanct.
SYBIL NIDEN GOLDRICH, Command Trust Network: The science? The devil with the science. It doesn’t matter anymore.

NARRATOR: Sybil Niden Goldrich is a former breast cancer patient who once had silicone implants. Today she spends much of her time as co-chairperson of Command Trust Network, one of a series of well-organized support groups that puts out newsletters and holds seminars. The thrust of such activist groups is that women should take charge of their own health. They are deeply suspicious of the medical establishment and don’t hesitate to criticize them.

INTERVIEWER: Women get autoimmune disease with our without breast implants. Agree or disagree?

SYBIL NIDEN GOLDRICH: I agree.

INTERVIEWER: To prove causality is a complex process involving epidemiology, good controls and so forth. Agree or disagree?

SYBIL NIDEN GOLDRICH: Disagree. Disagree because to prove causation, they should have done it before. If they wanted to really know whether this was going to be a problem — and obviously, they had a hint of it because they mentioned it — they should have established the studies beforehand.

Why now? Why now, all of a sudden, the hallowed institutions are coming forward and saying, "We must tell you you’re crazy"? No. Shame on them. They can’t get away with that. That’s wrong. The scientific community abdicated its responsibility when it did not do the science up front.

How many times has a woman gone to a doctor who said, "Oh, your aches and pains — my goodness, you’re 40. It’s to be expected. Now, now. Now, you take this little tranquilizer and go home and be a good girl."

MARCIA ANGELL: One of the things that has hurt me personally is the suggestion that this is a women’s issue and if you don’t believe that breast implants cause connective-tissue disease you are therefore anti-feminist or anti-woman. I’m a feminist. I think I’ve earned my badge as a feminist. I believe very strongly in women’s rights in — in all ways. But this is a scientific matter. It is not a matter of opinion. It’s not a matter of legal argument. It’s not a matter of debate. It’s a scientific argument and it will only be decided by good science.

NARRATOR: Late in 1994, Gladys Laas made it to trial. For 11 weeks O’Quinn argued her case before a Texas jury. Dow Corning’s lawyer, David Bernick, tried to sway the jury and the press with the Mayo Clinic study.

DAVID BERNICK: That scientific evidence shows no connection between breast implants and the kinds of rheumatic diseases that have been complained about and have been the subject of case reports.

NARRATOR: Laminack and O’Quinn waited anxiously while the jury deliberated. The jury had a lot of information to consider. Experts had discussed thousands of pages of internal memos, documents and scientific studies. Doctors had discussed Gladys’s medical history.

The jurors deliberated for 11 days before handing down their verdict. They awarded Gladys $5.2 million compensation for her suffering.

JOHN O’QUINN: We are extremely pleased.

REPORTER: Tell us how you’re feeling right now. This has been a long trial for you.

GLADYS LAAS: Oh! I’m very relieved it’s over with, that’s for sure. I’m also — I’m so thankful that 12 people that I never saw in my life could come together and realize that we’re all not crazy, that we really are sick, and that
these implants did this to us and that they can try to make these corporate people responsible for what they've done to us. And my husband and I both are very—just very glad that it's over with.

NARRATOR: How did the jury reach its verdict? Two jurors agreed to talk to us. We asked if they were satisfied that silicone caused Gladys's disease?

JOSE RAMIREZ: No, I don't think so.

JUDY SORENSEN NAUMAN: Uh-uh. Couldn't.

JOSE RAMIREZ: No.

JUDY SORENSEN NAUMAN: No.

NARRATOR: Why not?

JUDY SORENSEN NAUMAN: Evidence.

JOSE RAMIREZ: I don't think there is in those studies— I think they're probably still studying them right now to figure out if they really do cause disease.

NARRATOR: Was there any evidence that the implants hurt Gladys? Did the evidence prove that the implants were actually harmful?

JUDY SORENSEN NAUMAN: No, there isn't enough evidence—

JOSE RAMIREZ: No, there isn't.

JUDY SORENSEN NAUMAN: —for that.

NARRATOR: Was there enough evidence to prove the implants were safe?

JUDY SORENSEN NAUMAN: No.

JOSE RAMIREZ: No. They didn't—

JUDY SORENSEN NAUMAN: Nope.

NARRATOR: But what about the prestigious Mayo Clinic study that Dow Corning had pinned their hopes on? Did that figure much in the deliberations?

JUDY SORENSEN NAUMAN: Uh-uh.

JOSE RAMIREZ: No.

JUDY SORENSEN NAUMAN: That didn't really impress me that much. Uh-uh.

JOSE RAMIREZ: I don't think we went over that during the deliberations, either.

NARRATOR: So why, then, did they award Gladys such a large sum of money?

JOSE RAMIREZ: She had a couple of years to retire. We added that up. That went into the— the $5 million.

JUDY SORENSEN NAUMAN: She's having to have help—

JOSE RAMIREZ: Yeah.

JUDY SORENSEN NAUMAN: —with her housework. She can no longer cook. Her husband's having to do a lot of the cooking. They used to travel a lot and go on vacations—

JOSE RAMIREZ: Yeah.

JUDY SORENSEN NAUMAN: —and they can't do that anymore.

JOSE RAMIREZ: The future medical bills.

JUDY SORENSEN NAUMAN: I mean, it's just— you know.

JOSE RAMIREZ: All those added up together.

JUDY SORENSEN NAUMAN: Her life has been changed, both of them.

NARRATOR: Dow Corning declared the verdict "illogical" and promised to appeal. Despite Gladys's impressive victory, the Mayo Clinic study had been a portent of what was to come. By the summer of 1995, many more scientific studies had made it into print.

READER: [Englert and Brooks, "Australian A New Zealand Journal of Medicine," February, 1994] "This study failed to demonstrate an association between silicone breast implantation and the subsequent development of scleroderma."
READER: [Wigley et al., The Johns Hopkins Medical Institutions, 1992] "These data fail to support the hypothesis that augmentation mammoplasty with silicone gel-filled prosthesis is a risk factor for the development of scleroderma."

READER: [Wells et al., "Plastic and Reconstructive Surgery," April, 1994] "No cases of scleroderma or lupus were found and the incidence of arthritis was not significantly different"—[between the implant and control groups]

NARRATOR: The studies were remarkably consistent.

READER: [Burns, University of Michigan, May, 1994] "This study found no statistically significant association between silicone breast implants and scleroderma."

READER: [Strom et al., "Journal of Clinical Epidemiology, October, 1994] "No association was seen between silicone breast implants and the subsequent development of"—[systemic lupus erythematosus]

NARRATOR: Their conclusions were in total conflict with what was happening in the courts.

READER: [Goldman et al., "Journal of Clinical Epidemiology, April, 1995] "This study found no evidence that women with breast implants are at an increased risk for"—[having rheumatoid arthritis or other diffuse connective-tissue disease]

NARRATOR: While such studies did not exclude the possibility of a small association for perhaps a tiny subset of women, they effectively ruled out a large association between breast implants and connective-tissue disease.

In June, 1995, researchers at the Harvard Medical School published perhaps the best study so far in the New England Journal of Medicine. They, too, could find no association.

Dr. MARCIA ANGELL: This was a larger study than the Mayo Clinic study. It looked at roughly 90,000 nurses—again, a very old data base, looking at things that had happened in the past, before all of the publicity. And this, too, could find no connection between breast implants and connective-tissue diseases or symptoms—certain symptoms of connective-tissue diseases.

So these were the two studies that the New England Journal of Medicine published, both very well designed epidemiologic studies, neither one of which could find a connection.

NARRATOR: Only one epidemiologic study has reported a possible small association. It was published in this week's Journal of the American Medical Association. But the authors claimed the increased risk is too small to anything as the study is based on questionnaires that women filled in after 1992. The authors say the effect is as likely due to the influence of the media frenzy as to implants.

Three years before, Elizabeth Connell, the chairperson of the FDA Committee on Breast Implants, had bemoaned the lack of good scientific studies. Now there seemed to be an emerging consensus.

Dr. ELIZABETH CONNELL: One of the major recommendations of the panel was to have good scientists from good institutions go out and do good studies and put them into good journals. I think it's critical for people to recognize that without exception these well-done studies have shown no—I repeat, no—association between silicone breast implants and autoimmune diseases or any type of autoimmune response.

NARRATOR: For Dow Corning CEO Dick Hazleton, the studies provided some emotional relief. Whatever else people accused them of, the science seemed to be supporting their claim that breast implants did not cause systemic disease.

Last October, Hazleton agreed to go on the Oprah Winfrey show to try and get this message out.

OPRAH WINFREY: You said you wanted to respond to what she said?
DICK HAZLETON: Yes, if I may. I'm here for two purposes with Stephanie today. One is to try to speak to the issues of what women with breast implants—what their questions are and how we should do that and I'd like to do that in a way that is based on science and facts and not solely driven by perhaps understandable anger from people who disagree with me.

AUDIENCE MEMBER: We are the evidence.

DICK HAZLETON: Well— [crosstalk] Okay, if I can address—

AUDIENCE MEMBER: The study is we sitting here. The study is the 440,000 women who have claims in the settlement. That's a study. We can't buy science like you people can.

DICK HAZLETON: Really, I don't think you can challenge the ethics of places like the Mayo Clinic, Harvard University, the University of Michigan.

NARRATOR: But that's just what the women and their lawyers were claiming.

JOHN O'QUINN: Dow's engaged at the present moment of buying science with their fortune, of buying the research that favors them. Dow's engaged in a public relations campaign with some of the most powerful public relations companies. Put out the big lie—the big lie—even read it in The New York Times. "This is all about something called science and what does science say and science doesn't say you're right, so therefore you're wrong and so therefore we have done no wrong."

SYBIL NIDEN GOLDRICH, Command Trust Network: First let's get over the myth that just because Harvard or the Mayo Clinic or Yale says something that it's correct. We know where the bread is buttered. We know who gives the funding. Manufacturers fund, scientists do their studies.

Dr. MARCIA ANGELL, Executive Editor, "New England Journal of Medicine": That's not at all credible. These are great institutions. Harvard and the Mayo Clinic are great institutions. The New England Journal of Medicine is a great institution. We would be crazy to allow ourselves to be bought by a company.

More than half of all the medical research in this country is funded by private industry. If we were to dismiss all science, all biomedical research that was supported by private industry, it—we would decimate the science in this country.

The issue is how does the funding flow? What are the conditions of the funding? An institution such as Harvard and the Mayo Clinic have very clear-cut conditions for private industry that wants to support work on subjects that they have an interest in.

The—first of all, the grant is given to the institution, not to the individuals. Dow Corning doesn't walk up to Sherine Gabriel and say, "Here's a bunch of money," you know, "Do research and make sure it comes out my way." It goes to the institution and there are strings attached.

NARRATOR: And Angell argued there was a curious double standard in the plaintiff lawyers' protestation that science could be bought. They hired a series of scientists to appear in court for them and they were paid very well.

Dr. Marc Lappe has given expert testimony dozens of times and currently charges $3,000 for a day of his time. Dr. Nir Kossovsky charges $750 an hour for expounding his theories of silicone toxicity. And Houston hematologist Dr. Robert Lewy makes $625 an hour.

But much more dubious, critics argued, was the fact that plaintiff lawyers frequently referred women to some of these same doctors for diagnosis and treatment and paid their medical bills.

Dr. JOHN SERGENT, Rheumatologist, Vanderbilt University: These physicians, probably most of them, get a vast percentage of their referrals from lawyers so that
there has now developed and, actually, in '92, it had already developed, a network of doctors who were seeing patients, largely referred by lawyers, in which case the plaintiff went to the lawyer first and the lawyer arranged for the consultation.

NARRATOR: But the lawyers had another argument with the studies. They claimed that most scientists had not understood what was going on with the women they represented. They claimed the stories in the files proved beyond doubt the women had a new disease that medical science had yet to come to grips with.

Attorney RICK LAMINACK: Here's what convinced me. As I flipped through years and years and years of each woman's medical records, what I saw was complete frustration. Obviously, someone who is sick, and doctors struggling to figure it out.

And without question, if you look through the medical records, you will see stuff like, "Lupus-like disease." "Yes, she has lupus," says this doctor. "No, she doesn't," says this doctor. "Maybe it's M.S.," says one doctor. "No, I don't think it's M.S.," says this doctor.

From woman to woman, it is unbelievable how you see that same thing occurring, doctors struggling not to determine if they're sick, but exactly what is this we're dealing with. And after you see that hundreds and hundreds of times, you understand the common denominator is the silicone.

Obviously, we're dealing with something new because it doesn't pigeonhole into anything. So no, it's not in the textbook. You know, at a point in time, neither was polio or AIDS or—I mean, that doesn't mean these people aren't sick and something's not causing it.

Attorney JOHN O'QUINN: Nobody says that this product causes classic lupus. Instead, it causes a disease of the immune system that is in some ways like lupus and in some ways not like lupus.

INTERVIEWER: So this is a new disease.

JOHN O'QUINN: A new disease. And they're trying—they're finessing the thing by saying, "Well, you haven't proved it causes the old diseases." That's not what we're trying to say.

Dr. MARCIA ANGELL: Fine. If they have a hypothesis that there's a new disease, tell us what it is and I'm sure scientists will be interested in studying it.

NARRATOR: An enormous number of symptoms were now attributed to silicone and new ones were being added all the time. This, according to Angel I, was the problem.

MARCIA ANGELL: You can't study a disease unless you know what it is. If these symptoms that people believe are important are ever-changing and ever vaguer, then how can you do a study of them? You have to describe what it is you're looking for before you can look for it.

Dr. JOHN SERGENT: This so-called—this putative new disease that they talk about to me looks like what is described as fibromyalgia. It consists of diffuse aches and pains, poor sleep patterns, tenderness in various parts of the body, stiffness in the mornings when they get up, and so forth.

These are generally women who don't meet criteria for any of the so-called autoimmune diseases who are— who have a lot of symptoms. And I can't see any difference in the way those symptoms break out from the population of people that I see who would meet the criteria for fibromyalgia.

NARRATOR: But the lawyers claimed they did have some science on their side that provided objective proof of a new disease, special blood assays that claimed to be able to test if silicone had altered the immune system of women with implants.
One such laboratory in Memphis was widely used by doctors who believed they were seeing a new silicone-induced disease. For $350, they claimed to be able to tell whether the patient's immune system had been exposed to silicone leaking from breast implants. If true, these tests gave some credence to the notion that silicone could produce a full-blown immune response.

But were they true? Plastic surgeon Dr. Leroy Young from the Washington University, St. Louis, was very skeptical, so he decided to test the Memphis test. He got six women volunteers without breast implants, took blood samples and sent them to Memphis with made-up medical histories, claiming they had implants and various symptoms. Since these women did not, in fact, have breast implants, if the Memphis test was reliable then these women's tests should come back negative.

**Dr. LEROY YOUNG:** All six tested positive. All six of these people tested positive, despite the fact that none of them had implants.

**NARRATOR:** Young repeated the test and again it failed. He began to study the area and discovered that most immunologists were highly skeptical of these blood tests. So was the FDA. They have recently been taking a tough line with people marketing diagnostic blood tests. The inventors of this one, Detecsil, were ordered to stop selling it until they could prove it worked.

**Dr. JOHN SERGENT:** There is an extraordinary amount of junk science. These physicians certainly reflect the mainstream. They're way out on the end. I don't know any solid, well-respected immunologist who is reporting any of this stuff.

The studies are done with poor controls, poor planning, and largely by people with no prior history of working in that particular area. And as somebody who worked in immunology some in my— earlier in my career, I can tell you that most of these areas require enormous technical skill that usually takes years to acquire, and many internal controls when the tests are run, in order to be certain that what you're seeing is not some artifact.

**Dr. ELIZABETH CONNELL, Chair, PDA General and Plastic Surgery Devices Panel:** Tests are being done, not FDA-approved. Treatments, sometimes extremely expensive, and a few even dangerous, are being given to women in the total absence of any data that would suggest that they would be helpful. And the shuffling of women back and forth between a segment of the legal profession and a segment of the medical profession to me is one of the most incredible, amazing and distressing things to come along out of this entire scenario.

**NARRATOR:** Plaintiff lawyers like O'Quinn stand by the blood tests, insisting they do work.

**JOHN O'QUINN:** I mean, these women are sick. There's no question about that they're sick and they report sickness. The testing shows that their immune system has been triggered to react with silicone. The testing shows that their immune system has been altered.

**NARRATOR:** The key doctor who told Gladys Laas that she was crippled with a new silicone-based disease was neurologist Dr. Bernard Patten. Patten's fame was such that he attracted thousands of patients to his Houston offices for expensive diagnostic tests and treatments.

**NARRATOR:** Patten's diagnosis of Gladys and other breast implant patients depended to a large extent on a series of nerve and muscle biopsies, small pieces of tissue that are removed and examined under the microscope. Neurologists sometimes use them as a last resort, searching for evidence that the myelin sheath surrounding nerves has degenerated.
Neuropathologist Dr. Hannes Vogel, an expert on nerve tissue, has examined the medical records of 50 of Patten's breast implant patients. In 48 of them he found no detectable nerve damage. Gladys was one of two who did have a mild loss of nerve fibers. Did this indicate a serious systemic disease?

Dr. HANNES VOGEL: Absolutely not. It was not a substantial loss. I would rate it as mild. There was no evidence in this nerve biopsy of a serious, life-threatening situation.

NARRATOR: Such loss of nerve fibers is not that uncommon and might be the result of many things other than silicone. Given such weak evidence for a new silicone-based disease, some of Patten's colleagues are concerned that patients like Gladys may not only have undergone aggressive and possibly dangerous therapies, but also may have missed getting appropriate diagnosis and treatment.

Until last year Patten worked at Baylor College of Medicine in Houston. He took early retirement following a disagreement over his ideas on breast implants.

Dr. HANNES VOGEL: He was regarded by many in this community as a pariah and somebody whose scientific legitimacy was questionable.

We found Dr. Patten in Hawaii, en route to lecture in Japan. Despite examining 1,500 women for silicone-induced disease, he denies claiming a scientific link has been proved.

Dr. BERNARD PATTEN: I don't believe that connection has been scientifically proven and what we're doing is merely collecting data to look at that possibility. We have reported a group of women who are undeniably ill and they have circulating the antibodies against the nervous system and they need treatment. But the actual causal connection between the implant and their disease has not yet been established. That's what we're working on.

NARRATOR: But if the connection isn't scientifically proven, why then, critics ask, did he tell patients like Gladys that they had silicone-induced disease and begin such aggressive treatments?

Dr. BERNARD PATTEN: In the real world, we have to deal with sick people and we have to do our best to try and help them and we can't be 450,000 percent scientific when we're trying to save someone's life or restore them to health.

NARRATOR: Patten is one of several doctors being investigated by the FBI for health care fraud and abuse. He argues that he only wanted to help his patients. But in his desire to help, did he and other silicone doctors mislead women, telling them they had a new disease before there was any hard scientific evidence that it existed?

Dr. JOHN SERGENT: What I would say to people who disagree with me is that I know you're sick. I'm not saying you're not sick and I don't say that. I believe these women hurt and I believe these women have a problem. The only question is why should it be attributed to their silicone breast implants?

People are very quick to attribute new diseases to something that happened. You know, the rooster takes credit when the sun comes up and people— in general, people who develop a disease like rheumatoid arthritis or lupus or scleroderma will— many people will examine carefully everything that's happened in the previous two or three or five years and wonder, you know, "Maybe I shouldn't have taken— starting taking vitamin E" or "Maybe I shouldn't have started that exercise program" or— it's just natural to do that.

And so I think a lot of these women are— almost all of them, as a matter of fact, are— I think have real complaints and they're doing the kinds of things that people do when they're faced with an unusual disease. What's happened— what's the difference
here is that—that that question that is a natural one to ask is all of a sudden being fired by this—or fueled by this huge plaintiff lawyer interest.

SYBIL NIDEN GOLDRICH: I think that Dr. Sergent is wrong. We have more information than they do, on many levels. We know how many women were affected. I hear from those women.

NARRATOR: By last spring the office administering the global settlement had heard from 440,000 women, vastly more than anyone expected. Despite the scientific evidence, Dow Corning's hopes of putting the litigation behind them began to seem unrealistic. And last May, in a move that shocked everyone, they filed for Chapter 11 bankruptcy. The effects were immediate and dramatic. The global settlement fell into shambles.

VOICE MAIL SYSTEM: Thank you for calling the breast implant settlement information line. Judge Pointer has preliminarily concluded that there is no justification for keeping the current settlement in place.

NARRATOR: Without Dow Corning, it was hopelessly underfunded. Claimants were put on hold while the lawyers scrambled to build another deal with the remaining manufacturers. For Laminack and O'Quinn, it was even worse. As long as Dow Corning remained in bankruptcy, no cases could be tried. And for clients like Gladys, who had already had their day in court, but whose case had been appealed, everything was up in the air.

Rick Laminack struggled to maintain his clients' morale and convince those of them who had had Dow Corning implants all was not lost.

RICK LAMINACK: First thing that I want to address generally tonight is the Dow situation. Brief history—recall Dow filed bankruptcy.

You will also recall that for many months we anticipated that this would happen and began to build a case against who we perceived to be the real power and the real company behind the implant fiasco and that's Dow Chemical. And the plan that we put in place is very simple: Have a claim in the bankruptcy court against Dow Corning on the one hand and a lawsuit against the parent company, Dow Chemical, on the other hand.

NARRATOR: Dow Corning was 50 percent owned by the chemical giant Dow Chemical, America's second largest chemical company.

ANNOUNCER: [television commercial] If we don’t cause water pollution, there’ll be no need to clean up water pollution.

NARRATOR: While Dow Chemical had never made or sold breast implants, plaintiff lawyers argued that they bore responsibility for the actions of Dow Corning because, in the past, Dow Chemical knowledge and testing facilities had been used.

ANNOUNCER: [television commercial] [singing] Dow lets you do great things.

These arguments were used by lawyer Rick Ellis in a landmark trial in Reno, Nevada, in October, 1995, in which plaintiff Charlotte Mahlum and her husband, Marvin, brought a breast implant suit in which Dow Chemical was the sole defendant.

With the fortunes of a huge American corporation now at stake, there was great interest in the Mahlum case. The jury sat through a month of complex scientific testimony. Dow Chemical marshalled a stack of epidemiologic studies from Harvard, Mayo and elsewhere. Plaintiff lawyers attacked these studies and put their own experts on the stand. The jury deliberated or only seven hours.

JURY FOREPERSON: We, the jury, in this action find for the plaintiff, Charlotte Mahlum, and against defendant, as follows—

NARRATOR: The jury awarded Charlotte Mahlum $3.9 million plus $10 million in punitive damages. Dow Chemical was shocked.
DOW CHEMICAL SPOKESPERSON: The vast weight of evidence supports the proposition that breast implants are safe, that they do not cause autoimmune disease. So the question really is, where is—what did Dow Chemical do that should merit a $10 million punishment?

Dr. MARCIA ANGELL, Executive Editor, "New England Journal of Medicine: It's a sort of Alice in Wonderland a Never-Never Land when you have the court saying one thing and science saying another thing. You ask me can society tolerate it. Well, in a sense, yes, but it isn't a good society. And insofar as the courts undermine the scientific process, it bodes ill for all of us.

NARRATOR: So what about the Food and Drug Administration, whose actions had ignited the controversy? Kessler and his staff saw themselves as part of the scientific community and sided with them. Commissioner Kessler had absorbed the many studies on silicone and autoimmune disease and, on this question at least, he was reassured.

Dr. DAVID KESSLER, FDA Commissioner: The good news is that there is not a large increased risk of typical connective-tissue disease. The cause and effect is simply not there. I can't tell you that that's not going to change in the future, but there is no evidence that supports the association between silicone and either typical or atypical connective-tissues diseases. The scientific evidence just is not there to support that association.

NARRATOR: He still had some concerns about rupture. Estimates of rupture rates varied from 5 percent to more than 50 percent. But he urged people to put the rupture issue in perspective.

Dr. DAVID KESSLER: —could rupture. Could— when these devices break, could they cause certain local complications? Of course. We know that, but that's not the same thing as saying that they're really going to end up killing people.

CONGRESSMAN: Do you solemnly swear that the testimony you will give before the subcommittee will the truth, the whole truth and—

NARRATOR: Last summer Kessler faced tough questioning by Congress about what he intended to do next.

CONGRESSMAN: When are we going to have a decision? When is there going to be some resolution?

Dr. DAVID KESSLER: The bottom line, it's the responsibility of the manufacturer to submit data. We do not have—

NARRATOR: It is a paradox that the crisis that was set off by the FDA cannot be undone by the FDA alone. For Kessler and the FDA to change their ruling on silicone implants, they not only need to be fully satisfied of their safety, they need the manufacturers to resubmit an application to market them, but that is not likely to happen.

Dow Corning and the other big manufacturers have abandoned silicone breast implants for good and only one tiny company, Mentor, continues to make them for clinical trials.

In another unexpected twist, Dow Corning is seriously considering closing its entire medical division, which supplies medical-grade raw silicone to other companies for the manufacture of devices like pacemakers, shunts, heart valves and catheters. If this happened, the medical device industry fears that key life-saving devices might start to disappear. They have appealed to Congress to curb the powers of tort attorneys, arguing that the current legal climate is stifling innovation. Many scientists agree.

Dr. JOHN SERGENT, Rheumatologist, Vanderbilt University: I would be very reluctant, for example, if I were in the business of making some kind of biomedical material that would be implanted, like heart valves, to look at a new material. I would
be scared to look at a brand-new material that had never been implanted in anybody before because of this because it's quite clear that science is not what's ruling this—this discussion. It's the plaintiff lawyer frenzy.

NARRATOR: O'Quinn dismisses such arguments as corporate propaganda aimed at getting Congress to pass sweeping tort reform.

JOHN O'QUINN: There's a very famous poem that says, "Do not ask for whom the bell tolls. It tolls for thee." And right now the bell's tolling for the women that had breast implants. Next year it'll be some other product and the same arguments will be trotted out—same arguments. "Where's the scientific evidence?" Same arguments. "How can corporate America possibly survive if they can't make and sell bad products and get away with it?" Same arguments.

And if—if they convince Congress to pass laws that make it legal to sell bad products and not have to pay compensation, there will be more bad products. There will be more injured consumers. And you know who's going to pay the bill? We're going to pay the bill.

NARRATOR: It is perhaps ironic that a bag weighing a few ounces has caused so much conflict involving so many people in so many fields. The implant controversy has left in its wake a series of pressing questions.

Has mass tort litigation become so powerful that it threatens important parts of American industry or does the legal system itself need to be reformed? How are ordinary people, who make up juries, for example, supposed to weigh the opinions of expert witnesses appearing for the plaintiff against those appearing for the defense? Should courts have specially appointed neutral experts to advise them? And, perhaps most important, what does it mean when large groups of citizens think nothing of dismissing the results of scientific researchers from the top institutions in the land?

ELIZABETH CONNELL, Chair, FDA General and Plastic Surgery Devices Panel: We, as a scientific community, have been appalled at the way researchers and their institutions have been attacked. I can't think of anything in my lifetime that has been as destructive to women and their potential for good health care.

NARRATOR: But Sybil Goldrich sees it rather differently.

SYBIL NIDEN GOLDRICH: I think it has been a wonderful boom to women's health care because women now look at the medical and manufacturing establishment with question marks, appropriate question marks, and that's what people need. They need to think about themselves and what is appropriate for them. Just because a doctor says that this implant will last a lifetime, obviously, is not true. Women know that now and they know to come forward and they know to argue.

NARRATOR: The operation that Timmie Jean Lindsey pioneered 33 years ago is now the center of a bitter controversy and it's not clear just how it will end. Timmie Jean, who still has the same implants put in in 1962, has watched the events with interest. And how has her health been?

TIMMIE JEAN LINDSEY: Oh, my health is real good, except for just some arthritis in my body, but otherwise I'm pretty healthy. And, of course, I had a knee—the knee surgery and I'm planning to have it on my left knee, total replacement, and—but other than that, I'm doing real good.

NARRATOR: But she doesn't think her breast implants caused these problems, but something much more ordinary.

TIMMIE JEAN LINDSEY: I think it's just part of aging, getting older, is what I think. Makes me feel kind of proud that I got to be a pioneer among women. Yeah, it makes me feel kind of proud, kind of pleased that, well, maybe this is my mark on life.
NARRATOR: Gladys, by contrast, is convinced that her illness was caused by silicone. So far, the scientific evidence hasn't swayed her.

GLADYS LAAS: I don't have a doubt in my mind. I know that the Dow companies fund a lot of these studies, so that right there puts a big question mark on the validity of it. But what I find very interesting is, is that most things that come up like this come up, last a while and go away. But this does not go away and that's what I find interesting.

Dr. MARCIA ANGELL: There's no shortcuts. Passion, anecdote, claims, testimonials— they will not settle this issue. This is a scientific issue. It can only be settled by science and it will be settled by science.

NARRATOR: The implant controversy is far from over. Neither side is about to back down.

ANNOUNCER: And now more response to FRONTLINE's Gulf war series.

The Raytheon company, builder of the Patriot missile, and others were critical of statements that the Patriot performed poorly in Israel. Saudi Arabia's ambassador to Washington, Prince Bandar, wrote to FRONTLINE, "I have no first-hand knowledge of what Patriot did or didn't do in Israel or why. However, I know exactly what happened in my country and I'm surprised that your program didn't even mention the kind of outstanding performance that Patriot achieved in protecting our citizens."

PRINCE BANDAR: Ask me. I was there. And the most beautiful sight in the world that I have ever seen in my life was that Patriot streaking across the capital of Saudi Arabia hitting those Scuds. And the Saudi people think this weapons system is perfect.

ANNOUNCER: Another letter came from the commander of Patriot forces in Saudi Arabia. Major General Joseph Garrett told us, "The Patriot was never designed to defend large metropolitan areas against enemy missiles, but," he said, "it rose to the challenge."

Maj. Gen. JOSEPH GARRETT III: The system exceeded our expectations and delivered a solid performance. The U.S. Army performed a detailed, shot-by-shot analysis based on every shred of data and supporting material that existed. The result of that assessment showed that Patriot achieved an excellent success rate, more than 70 percent, within the Saudi Arabia theater of operations. I can tell you that Patriot served our country well in the Gulf and will continue to serve us well in the future.

ANNOUNCER: For more information on the Patriot controversy, visit FRONTLINE's Gulf war web site on the World Wide Web at pbs.org.

And next time:

TEENAGER: A kid can get a gun easier than he can buy a pencil.

ANNOUNCER: You may think you know this story. The inner city is violent. These kids live here. "A Kid Kills"— watch FRONTLINE.

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BREAST IMPLANTS ON TRIAL

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ABC NEWS ARCHIVES
CBS NEWS ARCHIVES
NBC NEWS ARCHIVES
COURT TV
CNN

"Walking in My Shoes"
M.L. Gore, composer
performed by Depeche Mode
EMI Blackwood Music on behalf of
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FRONTLINE Show #1511
Air date: April 22, 1997
Written, Produced and Directed by Jon Palfreman
Richard Rhodes, Correspondent

NARRATOR: No technology in history has generated more passion.

PROTESTERS: Hey, hey! Ho, ho! We say the nukes have got to go! Hey, hey! Ho, ho! We say the nukes have got to go! Hey, hey! Ho, ho!

NARRATOR: No technology in history has evoked such suspicion and fear.

MARY OSBORN: It is the most evil, most health-degrading type of energy that there is. It’s just the stupidest way I ever heard of to just boil water to generate electricity.

NARRATOR: America’s nuclear power industry is failing; crippled by public opposition, mounting costs and a politically intractable nuclear waste problem. Its critics have already declared victory.

ERIC EPSTEIN: Nuclear power’s dead. There will not be another nuclear power plant built here ever. I mean, there, there, it’s nothing that we really have to argue about. Nuclear power is unsafe, it’s uneconomical and it’s opposed by an overwhelming majority of Americans. The citizens distrust the technology. Wall Street distrusts the economic gamble. Nuclear power is dead. It’s over. It’s that simple.

NARRATOR: If the critics are right, the final resting place for the waste from four decades of commercial nuclear power may well be here, buried under a remote stretch of the Nevada desert called Yucca Mountain.
I'm Richard Rhodes. I spent 15 years studying the history of nuclear energy. I wrote about it in my book, "The Making of the Atomic Bomb." I find it extraordinary that half a century after the discovery of this new source of energy, I am standing on what may become its burial ground.

How did it happen that the nation that first harnessed this awesome new source of power is about to abandon it? What is it about this technology that stirs our passions?

Atomic energy burst upon the world 52 years ago in the New Mexican desert. In July, 1945, scientists in the top-secret Manhattan Project prepared to test an atomic bomb. They knew they were unleashing a force of mythic proportions. Physicist Robert Oppenheimer paid homage in the words of a Hindu God: "Now I am become death, the destroyer of worlds." A few weeks later, the world learned about atomic energy when the U.S. bombed Hiroshima and Nagasaki.

I remember the awe I felt as a boy when I heard about the destruction these new bombs caused. They shocked the world and ended a long and terrible war. Once discovered, this astonishing new technology could not be forgotten. The atomic age had begun.

But instead of destruction, scientists dreamed of harnessing the power of the nucleus, offering humankind a source of limitless energy. By 1951, American scientists had taken the same nuclear power that had destroyed Hiroshima and Nagasaki and used it to turn the lights on.

ALBERT REYNOLDS, Professor of Nuclear Engineering, University of Virginia: It was a very exciting field. We thought it would be the leading method of making electricity throughout the world. You have a very small amount of space, 12 feet tall and 12 feet in diameter, and you produce enough electricity to run a large city in that small space. So the energy source is extremely concentrated, which is one of its great benefits.

NARRATOR: The source of nuclear fission is uranium, a naturally occurring metal. Before the war, scientists discovered that a small fraction of the uranium atoms found in nature --less than 1 percent-- have a special property. When they're hit by neutrons, they split, releasing more neutrons that in turn can split other uranium atoms. Each split, or fission, releases large amounts of energy.

By fabricating thumb-sized uranium pellets, loading the pellets into fuel rods and assembling the rods into a core, scientists were able to produce a self-sustaining chain reaction that yielded enormous quantities of heat. The core's energy heats water, producing steam that drives turbines which generate electricity. Proponents argued it was a dream form of clean energy that would be too cheap to meter.

NEWSREEL ANNOUNCER: This new type of power reactor supplied city-wide the kind of energy which will someday power man's factories.
NARRATOR: But this rosy view of a nuclear future always had to compete with darker images, from terrible explosions and the end of civilization to nightmarish mutations induced by radiation run amok.

ACTOR: ["The Beginning of the End"] Do not panic! Do not panic!

NARRATOR: By the 1970s nuclear power had become a political target. Its leading critic was Ralph Nader.

RALPH NADER: The Atomic Energy Commission is licensing unsafe reactors operating near major metropolitan areas and that they clearly have been aware of this lack of safety. The press wasn't critical. The Congress bought into the Atomic Energy Commission party line. There was a huge taxpayer-funded propaganda for how good nuclear power was, going right into the high schools and elementary schools in our country with travelling road shows. The scientific community was part of the industry itself and there was no outside critique. There was no government critique. And there was secrecy above it all.

NARRATOR: Then, in 1979, came Three Mile Island.

WALTER CRONKITE, CBS News: [March 30, 1979] Good evening. The world has never known a day quite like today. It faced the considerable uncertainties and dangers of the worst nuclear power plant accident of the atomic age.

NARRATOR: It seemed to confirm our worst fears, that in trying to exploit nuclear fission, we had opened a Pandora's box. A series of technical and human errors led to a partial meltdown of one Three Mile Island reactor. The accident riveted America. Nothing would ever be the same.

While no one was injured or killed in the accident, the experience helped forge a generation of hardened anti-nuclear activists like Eric Epstein and Mary Osborn. They're convinced beyond doubt that nuclear energy is dangerous, that it kills people in an invisible and insidious way. They want to wipe it off the face of earth.

ERIC EPSTEIN, Three Mile Island Alert: I don't trust these people. These people got away with murder. They killed people. And you know, radiation is difficult to pin down. It's not like I put a gun to your head and shoot you. You know, with radiation it's going to be difficult to determine, you know, if a certain disease was caused by it.

NARRATOR: Since Three Mile Island researchers have studied public attitudes extensively. They've found that people's doubts about nuclear power have increased with time.

HANK JENKINS-SMITH, Director, Institute for Public Policy,
University of New Mexico: [to focus group] Let's go back now to your word association, associated with nuclear power, and I want to just go around the table and we'll start with Leo and go that way. What's your first image?

1st FOCUS GROUP MEMBER: Disaster.

HANK JENKINS-SMITH: Disaster? David what's your first image?

2nd FOCUS GROUP MEMBER: The first image I had was trouble.

HANK JENKINS-SMITH: Trouble?

3rd FOCUS GROUP MEMBER: Disgusting.

4th FOCUS GROUP MEMBER: My first thought was dangerous.

5th FOCUS GROUP MEMBER: The first thing I thought of was radiation.

HANK JENKINS-SMITH: Radiation. I'm going to read to you a list--

NARRATOR: Strong nuclear reactions. Like this focus group, many people fear radiation. But scientists like John Moulder, who work with radiation every day, feel differently. If we knew what they knew, they argue, we might feel less afraid. Biologists measure radiation in small units called millirems. Whether or not it's dangerous, depends on the dose.

JOHN MOULDER, Ph.D., Radiation Biologist: A sufficiently large dose of ionizing radiation, and here we're talking of millions of millirem, will actually kill you on the spot, within seconds. Getting down to somewhat more reasonable doses, hundreds of thousands of millirems, these can also kill people. It takes a while, typically, 7 to 21 days. There were people in the Chernobyl accident, some of the firefighters, who got doses in this range, 200,000 to maybe 600,000 or higher millirem. And they died as a result of this. This is called "acute radiation poisoning." Once you get below roughly 200,000 millirem, this doesn't happen. People do not get acutely sick as a result of radiation exposure. What they are, however, is at an increased risk of some time in the future developing cancer.

NARRATOR: Much of what's known about the effects of radiation was learned in the aftermath of Hiroshima and Nagasaki. In one of the largest studies ever conducted, 50,000 Japanese bomb survivors were followed up for 50 years to see if their cancer rates increased and whether they passed on genetic mutations to their children. Much to the scientists' surprise, there was no increase in inherited mutations. Despite the science fiction films, this fear proved unfounded. Cancer rates did increase, though, especially among those exposed to more than 10,000 millirems.
JOHN MOULDER: Of those 50,000 people, about 5,000 of them developed cancer. Based on what we know of the rest of the Japanese population, you would have expected about 4,500 of them. So we have 5,000 cancers over 50 years where we would expect 4,500. So we assume that those extra 500 cancers were induced by the radiation.

Not surprisingly, some of the citizens living near Three Mile Island see parallels with Hiroshima.

JOYCE CORRARDI, Concerned Mothers and Women: At the time of the accident, we left the area and when we got to my mother's home, my son went into the bathroom and threw up. He had thrown up a vile, green slime. There was no other way to explain it but that—no food, just heavy, thick mucous. And it was the color of a commercial cleanser. Approximately six months later, some doctors came in who dealt with the victims from Hiroshima and Nagasaki in Japan. I told them the story about my son and he said, "Well, that's a classic case of radiation sickness poisoning."

NARRATOR: But Moulder is skeptical because the dose at Three Mile Island was so much lower than Hiroshima.

JOHN MOULDER: In the case of Three Mile Island, it makes no sense whatsoever. We have a very good idea what the doses to the population were around Three Mile Island. Most of the population got something in the neighborhood of 2 to 10 millirem. To get radiation sickness, you need 200,000 millirem.

NARRATOR: But could the authorities have lied about the amount of radiation that was released?

JOHN MOULDER: There is no way in a technological society you could conceal radiation exposures that high. A dose high enough to cause radiation sickness would, for example, have fogged common photographic film for hundreds of miles. Any photographer would have noticed it. Any hospital that did X-rays would have noticed it. Any dental studio would have noticed it.

NARRATOR: The Environmental Protection Agency, the Nuclear Regulatory Commission, the state boards of health all concluded that extremely small amounts of radiation were released.

Small compared to what? Certainly, compared with Hiroshima, but also compared to the radiation we get from nature. The average American, myself included, gets about 350 millirems of radiation each year, most of it unavoidable. Cosmic rays shower down on us from outer space, giving us about 30 millirems per year. If you live at higher altitudes, like Denver, you get 60 millirems.

Then there are the rocks beneath our feet. Since the beginning of time,
radioactive elements in the Earth's crust have been decaying, giving off radiation. Because our building materials come out of the ground, they're slightly radioactive, giving us about 10 millirems a year. Some materials like granite give more. New York's Grand Central Station, for example, emits hundreds of millirems per year. We get about 50 to 80 millirems each year from medical sources like CAT scans and X-rays. And another 30 millirems or so comes from within our bodies.

JOHN MOULDER: So when we eat food, a certain part of the molecules in that food, the hydrogen and the potassium, even the oxygen, are very mildly radioactive. So all of us, and all animals and plants, are mildly radioactive and this has nothing to do with any man-made source of radiation. They always were and they always will be.

NARRATOR: But there's one source larger than all these combined. It came to light at this nuclear facility, thanks to the efforts of this man, Stanley Watras. A few years after the Three Mile Island accident, Watras, an engineer, was helping bring eastern Pennsylvania's Limerick reactor on line. Watras showed us what happened next.

STANLEY WATRAS: All the alarms went off. Sirens went off. Red lights went off. It came out on a digital display that I was highly contaminated throughout my entire body. So, obviously, that kind of set me back.

NARRATOR: Watras was decontaminated and went home. The next day it happened again. It happened for 2 weeks.

TECHNICIAN: You again?

STANLEY WATRAS: Yeah. Same old, same old.

TECHNICIAN: Come on over here. Let's see what we've got.

STANLEY WATRAS: Okay.

NARRATOR: Watras didn't seem to be picking up radiation in the plant, so eventually he persuaded the health physicists to check out his home.

STANLEY WATRAS: They took air samples, little grab samples. It was the standard norm back in 1984. They took these samples down to the chemistry lab and they found out that it was that the place was highly contaminated with background radon radiation.

NARRATOR: Radon-- it had long been known as a danger faced by uranium miners. It's a gas produced by decaying uranium in the soil. But no one suspected that significant amounts built up in houses. Ironically, Watras had been carrying radiation from his house to the Limerick plant, not the other way around. While few homes have as much as Watras's, radon collects in all our basements, sticks to all our furnace filters and air vents.
How does this source compare with what we get from a nuclear power plant?

JOHN MOULDER, Medical College of Wisconsin: Well, a typical house in the United States, the annual dose from radon is about 200 millirem, compared to, for the average person in the United States, the dose they get from nuclear power is a small fraction of a millirem. The annual dose from radon is hundreds of times bigger, probably thousands of times bigger. What dose would somebody get if they were living 24 hours a day, 365 days a year, at the closest part of the boundary fence? That's not very realistic, but that's beside the point. They would get a couple of millirem per year. It'd be very small compared to the background radiation.

NARRATOR: And ironically, the area around Three Mile Island is exceptionally high in radon radiation, four times the national average, yielding 800 millirems per year. This fact leads nuclear physicist Bernard Cohen to a startling conclusion.

BERNARD COHEN, Professor of Physics, University of Pittsburgh: As a result, people living in that area get more radiation from radon in their homes everyday than they got in total from the Three Mile Island accident.

NARRATOR: Many Pennsylvanians, like Linda Braasch, have been actively monitoring radiation from Three Mile Island since 1979. But have they had their own houses tested for radon?

LINDA BRAASCH: I have not had my house tested and perhaps I will some day, but I don't look at it as it's not a man-made thing. Radon is part of it, it seeps in through it's in the dirt. It's in the homes. And we've been building homes for many, many, many, many, years and my you know, where's my thinking wrong here?

NARRATOR: Can human cells tell the difference between a millirem of radiation from a man-made source and one of nature's millirems?

JOHN MOULDER: No, there is no logic to that. A millirem of penetrating radiation will do the same amount of damage, essentially, no matter what the source of it is. There is no logic worrying about radiation from a nuclear power plant five miles away and not worrying about the radon in your basement.

NARRATOR: Nuclear critics concede that a normally operating plant may not pose a major threat. Their biggest fear is what happens if something goes wrong.

ACTOR: ["The China Syndrome"] Oh my God! It's that pump.

NARRATOR: From the beginning Hollywood exploited our dread of a nuclear apocalypse. Films like "The China Syndrome" have left the
impression that nuclear reactors might cause devastation on the scale of Hiroshima.

**ACTOR:** ["The China Syndrome"] I may be wrong, but I would say you're probably lucky to be alive. For that matter, I think we might say the same for the rest of southern California.

**NEIL TODREAS, Professor of Nuclear Engineering, Massachusetts Institute of Technology:** Yeah, well, first, you couldn't—you couldn't have an explosion like a bomb, like a nuclear explosion. What you really have is a situation where you lose the cooling to the core. And you have the melting of the fuel.

**NARRATOR:** If nuclear reactors can't blow up like atomic bombs—and no one I spoke to says otherwise—the next worst imaginable scenario is a loss of the water that cools the core. When Western reactors lose this water that moderates or slows the neutrons, the nuclear reaction shuts down. That's the good news. The bad news is that the heat from decaying fission products can't be shut off and might melt the fuel rods.

The worst meltdown in history happened in 1986 at Chernobyl in the Ukraine. Critics and champions alike were appalled.

**CHARLES TILL, Argonne National Laboratory West:** Chernobyl was a very large plant. It had been operating long enough that it had a large inventory of radioactive materials in it. It was open to the atmosphere for days, on fire, with plumes of material, radioactive, going up into the air.

**NARRATOR:** Tens of thousands of people were exposed to high levels of radiation, some of them up to 50,000 millirems.

**RALPH NADER, Consumer Advocate:** There's nothing deadlier than a long-lasting, highly toxic ingredient that does not challenge your sensory perceptions because you can't see it, smell it, taste it or otherwise defend yourself against it. And you can see that around Chernobyl now. You've got all these villages and towns that have been abandoned, with the creaking doors swinging in the wind and abandoned buildings.

**NARRATOR:** Western utilities say it's unfair to condemn their industry because of what happened at Chernobyl. Unlike Western reactors, Chernobyl used graphite, not water, as a moderator, so the reactor didn't shut down but ran away, setting the graphite on fire. The resulting explosion spread radioactive fallout far and wide.

**ALBERT REYNOLDS:** The Soviet Union, at the time they built these Chernobyl-type reactors, they simply—they're so large that they couldn't afford to contain them. Our reactors are much smaller. The pressurized-water, the boiling-water reactors, the light-water reactors are very small, and they're all contained. They have to be contained in order to get licensed.
NARRATOR: By "contained" Reynolds means that the cores of Americans reactors are shielded within massive steel and concrete domes. Even if an accident occurred, the argument goes, the radioactive material would be confined inside the plant. But what about a fire?

ALBERT REYNOLDS: No they couldn't catch fire and even if they some of the fuel melted, that fuel cannot get out of the containment into the environment.

NEIL TODEAS: The worst accident that I can see in Western reactor is a couple, two to five fatalities, maybe, of people inside associated with the plant. I can't see the general public outside the exclusion zone.

NARRATOR: Whether you're convinced that a Chernobyl-type accident could or couldn't happen in America, one thing is certain: Chernobyl gave us a worst-case demonstration of just how bad a nuclear catastrophe can be. After Chernobyl, we don't have to rely on Hollywood to fuel our fears. We can examine the real thing.

The accident was economically devastating. Thousands of people had to abandon their homes and have a slightly increased risk of cancer. Some children contracted a rare thyroid tumor. Fortunately, it's curable. Despite these tragedies, some scientists argue that the evidence from Chernobyl is reassuring.

CHARLES TILL: That's as bad as accident can be in a nuclear plant and worse than any accident in a modern nuclear plant could possibly be. The point I'm, the point is that that reactor was on fire for days and days and days and yet the number of identifiable deaths from it are really only a handful.

NARRATOR: The actual death toll from Chernobyl is surprisingly low. Thirty-one firefighters died in the accident. So far, leukemia and adult cancers have not measurably increased. Terrible as Chernobyl was, there have many more deadly industrial accidents in this century, like the Bhopal chemical plant accident in India that killed thousands.

Supporters of nuclear power nuclear complain that if the chemical industry were held to the nuclear standard, it wouldn't survive. Even in America, more than a thousand people have been killed in chemical plant accidents during the past 40 years. Nuclear executives say their safety record is much better.

JIM HOWARD, CEO, Northern States Power Company: In this country no one has been injured or killed in a nuclear accident involving radiation exposure. No one. But people aren't really good at assessing risk. And somehow we've decided that nuclear power is very, very risky is a very risky business.
NARRATOR: A non-nuclear steam explosion at a U.S. nuclear facility killed four people in 1986. But Howard is right. In America there have been no deaths or injuries from nuclear accidents in commercial power plants. Physicist Bernard Cohen blames the media for singling out nuclear.

BERNARD COHEN, Professor of Physics, University of Pittsburgh: The media don't pay any attention to risk analyses. They just say this is radioactivity. They call it "deadly radioactivity." I don't know why they call it "deadly." It's not killing hardly anybody, if anybody. Nobody talks about "deadly electricity," which—although over 1,000 people a year die from electrocution in the United States. Nobody talks about "deadly natural gas," although I believe it's 5,000 people a year die from asphyxiation from natural gas, things of that sort.

NARRATOR: Have environmental groups unfairly targeted nuclear energy?

BILL MAGAVERN, Public Citizen's Critical Mass Energy Project: Well you'll find, actually, that Public Citizen and other allied groups have been very active critics of the chemical industry and the aviation industry and the coal industry. So I don't know why you're trying to distinguish among them. We are safety watchdogs and we're trying to improve health and safety for the American people. And the nuclear industry's record is nothing to shout about.

INTERVIEWER: But still, you're not trying to shut the chemical industry or the aviation industry down, are you?

BILL MAGAVERN: Ah, no, we're not.

NARRATOR: The record shows that some of these industries, coal for example, are environmentally unfriendly. Burning coal generates air pollution, acid rain, greenhouse gases and cancer-causing chemicals, but little protest or fear. If you think the difference is radiation, think again. Since coal contains radium, a coal plant actually emits much more radioactivity than a nuclear plant. A nuclear plant's cooling towers emit only steam—water vapor.

Dr. BERNARD COHEN: The health effects of coal burning are thousands of times worse than the health effects of nuclear power, according to anybody's analysis, not my analysis necessarily. But they never report it. I've never seen that in print.

NARRATOR: Scientists like Cohen, who rank risks according to cold statistical danger, seem to come up with a completely different picture than the public, which assesses risks more personally. What Cohen is doing is called "risk analysis"—determining statistically how dangerous various technologies actually are. What ordinary people engage in is risk perception—intuitively deciding how dangerous technologies seem.
Where do our perceptions come from? Why do we perceive this technology to be dangerous rather than safe?

HANK JENKINS-SMITH: [to focus group] What was the source of the knowledge that you have, the ideas that you have, the impressions that you've gotten about nuclear waste and nuclear power?

1st FOCUS GROUP MEMBER: Oh, I think that the very little that I know I probably heard on the news.

HANK JENKINS-SMITH: Okay.

1st FOCUS GROUP MEMBER: I don't know very much.

2nd FOCUS GROUP MEMBER: I've heard stuff on the news and read it in the paper and watched T.V. programs based on what could happen, you know, in Hollywood.

3rd FOCUS GROUP MEMBER: Television news, newspaper, public television.

NARRATOR: Scientists like Hank Jenkins-Smith have done extensive studies of the ways ordinary people think about nuclear power.

HANK JENKINS-SMITH, Director, Institute for Public Policy, University of New Mexico: Most of what we know as a population about nuclear power and nuclear stuff in general is an amalgam of images of nuclear war, in some cases the potential benefits, the technologies that can be harnessed, the energy that can be produced, but mostly images that are quite negative. Think about popular culture, which is one of the great deliverers of information about most concepts right now.

INTERCOM: ["The Simpsons"] Problem in sector 7G.

MONTGOMERY BURNS: 7G? Good God!

HANK JENKINS-SMITH: These bits and pieces of popular mythology feed the way that people understand facts about these things.

HOMER SIMPSON: Huh? Noise!

HANK JENKINS-SMITH: Most times, if you ask people, they'll say they really don't know a whole lot. But they still have a point of reference and that is sort of all these vague linkages to awful events.

HOMER SIMPSON: Oh, it's my problem! We're doomed!

INTERCOM: Section 7G is now being isolated.
HANK JENKINS-SMITH: It's got enormous implications. It creates this dread association, the fear that the worst can happen.

NARRATOR: Researchers say ordinary people use rules of thumb to measure risk. People tend to find technologies like nuclear power especially scary because of qualities that have nothing to do with how dangerous they are. First there's the dread factor, the fear of a catastrophic disaster. Second, say scientists like psychiatrist Robert DuPont, an expert in fears and phobias, there's the issue of who's in control.

ROBERT DuPONT: If you feel like you're in charge, you have the feeling that you can stop the risk, you can help yourself. It's the difference between driving a car and being a passenger in an airplane. When you're driving a car, you perceive your ability to stop or swerve or stay out of a situation, whereas when you're the passenger in 14C, then you've got to depend on the air traffic control system and the mechanics at American Airlines and the pilot and everybody else who is going to keep you up there. So you get more afraid.

Now, of course, the paradox here is that in the modern world, when someone else is controlling the risk, we're actually safer than when we control the risk because when someone else is controlling the risk, there are social institutions in place to reduce the risk. To fly an airplane, you actually have to have training. To drive an automobile you don't. So that you're actually much safer when somebody else is controlling the risk. But the perception, the psychology, is the opposite. So what happens with nuclear power—it's them, it's not me. It's somebody doing it to me that makes it unacceptable.

NARRATOR: DuPont, who was attacked in the 1980s by anti-nuclear groups for expressing these views, identifies two other important reasons we fear nuclear power, it's unfamiliar. Remote, exotic technologies are much scarier than technologies we encounter everyday.

Finally, there's need. Since most Americans know that the U.S. has ample supplies of coal and gas, they have little incentive to confront their nuclear fears. With air travel, which can't easily be replaced, people make great efforts to overcome their anxieties.

ROBERT DuPONT: On all four counts, nuclear power generates fear. It's a cataclysmic accident that people are concerned about. It's controlled by "them," the utilities or the government or the scientists or whoever it is that is perceived as the bad guys. It's unfamiliar to most people and most people feel they don't really need nuclear power, that they can get their power from coal or oil or windmills or some other basis. They don't really need the nuclear power.

NARRATOR: What's true for Americans is also true for Italians, Germans and Swedes. But it's not true
everywhere. There are countries where nuclear power is accepted, even popular—parts of Asia and especially in France. France runs on nuclear power. Seventy-five percent of French electricity is nuclear-generated. I visited the village of Civaux in southwestern France, the site of France's latest and most modern nuclear plant, to find out what local people like Madame Schoumacher thought of nuclear energy. I asked her if she was afraid.

YVETTE SCHOUMACHER: [subtitles] No, I'm not afraid of nuclear (energy). I think there is a lot more risk getting into my car in the morning or for those living under a dam or those who work in very dangerous occupations.

NARRATOR: This is Rene Barc, the village schoolteacher. Is he afraid that the nuclear reactors half a mile away will put his students in danger?

RENE BARC: [subtitles] No, I am not afraid. I visited the site several times during construction. I heard the explanations, saw the models, the films about the plans. They explained that it was a very advanced technology with a high degree of safety. So I'm not afraid.

NARRATOR: Everyone we spoke to in the village seemed unconcerned, from the baker—

JAQUES RAMBAULT: [subtitles] No, it doesn't scare me.

NARRATOR: _to the village hairdresser.

NATHALIE GAULF: [subtitles] No, I'm not at all afraid of nuclear energy. It was here before I came here. Since I moved here, it shows that I am not afraid.

NARRATOR: Since the technology is the same, why are the attitudes so different?

RALPH NADER: They're not well informed at all. They can't get the information from their government. There's the administrative state that's very, very secretive. And the industry and the government are almost indistinguishable, number one. Number two, they have no right to go to court to open it up. The courts don't have the influence in France against administrative agencies, the way our courts do. They don't have a tort law system the way we do. They don't have a Freedom of Information law the way we do. When it comes to nuclear power, they might as well be a totalitarian society. They're as closed on nuclear power as any—as the Soviet Union was.

NARRATOR: But are the French really so brainwashed or is there another explanation? Certainly, since the early '70s, there's been little public opposition to nuclear power. To the contrary.
CLAUDE MANDILL, Director General, Ministry of Industry: Three years ago we thought possibly it would be necessary to have a new unit. There was a fight between several sites, not to avoid the plant, but to have it. There were a lot of members of parliament who came to see the minister. "I want the plant." French people like big industrial projects and nuclear plants are one of the most often visited plants in France. During summer its the place where you go to bring family, you see?

NARRATOR: More than 6 million French people have taken tours, like the one I took of Civaux, which explained in exhaustive detail how everything worked.

TOUR GUIDE: [subtitles] We are going to continue the tour and go into the reactor building.

NARRATOR: Unlike Nader, I thought the French knew much more about nuclear power than Americans, not less. But I noticed a more striking difference: Unlike Americans, the French seem to trust their experts.

CLAUDE MANDILL: For a long time in the families, the good thing for a child was not to become a lawyer, it was to become an engineer or a scientist. French people like their engineers and their scientists. And they are confident. They rely on them.

NARRATOR: While French citizens have no more control over nuclear power than Americans, polls show they trust the people who do. That's an important difference. But more important even than familiarity and trust, it seems to me, is the fourth attribute: need. The French have few energy resources. After the 1973 oil crisis, they concluded that their future as a modern nation depended on nuclear energy.

JEAN-PIERRE CHAUSAUDE, Electricité de France: In France we have no oil, no gas, no coal, no choice. And for the French people, it was very positive to develop national energy with nuclear energy. And when we built these plants, we explained much. We developed many, many presentations.

1st ACTOR: [television commercial] [subtitles] Plug in his nuclear toaster.

2nd ACTOR: You mean electric.

1st ACTOR: Nuclear.

2nd ACTOR: Electric.

1st ACTOR: Nuclear

JEAN-PIERRE CHAUSAUDE: --to explain to the French that it was very important for France.
NARRATOR: If fear is less in France, so is cost. France's centralized political system allows standardization and control unimaginable in the U.S. The French selected just one American reactor model and charged one agency, EDF, to run the system for the nation. But America's decentralized system meant that from the start it was a messy and expensive free-for-all, many different designs managed by many different utilities. Ironically, in American hands, the energy that some dreamed would be too cheap to meter has ended up one of the most expensive ways to generate electric power.

BILL MAGAVERN, Public Citizen's Critical Mass Energy Project: And what we have coming in this country is more competition in the electricity market and a lot of these nuclear reactors cannot compete. Some of the existing ones will be able to compete and will keep running for a while, but they'll reach the end of their lifespans. Some of them will not be able to compete and will shut down well before the end of their projected lifespans. And building a new reactor is just a complete fantasy in this country.

RALPH NADER: What do you say about a technology that wants to persist on the public dole because it can't meet a market test? I don't know anybody in Wall Street and I don't know anybody in the electric utility industry who wants to build any more nuclear plants.

NARRATOR: Nuclear physicists like Charles Till argue that's short-term thinking.

Dr. CHARLES TILL, Argonne National Laboratory West: The exciting thing about nuclear power is its ability to handle mankind's needs in the future. It's not whether today in the 20% of electricity that it produces in this nation, whether it can produce it for two and a half cents a kilowatt hour or four cents a kilowatt hour where, you know, coal may be three and a half cents or whatever. That isn't the argument at all.

NARRATOR: Fossil fuels like coal, oil and gas, says Till, may be cheaper now, but as supplies decline that will change. Fossil fuels also produce pollution and greenhouse gases, so that many environmental groups oppose their use as well.

INTERVIEWER: So where do we get our electricity from?

RALPH NADER: We get it from solar. You want me to give you a book that shows how realistic solar is? You've got wind power. You've got biomass. You've got photovoltaics. You've got tidal. You've got all kinds of technologies now moving toward commercial viability.

NARRATOR: Can the sun and wind satisfy our energy needs?

Dr. CHARLES TILL: Energy has to be produced for modern society on a huge scale. The only way you can do that is with energy sources that have
concentrated energy in them, coal, oil, natural gas and the quintessential example of it is nuclear, where the energy is so concentrated. I mean you have something to work with. With solar your main problem is gathering it.

NARRATOR: Few seem to share Till's long-term vision. From Main Street to Wall Street, nuclear energy is perceived to be a risky proposition. And since America for now has ample supplies of cheap fossil fuels, it's a risk Americans don't have to face. That still leaves the 109 nuclear plants currently in service that produce 20 percent of our electricity. Anti-nuclear groups want these plants shut down because of what may be the biggest nuclear issue of all: nuclear waste.

On this surreal parking lot a few hundred yards from the Prairie Island reactor near Minneapolis sit five dry casks filled with nuclear waste. Inside each cask are 40 intensely radioactive spent-fuel assemblies that have been removed from the core. I don't keel over and die because nine and a half inches of stainless steel block the gamma rays.

TECHNICIAN: As you see right here, right on the cask, it's about 3 millirem per hour and a cross-country airline flight is going to give you about 5 millirem and a chest X-ray is about 30 or 50 millirems.

INTERVIEWER: Oh.

NARRATOR: A few feet away the level drops off to background. Of all the materials inside the casks, the one that probably causes most fear is plutonium, a substance that remains radioactive for hundreds of thousands of years. Plutonium has attained legendary status as the most toxic substance in the world.

WALTER CRONKITE: Plutonium is the most deadliest substance known to man. A tiny amount on the skin will kill.

NARRATOR: The truth is less dramatic. The radiation given off by plutonium can't penetrate human skin. It can even be stopped by a thin sheet of paper. While plutonium is dangerous to ingest, it's nowhere near the most toxic substance known to man. It is, however, a highly concentrated form of energy. There's as much energy available in one gram of plutonium as in one ton of oil. So outside the United States, in France, Japan and many other countries, they don't regard plutonium as waste. They recycle the plutonium and unused uranium and fabricate new fuel elements. By recycling the plutonium, they not only reduce the volume of the waste, they also get energy.

The U.S. is different. In the '70s, because of fears that reactor plutonium might fall into the wrong hands, the U.S. government decided not to reprocess plutonium, but treat it as waste. That means it's going to be around for a very long time.
RICHARD STALLINGS: When you make that decision that you are not going to recycle, then no longer are you dealing with a potential resource, but you're dealing with a waste product and a waste product that has a tremendous half-life. I mean, we're talking about a product that's not going to be just around for a few hundred years, but thousands of years.

NARRATOR: Richard Stallings was appointed in 1993 as the federal nuclear waste negotiator. It was his job to try to find a community willing to take the high-level waste from nuclear power plants on a temporary basis until the government established a permanent repository. He found it hard going.

RICHARD STALLINGS: It was a very hard sell. When people are terrified, they're not concerned about facts. The perception was anything nuclear just scared people to death. Their thought is that it's some kind of green, oozy stuff that's spewing poison, that you get near it and you'll die within minutes or hours.

NARRATOR: Stallings discovered that public fear of nuclear waste knows no bounds. Nobody wants this stuff in their back yards or traveling on their roads. The nuclear industry claims their transportation casks will survive any conceivable accident. They've hit them with trains, dropped them from the air, onto metal spikes, submerged them under water and burned them for hours. The containers survived intact. But somehow these demonstrations don't seem to make people feel safe.

Nevertheless, the waste has to go somewhere, even if the nuclear industry shut down tomorrow. That's one point both sides agree on.

RALPH NADER: This is, of course, the conundrum of conundrums because while you can stop nuclear power, what do you do with the waste that's available? Do you keep it next to the reactor, do you put it in a temporary repository or do you put it in a permanent?

NARRATOR: The Federal Government wants to send all the high-level waste from all the plants to Nevada, a state that has no nuclear power. In Las Vegas, people are mad as hell. Business leaders worry that the stigma will drive tourists away. Citizens worry about the dangers the waste might pose now and for thousands of years to come.

1st NEVADAN: How many deaths can we expect over the duration of this project?

2nd NEVADAN: We don't want to be scapegoats again.

3rd NEVADAN: We want to bring other people's nuclear waste into our state. How come they can't keep it?
NARRATOR: The proposed permanent repository is here at Yucca mountain, some 80 miles from Las Vegas. The Department of Energy has been tunneling for more than two years. It's quick to say that this is just a scientific investigation to see if the site is suitable. To dig and characterize this exploratory tunnel will cost $2 billion. To build the repository itself may cost 10 times as much. The repository, if it's built, will accommodate hundreds of casks of high-level waste, including plutonium, in a labyrinth of rock tunnels. The plan is to seal it up and leave it forever. Yucca mountain is a graveyard.

Nevadans want reassurance that the waste will be safe not only this year, but for the tens of thousands of years it remains radioactive. The government is not finding it easy to reassure people.

RICHARD STALLINGS, Former Federal Nuclear Waste Negotiator: I mean, you can't find any engineer that's going to sign onto a document that this hole in the ground is going to be safe for 10,000 years or safe for even 200 years. I mean, that's impossible to do.

NARRATOR: Research shows that people are even more opposed to living near a nuclear waste dump than a nuclear reactor. The difference isn't the risk, it's the lack of benefit.

HANK JENKINS-SMITH, Director, Institute for Public Policy, University of New Mexico: In the United States, of course, we don't reprocess. We don't reuse, recycle, however you want to describe it, that nuclear waste. What we've done is we've isolated all the bad attributes and packaged them up as nuclear waste and, you know, there's not much in the way of redeeming value in there to warm people up to it.

NARRATOR: In France, people worry about waste as well. A few years ago, when they discovered the strength of such attitudes, France redesigned its high-level waste policy. Research showed that what bothered people most was the idea of a permanent geological site, like Yucca mountain, where waste would be abandoned. People felt much safer with the concept of an underground laboratory, where waste is not only carefully monitored, but where research goes forward on how to transmute it to a safer form. Remarkably, redefining the site completely changes people's attitudes toward the same waste.

HANK JENKINS-SMITH: [to focus group] Now, if that kind of a strategy were opted for in the United States, would that seem more attractive than a place that's primarily a disposal facility where we permanently cork it up? Or what's—what's your sense about that? What's your reaction to it? Darlene?

1st FOCUS GROUP MEMBER: I think it would be a great idea for the simple reason that it would be carefully watched.

HANK JENKINS-SMITH: Shannon, what about you?
2nd FOCUS GROUP MEMBER: Oh, yeah, because it means somebody is doing something with it, instead of just leaving it in the ground and forgetting about and waiting till something happens down the road.

HANK JENKINS-SMITH: The research laboratory idea actually is a high-prestige kind of an entity. It brings in top-level scientific jobs. It creates the prospect that this dreadful stuff might actually be turned into something useful. Things that are seen as waste right now could be seen as the most valuable of resources in the future. I mean, we weren't using molybdenum much 150 years ago. It was in the way. Wood chips now that we use regularly as building material were a waste product not so long ago. I mean, as technologies change and as different uses are found or as other resources are used up, things that are now of no value could be of tremendous value.

NARRATOR: But U.S. policy makers don't want a laboratory. They want a graveyard. They're determined that Yucca mountain will open sometime after 2010.

RICHARD STALLINGS: And, essentially, it says to this nation that we're as smart as we're going to get on nuclear materials. No one's going to get any smarter. And the fact that there might be other things we can do with this material was completely lost. And so we just put it in a hole in the ground and thought somehow we could walk away from it and our problems would be solved.

NARRATOR: These children are visiting a teaching reactor in Virginia where it's possible to see a nuclear core glowing at the bottom of a containment pool. For them it's like a museum visit, a curiosity. If current trends continue, by the time they're middle aged, nuclear power may be largely phased out in the U.S., though it will almost certainly continue to thrive in France and in Asia.

Throughout history our species has encountered and mastered powerful natural forces, balancing promise and risk. In this century, when we unlocked nuclear energy, we built weapons capable of destroying the world because we thought we needed them. We haven't needed nuclear power in America, so we enjoy the luxury of investing it with our nuclear fears. Civilizations run on energy. What will our descendants make of our decision to reject this awesome source? Will they applaud us for having the courage to say no or will they condemn us for surrendering to our fears?

ANNOUNCER: So what do you think about nuclear power? Join in the discussion at FRONTLINE's nuclear web site at www.pbs.org. Check out Hollywood's radiation nightmares and dig deeper, take the nuclear phobia survey, tour the best of the nuclear web and much more at www.pbs.org. And let us know what you thought about tonight's program by fax at (617) 254-0243, by e-mail, frontline@pbs.org, or by the U.S. mail [DEAR FRONTLINE, 125 Western Ave., Boston, MA 02134].

Next time on FRONTLINE, the story of a warrior breed, the culture they
thrive in and what happens when it clashes with the sexual politics of the '90s. "The Navy Blues," a FRONTLINE investigation.

NUCLEAR REACTION

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FRONTLINE
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The Last Battle of the Gulf War
Written, produced and directed by Jon Palfreman

1st VETERAN: [at hearing] Are you going to allow us to die slowly of some unknown disease? We need - as a nation, as a people - to make a statement to the world.

2nd VETERAN: I get angry at people for no reason. And I want to just twist Washington's head right off.

NARRATOR: America's veterans are angry. America's veterans are sick.

KIM HEBERT: When Randy left for the war, he was just in perfect condition, until he came back from the Gulf.

NARRATOR: Did something happen in the Gulf War that made the vets sick? The idea has excited the media.

TED KOPPEL, ABC News: ["Nightline"] Tonight, Gulf War Syndrome, the battle between soldiers and-

ED BRADLEY, CBS News: ["60 Minutes"] mysterious illness that has come to be known as Gulf War Syndrome-

NARRATOR: The possibility has enraged some members of Congress.

Rep. CHRISTOPHER SHAYS, (R), CT: [at hearing] You didn't listen to the veterans. Nobody was listening to the veterans.

NARRATOR: But many scientists worry that emotion has overwhelmed scientific reality.

Dr. STEPHEN JOSEPH, Assistant Secretary of Defense, Health Affairs 1994-1997: What could be more sensational than
this— you know, "U.S. soldiers gassed in the Gulf" or "Mystery illness strikes down American military after the war"? But it's pretty clear there is no magic bullet. There is no mystery illness. There was no "Gulf War illness."

NARRATOR: Seven years after the ceasefire, the battle rages over "Gulf War Syndrome."

In 1991, American troops returned from a stunning victory. The Iraqi forces had been decimated at a cost of only 146 American lives. Yet within a few months there were signs that all was not well with the troops. Some members of an Army reserve unit in Indianapolis based at Ft. Benjamin Harrison began complaining of strange symptoms. One was Sergeant Jim Simpson.

Sgt. JIM SIMPSON, 123rd Army Reserve: I started having problems with concentration and that's when I noticed the fatigue really setting in. At times, it was very hard to focus. I felt nauseous. I didn't- didn't really want to eat.

GLENDA SIMPSON: He was just exhausted constantly. He could never get enough rest. His motivation was deteriorating. He couldn't remember what was being told to him. There would constantly be arguments and fights in the house with me and the kids and him because we'd say, "Well, we told you," and he wouldn't remember.

Sgt. JIM SIMPSON: And it was about some time in November I ran into a soldier from the battalion that said I looked terrible. And she started asking me a lot of questions—"Have you been having problems with headaches, blurry vision? And have you had some rashes, extreme fatigue?" Then she informed me that there were a lot of other people were having the same problems.

NEWS ANCHOR: [Channel 18 News, Lafayette, Indiana, March 19, 1992] Good evening. Soldiers from three Indiana-based Army reserve units that served in the Persian Gulf are reporting health problems that could be related to the Gulf region.

REPORTER: 123rd ARCOM command surgeon Norman Teer says none of the illnesses are life-threatening.

Dr. NORMAN TEER: We haven't been able to rule out anything, so we're not trying to rule out, so we're just trying to make sure that get into the right channel and get the right tests done on them.

NARRATOR: Dr. Norman Teer examined dozens of reservists, but he was completely baffled.

Dr. NORMAN TEER: We got a variety of symptoms that did not
fit any one disease entity and it made it kind of confusing to us. They complained of fatigue, problems sleeping, memory loss, bleeding gums, losing hair, rashes, gastrointestinal problems, joint pain. So there were so many symptoms, we couldn't attach it to any particular disease entity at that time.

NARRATOR: So Teer called the Pentagon, which sent a special medical team to investigate.

Dr. NORMAN TEER: It consisted of an epidemiologist, environmental specialist, a dental pathologist, a psychiatrist and a medical technician that they brought with them. And that particular weekend, we know up to about 80 some people that we examined. And they took specimens of blood, urine, medical histories from all the specialists, took that back to see if they could make a determination.

NARRATOR: The tests found nothing. The Pentagon report stated there was "no organic disease" and concluded that most symptoms were likely the result of stress. But the problem was not confined to Indianapolis. Members of a reserve Naval construction unit in Alabama and Georgia - the Seabees - were also ill. One was Larry Perry.

LARRY PERRY, Seabees: It's like something you never had before. Like when you have the flu, you don't hurt anywhere in particular, you just feel miserable all over. And that's pretty much the way it runs. You get the severe headaches and when you get two or three symptoms together, you're in the bed. You just can't go- you can't- you can't function. There's times when I couldn't find my way home. I've attempted to go back to work about eight times. I wound up in the hospital with exhaustion. I can last about two weeks.

NARRATOR: Perry made contact with other Seabees who had served in the Gulf and who were feeling ill, like Sterling Sims, Lester Hallman, John Gonzales and affected worst of all, their friend, Gene Trucks, who is confined to a chair.

STERLING SIMS, Seabees: Old man, how you doing?

GENE TRUCKS, Seabees: Hi.

STERLING SIMS: You put on some weight yourself.

GENE TRUCKS: I have.

NARRATOR: They felt their symptoms were due to Iraqi chemical weapons. They were stationed at the Saudi port of Al Jubayl when a loud explosion awakened them one night.
STERLING SIMS: When I got out of the tent, there was a mist in the air. My eyes had been burning, my throat was burning, my nose was running, my skin was on fire.

JOHN GONZALES, Seabees: My eyes started watering and I could not- I could not breathe from- by no means and I was just about- just about losing it.

LESTER HALLMAN, Seabees: It was a yellow, powder-type substance that settled over the flat surfaces of the compound. You could see it on the tents, on the vehicle. Anything that had a flat surface of any description, you could see it the next morning.

NARRATOR: Had chemical weapons been used at Al Jubayl? The Department of Defense said there was no evidence they were used there or anywhere else. A Navy medical team was sent in to examine the Seabees. Their investigation, like the Army's in Indianapolis, found nothing and concluded stress was a likely explanation.

Unlike active duty troops who had full medical coverage, many veterans depended on the Veterans Administration. To get medical help they had to negotiate a bureaucratic maze and prove their sickness was connected to their service in the Gulf. With an unrecognized disease and no idea what caused it, many were turned away.

MATT PUGLISI, Director of Gulf War Illnesses, American Legion: Service connection for V.A. used to be a pretty simple thing way back when. You were shot, you stepped on a mine, you were run over by a tank or some other awful thing that occurred in combat and you had a clear injury that you went to the battalion aid station with. You were treated. It was in your medical records and then you could be compensated. When you're talking about chemical exposure or investigational drugs that were taken, and no records were made in your medical records, that's something altogether different.

1st VETERAN: [at meeting] The doctors that we have in the VA hospitals now, are students.

NARRATOR: As veterans shared stories, their anger at the V.A. and the DoD grew.

1st VETERAN: [at meeting] Well, what the hell. If I- if I knew what was wrong with me, why the hell would I come here?

2nd VETERAN: We want you to hear our problems, what we feel those problems were in the Gulf.
NARRATOR: In desperation, they took their story to the media.

DAVE PARKS, "The Birmingham News": Sterling Sims called me up out of the blue one afternoon and said, "Listen, I'm a Gulf War veteran. You want a story?" I said, "Yeah." He said, "You got enough guts to print it?" And I said, "Well, it depends on what it is." He said, "Well", he said, "I'll give you a heck of a story."

NARRATOR: Dave Parks would write dozens of articles on what became known as "Gulf War Syndrome." Journalists everywhere jumped on the story. It was a compelling tale, a story of sick vets, of a mystery disease perhaps caused by something exotic in the Gulf.

LYNN SHERR, ABC News: ["20/20"] How many of you have had symptoms of aching joints?

ED BRADLEY, CBS News: ["60 Minutes"] How many of you get tired very easily? How many of you have joint pain?

NARRATOR: Vets also told their story to Congress.

BRIAN MARTIN, Veteran: [at hearing] I have experienced swollen and burning feet, swollen knuckles, loss of strength in my right hand, problems with my heartbeat, shortness of breath.

1st VETERAN: Joint and muscular pain, testicular pain, myofacial pains-

2nd VETERAN: I can't sleep. I can't drive.

NARRATOR: The vets' stories had a similar theme.

3rd VETERAN: [at hearing] Do we all have to die first before you believe us?

NARRATOR: Before the war they were fine. After it they were sick. The diseases varied enormously. One of the most striking was that of Marine Major Randy Hebert. Hebert was diagnosed with Lou Gehrig's disease.

Rep. CHRISTOPHER SHAYS: [at hearing] Your testimony will be read by your dad, is that correct?

NARRATOR: He believes his condition is due to the Gulf. He is a shadow of his former self.

KIM HEBERT: When Randy left for the war he was very active, a health nut. He was that poster-board Marine until he came back from the war and just slowly deteriorated from there.
NARRATOR: Did all these illnesses constitute a "Gulf War Syndrome" and, if so, what was the cause?

KIM HEBERT: We believe Randy's illness is due to the chemical poisoning that he received while in the Gulf War.

NARRATOR: Stung by the criticism, the V.A. began treating more Gulf War vets and the Pentagon appointed Dr. Stephen Joseph, a seasoned public health physician who'd worked in New York at the height of the AIDS epidemic, to lead its medical investigation of Gulf War Syndrome.

Dr. STEPHEN JOSEPH, Assistant Secretary of Defense, Health Affairs 1994-1997: In many ways, it was a classical public health problem because there was a scientific dilemma, a medical dilemma. Here were people with symptoms that had all been in the same place at the same time.

The important thing, from the public health and the medical point of view, is what are they ill with? What symptoms do they have? Can you cluster those symptoms into groups that lead you to look for a single cause?

NARRATOR: Working with the V.A., Joseph invited any Gulf War veteran who was feeling ill to register and undertake a full exam. Panels of scientists were asked to review everything known about any toxin vets might have been exposed to in the Gulf, from tropical infections to chemical weapons. Millions of dollars were authorized to support a series of epidemiological studies to see whether Gulf War servicemen were being hospitalized at a higher rate than normal, to find out if they were dying at a higher rate than expected.

In all, four blue-ribbon panels were set up, including the Defense Science Board, the Institute of Medicine and a special panel created by the president, the Presidential Advisory Committee, the "P.A.C." Chaired by Dr. Joyce Lashof, former dean of public health at U.C. Berkeley, it had an all-star cast of scientists, physicians, ethicists and Gulf War veterans. Designed to be as free as possible of political influence, its mandate was to get to the bottom of the science and report on what was really happening to the vets.

Meanwhile, the scope of Gulf War Syndrome was spreading. Some families now reported wives and children were becoming ill.

GLENDA SIMPSON: I have noticed joint aches and pains like he experiences. I'm starting to struggle with my memory. And the fatigue, I'm getting it, and the exhaustion, the pure "I just can't function anymore. I have to go lay down."
Sgt. JIM SIMPSON: I started hearing about other soldiers that had these illnesses, and their kids coming down with strange things, and I started getting a little nervous about certain contacts with my kids. And we're getting to the point where we're paranoid of, "No, I drank out of that glass. You leave this glass alone. Don't drink out of my glass."

NARRATOR: But for other vets the news was even worse.


NARRATOR: They believed that Gulf War Syndrome had caused birth defects in babies born after the war.

CONNIE HANSON: When Jayce was born, he was born with no upper or lower arm bone and his wrists connect at his shoulders. Before he had his legs amputated, his legs were bent and twisted up, like if you can imagine sitting Indian style. Paul and I had never seen a child like Jayce before.

Sgt. PAUL HANSON: It was a shock. I was real hurt and I immediately- I wondered, "Man, what in the world happened?" You know, I'm not a scientist. I'm not somebody who can figure out stuff like that, but I believe it was the chemicals. There were oil well fires constantly. We took pills that we had no idea what type of effect they were going to have on our systems. There are so many contributing factors that could have caused him to be born that way.

CONNIE HANSON: As Jayce approaches the different obstacles in life, the pain's going to come out. And that hurts me probably as much as it hurts him because you hate not to see your children succeed in simple things in life- just to be able to catch a ball!

NARRATOR: In November, 1995, "Life" magazine put the Hansons on their cover. But if the media and Congress had accepted there was a true Gulf War Syndrome, the scientific community was far from convinced. By 1996, the DoD had examined 20,000 Gulf War vets, one of the largest clinical investigations ever undertaken. The results were shocking.

Dr. STEPHEN JOSEPH, Assistant Secretary of Defense, Health Affairs 1994-1997: We found that there was no single unifying hypothesis that could explain the symptoms of large numbers of people. There was no magic bullet. There was no mystery illness. There was no "Gulf War illness."

NARRATOR: Joseph had found lots of common illnesses, but no new mystery disease, no unique "Gulf War Syndrome."
Dr. STEPHEN JOSEPH: In some cases, they were illnesses that people would have had whether they went to the Gulf or not. In some cases, they were injuries that were a result of being in the Gulf. If you have a chronic arthritis of the hip from an injury that you got jumping off the mechanized vehicle, that's related to your service in the Gulf very directly. Then there was a small group who had symptoms that really couldn't be understood or put into a current diagnostic framework- headaches, fatigue, depression, muscle soreness, joint pains, et cetera.

NARRATOR: Did these symptoms have anything to do with the Gulf? That depended, Joseph said, on how many vets were sick out of the estimated 700,000 service men and women who went there.

Dr. STEPHEN JOSEPH: It's not surprising that four or five years after the event, you have 40,000 or 50,000 people out of 700,000 who are ill. If you looked at a small or medium-sized American city on any given day and said to over half a million people, "How many of you in the last four or five years have been ill for some period of time or haven't felt well or have had symptoms of any kind?" you would have a number probably much larger than that.

CONGRESSMAN: [at hearing] I might say, Dr. Joseph, is there a yes or no answer to the question? Is there a "Persian Gulf syndrome" or illness?

Dr. STEPHEN JOSEPH: Yes, there is an answer and the answer is no, if by that you mean-

NARRATOR: As Joseph delivered the stunning conclusion in his characteristic blunt style, he met with skepticism and mistrust. Vets now pinned their hopes on the Presidential Advisory Committee, the PAC, chaired by Dr. Joyce Lashof. The PAC decided to hold hearings all around the country to find out first-hand about the veterans' problems.

1st VETERAN: [at hearing] Listen to the veterans who were there, veterans who answered the call and are concerned about their health and the health of their family. Don't turn your back on us.

1st VETERAN'S WIFE: A few months later we were given the devastating news that the-

JOYCE LASHOF, M.D. Chair, Presidential Advisory Committee (PAC): It was extremely important to the work of our committee that we really understand how the veterans were feeling and what the issues were to them.

2nd VETERAN: [at hearing] I'm tired and I get so darned
depressed.

Dr. JOYCE LASHOF: It was very difficult to sit and listen to the vets describe their problems.

2nd VETERAN'S WIFE: [at hearing] I lost my husband and I have a deformed child.

Dr. JOYCE LASHOF: Many of them are heartbreaking.

FATHER OF VETERAN: [at hearing] This cancer crucified him. It just crucified him.

NARRATOR: Tragic and compelling though the stories were, the PAC couldn't find any scientific evidence to support the idea that acute and dramatic conditions like cancers were connected with the Gulf War.

Dr. JOYCE LASHOF: The problem you have is, when a group of people come back from a particular experience and various ones find that they're ill, and they weren't ill before they went, they naturally blame it on having gone to the Gulf. Well, someone else could have come down with that exact same illness who didn't go to the Gulf.

3rd VETERAN: [at hearing] Family members, wives, that are now sick-

Dr. JOYCE LASHOF: We heard veterans describe their diagnosis that we know happened to the general population. I mean, amyotrophic lateral sclerosis is a disease that happens to people.

JON PALFREMAN: That's Lou Gehrig's disease.

Dr. JOYCE LASHOF: Lou Gehrig's disease. And there is a veteran who has that. He feels it's due to his service in the Gulf. We don't know the cause of Lou Gehrig's disease, but we know it happens to lots of people who didn't go to the Gulf. It was heartrending to sit and listen to the woman with a child with a congenital defect. She feels it's due to service in the Gulf. I think it's completely understandable, but it's just not valid. Birth defects are very common. About 3 percent of births have some type of congenital defect. The initial studies we have show no greater frequency of birth defects among those children born to veterans who were in the Gulf, either women veterans or men.

NARRATOR: The first thorough epidemiological studies began to appear in the medical journals, studies comparing troops who served in the Gulf with troops who didn't. The results were reassuring. Gulf War vets were not dying from disease at a higher rate than expected,
although more had died in car accidents, something that has been found after other wars.

Gulf War vets weren't being hospitalized at a higher rate than military servicemen who didn't go to the Gulf. And a large study showed that babies being born to Gulf War vets had no higher rate of birth defects. [www.pbs.org: Read the results of the studies] The PAC had discovered only a handful of cases where there was no doubt the disease was Gulf-related.

PHILIP LANDRIGAN, M.D., Epidemiologist (PAC): There were a few cases of acute disease in the vets that were quite clearly associated with service in the Gulf. There have been some 30 or 40 cases of the parasitic disease Leishmaniasis. There had been a few cases of malaria. But I think they're different from the chronic sort of illness that seven years post-service continues to plague some number of the veterans.

NARRATOR: Essentially, the PAC agreed with Dr. Joseph: There was no unique Gulf War Syndrome. There were unexplained symptoms like migraine, joint pain and insomnia. For the scientists, there was still the issue of whether these common symptoms could have been caused by something in the Gulf. But the media continued to act as if there was a Gulf War Syndrome, pursuing theory after theory about its cause.

NBC NEWS CORRESPONDENT: ["Dateline"] Mixed in with the smoke pouring from those burning Iraqi tanks was a toxic radioactive dust released when those highly effective-

NARRATOR: "Dateline" speculated that radioactive debris from the uranium shell casings used to pierce Iraqi tanks might be the cause of Gulf War Syndrome.

Dr. PHILIP LANDRIGAN: I don't think so. The number of vets who have been documented to have fragments of depleted uranium is, at most, a couple of hundred and, using strict criteria, fewer than that. It just doesn't account numerically for the thousands of people who complain of symptoms.

NARRATOR: 20/20 wondered about the oil fires that Saddam Hussein had set-
LYNN SHERR, ABC News: ["20/20"] -those fires in the oil wells that were burning out of control for so long to increased health risks.

NARRATOR: Scientists now agree that the heat drove most of the fumes high up into the atmosphere, away from the troops on the ground.
JOYCE LASHOF, M.D., Chair, Presidential Advisory Committee (PAC) Surprisingly enough, the data from the air monitoring which was done shows that the air was no dirtier than an average American city which, you know, sounds illogical to us when we saw all the pictures of the oil wells and the fires.

ED BRADLEY, CBS News: ["60 Minutes"] Every eight hours during the war, hundreds of thousands of American soldiers stopped what they were doing to take a pill, pyridostigmine bromide, or P.B.

NARRATOR: 60 Minutes wondered if side effects from P.B., a drug given to protect against the nerve gas soman, might be the cause of Gulf War Syndrome. It had, after all, never been given to large numbers of troops. But it's not new. People like Janet Wagner have been taking it for decades, in doses 20 times larger than that used by the troops, for the neurological disease myasthenia gravis. The FDA regards it as a perfectly safe drug and Janet, like most users, hasn't experienced any of the chronic side effects that Gulf War veterans have reported.

Dr. JOYCE LASHOF: The doses, as compared to treatment doses, were quite small, so that, as a cause of any long-term illness, was considered very unlikely.

NARRATOR: Nightline brought up another possibility: pesticides.

JOHN McWETHY, ABC News: ["Nightline"] -causes could be heavy use of pesticides to protect soldiers from such deadly insects as scorpions.

Dr. PHILIP LANDRIGAN: Pesticides are certainly toxic chemicals and we've seen cases of neurotoxicity in people like park rangers in the Everglades who slathered themselves with DEET every day for a whole season. But I just can't imagine that thousands of people had the kinds of heavy exposure to pesticides that would be required to produce the overall pattern of illness that we're seeing here.

NARRATOR: Dan Rather suggested vaccines.

DAN RATHER, CBS News: ["CBS Evening News"] The veterans may be suffering side effects from experimental vaccines.

Dr. JOYCE LASHOF: The majority of the immunizations which they received are standard immunizations that we've been using in civilian life and in military life for a long time. The two that cause concern were those that were more unusual and not part of the standard immunization routine and that would be anthrax and botulinum toxin.
NARRATOR: But the panel could find little evidence that these vaccines caused the chronic symptoms.

Dr. JOYCE LASHOF: There is no reason to believe that the vaccines could cause any problem, nor that they could be a vehicle for transmitting any other organism, as has been postulated. These are safe vaccines.

NARRATOR: But the media's favorite theory by far was that chemical weapons might be to blame. Since the war, the DoD had repeatedly denied that U.S. troops had been exposed to chemical agents. But many vets were skeptical of these denials because during the war hundreds of chemical alarms had gone off.

BERNARD ROSTKER, Ph.D., DoD Special Assistant, Gulf War Illnesses: There are many chemicals that will set off a chemical alarm. Insect repellent will set off a chemical alarm. Diesel fuel exhaust will set off the chemical alarm. The fact that an alarm went off in no way is definitive that you've been exposed to chemicals.

NARRATOR: But the PAC detected a logical flaw in this argument.

Dr. JOYCE LASHOF: DoD said all these other things like oils and petroleum, waxes, all of them could cause alarms to go off, there's no way you can say that it was due to a chemical warfare agent. And that's correct. But there's also no way you can say that it wasn't due to it. All you can say is "It could have been, it could not have been".

NARRATOR: But still the PAC had medical reasons for doubting that Saddam had used chemical weapons. Their effects on humans are hard to miss. When a religious cult released the nerve agent sarin into a Tokyo subway in 1994, the effects were immediate, dramatic and followed a classic pattern known to physicians since World War II: constriction of the pupils, tearing of the eyes, respiratory and neurological symptoms, paralysis and death.

Since no such acute effects were seen anywhere in the Gulf, what were the chances that sarin or any other chemical weapons were used by Saddam?

Dr. JOYCE LASHOF: If there had been an offensive release, there would have been acute health effects. There's no way you could have shot off a warhead full of chemicals and released it into a battlefield situation and not have had illness. So I think everyone was satisfied that there was no offensive use of chemical agents really designed to kill people. But could there have been some release of low level? We felt that was worth exploring.
NARRATOR: While there was no scientific evidence that low levels of nerve agent could cause delayed chronic effects like those seen in the vets, the PAC recommended more animal research be done. But their report in early 1996 was clear and agreed with the other scientific panels. There was no unique Gulf War Syndrome and the symptoms, like fatigue and joint pain, were not likely the result of the risk factors publicized in the media, including chemical weapons. There was one factor, however, the PAC thought very likely to have contributed to the vets’ symptoms: stress.

Dr. JOYCE LASHOF: Stress has profound physiological effects on the human body. Stress can contribute to the development of cardiac symptomatology and even heart attacks. Stress impacts on diabetes. It’s not the primary cause, but it has an effect on the disease and how the body is handling the disease and how severe the disease is. So stress has profound effects. And they’re not imaginary, they’re real.

NARRATOR: The vets were not impressed.

LESTER HALLMAN, Seabees: Bunch of bull. If you go back and look at these blue-ribbon panels, they are government-sponsored and government employees, for the most part. Need I say more?

STERLING SIMS, Seabees: Do we look like we’re stressed out? It’s just another delaying tactic, is all the world it is.

DENISE NICHOLS: [at hearing] This is not stress. The stress is what the government has-

NARRATOR: Anger mounted.

DENISE NICHOLS: [at hearing] -done to us for seven years.

FATHER OF VETERAN: I know what my son died of. He died of cancer. I want to know what killed him. And it wasn’t stress.

VETERAN: It’s not in your head. This illness is real. What’s happening to me is real. It’s destroying my life. It’s destroying my body. And as every day goes by-

NARRATOR: So great was the anger that threatening phone calls were made to the PAC. The panel continued its work protected by federal agents, their conclusions unchanged. One reason they felt so sure of their conclusions was because of the work of this man. Captain Craig Hyams, an infectious disease specialist and Gulf War vet, wondered whether anything like Gulf War Syndrome had happened before.
Capt. CRAIG HYAMS, M.D., U.S. Naval Medical Research Institute: It took over a year, actually, to find all of the articles written by the physicians at the time. Starting with the Civil War, we had a war-related health problem known as "irritable heart" or Da Costa Syndrome and it presented similarly to the illnesses that we're seeing now amongst Gulf War veterans. The veterans complained of fatigue and shortness of breath and headache and problems with sleeping and problems concentrating and remembering. At the beginning of the First World War, there was a major problem when the British had to evacuate soldiers from the front in France because of a condition known as "effort syndrome" and, again, this condition presented with fatigue and headache, shortness of breathe and problems remembering and concentrating. In fact, after all the major wars the veterans have had the sort of physical complaints that we're seeing amongst Gulf War veterans.

NARRATOR: And the cause? Many military doctors had thought stress was the likely explanation.

Capt. CRAIG HYAMS: If you read the medical literature, with all major wars the troops suffer from psychological problems after the wars. Anyone who's been traumatized, their life has been threatened, is going to have some problems afterwards.

NARRATOR: Are Gulf War vets like Simpson simply going through what previous generations of soldiers have gone through? While few were traumatized by the violence of the Gulf War, they endured the stress of a long build-up in a harsh desert environment, fearful of what Saddam might do with his army and chemical weapons. And many have had trouble adjusting back to civilian life. Still, they found the stress theory repellent.

Sgt. JIM SIMPSON: Yeah, it was an insult. It was a downright insult. Wouldn't you feel stressed if you lost your job and you were suddenly unable to do certain things that you used to do on a regular basis?

Dr. STEPHEN JOSEPH, Assistant Secretary of Defense, Health Affairs 1994-1997: Why? Why is it so difficult to accept the message that when you put young Americans or anyone in a situation that is uncomfortable, dangerous and uncertain, that a number of those people come back from that situation with a combination of physical symptoms and psychological symptoms? I think we all know that. We look at ourselves in the mirror, every one of us knows that and understands that in our own life. When you wake up in the morning and don't feel well and don't want to go to work because you have something unpleasant that's going to happen to you at work that day, you understand this combination of physical symptoms, whether it's sleeplessness or depression or pains in your...
joints or pains in your stomach and what's going on in your psyche.

NARRATOR: Vets who had placed their hopes in the PAC were disappointed. So were some their advocates in congress.

Rep. CHRISTOPHER SHAYS: The President's commission were quick to accept that this was basically more of a mental problem than a physical problem. I find that pretty outrageous.

NARRATOR: Congressman Shays, who had spent years investigating Gulf War Syndrome, found stress an unsatisfactory answer.

Rep. CHRISTOPHER SHAYS: Gulf War Syndrome is not one cause, not one illness. It's many causes, many illnesses.

JON PALFREMAN: So it doesn't rule out yet, in your view, the idea this could be an infectious disease that affects family members?

Rep. CHRISTOPHER SHAYS: Oh, it doesn't rule out that at all. No, I think it can be infectious. In some cases, I think it is.

JON PALFREMAN: It doesn't rule out that it can cause birth defects in children?

Rep. CHRISTOPHER SHAYS: Doesn't rule out that it can cause birth defects. I believe it can.

Rep. BERNARD SANDERS, (I), VT: There is no question in my mind - none, zero - that tens and tens of thousands of our soldiers are suffering from a wide range of illnesses, which I believe are attributable to their service in the Gulf.

JON PALFREMAN: But does this go beyond symptomatology to include things like Lou Gehrig's disease and cancers?

Rep. BERNARD SANDERS: Could it? The answer, again- you're- I'm not a physician and I'm certainly not an expert on that illness. Do I think it is possible? Yes, I think it is possible.

Dr. STEPHEN JOSEPH, Assistant Secretary of Defense, Health Affairs 1994-1997: People have a great resistance to hearing what they don't want to hear. It was not a palatable message to some of the members of the media, to some members of the veterans' groups and, regrettably, to some members of the Congress to accept what the information- what the scientific data showed, which is that there was a wide variety of symptoms, there was no single or unique mystery illness and, most importantly, that stress- that psychological stressors were very intimately and importantly
related to the physical symptoms. This was a disagreeable message and people did not want to hear it.

NARRATOR: Vets had craved answers to explain why they were ill. But all the scientific panels had failed to find a Gulf War Syndrome. The story seemed to be at an end. Then something happened that would change everything.

ED BRADLEY, CBS News: ["60 Minutes"] After denying it for years, little by little the Pentagon is now admitting to something American soldiers who fought in the Gulf War have been claiming for years, that they could very well have been exposed to deadly nerve gas.

NARRATOR: In June, 1996, the Pentagon admitted it had made a big mistake. Shortly after the ground war ended, U.S. troops had blown up an Iraqi ammunition dump called Khamisiyah and in the process had blown up some rockets filled with the nerve agent sarin. The Pentagon, which had resolutely denied any chemical weapons exposure, now found itself under attack from all sides.

Rep. BERNARD SANDERS: [at hearing] I think the key question that all of us want to know is that how come it took the Pentagon five years to acknowledge that?

NARRATOR: Dr. Stephen Joseph, the DoD’s main medical spokesman on Gulf War illness, was accused of being part of the conspiracy.

ED BRADLEY, CBS News: ["60 Minutes"] If you knew the information since 1991, why did the Department of Defense spend so much time-

WOMAN ON ELEVATOR: Can we please get off, please?

Dr. STEPHEN JOSEPH: Excuse me.

WOMAN: Thank you.

Rep. CHRISTOPHER SHAYS: [at hearing] My question to you is when did you know there was a chemical weapon in any of these bunkers?

Dr. STEPHEN JOSEPH: When did I know that there was a chemical weapon in the bunkers?

Rep. CHRISTOPHER SHAYS: Yes.

Dr. STEPHEN JOSEPH: Several days before the press
Rep. CHRISTOPHER SHAYS: How many days before?

Dr. STEPHEN JOSEPH: I can't tell you exactly.

Rep. CHRISTOPHER SHAYS: No, no, no. You can. This-

Dr. STEPHEN JOSEPH: It would be an understatement to say that I was surprised. It would be an understatement to say that I was embarrassed for the department and for ourselves. I mean, this- the Khamisiyah issue just destroyed any credibility the department had. It threw everything into further uncertainty and, of course, total loss of public credibility.

NARRATOR: The heroes of the Gulf War were hauled before Congress to answer charges of a cover-up.

Gen. NORMAN SCHWARZKOPF, U.S. Army (Ret.): [at hearing] Certain people have charged that I and my commanders knowingly placed our troops at risk to chemical weapons while we sought protection for ourselves. Such a statement is a blatant lie.

Gen. COLIN POWELL, U.S. Army (Ret.): I don't think there is a conspiracy going on. I think there's a lot of- a lot of confusion with respect to what intelligence information did or did not exist.

NARRATOR: Everyone wanted to know what happened. Khamisiyah was a large Iraqi ammunition storage depot that allied troops blew up in March, 1991, shortly after the war ended. Days before the demolition, at least three intelligence leads raised the possibility that the site might contain chemical weapons. But the Pentagon says they were lost in the fog of war. So thinking it was a conventional weapons site, the Army blew it up and moved on. There were no confirmed chemical detections and no medical symptoms reported. The site was forgotten.

A few months later, in October of '91, Khamisiyah was visited by a United Nations inspection team. They found parts of the site heavily contaminated with sarin. They also found an empty U.S. Army explosives crate. Since whoever destroyed the site might have been exposed to sarin, the U.N. passed on its findings to U.S. authorities. The Pentagon investigated, but dismissed the possibility that U.S. troops had been involved. Now, five years later, Congress wanted to know why.

Rep. CHRISTOPHER SHAYS: Oh, it's clearly a cover-up. I mean, I have no reluctance in saying that. I might have earlier on, but after 11 hearings, everything that we've learned we've had to pull
out of DoD.

NARRATOR: The Pentagon claimed it was all an innocent mistake.

Dr. BERNARD ROSTKER, Ph.D., DoD Special Assistant, Gulf War Illnesses: There was no cover-up. No one who was at Khamisiyah had any indication, any inkling that they were dealing with chemical weapons, either during the period they were rigging the site for demolition or after it blew up.

[www.pbs.org: More on the cover-up question]

NARRATOR: Khamisiyah was a devastating blow for the Pentagon. In an effort to restore credibility, it embarked on an extraordinary mission: to reconstruct the Gulf War, to investigate each and every potential Khamisiyah. The Pentagon took their show on the road to special town meetings at which the new spokesman, Bernard Rostker, tried to reassure vets that they were now being taken seriously. But far from reassuring the vets, Rostker attracted a newly energized anger.

1st VETERAN: [at meeting] -you guys doing anything about it.

2nd VETERAN: Wait a minute. Wait a minute. Wait a minute! Okay, I gave- I gave you an opportunity. Let me finish speaking.

Dr. BERNARD ROSTKER: I'll let you finish, but I take great exception to that.

2nd VETERAN: You should be ashamed to call yourself a veteran. You know what-

NARRATOR: The news went from bad to worse. Complex computer models of the Khamisiyah release showed that over four days, a plume of very low levels of sarin gas passed over nearly 100,000 American troops. The media, led by The New York Times, portrayed the Khamisiyah revelations as if they were evidence that the cause of Gulf War Syndrome had now been found: chemical weapons.

ED BRADLEY, CBS News: ['"60 Minutes"'] And if Pentagon officials lied about Khamisiyah, are there other Khamisiyahs?

JOYCE LASHOF, M.D., Chair, Presidential Advisory Committee (PAC): I don't reach conclusions without scientific data. I'll wait for the scientific data. That's my training. That's my job.

NARRATOR: The PAC was as angry with the DoD as anyone
else, but Dr. Lashof was also worried that the careful scientific work of her committee was being obliterated by the media frenzy over Khamisiyah. Medically, she said, Khamisiyah made no difference.

JOYCE LASHOF, M.D., Chair, Presidential Advisory Committee (PAC): The problem we had throughout was trying to separate the issue of exposure to chemicals and illness due to chemicals. I continually have people come up to me and say, "I read in The New York Times that chemicals are the cause of it." I say, "No, no, no. That's not what we in the committee have found." We are concerned about the issue of exposure because we think the veterans have a right to know and we make an issue of that. And we've made an issue of the DoD for not doing a good job of exposure. But that is not to say that we believe that those exposures are the actual cause of illness.

NARRATOR: In reality, Khamisiyah had changed the politics, not the science. There was still no evidence that very low levels of chemical weapons could cause delayed chronic symptoms like fatigue.

And there was another problem. The vast majority of the troops in the plume are not ill. And most of the troops who went to the Gulf, including thousands of vets who were ill, like the Seabees at Al Jubayl, were not in the plume. But most of the media failed to point this out to their readers. In this charged media climate, vets like the Seabees were not inclined to believe the official DoD report that they had not been exposed to chemical weapons at Al Jubayl, that the loud noise was a sonic boom and the yellow mist chemicals from a nearby fertilizer plant.

LESTER HALLMAN, Seabees: They knew what happened over there, but they would have egg on their face, as the old saying goes, if they admitted it.

NARRATOR: Vets seemed more fearful than ever.

LEGIONNAIRE: [to Matt Puglisi] We weren't too happy about that Scud missile.

NARRATOR: American Legion spokesman Matt Puglisi, himself a Gulf War vet, had made great efforts to get vets to pay attention to the emerging scientific studies. Now he saw things falling apart.

MATT PUGLISI, Director of Gulf War Illnesses, American Legion: [at meeting] The media is very, very interested in the risk factors- There were a lot of reckless statements being made about these illnesses that took on a life of their own. They're not helpful to the
veterans. They frighten those who are in good health and they
frighten those who suffer from poor health, as
well. If you look at The New York Times, which has some of the
best medical reporters in the nation, it hasn't been allowing them- it
hasn't encouraged their medical reporters to cover this issue. Why
not? They've been covering it from a political angle with their
Pentagon reporter. Doesn't help the nation understand what's really
important about Gulf War illnesses, what are the medical
complexities of this. This is not a political story. This is a medical
story. Gulf War veterans went to the Gulf and came back and some
of them suffer from poor health. Let medical doctors try to answer
that.

NARRATOR: We wanted to ask The New York Times why they
hadn't assigned their medical reporters to cover this story and to
answer the charge that they had created the impression of a
connection between Khamisiyah and Gulf War Syndrome. But
editor Andy Rosenthal, after agreeing to an interview, canceled at
the last minute, saying, "I never wanted to do the interview anyway."

Dr. STEPHEN JOSEPH, Assistant Secretary of Defense,
Health Affairs 1994-1997: I think the media in general did a very
poor job of covering what the medical facts and what the scientific
realities were.

NARRATOR: Joseph had been incensed by Life's 1995 cover
story on the Hansons.

Dr. STEPHEN JOSEPH: The Life magazine piece was both a
charade and very cynically done. We talked to the people at Life
magazine, told them what the scientific data showed, that there was
no evidence for congenital defects. They went ahead and published
in the most sensationalistic way anyway. I think they did a great
disservice to- not only to the people who served in the Gulf, but to
their families. I think they scared a lot of people.

MATT PUGLISI, Director of Gulf War Illnesses, American
Legion: In one health survey that's been conducted, a majority of
male Gulf War veterans responded that they'd delayed having
children because of reports of excess birth defects in the Gulf War
veterans population. That's a tremendous change in behavior.

NARRATOR: When asked to respond to these charges, Life
magazine said they stand by their story. [www.pbs.org: More on the
media coverage]

Rep. BERNARD SANDERS: [at hearing] Answers to questions
about troop exposure to chemical agents and their connection to the
Persian Gulf War Syndrome are long overdue.
NARRATOR: Like the media, Congress, too, had been reenergized by the Khamisiyah revelations. Congressman Bernard Sanders got 86 of his colleagues to sign a letter asking the Presidential Advisory Committee to change its conclusion that stress was the likely cause of the vets' illness.

He wanted the PAC to consider the work of other scientists who'd come to different conclusions, like Garth and Nancy Nicolson, who believed Gulf War Syndrome was caused by a insidious biological weapon; or Robert Haley, a Texas epidemiologist funded by Ross Perot, who had studied the Seabees and concluded that vets who thought they had been exposed to mixtures of chemicals displayed subtle neurological changes; and Mohamed Abou-Donia, who injected a combination of very large quantities of pesticides and pyridostigmine bromide into chickens and showed that their brains were affected, evidence, he argued, that a combination of chemicals might be the cause of Gulf War Syndrome.

The PAC had already considered and rejected each of these studies. JOYCE LASHOF, M.D., Chair, Presidential Advisory Committee (PAC): One of the studies, for instance, in chickens, of Abou-Donia, in which he gave very large doses of DEET and pyridostigmine bromide, is not duplicative of the type of situation we saw among the veterans. If he really wanted to duplicate what we saw in the Gulf, he would have given them in lower doses, not have caused symptoms, and then have stopped them and then waited several months and then sacrificed them to see if there was anything there.

JON PALFREMAN: I asked them about many of the studies of the people in your letter. And I think it's pretty clear that they've considered them. They don't actually think very much of them.

Rep. BERNARD SANDERS: Fine. They don't think very much of them, but go out to the veterans' community and go out to the people who are suffering and speak to them. But let me turn the tables and say to all of these scientists who tell us that nobody else is doing serious work out there, what have they discovered after six years? What is their understanding? Oh, it's an incurable problem? There is no cause to the problem? That's not a particularly good answer.

Dr. STEPHEN JOSEPH: Well, one could say Congress has had 175 years to sort out some of their problems and they haven't gotten-I mean, that's a ridiculous argument. Hard problems are hard. You can't make them easier by plucking solutions out of the air.

NARRATOR: In the wake of Khamisiyah, the government has allocated millions of dollars of research to investigate each and every theory, but many vets are tired of waiting. They have sought out the
handful of scientists who believe in Gulf War Syndrome and claim they can cure it. One of these scientists is Garth Nicolson. Nicolson believes the vets' symptoms are caused by an organism called a mycoplasma that Saddam had modified with genes from the AIDS virus.

According to Nicolson, Saddam then delivered this biological weapon in Scud missiles. But critics ridiculed his theory. What would be the purpose of a weapon that didn't kill the enemy, but caused chronic symptoms years later?

GARTH NICOLSON, The Institute for Molecular Medicine, Ph.D.: Saddam said he would send the war back to the United States and I think this is how it was done.

JON PALFREMAN: But wouldn't he have rather won the war?

NANCY NICOLSON, The Institute for Molecular Medicine, Ph.D.: It's a question of what you mean by "winning." See, you can- to him it was probably, in his mindset, just a battle, but sending home a deadly illness like this, the aftermath is- in a way, he- he has won.

NARRATOR: The best proof of his theory, Nicolson argued, was that by using very large doses of certain antibiotics to kill the mycoplasma he had been able to cure many Gulf War veterans. One vet that Nicolson approached was Randy Hebert.

KIM HEBERT: We received a call from Dr. Nicolson right after we testified up in Washington. He had seen Randy on CNN. And we were very interested in trying because he was the only one that had given us any type of hope. You've just got to put faith in someone that positive.

NARRATOR: Initially Randy seemed better, but after a few weeks he had a setback. Nicolson also tested Kim Hebert for mycoplasma and diagnosed her with Gulf War Syndrome, as well.

KIM HEBERT: Dr. Nicolson really believes that my signs, as far as migraines and vision going bad and- is a sign of the mycoplasmas. But I think all my signs are due to stress. You know, our household is not normal anymore. I mean, we just went from a healthy relationship to, you know, your husband being sick. And it turns your whole house upside down when Daddy's not well.

JON PALFREMAN: Can you cure Lou Gehrig's disease with antibiotics?

Dr. JOYCE LASHOF: No. If we had a cure for Lou Gehrig's
disease, especially with antibiotics, we wouldn't have any deaths from Lou Gehrig's disease. No one can cure Lou Gehrig's disease today.

**NARRATOR:** The PAC disbanded last November and Joyce Lashof is back teaching at Berkeley, frustrated that the panel's conclusions got so little attention from Congress and the media. Joseph left the DoD medical department and is now in private practice. He is philosophical about what happened.

**Dr. STEPHEN JOSEPH:** The veterans, they were hurting and they wanted answers that were most acceptable to them. They wanted medical labels and psychological stress was a message that was not and is not today palatable to the vets. They don't want to hear that. I think part of the blame rests on those who continue to whip up the issue. I mean, I think there were certainly those in the media, there were pseudo scientists, there were individual members of Congress who just would dredge up the most fantastic hypotheses and explanations without a shred of acceptable scientific and medical evidence.

Eventually, this will all sort out. Eventually, those self-interested loud voices of sensationalism will pass away. Eventually, people will look back at this three years, five years from now and say "What did we learn from this?"

**ANNOUNCER:** Examine more of this report on Gulf War Syndrome at FRONTLINE online. Read the scientists' conclusions on the major theories on causes. Take a closer look at Khamisiyah. Was there a cover-up? And check out Gulf veterans' health compared with other veterans- and much more at FRONTLINE online at www.pbs.org.

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Next time on FRONTLINE: old age. We all face it. Most of us dread it.

**SPEAKER:** What is the definition of "retirement" and what does it mean to you?

**MAN AT MEETING:** Death.

**SPEAKER:** Death? Did he say "death"?

**MARIAN MARZYNSKI:** Now I am approaching 60 and wonder what is the American dream for the old?

**ANNOUNCER:** Filmmaker Marian Marzynski takes us on a poignant journey exploring the many faces of old age.

**MAN IN CLASSROOM:** How many geezers do we have out there?

**ANNOUNCER:** *My Retirement Dreams* next time on FRONTLINE.

Now it's time for your letters. Our program on captive whales and dolphins left many viewers unsatisfied. Here's a sample.

**MARK MACHADO:** [Swansea, MA] Dear FRONTLINE: I find
it distasteful that your organization would downplay the role of important marine mammal research at the expense of a few captive animals. Furthermore, the business of theme parks is an absolute and necessary component in advancing these studies.

DAVID KRAUS: [Lincoln, MA] The views presented were not balanced and the positive side of keeping wild animals in captivity to educate and inspire the public were ignored in favor of a purely emotional attachment to one animal.

RUTH MUSGRAVE: [Bakersfield, CA] I was disappointed that you, like the rest of the media, took the subjective, pop-biology road. You gave legitimacy to those whale-huggers based on their ability to cry on cue or create their own publicity. Millions and millions of dollars were raised to save one whale, who is now better cared for than most of our children and senior citizens. This should scare you. It does me.

ANNOUNCER: Tell us what you thought about tonight's program by fax [(617) 254-0243], by e-mail [FRONTLINE@PBS.ORG] or by the U.S. mail [DEAR FRONTLINE, 125 Western Ave., Boston, MA 02134].

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NOVA/FRONTLINE SPECIAL: Harvest Of Fear. [120’].
NARRATOR: It was the eve of a new Century and Catherine Ives left her home near the quiet Michigan State University Campus.

CATHERINE IVES, Michigan State University: I was walking into downtown East Lansing to go out for New Year's Eve and we saw the fire trucks and the engines moving onto campus and we said oh, gee, I wonder what is going on here. And I looked up and I counted the floors and I said that's my office.

NARRATOR: The fire completely destroyed Ives' department. It was arson... but investigators had no clue why an agricultural center devoted to helping developing countries would be a target.

CATHERINE IVES, Michigan State University: The issue was did we have any ex-boyfriends or girlfriends that would be mad at us.

NARRATOR: Then, a communiqué arrived. It came from a basement office in Portland, Oregon. From a representative of an underground group--the Earth Liberation Front.

CRAIG ROSEBRAUGH, Spokesperson, Earth Liberation Front: There was an ELF action at Michigan State University on December 31st this last year and it was a fire that burned down part of a building where a genetic engineering research project was going on run by a woman named Catherine Ives. It did about $900,000.00 worth of damage.

NARRATOR: From burning buildings to destroying crops, the Earth Liberation front has declared war on biotechnology.
CRAIG ROSEBRAUGH, Spokesperson, Earth Liberation Front: I think the motives behind biotechnology are sickening. We know right now that there are problems associated with biotech and we’re not going to know the extent of those problems for years to come.

NARRATOR: The ELF are at the extreme end of a movement passionately opposed to genetically modified food.

Environmentalists call it Frankenfood and want it banned.

CHARLES MARGULIS, Greenpeace: We feel that this is a mass genetic experiment that’s going on in our environment and in our diets.

NARRATOR: But giant multinationals who have bet their future on this technology insist it’s safe.

HUGH GRANT, Chief Operating Officer, Monsanto: These are products, they’re technologies that have been more widely tested than any other food product that came before them in history.

NARRATOR: There are scientists on both sides of the debate.

CHARLES ARNTZEN, Cornell University: We haven’t has do much as a headache from any genetically modified food.

JANE RISSLER, Union of Concerned Scientists: We know very little about the long term impacts of genetically engineered food, so as a general matter they should be subject to more scrutiny.

NARRATOR: At once exciting and scary, this may be the future of our food.

From corn that makes its own pesticide...

To bananas that contain medicine.

to fast growing fish...

JEREMY RIFKIN, Author, "The Biotech Century": This revolution affects the most intimate aspect of life on earth, our own biology, the biology of our fellow creatures. If ever there was a time when we human beings had to take personal responsibility for the future, this is it.

ANNOUNCER: Tonight NOVA and FRONTLINE disentangle the fight about genetically modified food, the risks, the benefits, the hopes and the fears.

NARRATOR: In the early 1990s, on the big island of Hawaii, there was a disaster brewing. Like many farmers, Rusty Perry’s livelihood was based on the papaya, a sweet-tasting fruit and one of Hawaii’s most important crops. Then a lethal disease - the papaya ring spot virus - began decimating the plantations.
RUSTY PERRY, Papaya Farmer: We first found it in- I think it was late '93, and by '94 it was starting to become a real problem. And by '95 we had lost most of our fields. We had about 14 non-family employees. We went down to one.

NARRATOR: Dennis and Carol Gonsalves, two Hawaiian molecular biologists working at Cornell University, came to see the damage for themselves.

DENNIS GONSALVES, Cornell University: It's amazing. Look at that tree over there, typical symptoms of papaya ring spot. These are the shoe-stringing of the leaves over here. Look at this ring spot here. This is why they call it papaya ring spot

CAROL GONSALVES, Cornell University: Boy, those fruit are terrible.

DENNIS GONSALVES: Yes, this farmer's not going to make any money.

NARRATOR: Nothing seemed to stop the virus - not physical barriers, not chemical pesticides. And most farmers were resigned that within a few years, the $45 million papaya industry would be gone forever.

Back in New York state, at Cornell University, Dennis and Carol Gonsalves searched for a solution. They wondered if the cutting-edge technology of genetic engineering might help. Genes are the chemical instructions in each cell that govern how plants and animals reproduce and grow. The Gonsalves's colleagues had been manipulating them since the '70s. Many medicines, from insulin to AIDS drugs, were now genetically engineered. Perhaps, he thought, the same techniques could help plants, as well. Even though plants don't have immune systems, Gonsalves thought it might be possible to protect them against a future infection.

Among the many genes making up the ring spot virus, Gonsalves identified one that made a harmless protein in the virus's outer coat. If he could splice this gene into the papaya chromosome, making a transgenic papaya, then perhaps the papaya would be protected - in effect, vaccinated against future infection.

But how do you get genes into plants? Scientists at Cornell had invented a crude but effective way called the "gene gun." The ammunition is genes, the target a plant. The shot is propelled by compressed gas.

Magnified many times, the process works like this. First, tens of thousands of copies of the desired viral gene are made. Next they're mixed with tiny tungsten balls to which the genes stick. When the balls are fired, the genes are carried along into the leaf. As the balls pass through the plant, some of the genes get inserted into some of the cells. These transformed cells can be grown in culture to become new plants, transgenic plants.

Gonsalves grew hundreds of transgenic papaya plants in dishes and subjected them to chemical tests. In a few, the new viral gene appeared to be working. Now came the moment of truth. Would genetically modified papaya plants be killed by the ring spot virus or would they resist?

CAROL GONSALVES: The real severe and the best test is after the gene is in, you rub
the plants with an isolate of the virus to see if it actually indeed withstands infection.

DENNIS GONSALVES: This here is a virus-infected plant. The effect of the virus is on the leaves and also the fruit. On the leaves- the leaves, instead of being full, are narrow, and they also show this yellowing here, as opposed to the genetically engineered papaya here. This leaf is a normal-looking papaya leaf. It’s fully green, and the growth is very good. Now, the only difference here is that this one plant has the one gene making it resistant to the virus.

NARRATOR: A decade of work had produced a breakthrough and perhaps saved an industry.

If genetic engineering could protect a papaya from a lethal virus, why stop there? At Cornell, a world center of agricultural science, researchers were hard at work genetically engineering crops. Some were working on getting medicines into plants. Others were striving to make crops like rice more nutritious. But the early ’90s was also a time when scientists speculated about exotic possibilities which might never make it into commercial products.

For example, by splicing a gene from a firefly into a tobacco seed, scientists could produce tobacco plants that would glow whenever they needed watering. Another idea was to splice a gene that enables an Arctic flounder to tolerate cold into a strawberry to protect it from frost damage.

While such speculations did not turn into commercial products, the new science of agricultural biotechnology had attracted the attention of some large corporations. Monsanto, an agro-chemical company, realized that biotechnology might offer a way out of the pesticide business, which had become increasingly unprofitable.

HUGH GRANT, Chief Operating Officer, Monsanto: Further development of pesticides was no longer a viable business opportunity and, from an environmental point of view, didn't really make sense, either. So we stopped all chemical investment and really redirected our energy towards biotech.

NARRATOR: Hiring hundreds of researchers, Monsanto set out to build a new industry. The first products were aimed squarely at their traditional customers, the same farmers who had bought their herbicides, pesticides and fertilizers. Farmers like Gerald Tumbleson, who farms in southern Minnesota.

Eighty-five percent of the food we eat comes from large farms like this. On 2,700 acres, Gerald Tumbleson grows only two crops, corn and soy. Americans have come to expect cheap food, so to stay in business, Tumbleson is continually looking to technology to cut his costs - satellite navigation, the latest combine harvesters, and heavy use of pesticides and fertilizers. He was hoping that Monsanto's genetic technology could help him get rid of a big pest, the European corn borer caterpillar.

GERALD TUMBLESON, Minnesota Farmer: They burrow into the stalk, and then it rots the inside of the stalk. They burrow into the shank that holds the ear, and it rots that, and the wind comes up and the corn falls off. Now, to keep that from happening, we spray
our field with an insecticide, but we can't get selective. We spray for an insect, and we might get four or five that we don't want dead, and we've killed them.

NARRATOR: Monsanto had a solution to sell, corn which made its own pesticide.

Scientists had long known that a humble soil bacterium called Bacillus thuringiensis, or Bt, produced toxins that killed caterpillars. Monsanto scientists spliced the bacterial gene that made the toxin into corn. Now every cell of the modified corn makes its own pesticide, a chemical protein harmless to most insects and to humans, whose bodies rapidly break it down, but lethal to the corn borer caterpillar.

In Monsanto's greenhouses, scientists put Bt genes into other crops: soy, potatoes, and into the most intensively sprayed crop of all, cotton. Because Bt crops replace pesticides, many scientists believed genetic engineering could help save the environment.

SUSAN McCOUCH, Cornell University: Cotton is the world's number-one user of pesticides. It is ironic to me that we think of cotton as a natural fiber, and we don't understand that it is a major pollutant environmentally. And Bt cotton presents us with an opportunity to reduce the amount of pesticides that we're spraying on our crops. That not only has an environmental implication, but it has a major implication for the people who actually have to handle pesticides and do the spraying.

GERALD TUMBLESON, Minnesota Farmer: If you've ever been around here when you've sprayed an insecticide, if you've ever used that- we put it on- we put, you know, leather gloves on and coveralls on so it doesn't get on us. That is not a fun thing. That is not something I even want to dream about. I don't even want the thing in my machine shed when my grandkids are around. But those are the types of things we don't have to have with this Bt corn.

NARRATOR: Along with soybeans, which were genetically modified to manage weeds with much less herbicide, the Bt crops were received enthusiastically. Within a couple of years, the majority of soy and cotton and a third of all corn were genetically modified. Farmers like Gerald Tumbleson were convinced that biotechnology had the power to transform agriculture.

GERALD TUMBLESON: We're going to be raising things on this land, on this soil, that we haven't even dreamt of in 10 to 15 years. I envy my sons because they're just getting started in a time which, I think, to me is very important.

NARRATOR: By 1996, grain handlers were treating GM crops like any other grain. They mixed them in with non-GM crops and shipped them to food processors all over America. Because corn and soy are used in hundreds of products, these genetically modified organisms, or GMOs, rapidly found their way into everything from cereals to sodas and into the stomachs of millions of Americans.

Consumers had no idea this had been happening to their food. Even environmental groups had said little about the issue. One exception was Jeremy Rifkin, a long-time critic of biotechnology. For two decades he had tried to get the public interested.
JEREMY RIFKIN, The Foundation on Economic Trends: It seemed to me we needed to have a thorough and thoughtful global discussion on the potential environmental implications of reseeding the earth with genetically modified organisms.

NARRATOR: Rifkin would get his debate, but only when GM food left the U.S. loaded on ships bound for other nations, like Japan and the countries of the European Union. Within months of arriving in Europe, it was clear that the fortunes of GM food were about to change.

DAVID BOE, European Parliament: You started to see it, first of all, in Germany and Austria, where there was almost a paranoia about anything to do with genetic modification. Eugenics as an issue is a very, very sensitive one because of recent history in Germany, and I think it was there that you first started to see real public concern. It was from Germany and Austria that the ball really started to roll, and it didn’t stop there.

NARRATOR: Environmental groups - like Greenpeace International - staged demonstrations in country after country, even dumping GM soy in front of the British prime minister’s residence.

DOUG PARR, Greenpeace UK: The public are becoming quite skeptical about the ability of scientific evidence to tell us all we need to know about potentially irreversible innovations. And genetic engineering seems to be crossing those boundaries of what we can know and should do.

NARRATOR: Europe was already reeling from another, unrelated food crisis. Mad cow disease was condemned as a disastrous failure of science and regulation.

DAVID BOE: The confidence in government agencies to stand up for people, and not roll over to private companies who are trying to make a profit, was just not there.

NARRATOR: Farmers had their GM crops pulled up. Food companies had their brands targeted. Supermarkets were pressured to dump GMOs from their shelves. There was now a broad-based popular movement, angry that GM food had been introduced without consultation.

JEREMY RIFKIN: In Europe there’s a seamless web between culture and cuisine. The way food is grown, the way the agricultural areas are preserved, the way food is processed and served, all of that is a deep statement of the values of each country in which that food is grown. The Europeans were saying, "We don’t want a handful of life-science companies to undermine the cultural values behind our food and food policies in Europe."

GORDON CONWAY, President, The Rockefeller Foundation: There’s no benefit to European consumers, and there are risks. of course. And so it’s quite logical, if you buy up the fact there are no benefits and there are risks, that you will be against them. At the moment, all the benefits are going to American farmers, and I think that isn’t appreciated in Europe.

NARRATOR: As public opinion hardened, the European Union voted for a ban. No new genetically modified organisms would be commercialized until further notice, and all
imported GMOs would have to be labeled.

The scale of the European opposition called into question the entire future of GM food. U.S. exports would be affected, but far more important to U.S. companies was the risk that American consumers might turn against GM food, which had now penetrated throughout the $600 billion U.S. food industry.

At the University of New Mexico, political scientist Hank Jenkins-Smith has embarked on a major opinion survey about genetically modified organisms

TELEPHONE POLLSTER: Do you currently eat any genetically modified foods or foods that include genetically modified ingredients?

NARRATOR: He wants to know if we are likely to reject GMOs, like the Europeans.

HANK C. JENKINS-SMITH, University of New Mexico: The stakes are high. Food is such an intimate thing for most people. We consume those items. We take them into our bodies. We're dependent on the producers of those foods to make sure that they're safe, that they are of high quality. That is what makes this such a fascinating public policy question.

NARRATOR: In designing surveys, researchers use focus groups to get an idea of what snippets people have picked up about a controversy.

HANK C. JENKINS-SMITH: Have any of you eaten genetically modified foods, to the best of your knowledge?

FOCUS GROUP PARTICIPANT: No.

FOCUS GROUP PARTICIPANT: Not knowingly.

FOCUS GROUP PARTICIPANT: There were taco shells.

HANK C. JENKINS-SMITH: Only roughly 20 percent of the people we talked to would say, yes, that they do eat genetically modified organisms. A fair number simply say they don't know. And then the majority say no, they don't.

Any of you ever consume any of that?

FOCUS GROUP PARTICIPANT: Yes.

HANK C. JENKINS-SMITH: We're getting close to home here?

FOCUS GROUP PARTICIPANT: Uh-oh.

HANK C. JENKINS-SMITH: This is soy oil. It's cheese.

NARRATOR: The research is clear. Most Americans have no idea they've been eating GM foods for over five years. And when they find out, they get upset.
FOCUS GROUP PARTICIPANT: And why weren't we allowed to be in on that? Yeah.

FOCUS GROUP PARTICIPANT: What's it going to do to my daughter? What's it going to do to my 8-year-old little boy when he - you know, for reproducing later on? Is there going to be a problem?

NARRATOR: A key element of any controversy is trust. Europeans didn't trust their regulators. What about Americans?

HANK C. JENKINS-SMITH: The department of Agriculture, interestingly, gets quite high ratings of trust. On a scale of zero to 10, where zero is not at all trusted and 10 is completely trusted, they rank close to a 7. And we don't see agencies that get that high very often. Not far behind them comes the FDA.

TELEPHONE POLLSTER: Suppose a spokesperson from the U.S. Environmental Protection Agency said the-

NARRATOR: But as happened in Europe with mad cow disease, trust in regulators can be lost overnight. It's a critical time.

HANK C. JENKINS-SMITH: If there were to be some event that galvanized public concern, you can change an issue like this substantially, as Three Mile Island did, for example, with the nuclear technology policy debate. We haven't seen such a thing yet. If it were to happen, it could be devastating.

TELEPHONE POLLSTER: To the best of your knowledge, have most scientists concluded that genetically modified foods are unsafe for human consumption, safe for human consumption, or they haven't yet reached a conclusion?

Are GMOs safe to eat?

NARRATOR: Unraveling the truth about GM foods means confronting some difficult questions. Are scientists tampering with nature? Will genetically modified organisms damage the environment? Does the world really need GMOs?

But first a more fundamental question. How do we know they're safe to eat?

In the coming years, biotech companies have plans to introduce dozens of new genetically modified organisms - vegetables, fruits, nuts and more. What guarantees do we have that these GMOs will be safe to eat?

[www.pbs.org: What's coming in GM foods?]

JEREMY RIFKIN, The Foundation on Economic Trends: We've spent a long part of our history testing various things we could eat, and a lot of people have died as part of this grand experiment to see what we could consume. Here, for the first time in history, because we're introducing genes from novel sources, we're introducing genes that code for proteins we've never put in the human body. Many of them will be safe. I am sure. Will most of
them be safe? Nobody knows.

GORDON CONWAY, President, The Rockefeller Foundation: You cannot prove that it's safe. You can't prove that any new technology that we have in the world today is absolutely safe. Whether you have a mobile phone that you're listening to, whether that affects you, whether overhead power lines affect you, whether you are a woman and you take a birth control pill or take hormone replacement therapy, we cannot in any of those circumstances prove that it's absolutely safe. What you can do is try and minimize the risks by doing proper testing, and that's what we have to do with genetically modified foods.

NARRATOR: Biotech companies argue that's just what they've done. The new crops are tested for toxicity by feeding the genetically engineered proteins to mice in doses 1,000 times greater than humans would receive. According to Monsanto's chief operating officer, Hugh Grant, such tests have failed to find any evidence of harm.

HUGH GRANT, Chief Operating Officer, Monsanto: These are products, these are crops that the technologies have been more widely tested than any other food product that came before them in history.

NARRATOR: To test that the GM foods are substantially the same as their non-GM equivalents, company scientists compare the chemistry in minute detail. Molecule by molecule, they analyze the GM and non-GM crops. If the resulting graphs from a mass spectrometer line up exactly, the two products are chemically identical. This is what the regulators call "substantial equivalence," and it is one reason GM foods normally do not require special labels.

JANE HENNEY, Former Commissioner, FDA: Most of these foods that are being changed are foods we know very well - corn, soybeans and the like. And what is being changed is usually something that is very - today has been something of very small difference.

NARRATOR: The regulation of GMOs is shared between three agencies that treat them in the way they treat regular crops. The USDA checks that they're safe to grow, the FDA checks they're safe to eat, and the EPA also gets involved with crops, like Bt corn, that contain pesticides.

DAN GLICKMAN, Former U.S. Secretary of Agriculture: I don't think we're going to have the same problems here they have in Europe, and the simple reason why is because our food safety regulatory system is head and shoulders above anybody else's in the world.

NARRATOR: But critics worry that in regulating GMOs no differently from traditional foods, the agencies may be exposing the public to unknown risks, like allergies.

JEREMY RIFKIN, Author, "The Biotech Century": We know that 8 percent of children and 2 percent of adults have allergenic reaction to traditional foods. What we're dealing with is the introduction of new genetic foods that have genes that code for proteins that we've never consumed. We just don't know what the reaction's likely to be.

NARRATOR: At Cornell's Department of Food Science, scientist Joe Hotchkiss is an
JOSEPH HOTCHKISS, Cornell University: Allergenicity is very, very difficult to predict. Probably the most allergenic food is peanuts. There is a protein in peanuts which is a very serious allergen for a very, very small portion of the population. It's very difficult to find out who that population is unless they have had a very bad accident or episode.

[www.pbs.org: Read the full interview]

NARRATOR: People can avoid peanuts by looking at the labels the FDA insists upon. But the ability to manipulate individual genes presents new challenges. One biotech company actually engineered a gene from a Brazil nut into a soybean, making the soybean allergenic. If the soy had ended up in hundreds of products, individuals allergic to Brazil nuts might have unknowingly consumed a life-threatening food. But it never made it to supermarket shelves. The allergy was picked up by a laboratory test.

Scientists like Charles Arntzen of Cornell believe the public should have confidence in GMOs because they are based on three decades of research.

CHARLES ARNTZEN, Cornell University: We've been working on this stuff since the '70s. We haven't had so much as a headache from any genetically modified food, and I think that's because we thought about these things. In the U.S., it's been science-driven. We've had great cooperation between federal agencies, but we've had the scientists who understand this and who've developed it working on this all the way through.

NARRATOR: Despite such assurances, watchdog groups like the Union of Concerned Scientists believe this technology deserves special scrutiny. Their spokesperson is former EPA scientist Dr. Jane Rissler.

JANE RISSLER, Union of Concerned Scientists: You've heard industry say there's no evidence these foods are harmful, and after all, people in the United States have been eating them for several years now. Do you believe that statement? I mean, how are you affected by that? Isn't it a bit disingenuous? How would we know if someone had gotten ill from genetically engineered food if it's not labeled?

I mean, how could there be evidence if they haven't allowed the food to be labeled? They're now saying, "Well, there's no evidence of harm." That's because they haven't allowed any way to track any harm.

NARRATOR: There is perhaps no better example of the difficulties of keeping track of GM food than the story of a corn called Starlink. Developed by Aventis, one of Monsanto's competitors, Starlink was intended for America's breakfast tables. But things didn't work out as planned.

Starlink is identical to regular corn except that it was engineered to make a toxin called Cry9C, one that Aventis had to prove was not an allergen. To test for this, scientists recreate in a test tube the chemical conditions of the human gut and time how long a new protein takes to break down. The longer it takes, the more likely it will be an allergen.
Since Cry9C broke down relatively slowly, the EPA concluded it was a potential human allergen and approved it only for animal use. Convinced it was safe for humans, Aventis conducted more tests. Meanwhile, they decided to go ahead and sell it to farmers strictly for animal feed.

The environmental group Friends of the Earth routinely checks agency releases for news of GM crop approvals. In July, 2000, on an EPA Web site, they noticed Starlink and realized it might be very important.

**LARRY BOHLEN, Friends of the Earth:** What are the potential health effects here?

**COLLEAGUE:** Well it looks like it produces this protein that could be a food allergen.

**LARRY BOHLEN:** We learned that the Starlink corn that has the bacterial toxin Cry9C in it was not approved for human consumption, only for animal consumption. We were in conversations with farmers who were telling us that most farmers do not separate genetically engineered corn from conventional corn. Given that very little of the corn is separated and there's a type of corn not approved for human consumption, I thought there is a good chance that it had made it into our food.

I went into my local Safeway, and I bought 23 different corn-based products—boxes of corn flakes and taco shells and tortilla chips, I had a corn muffin mix, some corn meal and also a couple of enchilada TV dinners.

**NARRATOR:** He took them back to the office and shipped them off to a laboratory with a single question: Do any of them contain the unapproved protein Cry9C? The lab found Starlink corn in one product, taco shells, made by Taco Bell.

**LARRY BOHLEN:** We double and triple-checked the tests, knowing that consumer confidence, millions of dollars and the fate of farmers were all on the line here.

**PETER JENNINGS, ABC News:** Today government officials say they are investigating reports that they are investigating that Taco Bell uses genetically modified corn that is only fit for animals.

**NARRATOR:** The next day, tacos were all over the news, and accusations were flying.

**BARRY SERAFIN, ABC News Correspondent:** The biotech industry says before any action is taken, the test results must be verified, noting that the lab that was used in this case has been wrong before.

**VAL GIDDINGS, VP, Biotechnology Industry Organization:** These results have been alleged by a company that has a history of finding things that aren't there.

**BARRY SERAFIN:** The Food and Drug Administration says it will conduct its own tests and order a recall if the taco shells do indeed contain the unlicensed corn.
JANE HENNEY, Former Commissioner, FDA: We have confirmed within our own labs that, yes, this did enter the food supply. Whether it posed a true safety issue or a real health issue for the American consumer I think is still very much in question.

JANE RISSLER, Union of Concerned Scientists: Suppose Friends of the Earth had never done this testing? Suppose that there are people who, in fact, are allergic to Cry9C? Would we have known? Was someone who was eating a taco shell who got ill- would that person say, "Oh, my. There's genetically engineered corn in the taco shell"? Well, how would a person know? The absence of evidence is not absence of harm.

JANE HENNEY: I don't think that it demonstrates that the whole system is flawed. Clearly, this was an issue that has been a very strong lessons learned for, I think, all of us.

NARRATOR: But how did corn meant for animals find its way into American stomachs?

JIM MARYANSKI, Food and Drug Administration: The company that developed this particular plant believed that they had a management program that would ensure that the growers of this corn would channel that product into feed use and keep it out of the food supply. Obviously, it didn't work.

LARRY BOHLEN, Friends of the Earth: Aventis made a big mistake by assuming that thousands of people making decisions every day on their farms would be able to separate the Starlink corn from conventional corn. But harvest days last for 14 hours. Farmers are driving late into the night. They're under a lot of pressure. Farm prices are really low. There's even pressure for some people to sell the Starlink into the food system to get a higher price. There's so many reasons that the Starlink corn can get into the food supply that it was a risk that wasn't worth taking.

NARRATOR: At a cost of $500 million, Aventis has now withdrawn Starlink corn from the market, but not before it had spread all over the world.

LARRY BOHLEN: Starlink corn was found in Japan in a baking mix. It was found in Korea and in the U.K. and in Denmark. So contamination is worldwide.

Are we tampering with nature?

DAVID BOWE, European Parliament: An underlying concern about GM is that perhaps it's not quite right, it's against the will of God, it's manipulation of the natural order of things in a way that's against religious feeling, almost.

NARRATOR: But scientists argue humans have been tampering with nature for a very long time.

JOSEPH HOTCHKISS, Cornell University: I don't like the word "genetically modified food." Virtually all of our foods have been genetically modified. If you take the apple, for example, there are literally dozens of varieties of apples. How did we get those dozens of varieties? We genetically modified the apple through conventional breeding. We crossed one kind of apple with another apple, and we produced very different apples- different color, different flavor, different functions.

//www.pbs.org/wgbh/harvest/etc/script.html
NARRATOR: The fruits and vegetables we take for granted, scientists say, are not the way nature made them. They have all been genetically modified for our benefit.

MARTINA McGLOUGHLIN, University of California, Davis: People think when they go to the store and buy potatoes or tomatoes or grapes that this is the way they always were in nature. In fact, that's not the case. Here we have a wild variety of potato, in fact, which very much looks like the ancestor of this modern potato. It's the same potato, except for a few genes difference that were introduced through breeding and selection. This is the same for tomato. And it really is difficult to believe that using just basic selection and cross breeding over hundreds of years that you went from this ancestor to modern-day tomatoes.

NARRATOR: If crops bred by traditional methods are not natural, neither are they necessarily safe.

JOSEPH HOTCHKISS, Cornell University: The potato contains a naturally occurring chemical that's quite toxic, called a glycoalkyloid. Those glycoalkyloids in some potatoes, as a matter of fact, have caused severe human poisonings and near death. When you breed potatoes, it's possible to breed in high levels of that toxin into a potato. And as a matter of fact, there are a number of breeds of potatoes that have high levels. Fortunately, they did not make the marketplace for that reason.

Another great example of the risks of traditional breeding is celery. Celery naturally contains a chemical, when it hits sunlight, becomes toxic. There was a case in California where a new variety of celery was bred. It had, unknown to the people who bred it, high levels of this toxin in it. It was planted, and the workers who harvested this came out with a very severe skin rash. So normal kind of breeding can produce risks, just as any other genetic or other kinds of breeding can produce risks.

NARRATOR: So is GM technology simply a high-tech version of the tampering traditional breeders have been doing for centuries?

Everyone agrees there are some significant differences. Classical breeders can only cross related plants, like two varieties of potato. And a cross involves mixing tens of thousands of genes at a time.

[www.pbs.org: Engineer a crop yourself]

Genetic engineering, by contrast, is much more precise, moving individual genes into plants. And it can also do something traditional breeders have never managed to do: move genes between different life forms, putting not just plant genes into plants but genes from insects, animals, fish.

JEREMY RIFKIN, The Foundation on Economic Trends: You can cross a donkey and a horse in classical breeding - they're very close relatives - and you can get a mule. But you can't cross a donkey and an apple tree in classical breeding. What the public needs to understand is that these new technologies, especially recombinant DNA technology, allow scientists to bypass biological boundaries altogether. This is something we've never seen in 10,000 years of classical breeding.
NARRATOR: Moving genes across species to produce so-called transgenic life forms seems to many a radical step. One experiment, proposed but never carried out, to splice a flounder gene into a strawberry to protect it from frost, has caught the public imagination. It's the stuff of fear and myth. What have we created, fish or strawberry?

CHARLES ARNTZEN, Cornell University: You can almost see their nose wrinkling up because there's something about a fishy smell to a strawberry. And it's a mental image. It's more then anything else just, "Oh, I wouldn't like that." It has nothing to do with the science, I believe. It's just the way we're wired in our brain. A fish is supposed to smell like a fish and a strawberry like a strawberry, and just superimposing words on each other gives us- we back off. We don't like that.

NARRATOR: The modern scientific view of nature holds that all living things - be they plants, animals, insects - are controlled by DNA. All are based on thousands of tiny genes that control the way things grow, genes that are similar across all species, from humans to the food they eat.

MARTINA McGLOUGHLIN, University of California, Davis: We probably share about 50 percent of our genes with plants. Take an example. There is a protein, Cytochrome C, which is a very important component of our respiratory machinery, if you like. And this product, Cytochrome C, is identical in you, in a pea, in a cow- the total- the absolute same gene. That gene is just a coding sequence. You do not find the whole essence of an organism in that gene.

NARRATOR: Scientists argue that since tens of thousands of genes go into making most animals and vegetables, moving a single gene doesn't change the essence of a life form. A tomato with, for example, a single pig vitamin gene is still only a tomato.

Back in Hawaii, Dennis Gonsalves had to make a similar argument to U.S. regulators, that his transgenic papaya with a single gene from the ring spot virus is substantially the same as a regular papaya. For the USDA, he needed to field-test his GM papaya and prove it didn't harm other plants and animals.

DENNIS GONSALVES, Cornell University: Do they have enough water going?

RUSTY PERRY, Papaya Farmer: The weather's been real good.

DENNIS GONSALVES: And how many acres do you have over here?

NARRATOR: He'd asked farmer Rusty Perry to carry out this trial.

DENNIS GONSALVES: This is a big growth for one month.

NARRATOR: Next he had to submit data to the EPA that the GM papaya wouldn't adversely damage the environment. Finally, he had to convince the FDA that the papaya was safe to eat.

DENNIS GONSALVES: We had to show FDA that our papaya was substantially equivalent to a non-transgenic papaya. That means the vitamin levels were about the same.
It did not have any unusual properties except virus resistance.

By the end of 1997, we had approvals from USDA, EPA and FDA.

NARRATOR: The GM papayas were thriving. For Gonsalves and his collaborators from the University of Hawaii, it was a moment of relief. But they still had one other hurdle. The papaya they'd engineered wasn't theirs to use.

While the GM papaya looked and tasted like a regular one, it owed its existence to years of sophisticated technology costing millions to develop, technology that universities and corporations had patented. It was time to hire a lawyer. Gonsalves had invented the GM papaya, but he needed intellectual property lawyer Mike Goldman to get it to market.

MICHAEL L. GOLDMAN, Esq., Nixon Peabody LLP: -companies that hold those patents, so I'm going to need you to explain to me what is in the transgenic papaya and how it was made.

DENNIS GONSALVES: OK. Well, let me show you briefly this genetic map that we have here. Our main component, basically, was the co-protein gene. And both Cornell and Upjohn have filed patents. Now, the other component we have is the 35S promoter here, to drive the gene. And this one here, as I understand it, is patented by Monsanto. And right in here, we have the leader sequence, and to tell you the truth, I don't know if anybody owns the patent on this.

NARRATOR: This practice of patenting genes attracted considerable criticism.

JEREMY RIFKIN, The Foundation on Economic Trends: We have less than 10 life science companies in the world that have a virtual lock on the seeds upon which we all depend for our food and survival. The issue here is, can companies like Monsanto use their control of intellectual property to force the rest of humanity to accept their terms in the commercial arena?

NARRATOR: Monsanto was sitting on a mountain of intellectual property. They held 28 percent of all U.S. agricultural biotech patents. This knowledge had cost them an estimated $7 billion in research, and anyone wanting to use this technology had to negotiate a license.

Lawyer Mike Goldman thinks that's fair.

MICHAEL L. GOLDMAN: Our patent system in this country is based on the Constitution, which rewards those that invent with the opportunity to use that technology as they see fit. So in my view, given the amount of money and effort that goes into research that is needed to develop this very complicated and important technology, there should be a return for that.

NARRATOR: But this defense of intellectual property, some critics argue, appears to contradict the claim that genetic engineering is merely a continuation of traditional plant breeding.

DOUG PARR, Greenpeace UK: I think the problem the biotech companies have got is
that they want to say they're extremely different so that the genetic material can be patented and that it's very novel, whilst at the same time saying, "Well, they're pretty much the same" in order to get the foods through on the basis of substantial equivalence.

And I think that really doesn't wash. Either they're different, or they're very similar. But it seems like the biotech companies really want to have it both ways.

NARRATOR: Urged by Gonsalves that time was running out, Goldman began the job of getting licenses.

DENNIS GONSALVES, Cornell University: I had my doubts that we would be able to get the intellectual property rights, especially from Monsanto. Monsanto was dealing with big issues—soybeans, cotton and so forth. And papaya was just one of them. It just so happened that they had intellectual property rights, and we put it into papaya, and they really were not interested. So in as far as them thinking about it and so forth, it was not in their priority, but it was in our priority.

NARRATOR: But Monsanto was distracted by other things, for there were signs that the European concerns about GMOs were spreading to America.

Do GMOs damage the environment?

NARRATOR: From the GM papaya to the gene gun, Cornell University was on the frontier of biotechnology. Most of its scientists were excited about the possibilities that GMOs offered. Then in 1999, the campus became embroiled in a bitter controversy involving one of the most celebrated symbols of nature.

Every year the Monarch butterfly makes a long journey to Mexico and back. On the way home, it stops to feed and lays its eggs on milkweed, for milkweed leaves are the only food young Monarch caterpillars eat. In thinking about the Monarch, a young Cornell entomologist, John Losey, realized that the only milkweed available in the vast American corn belt grows in and around corn fields, many of which now contained Bt corn designed to kill caterpillars.

Losey was curious whether the closeness of the milkweed to the Bt corn would affect the Monarch caterpillars, so he decided to do an experiment. Losey took milkweed leaves and dusted half of them with regular corn pollen and half with one variety of Bt corn pollen. Then he placed Monarch caterpillars on the leaves and let them eat their fill.

JOHN LOSEY, Cornell University: What we found was the caterpillars feeding on those leaves dusted with the Bt corn pollen, they ate less, they grew more slowly and they suffered higher mortality. More of them died than in the other two treatments. Forty-four percent died over four days, and none of the others died, the ones eating the regular corn pollen or the no pollen. None of those died over the four days of the treatment.


JOHN LOSEY,: We thought that it certainly probably would generate some interest. What we certainly weren't prepared for was the level of reaction to the paper, and I don't think I
could have ever been prepared for that.

NARRATOR: For the first time in the history of GM food, the American press paid attention, from local newspapers to Time magazine.

CHARLES MARGULIS, Greenpeace: It was the first time I think that the public had an image of what could be the consequences of genetic engineering, you know, sort of a user-friendly, family-friendly butterfly which most Americans are very familiar with.

NARRATOR: Greenpeace’s U.S. office had been waiting for something like this to ignite the GM issue in America. Their coordinator was Charles Margulis.

CHARLES MARGULIS: We feel that this is a mass genetic experiment that's going on in our environment and in our diet. Nobody knows what the consequences are going to be, and the untoward side effects will be irreversible. You can't recall genes once they're released into the environment.

NARRATOR: The Monarch scandal energized Greenpeace USA. They began looking for dramatic ways to tell consumers that their food had been changed.

CHARLES MARGULIS: We pulled food products off of the shelves and tested to see if they contained genetically engineered material. And one product in particular, Gerber Baby Food, tested positive for genetically engineered corn and soybeans. We sent Gerber a letter and let them know that Greenpeace had concerns about genetic engineering and we thought consumers would share those concerns.

Gerber didn’t respond to us. So we decided to go public with our findings, and a few weeks later Gerber announced that they would stop using genetically engineered ingredients in their products. I think it showed consumers that when they want to, these big companies can move overnight. It doesn’t take years of government regulation. What it takes for these companies to fear that they’re going to lose a little bit of their market share.

NARRATOR: At press conferences, Greenpeace exposed other food companies that routinely used GM corn and soy.

CHARLES MARGULIS: Well, it took Kraft a potential loss of a $50-million-a-year product to call for some more regulations.

NARRATOR: After Gerber, they zeroed in on Kraft, Campbell’s, and Kellogg’s. As in Europe, they staged stunts, targeting brands built up over generations. As in Europe, they filmed the events themselves.

CHARLES MARGULIS: Is Mr. Gutierrez in today?

RECEPTIONIST: You need to have an appointment.

CHARLES MARGULIS: I understand.

RECEPTIONIST: You need to have an appointment, and they would be glad to
CHARLES MARGULIS: I see.

MAN IN TIGER SUIT: What have you done to my cereals? They're fake!!

RECEPTIONIST: Sir, you can't say that here.

CHARLES MARGULIS: See, this is Frankentony. He's very upset because he's genetically modified.

RECEPTIONIST: Hold on a sec.

SECURITY GUARD: I'll ask you guys to wait out here, please. Please.

MAN IN TIGER SUIT: What have you done to my cereals? They're fake!!

NARRATOR: Such demonstrations haven't so far attracted much media attention.

CHARLES MARGULIS: Creating public awareness has been harder here. But recently the public awareness has increased, and I think the situation in the U.S. now is very similar to the situation in Europe a year ago.

MAN IN TIGER SUIT: I was a little disappointed that we didn't get to talk to anybody in the executive suite. It would have been nice to be able to let them see what they have done to me, what kind of a monster they've turned Tony into.

SECURITY GUARD: Call Bill Duggan and tell them they are over here in Cereal City and get the police over here.

POLICE OFFICER: This is a city sidewalk, and I need your driver's license, sir.

NARRATOR: Small though some of these demonstrations were, they seemed to scare the $600 billion food industry. No one wanted their brands to be tarnished with the image of Frankenfood.

GREENPEACE DEMONSTRATOR: Greenpeace is here to send a clear message to the Kellogg's Corporation that we need pure food. We need pure food on our breakfast tables, and we need pure food for our children. Stop the use of genetically modified organisms.

NARRATOR: While the U.S. food industry hasn't been hit here as hard as in Europe, no one wants to be targeted. None of the major food companies was willing to participate in the making of this program.

KELLOGG'S STATEMENT: "We can't grant an interview because we do not want to be singled out."
GERBER STATEMENT: "It's not our issue to fight. It's an industry-wide debate."

SAFEWAY STATEMENT: "It is an industry-wide debate, and it's not in our best interest to participate."

GENERAL MILLS STATEMENT: "Biotech is a very promising science. We don't see any evidence that the technology is unsafe. However, we do not want to be singled out."

PROCTER AND GAMBLE STATEMENT: "We cannot confirm whether or not we use GMOs in our products."

NARRATOR: Instead, the companies chose Gene Grabowski of the Grocery Manufacturers of America to speak for them.

GENE GRABOWSKI, Grocery Manufacturers of America: Food companies have learned that the groups are not intent on having a reasoned debate about biotech or helping consumers find out about biotech. It seems that their motive is to scare people. I don't dispute some of their research. I don't dispute their motives.

What I dispute, and I think what the industry questions, is the tactics, the street theater, the antics, the attempts to gain publicity at the expense of truth. It gets a lot of attention. That shouldn't be confused with how broad the movement is. We have not seen any indications through any surveys that they represent the vast majority of consumers or even near a majority of consumers.

PROTESTERS: [singing] Where have all the Monarchs gone? Died because of genetic crops. When will they ever learn, when will they ever learn-

NARRATOR: The Monarch had become a powerful symbol, but how much science was there behind the rhetoric?

Back at Cornell, Losey had been dragged into the contentious debate surrounding biotech food, and he was forced to defend his conclusions, point by point, against his own scientific colleagues. In the lab, Monarch caterpillars fed leaves with Bt pollen died. But out in the field, things were more complicated.

TONY SHELTON, Cornell University: The real question is what is the effect out in the field. There's a whole series of events that have to occur to really make this a significant risk. Bt corn pollen is fairly heavy, so it doesn't travel very far.

JOHN LOSEY, Cornell University: That's certainly true, and that's one thing that I think has been shown since our paper came out, is that the pollen really doesn't go very far. So if there's going to be an effect on the Monarch, it's going to be probably within the corn field or within a few yards of the corn field.

TONY SHELTON: You got to realize milkweed is a weed, and growers try and control it. It's actually on the federal list of noxious weeds. So you don't find a lush population of abundant milkweed inside a corn field.
NARRATOR: But Losey disagrees, saying that in most corn fields there's plenty of milkweed.

JOHN LOSEY: A substantial proportion of the milkweeds that exist anywhere actually exists in corn fields, so this idea that there is not milkweed in corn fields- that's just not true.

NARRATOR: Challenged by Losey's paper, researchers are trying to discover if, out in the field, Monarch caterpillars really do eat enough Bt pollen to do them harm. This has turned out to be a very complex task, and so far there are no conclusive results. However the science turns out, Losey believes more tests should have been done before the EPA approved Bt corn for widespread use.

JOHN LOSEY: Where the system fell down a little bit is that there weren't more tests done on these non-target butterflies. There should have been more data collected.

NARRATOR: But biotech companies counter that the press had missed the most important factor: Bt pollen is certainly less damaging than traditional ways of controlling the corn borer, like massive spraying of chemical pesticides, killing not just caterpillars but every insect in the field, including Monarch butterflies.

TONY SHELTON: If crops like Bt corn are banned, then I think there will be increased pesticide use that'll have some deleterious effects.

NARRATOR: Even Losey accepts this would be a bad thing.

JOHN LOSEY: If you have the choice between putting out the Bt, which is very specific to just lepidoptera, or butterflies, and spraying with an insecticide which is generally fairly broad, you know, is going to almost kill all the organisms that are out there, then you are having less environmental impact almost undoubtedly by using the Bt then by using the insecticide.

NARRATOR: From corn to cotton, biotech companies have tried to portray GM crops as highly beneficial to the environment.

HUGH GRANT, Chief Operating Officer, Monsanto: Bt cotton has really been a breakthrough in how insects are controlled in the crop. Historically, the crop is sprayed 8 to 10 times with insecticide, usually flown over the top of the crop. Today the cotton crop is grown with one or two applications.

NARRATOR: But the biotech industry will first have to earn the trust of environmentalists.

GORDON CONWAY, President, The Rockefeller Foundation: One of the things you have to realize is that the big biotech companies were originally agro-chemical companies making pesticides. They still do. The reason why they got into biotechnology is that they could see the end of the market for pesticides.

JANE RISSLER, Union of Concerned Scientists: Now, of course, the argument is, "Well, this is not as bad as the synthetic pesticides." Well, I don't think it is, but do we really- do we want to replace one technology that is harmful to the environment with
another technology that is harmful to the environment?

NARRATOR: Pesticides weren't always thought to be harmful. To the contrary. In 1947, Time magazine carried an advertisement claiming DDT was good for people, homes and farms. It took 20 years before scientists realized how dangerous it was.

JANE RISSLER, Union of Concerned Scientists: So if you just replace that with "Biotechnology is good for me"- see, these same people who once told us that pesticides were good for us are now saying, "Well, those pesticides, they're dangerous. But you take these biotech products. They're much safer."

I think that there are a lot of people that finally believe that we're not farming the right way, we're not producing food in the right way in this country.

[www.pbs.org: Should we grow GM crops?]

NARRATOR: Welcome to Full Belly Farm. It's very different from most modern industrial farms. Instead of two crops, California farmer Paul Muller grows 70 on just 200 acres. And everything is grown organically.

PAUL MULLER, Organic Farmer: This is a field that's one of our fall plantings, and it's not a very big field. It is about six acres. It has a variety of things that we grow in here for harvest and marketing all fall. We have broccoli. We have cabbage. We have different kales, hardy winter greens. There's some beets over there and some red cabbage. On this side, we have lettuce and onions and chard and things like that.

NARRATOR: Muller sells fresh produce to people who share his belief that farming should be done in a sustainable way, in harmony with nature. Although more expensive and accounting for less than 2 percent of all food produced, it's a growing trend.

CHARLES MARGULIS, Greenpeace: When people are given the choice if they'd rather eat food produced with toxic chemicals and pesticides, food produced with genetic engineering or food produced organically, people choose organic food time after time in survey after survey.

NARRATOR: What is organic farming? Instead of herbicides, Muller uses sheep to clear the weeds. He has no chemical fertilizer. Instead he uses compost.

PAUL MULLER: It's not a natural process, what farming is. It's far from it. And so we're trying to minimize the amount of harm done and maximize the amount of health in the system over the long haul. And that's why we believe some of these tools are better tools then chemical fertilizers.

NARRATOR: But there is one product that Muller uses from time to time to control pests, something that's pitted him against the biotech industry: the organic pesticide known as Bt.

A hundred years ago, Japanese silk farmers discovered that a soil bacterium, Bt, produced toxins that killed their silk worms. Organic farmers later realized that this bacterium might be useful in killing caterpillars. Today they spray a Bt formulation on their leaves.
PAUL MULLER: The Bt that we use is very specific. It doesn't have a very long life. And we use it sparingly. We may spray only a field like this once, once a year, once a season. And we don't use it unless we have to.

NARRATOR: For a long time, organic farmers had Bt more or less to themselves. Then a decade ago, the biotech industry began splicing various Bt genes into crops like cotton and corn. Companies like Monsanto thought environmentalists and organic farmers would be happy.

JEREMY RIFKIN, The Foundation on Economic Trends: Monsanto says, "This is a leap forward. We're ending pesticides." Well, yes and no. Yes, they're ending the use of the pesticides, but now they're introducing more toxin then they ever introduced with pesticides. You have to think of that corn now as a factory producing toxin.

NARRATOR: And, say critics, this toxin will cause a worse problem: resistant pests.

It's not a new problem. Pesticides have never killed every last pest in a field. There's always a small number with genetic variations that resist the poison. Because these survivors eventually repopulate the entire field with resistant descendants, over time pesticides stop working.

A field of Bt corn potentially makes this situation worse. Seven days a week, 24 hours a day, the corn puts out Bt, killing most but not all corn borers. The resistant survivors soon repopulate the field. The Bt is now ineffective against those pests.

PAUL MULLER: By engineering Bt into corn, they're taking a tool away from farmers. Over the long haul, that Bt will disappear as an effective tool for a farmer like me to use. And it'll be something like Monsanto or whoever has developed the corn that has the Bt gene in it, will have captured the profits, captured all the future benefits and put that into their pocket in a very short period of time.

HUGH GRANT, Chief Operating Officer, Monsanto: Resistance is something we take very, very seriously. We've made investments in these technologies for a decade, so it's in our interest to make sure that they last for another 10 or 20 years.

NARRATOR: To stay ahead of the resistance problem, companies like Monsanto say they've identified dozens of other bacterial genes for future use.

CHARLES MARGULIS, Greenpeace: You're going to be stuck going back to that biotech company for the next generation of genetically engineered crops, and they're going to be more and more costly and keep you more and more dependent. It's the same kind of treadmill that farmers have seen from the pesticide industry for 50 years.

NARRATOR: The EPA has mandated another solution to the resistance problem. It's called a refuge. For every field of Bt crops, farmers must plant a section with non-Bt crops, a place where non-resistant pests can live. Because these pests will mate with resistant pests, the refuge should ensure continuing generations of susceptible bugs.

But are farmers really setting aside valuable land to be devoured by insects? It's the EPA's
job to check up on them.

**STEPHEN JOHNSON, Environmental Protection Agency:** We hold the biotechnology companies responsible. They have to provide us with reports. They have to monitor. And if we found that they were not complying with the terms of conditions, then we would revoke their license.

**HUGH GRANT, Chief Operating Officer, Monsanto:** The growers themselves self-police the system. They recognize the long-term value in insect control without insecticides.

**NARRATOR:** But given the ease with which Starlink corn got into the human food supply, critics argue it's unrealistic to expect overworked farmers to comply with onerous and costly regulations.

**JEREMY RIFKIN:** How many farmers are actually creating these refuges? I know that they have licensing agreements where they're supposed to, but you cross America and ask how many farmers are actually spending the time to build these elaborate refuges in their farms. Maybe in some of the test farms that you're in they will say they are. But I know that I've talked to enough farmers that say it's too much time and trouble to do it.

**NARRATOR:** Even if the refuge system works perfectly, genetically modified agriculture may pose another threat to organic farmers: pollen drift. The organic food industry prides itself on being pure, but contamination by GM pollen makes it difficult to guarantee their food is truly GMO-free.

**CHARLES MARGULIS:** The biotech industry knows that their crops will contaminate neighboring fields, and that will make it difficult, if not impossible, for organic farmers to provide their consumers with food that's free of genetically modified material.

**NARRATOR:** Muller believes that all technology-based farming is a mistake. He admits it's produced cheap food, but only at the expense of the environment and the American farmer.

**PAUL MULLER, Organic Farmer:** There's been over-production for years. Prices are low. The farmers' only response is to grow more at that low cost. But everybody's doing the same thing. So we're producing more. The price goes down further, and then you look for another technology to allow you to produce more. So there's a treadmill going on there.

And what's not being accounted for? What's not being accounted for is the whole environment, you know, from the beneficial insects to the Monarch butterflies that fly through, to the waterways that have to deal with what runs off his field, whether it's nitrate fertilizers or pesticides. I would like to see more organic farms. I would like to see all agriculture be organic.

**NARRATOR:** But how feasible is this? With its fertile soil, good climate, cheap labor and affluent customers, California is perhaps the ideal place to grow organic food. But can organic farming work for the rest of the world?

**NORMAN BORLAUG, Texas A&M University:** This organic movement is ridiculous.
For those who want to go the organic route, God bless them. Let them spend more money for their food. But looking at the world at large, this is an impossibility.

NARRATOR: Norman Borlaug won the Nobel Prize for his work on the green revolution. He used chemical agriculture and crop genetics to save parts of the developing world from starvation.

NORMAN BORLAUG: Most of the people who are opposing biotechnology, they've never known hunger. These people say that the little farmer should permanently accept that he's going to stay on that three-acre farm with a hoe and a machete. That's fine in Utopia, but don't give the world the false idea that they can produce the food that's needed for six billion people.

Do we need GMOs to feed the world?

NARRATOR: In Africa, virtually every farmer is an organic farmer. Here it's called subsistence agriculture. At the mercy of the weather, but blighted with year-round pests and poor soil and unable to afford fertilizers and pesticides, most barely grow enough to feed their families. But Florence Wambugu, a Kenyan scientist, wants to change this.

FLORENCE WAMBUGU, Kenyan Scientist: You see, the farmer is very intelligent. What he is rejecting is virus-infected. He is calling it burnt, sun-burnt, [unintelligible] sclerotic, whatever. But that is indigenous wisdom. That is the way he has kept his crop growing.

NARRATOR: This farmer grows sweet potato, a very important staple but one that is under constant attack from weevils and the feathery mottle virus.

FLORENCE WAMBUGU: This one is a typical symptom of feathery mottle virus, the canking here, the reduction in size. So the poor quality. This is not the color of the sweet potato. The normal color should be this. So you can see, the color has been destroyed by the disease.

This is one hectare? You've got two hectares.

From this area, he should be harvesting probably four times what he is getting right now.

NARRATOR: Traditional methods of farming have so far prevented the virus from wiping out the sweet potato crop. But this type of subsistence agriculture cannot raise Kenyans out of poverty or feed the rapidly growing population. To break the cycle, Wambugu believes, Kenyan farmers must greatly increase productivity. And the quickest way to do this, she thinks, is to use biotechnology.

So in 1992, she traveled to St. Louis to spend three years at Monsanto, where the company supported her research to make a genetically modified sweet potato. What were they expecting in return?

ROB HORSCH, Monsanto: Projects like the sweet potato for Africa we will never make any money from, have no expectation to. The reason to do it is several-fold. To my mind,
the most important one is because we can. And it doesn't cost us that much to do it. In the longer term, as poorer farmers do better, they become richer farmers. And at some point, those richer farmers can start buying our other products.

NARRATOR: Returning home to Kenya, Florence Wambugu set out to test the GM sweet potato to see if it would resist the feathery mottle virus. The Kenyan Agricultural Research Institute set up field trials at a number of sites. The results were striking. While the diseased plant had small damaged leaves, the GM variety grew tall and lush.

And underground, the difference was even more pronounced. The GM variety was large and healthy. Unmodified sweet potatoes, grown with traditional organic methods, could not compete.

FLORENCE WAMBUGU: May I say that organic farming has not worked in Africa, and it is not going to work. It is not the answer.

NARRATOR: Ironically, says Wambugu, the answer for the least developed people in the world may be the most advanced technology. In contrast to complicated and costly chemicals, GM technology is built into the seed. All the farmer has to do is plant it.

FLORENCE WAMBUGU: What farmers need is technology that is packaged in the seed, the seed that actually is resistant to the pests and diseases, and plant it the way they have always planted. That to me is sustainable. The GM technology is appealing, and to me, I say it's user-friendly. It does not demand the farmer go out to be educated on how to use it.

NARRATOR: But can a poor country like Kenya oversee this powerful new technology without the equivalents of the USDA, EPA and FDA?

CATHERINE IVES, Michigan State University: We have trained some of their researchers. We have also supported training of a number of their regulators to develop a Kenyan national regulatory system, which they have done. And we have trained their extension workers, so when it comes time to field test these plants in a number of different locations, which is currently ongoing, that they will know how to do that.

NARRATOR: Catherine Ives runs a program at Michigan State University to help developing nations produce more food.

CATHERINE IVES: People understand that if they can produce more food, they can feed their families and keep their children healthier. They understand that if they can make their land more productive, maybe they can send their children to school, as opposed to having them out in the field all day.

NARRATOR: One of the biggest obstacles poor farmers face, especially in the tropics, is poor soil, loaded with excess minerals like aluminum or salt. Near Irapuato, Mexico, for example, toxic aluminum greatly reduces productivity of crops like corn. Scientist Luis Herrera wondered whether GM technology might offer a solution.

LUIS HERRERA-ESTRELLA, Plant Geneticist: This maize is not growing very well because it has problems of soil acidity, which leads to aluminum toxicity and low nutrient
availability. So what happens is that the root system of the plant doesn't grow, and it cannot make— it cannot supply the plant with enough nutrients to grow. And what the farmer finds is that the productivity of the plant is not good. Usually, you should have this big, and you have very little production.

**NARRATOR:** In his laboratory, Herrera genetically modified the maize so it would produce a natural chemical called citrate, which binds to the toxic aluminum, keeping it in the soil and away from the plant. The results were dramatic.

**LUIS HERRERA-ESTRELLA:** So you can see here that the root formation of a normal plant in an acidic soil is not very good. And in plants that we produce citrate, the root growth is much better. And this is a way we have to demonstrate the system is working.

**NARRATOR:** When word of Herrera's research got out, Greenpeace arrived in Mexico, protesting that his GM maize was unsafe. Under pressure, the Mexican government halted his field trials.

**LUIS HERRERA-ESTRELLA:** We are not sure whether, because of the pressure of these groups, the government will ever allow us to field test our technology or they will not allow us to provide it to the farmers for commercial use. These people speak selectively, only the negative thing, and they totally ignore the positive benefits not only to humans but also to the environment.

The potential benefit is so important that this technology cannot be stopped. It must not be stopped.

**NARRATOR:** Herrera says there's much more at stake than his own research.

**LUIS HERRERA-ESTRELLA:** We need more food. There is people daily dying because of lack of food.

**PROTESTER:** We have more food today on this planet per person than ever before in human history!

**NARRATOR:** But environmental groups reject the whole premise that GMOs are needed to feed the world.

**JANE RISSLER, Union of Concerned Scientists:** I think it's a ploy. It's playing on the guilt of relatively well-off people that, somehow, if they don't approve of this technology by agreeing to buy the products, that somehow the result will be people dying of starvation in the developing world.

**INTERVIEWER:** You don't believe that this technology can help people in the developing world.

**JANE RISSLER:** The biggest problem behind hungry people is lack of money. It's not technology.

**CHARLES MARGULIS, Greenpeace:** We live in a world today where 800 million
people a year are going hungry, in a world that produces enough food for almost 9 billion people. Yet we only have 6 billion people on the planet. Why isn't that food being distributed more equitably? It's because people who can't afford to buy food simply aren't being given it. It just isn't being given to them.

FLORENCE WAMBUGU, Kenyan Scientist: They don't have a clue what they're talking about because most of those people who talk like that get all of their food from the supermarket, and they just think how it is going to appear in another place in another supermarket.

The transport costs in this country are huge. Even if that food was donated for free, it would have to cost something when it arrives here. And there is the pride. If you cannot feed your family, if you cannot feed yourself, you have a mentality that makes you feel you are useless. People have pride in feeding their family. People have pride in being able to purchase. Everybody- how would anybody like to be a beggar? How would you like to be there waiting that until some food comes, you are going to stay hungry?

GORDON CONWAY, President, The Rockefeller Foundation: Whether or not people in developed countries like biotechnology, they should not deny those potential benefits to the developing countries. We've got 800 million chronically undernourished people. We've got 1.5 billion more people who will be added to the world population by the year 2020. That's an enormous number of people to be fed. And we believe that biotechnology, along with agriculture ecology, is going to be able to feed that population.

NARRATOR: Are the dreams of raising Africa out of poverty on a collision course with the concerns of people living in rich nations half a world away?

FLORENCE WAMBUGU: To build this house where we are today, there was a designer, there was an architecture, there were people. It took some time to build this house. It needed expertise. To build GM technology has taken years, has taken resources, has taken time. Now, if you want to destroy and bring down this house, you don't need expertise. All you need is some people from the streets, hooligans. Give them hammers, they will beat this house down within a day. And I believe that's what is happening. Greenpeace and many of those activists are just beating down a house that took years to build, years of research.

NARRATOR: One of the universities that supports Florence Wambugu's work in Africa is Michigan State University. They were largely unaffected by the GMO controversy until New Year's Eve, 1999.

CATHERINE IVES, Michigan State University: I was walking into downtown East Lansing to go out for New Year's Eve, and we saw the fire trucks and the engines going towards the area where we worked on campus and saw smoke. And we said, "This is a real fire." And I looked up, and I counted the floors. And I said, "That's my office."

Our offices were totally destroyed. I mean, they were pretty much reduced to ash. We assumed that there was an electrical fire, but it became clear to the investigators that it was an arson. The initial investigation issue was did we have any ex-boyfriends or girlfriends that would be mad at us.

• Association for Behavior Analysis annual conference in Atlanta. "Lessons from Facilitated Communication". 1994.

• Association for the Advancement of Science. "Graphics as Metaphor" part of a special session on use and abuse of visualization in scientific communication. 1992.

• British Council. Sponsored lecture tour of Brazil and Chile on scientific communication including the organization of a television workshop.
NARRATOR: After three weeks, police still had no idea who was behind it. Then a communique arrived from an underground group, the Earth Liberation Front.

CRAIG ROSEBRAUGH, Spokesperson, Earth Liberation Front: There was an Earth Liberation Front action at Michigan State University on December 31st this last year, and it was a fire that burned down part of a building where a genetic research project was going on, run by a woman named Catherine Ives. It did about $900,000 worth of damage.

Her program was to try, in my view, to coerce people in developing nations into believing they should give up sustainable agricultural practices that have been practiced for years and years, throughout many generations, and rely on Monsanto's genetically engineered crops because that's going to end world hunger. And that's what Catherine Ives herself said, is "My project- how could the ELF do that? My project is going to end world hunger." That's ludicrous. It's not going to end world hunger, it's going to make more profits for Monsanto.

NARRATOR: As Ives and her colleagues got the center up and running again, they struggled to comprehend the motives of their attackers.

CATHERINE IVES: I would wonder how much time has been spent by people in this organization in developing countries. I see women hiking for miles to bring firewood in because they've cut down everything around them and have no productive soils. I see children who are malnourished. They do not have sustainable agricultural practices in place in many parts of the world. That is what we are trying to help them develop.

NARRATOR: Ives also wondered whether the ELF was aware that Monsanto's contribution to a $20 million budget was only $2,500 dollars.

CRAIG ROSEBRAUGH: I know it wasn't millions and billions of dollars for that project, but it was some money. And I don't care if it's 50 cents or $500,000, it's still coercion, I think, to some degree, that a corporation is funding a project, I think, for their own benefit. And she's playing into it. It's not the money, it's the morals involved.

CATHERINE IVES: "It's the morals involved." Interesting. I don't think there's ever any justification for violence, and certainly not for an attack that very easily could have killed a student on a college campus.

NARRATOR: The FBI has not managed to catch the people responsible for the arson attack. And despite several appearances before a grand jury, Craig Rosebraugh insists he's just the ELF spokesman, he doesn't know who did it.

CRAIG ROSEBRAUGH: I received, I believe, a total of six subpoenas to either testify or supply information, give fingerprints, to that grand jury. So far, I have been able to steer myself away from any formal charges by the grand jury.

NARRATOR: Mainstream environmental groups like Greenpeace disavow the actions of ELF both for their violence and their secrecy.

CHARLES MARGULIS, Greenpeace: Greenpeace has never supported random acts where the activists don't take responsibility. If there's an injustice in your community, it's
your responsibility to point that injustice out and to make it public and to take responsibility for taking that action.

NARRATOR: Undaunted, the ELF has continued its program, targeting a series of university test sites growing new varieties of GMOs.

CRAIG ROSEBRAUGH: Companies a lot of times are not going to listen to ethics or ones saying that, "Please, please use your morals to stop the unjust acts," when they're making millions or billions of dollars a year off it. What they're going to listen to is their profit-and-loss margin. If you cause them enough economic damage or economic sabotage to their company, hopefully, they will see that it's in their best interest to stop their unjust acts.

NARRATOR: Meanwhile, back on Hawaii, there was cause for celebration. They'd negotiated the licenses they needed from Monsanto and the other patent holders. It had taken more than a decade, but Dennis Gonsalves and his colleagues believed they'd beaten the ring spot virus and saved a $45 million industry.

DENNIS GONSALVES, Cornell University: Once in a while, a technology comes along that is really good, that you can do something within your career span, and this is one technology. For me it's been very satisfying. It'd be even more satisfying to try to see where one day I visit Thailand, or visit Brazil or Jamaica, and can see the transgenic papaya just like how they grow in Hawaii.

RUSTY PERRY, Papaya Farmer: I can say I'm back in business, I guess, is what it really comes down to. I can say that we're going to be in business for a long time now.

What does the future hold?

NARRATOR: On Prince Edward Island in Canada, fishermen prepare their nets to go out and fish, the way they have for decades. But this kind of fishing is dying. Increasingly, fish is produced in farms where fish are raised and fed like cattle. This salmon could be the first genetically modified fish product in your stores. Elliot Entis, the CEO of AQUA Bounty Farms, the company that engineered it, believes we're on the verge of a revolution in fish farming.

ELLIOT ENTIS, CEO, AQUA Bounty Farms: In order to maintain the present world per capita consumption of fish, we will have to increase aquaculture seven-fold. Now, that's an enormous increase in the amount of food product that we have to produce.

NARRATOR: These salmon have been genetically engineered to grow four times faster than normal salmon. Awaiting U.S. regulatory approval, AQUA Bounty Farms grows them in tanks in a secure facility. Normal Atlantic salmon don't grow in the winter. The GM salmon, however, has been engineered with a gene from another fish, the ocean pout. This triggers a growth hormone gene, causing the salmon to keep growing even in winter. Transgenic salmon don't grow bigger, but they reach their full size in one quarter of the time.

AQUA Bounty Farms wants to become the Monsanto of the sea.
ELLIOIT ENTIS: We’ll be a little bit like seed suppliers in other industries. So it’s our hope to run a hatchery or several hatcheries in which we will produce eggs, and those eggs will be sold to existing farmers, who will then use them to grow their own AquaAdvantage fish.

NARRATOR: But one scientist was worried what might happen if, by accident, these fast-growing salmon escaped into the wild. On the face of it, they would have a clear mating advantage.

WILLIAM MUIR, Purdue University: Size relay matters. Larger males are what females prefer. Fish just 25 percent larger will get 400 percent more matings than a fish of average size. And the theory behind that is called the "good genes" hypothesis, that if a male is large, this male must be good in securing resources, must be able to find its food, must be able to avoid predators. You know, so therefore it carries the good genes to make it a better parent.

NARRATOR: But would the fast-growing GM fish really be better parents? Escaping GM fish would also have to compete with wild fish at finding food, avoiding predators and producing viable offspring. Muir decided to investigate this ecological mystery by genetically engineering a laboratory fish called a medaka to grow fast. He then developed a computer model to mimic what would happen if these fast-growing transgenic fish escaped into the wild population.

WILLIAM MUIR: I was working on this at home late one night, trying to bring together all of these parameters into one mathematical model that would put all these things together. And when I put the mating success in there, my computer crashed. And I said, "Oh, my God. There’s something wrong with my program." So I started looking through the code, looking everywhere. And what was happening was the population size was going to zero.

NARRATOR: The fast-growing GM fish got all the matings, but fewer of its genetically modified young survived. It was a recipe for an ecological disaster.

WILLIAM MUIR: You have a situation where the least fit individuals are getting all the matings but producing the fewest number of offspring. So gradually, over 20 or 30 generations, the population could go to extinction.

NARRATOR: If AQUA Bounty Farms salmon escaped and if they behaved like the medakas, it might lead to a catastrophe. At the moment, the genetically modified salmon are reared in fish tanks on land. But AQUA Bounty Farms wants permission to grow their transgenic fish in off-shore pens. And every year, millions of fish escape from these pens into the ocean beyond. AQUA Bounty Farms says they have anticipated this.

ELLIOIT ENTIS: We can’t ever guarantee that a fish won’t escape from a pen. It’s not possible. What we can guarantee with a high degree of certainty is that virtually all of our fish will be sterile. And we certainly can guarantee to 100 percent certainty that all of the fish will be female. Both of those factors really limit their general ability to interbreed.

NARRATOR: Despite these safeguards, Muir says we should be cautious.

WILLIAM MUIR, Purdue University: The worst-case scenario is that transgenic salmon
get loose from net pens, and that one of them happens to be fertile. Theoretically, one fish can do it. It's not highly likely, but as we have more and more fish pens and more and more escapes, the probability increases.

NARRATOR: Unlike Bt pollen drifting a few feet into a neighboring field, an escaped transgenic salmon can spread its new genes throughout the ocean. The FDA is expected to rule on GM fish by the end of 2002. But even if the U.S. doesn't allow it, other countries in the developing world will still go ahead. And their ecological problems could, in time, become ours, as well.

Whatever the fate of GM fish, many other GM products are in development. Scientists at Cornell are already working on the second generation of genetically modified organisms, and they're moving beyond simply producing food.

Some, like Charles Arntzen, want to make medicines. For 10 years, he's been trying to produce safer vaccines for Hepatitis B and Norwalk virus, diseases which kill millions in the developing world.

CHARLES ARNTZEN, Cornell University: How can we deliver a very effective vaccine but make developing countries less dependent on philanthropy and big industry? How can we provide the technology that a third-world country can make the vaccines themselves?

NARRATOR: Arntzen's radical proposal is to make a vaccine you can eat, a genetically modified banana.

CHARLES ARNTZEN: I don't see a village banana tree with vaccines in it, where everyone goes up and takes one when they want to. This is a medicine. I think something like a baby food puree, so you can make tens of thousands of little containers of a banana baby food, and you can sample each one and verify that the dosage is uniform, that they're free of any sort of bacterial toxins or anything else, the standard sort of stuff that has to be done with any pharmaceutical product. And we just- our switch on this is we can use food-processing technology, which is available in the developing world, and apply it to a medicine.

NARRATOR: Because bananas are hard to engineer, he started with potatoes, then moved on to tomatoes. Bananas are next. If everything goes well, Arntzen hopes to have an edible vaccine approved for use in six years.

In Switzerland, scientists have engineered a crop to prevent blindness in millions of children who lack vitamin A. It's rice.

INGO POTRYKUS, Swiss Federal Institute of Technology: My entire scientific career has been devoted to this dream to be able to help to solve burning problems of humanity.

NARRATOR: Ingo Potrykus spliced genes from a vitamin-rich flower - the daffodil - into the rice. Because that gave it a yellow tint, it became known as golden rice. Potrykus hopes eventually his rice will supply a quarter or more of a child's nutritional vitamin A needs. But as with the papaya, there were problems with patents. Before golden rice could ever be
used, Potrykus would have to negotiate licenses with a dozen patent holders, including Monsanto.

HUGH GRANT, Chief Operating Officer, Monsanto: These are things that three years ago we, as a company, would never have considered. I think if you look at the model looking forward, this is going to be a prerequisite, how we will look at technologies and share them, share them around the world. And personally, that makes me feel good.

NARRATOR: And this time, facing a huge public relations problem, biotech companies were quick to give their agreement. The biotech industry launched a lavish advertising campaign, even though Potrykus's work is in a preliminary stage, years away from realization.

CHARLES MARGULIS, Greenpeace: Monsanto and the biotech industry has used this as a public relations tool. Biotech foods are being sold to the American public and to the European public on the backs of the developing world with this image campaign that we need this technology to feed the world.

HUGH GRANT: We are doing this not because of PR. And I think sometimes, when we make these gifts, that's the first question. I think what we're seeing today, after a few months with the rice genome work and after a few months between Monsanto and Zanetca with golden rice, there's a recognition that this is a genuine gift given in good faith.

NARRATOR: Whether you think GMOs are a force for humanity or a reckless experiment, some experts argue that we shouldn't judge it by what we've seen so far.

NICHOLAS KALAITZANDONAKES, University of Missouri-Columbia: If you think back to the first airplane that the Wright Brothers flew, the speed was seven miles an hour. So technology in the very early stages is crude.

NARRATOR: Biotechnology may be in its infancy, but according to Dr. Kalaitzandonakes, it's already clear that it will transform many industries, from drugs to synthetic materials. Like aviation and computers before it, biotechnology has the potential to change the world.

NICHOLAS KALAITZANDONAKES: Biotechnology is much like information technology. It's a very broad technology with very broad applications. Agriculture and food is just one application of it. Pharmaceuticals, waste management, forestry, cosmetics, energy and so on, the potential is so large that it's difficult to walk away. Nobody's walking away.

NARRATOR: This prospect of biotechnology dominating 21st century commerce has not gone unnoticed in Europe. In February, 2001, marking a radical turn-around, the EU voted to end the ban on GM crops. In its place, they are setting up a rigorous system to regulate, label and track GMOs.

European politicians like David Bowe are gambling Greenpeace won't have enough popular support to overturn it.

DAVID BOWE, European Parliament: Some of the campaigns that Greenpeace are
running have run out of a bit of steam, I think. Everybody will tell you, you can only run one mark, one scare once. You know, after a while, if you cry wolf again, people ignore you. And I think that may be what's happening with some of the Greenpeace campaigns. And I think as long as we operate the rules rigidly and strictly and in the interests of the general public, we will succeed in getting acceptability of GM products in the marketplace, whether they're food or pharmaceuticals or many of the other applications that we're going to see.

**JEREMY RIFKIN, The Foundation on Economic Trends:** Europe will not accept genetically modified foods. And it will make no difference what the European Union says or Washington or the World Trade Organization. I think the introduction of genetically engineered foods in Europe and in parts of Asia and, hopefully, in America- I think it's going to be considered one of the great financial miscalculations in the history of introducing a new commercial line into the marketplace.

**TELEPHONE POLLSTER:** How do you rate the following statement: "New technologies are generally worth the risk"? "Our technologies have now become so complicated that we can no longer".-

**NARRATOR:** Compared to the passion of the European debate, Americans have so far shown little interest in GMOs, even though they've been eating them for five years. But everyone believes there is one issue that has the potential to turn public opinion against GMOs: labeling.

**CHARLES MARGULIS, Greenpeace:** The biotech industry is scared to death of labeling. In fact, biotech industry representatives have said putting a label on genetically engineered foods is like putting a skull and crossbones on it.

**GENE GRABOWSKI, Grocery Manufacturers of America:** To put a label on biotech foods, a mandatory label, would be an indication that something is wrong. That's the implication. And that would be absolutely false. That would be misleading to consumers.

**HUGH GRANT, Chief Operating Officer, Monsanto:** We believe very strongly, very strongly, that these products are safe. And in their safety, there is no need to label. And that's the position that has been held by the FDA.

**JEREMY RIFKIN:** You know we label everything in the United States. You can look on a label on processed food, and you can see the whole history of that food. Why would we make an exception when it came to genetically modified food ingredients?

[www.pbs.org: Read more of the interviews]

**NARRATOR:** If the FDA were to insist that all GM foods should carry labels, would that cause people to reject them?

**HANK C. JENKINS-SMITH:** Well, suppose we go, then, for a policy in which we add a requirement of labeling. How many of you could vote for that type of a policy? Virtually everyone.
PARTICIPANT: I think that you should label it and let people have a choice, just like we know about our calories.

PARTICIPANT: I want to be aware that it's in there. I want the choice to decide if I want my children and myself to ingest it or not.

HANK C. JENKINS-SMITH: If this stuff was all labeled, would your qualms about allowing companies to go ahead and try them be less? Does it affect your willingness to tolerate, essentially, research and development, if you know that whatever is produced has to be labeled?

PARTICIPANT: It lets me make my own choices instead of having it hoisted upon me with no information.

PARTICIPANT: I think the labeling is just automatic.

NARRATOR: The full survey results are equally clear-cut. The effect of labels is the opposite of what most people expect.

HANK C. JENKINS-SMITH, University of New Mexico: The single strongest point that leads people to increase their level of support is the labeling question. If people were— if labels were there and people could choose, you get a massive majority in favor of GMOs.

NARRATOR: Why should labels reduce Americans' fear of GM food? It's all about choice.

HANK C. JENKINS-SMITH: Many people accept risks. We ski. We ride mountain bikes. Extreme sports are a big deal in the United States, so people like taking risks, but they like to choose their risks. People don't like to have others imposing risk upon them, particularly if they are imposing the risk for purposes of generating a profit.

NARRATOR: Ironically, by the time U.S. consumers get a choice, it may be impossible to find much food without GMOs. In recent months, U.S. food companies like Gerber, who sought out non-GM grains so they could label their produce "GMO-free," have been shocked to discover that their products still contain genetically modified ingredients. Six years of growing, shipping and processing GMOs appear to have dispersed them throughout the U.S. food system.

Every country in the world is now trying to decide what to do about GMOs. Because the controversy has forced us to question the safety of the food we grow, in the long run we are all better off. But in the short run, there may be casualties in the GM food war.

Dennis Gonsalves has had a setback. The Japanese, who buy 35 percent of Hawaii's papayas, have refused to import them pending a full scientific review.

DENNIS GONSALVES, Cornell University: Japan has not allowed the papaya to come in yet, so some people are saying that it's not a success, that, "Look, we have a problem there."
NARRATOR: So desperate are some farmers to sell to Japan, they've gone back to growing non-GM papayas, and the ring spot virus is once again ravaging Hawaii. Gonsalves believes that the survival of the transgenic papaya, like any GM product, will ultimately depend on whether consumers need it more than they fear it.

DENNIS GONSALES: With the papaya, you can see the situation. You can see that just having the technology is not enough.

Harvest of Fear

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ANNOUNCER: Explore more about biotech foods on the FRONTLINE/NOVA joint Web site. Sample the arguments on whether we should be creating genetically modified foods. See what genetically altered foods will be on U.S. grocery shelves in the future. Take a closer look at how genes can be manipulated, traditionally or through bioengineering. Or check out our Best of the Web list on the GM foods controversy. Then join the discussion at
Next time on FRONTLINE: It's all about buying and selling cool.

EXPERT: The system closely studies kids to figure out what will push their buttons. Then it blares it back at them relentlessly.

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NOVA/FRONTLINE SPECIAL: What’s Up With the Weather? [120’].
GLWAOOOK "What's Up With the Weather?"
Air date: April 11, 2000
A NOVA/FRONTLINE Special Report

What's Up With the Weather?
Written, produced and directed by Jon Palfreman

NARRATOR: From record heat to raging storms, something strange is happening with the weather.

Vice Pres. AL GORE: Global warming is real.

NARRATOR: Or is it?

FRED PALMER, Western Fuels Association, Inc.: There is no basis to say that more CO2 in the air is going to lead to catastrophic global warming.

NARRATOR: But what do we really know about the greenhouse effect?

JAMES TREFIL, George Mason University: You're dealing with something where there is legitimate uncertainty in the science.

NARRATOR: Is there a real solution to our dependency on fossil fuels?

MARTY HOFFERT, New York University: If humankind is going to have a future on this planet, it is absolutely inevitable that we are going to have to find another energy source.

NARRATOR: And does America and the world have the political will to tackle what could become the most troubling issue of the 21st century?

FRED PALMER: The notion of reducing carbon dioxide emission levels by the year 2010 is a complete fantasy. We are not going to do it, as a society.

NARRATOR: Tonight PBS's premier science and investigative series join forces to investigate the truth about global warming.

For most of history, humans believed that the weather was governed by
forces outside their control, but today we’re no longer so sure. Something weird, it’s claimed, is going on with the weather, from storms and hurricanes to droughts.

Vice Pres. AL GORE: Withering heat waves in Texas and in Florida, cities that are setting thousand-year records for high temperatures- how much more proof do we need that global warming is real?

NARRATOR: And the future, some argue, could be apocalyptic, as ice caps melt and sea levels rise as much as 20 feet.

DAN LASHOF, Natural Resources Defense Council: Over the last few years, you begin to get increased probability of extreme events. You’re beginning to get a sense that these are happening more than they used to. And people are beginning to connect that with global warming.

NARRATOR: Vice President Gore is so convinced humans are warming the planet, he advocated an international treaty committing America to drastically reduce emissions from oil, gas and coal.

Burning these fossil fuels, he argues, puts greenhouse gases into the atmosphere which trap heat and warm the globe. His opponents object that the risks are exaggerated and any attempt to limit or get rid of oil, gas and coal -which provide 90 percent of our energy - will cause an economic apocalypse, from job losses to recession.

FRED PALMER, Western Fuels Association, Inc.: This is the United States government identifying with a policy that would be devastating. What the long-term goal of the vice president of the United States is to ultimately eliminate all fossil fuel use in the United States. That is their goal.

NARRATOR: At the heart of this contentious issue is a battle for the truth. When we strip away the rhetoric and politics, what does science really know about global warming? The question has pushed the once obscure science of climatology into the spotlight. But the climate system has turned out to be very complex.

TOM M.L. WIGLEY, Nat’l Center for Atmospheric Research: Now we’re getting near the end of the run, where the CO2 level is much more than double present day, and-

NARRATOR: And scientists’ pronouncements about the future of the planet vary widely as they struggle to determine whether the changes in the climate are natural or caused by human beings.

TOM M.L. WIGLEY: A 5-degree warming will just change the whole climate system radically. Precipitation patterns will be entirely different. The amounts of precipitation will be entirely different.
PAT MICHAELS, Cato Institute: The climate changes, whether or not human beings have something to do with it. You know, there's- there's this little anomaly called the Ice Age. The Earth's climate naturally goes from its current state to having 5,000 feet of ice over Chicago. The climate is unstable.

NARRATOR: Tonight NOVA and FRONTLINE set out to uncover the truth about global warming. A lot is at stake.

SEN. FRANK MURKOWSKI, (R) Alaska: Any new climate treaty must not result in serious economic harm to the United States. What could be more basic than that?

NARRATOR: From the wealth of nations to the future of the planet: Are humans warming the globe? Or are we an insignificant influence compared with the natural forces which have determined the climate for millions of years?

JAMES TREFIL, George Mason University: If you sat down and said, "I'm going to design a public issue that is the absolute worst nightmare of every scientist, of every communicator in the world," you couldn't do better than the greenhouse effect.

You're dealing with something that's very complicated. You're dealing with something where there's legitimate uncertainty in the science. It's not that people are trying to pull the wool over anybody's eyes. There's legitimate uncertainty. You're dealing with something that has enormous consequences for people. And you're dealing with something whose effects will happen 30 years down the road, you know, when they happen.

And then you say- you give people this and say, "Okay, do something about it."

TOM BROKAW, NBC News: It is, in fact, a heat wave of global and historic proportions, more than-

NARRATOR: The issue is typically framed in the media as a simple question: Is it getting warmer?

DAN RATHER, CBS News: Final figures in from Canada today show October '98, was the warmest October on Earth on record.

JAMES TREFIL: Unfortunately, when people talk about global warming, it's always in terms of, "Oh, gosh, it was hot last summer." And that doesn't work because weather and climate are two very different things. Climate is sort of long-term things. Weather is short-term- daily, hourly, monthly, whatever. And what we're talking about when we talk about the greenhouse effect is we're talking about climate.
NARRATOR: James Trefil is a physicist and science writer who has followed the global warming issue closely.

JAMES TREFIL: In order to say it is actually getting warmer now, you have to know what it's been in the past and you have to know that what you're seeing is not just a fluctuation. I mean, I remember when I was a kid, in the 50's, hearing stuff about the coming ice age because there was--we were in a kind of a little cold snap then. And people--I remember pictures on the covers of magazines showing glaciers moving down across American cities.

So if you take any short-term timeline, any short-term database for temperature and extrapolate it, you can get crazy results. In order to make an incontrovertible case for global warming, you'd have to have a long-term temperature record, centuries, that was over a large part of the globe. And so you have to look over a long term and say "What's the average been for several hundred years, and is this a significant departure from that?" And that's what's very difficult to do.

NARRATOR: Bad weather in one place at one time does not prove the climate is changing. To prove humans are warming the globe requires detailed knowledge of the entire Earth's weather over long stretches of history. And this has turned out to be an enormously complex scientific challenge.

The Earth is a big place. Three quarters of it is covered by water. There are giant ice caps and deserts and mountains. But climate scientists somehow need to take the Earth's global temperature.

Today the Earth's weather is measured daily all over the globe by an international network of stations on land and sea which report temperature, pressure, rainfall, humidity and a host of other variables. Such global measurements are the prime data base for climatology.

Millions and millions of figures have been collated, corrected, adjusted and synthesized. The problem is, these measurements have only been taken systematically for a century. When averaged, a pattern emerges. During the past 100 years, the global surface temperature has risen by one degree Fahrenheit, or about half a degree Celsius.

This is a temperature record of the entire Earth's surface, not just the weather in one place. But is a 1-degree rise over a century a little or a lot?

JONATHAN OVERPECK, Nat'i Oceanic and Atmospheric Adm.: What's really remarkable about the warming over the last century is both its magnitude, in terms of half a degree Celsius, and it's the fact that it has been almost worldwide. Almost every site you look at has warmed dramatically since the middle of the last century. [www.pbs.org: The debate on man's impact on warming]
NARRATOR: But not everyone's convinced this is evidence that humans are warming the globe. Fred Singer, an atmospheric physicist, is one of a small band of scientists who have become known as greenhouse skeptics. He argues that the 100-year record is not what it appears to be.

FRED SINGER, George Mason University: The data are ambiguous. For example, the data show that the climate warmed between 1900 and 1940, long before humanity used much energy. But then the climate cooled between 1940 and 1975.

NARRATOR: Only in the last few decades do rising global temperatures seem to coincide with the greenhouse gases we put into the atmosphere. Skeptics like Singer have also argued that long before the industrial revolution, the climate warmed naturally. For example, records show that in the Middle Ages, parts of the world, like Greenland, were warmer than today. The Vikings built settlements there and farmed the land.

FRED SINGER: The Vikings were able to grow crops, and life was good in Europe. Cathedrals were being built. There was plenty of food.

Climate change is a natural phenomenon. Climate keeps changing all the time. It's either warming or cooling.

NARRATOR: But records of one place, like Greenland, during one time, the Middle Ages, may not prove anything. Only by knowing the average global temperature 1,000 years ago can scientists know whether the Earth back then was warmer or colder than today.

JONATHAN OVERPECK: What we're looking for is a period in the past - or periods - that are as warm or warmer than today because, of course, if they were that warm, they were probably that warm due to natural processes. And that might give us some clues about what natural processes, as distinct from human ones, could be causing the warming today.

NARRATOR: Long before thermometers were invented, human beings recorded the weather, sometimes in great detail. And these records are now being scrutinized by climate historians.

CHRISTIAN PFISTER, Environmental Historian, Univ. of Bern: Weather was an extremely important variable in daily life, and most people worked outdoors and they were outdoors for most of the day. They were much more vulnerable, and they knew it. And for this reason, there was extreme interest in any kind of predictions.

NARRATOR: Throughout history there have been people who documented events regularly and meticulously—physicians, artisans, and the monks here at Einsiedeln in Switzerland. They recorded the time the cherry blossom appeared, the freezing and thawing of lakes, the state of
the wine harvest.

CHRISTIAN PFISTER: For instance, a very early cherry blossom is always related to a very warm month of March. If the Lake of Zurich is completely frozen, we know it is the equivalent of two extremely cold months always because we know it from the period when we have both the observations and the measurements.

NARRATOR: From these diverse records, climate historians can glean a lot about the past climate. By combining data from many sites, this clever forensic work can yield a detailed picture of areas like central Europe going back more than 1,000 years. Has Pfister found any period in the past as warm as the 1980s and '90s?

CHRISTIAN PFISTER: We had other periods which was also very warm, but it was equivalent to the 20th century prior to 1988. I would say this was a period of warm climate, but I would say it was a period of warm natural climate. With the period between 1988 and 1997, there's absolutely no equivalent as far as I can look back.

NARRATOR: But this technique, too, is limited. Only a few areas, like Europe, have long-term records which survive. To get a handle on the global climate, scientists have been forced to go beyond human accounts of the weather.

Five hundred miles from the North Pole, a frozen lake will be home to a team of scientists for the next few weeks. It's part of an international effort to try and reconstruct the climates of the past.

RAYMOND S. BRADLEY, University of Massachusetts: We are here in the Canadian high Arctic, on Ellsmere Island, about 500 miles from the North Pole. And it might seem strange that we would come to this kind of environment to study the problem of global warming. But what we need to do is try to reconstruct the longer-term history of climate, and we do that by using so-called natural archives of climate, things that in some way retain in their structure a measure of how the climate has varied in the past.

NARRATOR: Bradley and his team will spend the brief Arctic summer drilling through the ice and sampling the pristine sediments at the bottom of Lake Tuborg.

RAYMOND S. BRADLEY: Because the lake is frozen over for most of the winter, what we have is a very brief period during the summer when the snow melts and the sediments are carried into the lake. And that settles out into the lake, and it forms these layers, just like the layers you see in a tree ring or in an ice core. Year by year, we get a nice sedimentary record.

NARRATOR: These year-by-year variations in thickness will be used to estimate past temperatures at Lake Tuborg. A thicker layer means there
was a warm spring which melted more snow and produced more mud. This expedition yields temperature information going back hundreds of years, but in just one location. To estimate the past average global temperature, such measurements must be made all over the Earth’s surface.

Thirty-five hundred miles to the south, a team from Scripps Institution of Oceanography are examining the trees in Mammoth Park, California. Franco Biondi and his colleagues have done this many times.

FRANCO BIONDI, Scripps Institution of Oceanography: The way the trees grow, they will cover themselves entirely every year with a new layer of wood. And if you take a horizontal section, you’re going to see the width of each one of these layers.

NARRATOR: Because trees grow all over the world, they are one of the most powerful natural recorders. Their annual rings not only give scientists a built-in date, they also contain a record of past temperature and precipitation.

FRANCO BIONDI: Each one of these layers is an annual layer seen in cross-section. The annual layer is formed by these two portions together, the early wood and the late wood. And the width of the layer is our first indication of a climate pattern. So the narrow band that you see here indicates a year when the winter and spring were drier than normal. And then the larger layers that you see here indicate a period when winter and spring precipitation were more abundant than normal.

NARRATOR: Trees are very common on land, but for the three quarters of the planet covered by ocean, scientists need other recorders. Like trees, corals can live for hundreds of years and grow at different rates, depending on the temperature at the sea surface. The Earth’s temperature is also preserved in the chemistry of ice layers extracted from glaciers all around the world.

Each natural recorder produces estimates of temperature and rainfall for a given place and time. Combining them all, scientists have been able to extend back the temperature record for the northern hemisphere about 1,000 years. According to this graph published in 1999, the 20th century’s one degree warming stands out dramatically. [www.pbs.org: Visit the "stories in the ice"]

But what about Greenland and its controversial medieval warm period? According to the combined data, there was no medieval warm period. Specific regions like Greenland may have been warm, but the average global temperature back then was cooler than today.

Even though the data is preliminary, Bradley is convinced the climate of the 20th century is unprecedented.
RAYMOND S. BRADLEY: We think this warm period 1,000 years ago was just a regional anomaly. We find almost no period in that whole 1,000 years which has temperatures as high as we've seen in the last part of the 20th century. And in particular, the 1990s were exceptionally warm. It was an incredibly unusual decade, and we have no evidence that there was a decade quite like the 1990s all the way back 1,000 years.

NARRATOR: If this finding holds up, does it prove humans are causing global warming? Some greenhouse skeptics like MIT's Richard Lindzen urge caution.

RICHARD S. LINDZEN, Mass. Institute of Technology: Well, it leaves out a couple of things. First of all, one has to distinguish the statement "warming," meaning temperature has gone up, from "warming," meaning man has caused temperature or something has caused temperature to increase.

NARRATOR: How can we be sure that recent warming is man-made rather than natural? And what evidence is there to link this temperature increase to human activity?

Perhaps no man has done more to help answer this question than Charles David Keeling. Forty years ago, nobody knew for sure whether industrial greenhouse gases like carbon dioxide were increasing in the atmosphere or whether they were being absorbed by the oceans. In 1957, Keeling set out to discover which was right. Taking advantage of the special funding available in the International Geophysical Year, he set out with the latest analyzers to begin what would become his life's work.

CHARLES D. KEELING, Scripps Institution of Oceanography: This program afforded me an opportunity, even though I was just out of school, practically, and a very young man, to, commandeer enough resources to see that these analyzers were put in several places, and rather quickly at that. One analyzer was put in Little America Antarctica, and shortly after, another one was placed on a mountain in Hawaii called Mauna Loa.

NARRATOR: The ideal place to measure carbon dioxide is away from cities, which produce it and distant from vegetation, which absorbs it. On the Hawaiian mountain of Mauna Loa, Keeling found the ideal spot. Located at 11,000 feet in the midst of a barren lava field, he began to sample the Earth's air.

CHARLES D. KEELING: At Mauna Loa Observatory we started the measurements in March, 1957, and I expected the concentration would be perhaps almost dead constant, knowing nothing else as a hypothesis, but that wasn't what happened. The concentration rose for several months, and then it dropped. And it dropped all during the period from May until September. And then it started to rise again.

As soon as we saw that much information, less than a year's worth of data,
it was pretty obvious that we were looking at the breathing of the plants in the northern hemisphere because they absorb carbon dioxide during their growing period in temperate and high latitudes, and then it's released again in a cyclic process in the wintertime.

NARRATOR: Keeling's sensitive measurements had picked up the Earth's respiration. Every spring, plants bloomed, sucking carbon dioxide out of the air. Every fall, CO2 was released back into the air as the plants decayed.

But Keeling noticed that year by year, the total concentration of CO2 increased. Superimposed on the annual cycle was a rising curve. Each year, more CO2 was inhaled and exhaled by the biosphere. Over 40 years, the concentrations rose from 330 parts per million to almost 370 parts per million. The Keeling curve appeared to prove what many had suspected, that humans were changing the composition of the atmosphere.

But why should adding an invisible, non-toxic gas be cause for concern? Compared to the major atmospheric gases - oxygen and nitrogen - the amount of CO2 is minuscule, but through an accident of physics - the greenhouse effect - its consequences are significant.

Perhaps the most dramatic example of the greenhouse effect is the Earth itself. But for this effect, the Earth would be frigidly cold. Of the energy coming from the sun, about half of the light gets scattered and absorbed before it reaches the surface. The rest is radiated back as heat or infrared radiation.

In the absence of a greenhouse effect, this heat energy would escape back into space, leaving the Earth with an average temperature of zero degrees Fahrenheit. All water would freeze. The reason this doesn't happen is that greenhouse substances - gases like carbon dioxide and methane - and water vapor and clouds - all act to trap escaping infrared radiation. The net effect is to cause the Earth's surface to warm up to an average of 59 degrees.

RICHARD C. J. SOMERVILLE, Scripps Institution of Oceanography: It's as real as gravity, and it keeps the planet habitable. We'd have an average surface temperature on the Earth below the freezing point of water were it not for the greenhouse effect.

NARRATOR: But since the industrial revolution, there has been a new and growing source of CO2: fossil fuels like coal, oil and natural gas. When fossil fuels are burned, their carbon atoms combine with oxygen in the air to make CO2. Every time we turn on a light or drive our cars, we are adding CO2 to the atmosphere. [www.pbs.org: What's your carbon diet?]

CHARLES D. KEELING: It's hard for people to understand how much carbon dioxide is being put into the atmosphere in absolute terms, but in
relative terms we can say as follows: At the end of World War II, about a billion metric tons of carbon, in the form of CO2, was being emitted to the atmosphere. When I started my measurements, it had risen to two and a half. At the present time, it's almost seven.

NARRATOR: According to the theory of the greenhouse effect, adding more greenhouse gases like CO2 to the atmosphere should cause the average global temperature to rise for as long as we continue burning fossil fuels.

The climates of Mars and Venus were also shaped by the greenhouse effect.

PIETER TANS, Nat'l Oceanic and Atmospheric Adm.: Venus has an extremely high concentration of CO2 in its atmosphere, and it's blazing, boiling hot at the surface of Venus. And the Martian atmosphere, for instance, is very, very thin. And also within that thin atmosphere, there's only very small amount of CO2. And water vapor is also very, very low. And the surface temperature of Mars is frigid- very, very cold.

NARRATOR: In the contentious debate about man-made global warming, all sides agree on the physics of the greenhouse effect. It can even be demonstrated in the lab using a FLIR thermaCAM, a special infrared camera.

PIETER TANS: So we're going to demonstrate to you how the CO2 absorbs infrared radiation, which causes the Earth's greenhouse effect. Infrared radiation is another word for heat radiation, which is coming off of my face, and which is picked up by a camera that I'm looking at. The camera is sensitive to heat radiation. Between me and the camera is a volume that we will fill with CO2 gas, and as we turn on the gas, my image will slowly fade.

NARRATOR: This physical property of CO2, known to physicists for a century, is the bedrock of the concern about global warming. Because the ordinary air in the tube, composed mainly of nitrogen and oxygen, does not block infrared radiation, the camera sees the heat coming off the scientist's face clearly.

PIETER TANS: And as we turn on the gas, my image will slowly fade.

NARRATOR: But when the tube is filled with CO2, or any greenhouse gas, their molecules absorb the heat radiating off his face, blocking its path. As less and less heat reaches the camera, the image fades. If the scientist were surrounded on all sides by CO2, then the effect would be for him to get warmer, like the Earth in space.

Today the atmosphere is sampled at many sites on land and sea. Flasks are filled and sent to central laboratories like the National Oceanic and
Atmospheric Administration lab in Boulder, Colorado, to be analyzed for CO2 and other greenhouse gases. Even though most of the CO2 is put into the atmosphere in the industrial northern hemisphere, analysis reveals it pretty soon shows up everywhere.

PIETER TANS: If you burn, say, a gallon of gasoline that is turned into CO2 molecules, it will spread throughout the entire atmosphere. So what you burn today in your car will show up in Antarctica by next year.

NARRATOR: The other important fact scientists have discovered about CO2 is its permanence. Unlike water vapor, which stays around only for days, CO2 remains in the atmosphere for, on average, 100 years before being absorbed by the oceans. Our CO2 emissions are therefore changing the atmosphere not just for us but for future generations.

The measurements at Mauna Loa had produced clear evidence that humans were changing the composition of the atmosphere. But the data went back only 40 years, while we've been burning fossil fuels for more than 150 years, all during the industrial revolution. Just as scientists had used natural recorders to get at past temperatures, they now wondered if the giant ice sheets in Greenland and Antarctica might have captured past CO2 levels during and before the industrial revolution.

And what they found was remarkable. Trapped in the ice cores are bubbles of air, time capsules preserving the atmosphere of the past. With care, these bubbles of fossilized air can be analyzed for carbon dioxide and other gases. Sensitive analysis of the air bubbles reveals that before 1957, the atmosphere had less CO2. Indeed, CO2's rapid rise starts at the beginning of the industrial revolution.

Subsequent research has extended the curve far back in time. It's now established that current levels of CO2 are higher than at any time for the past 450,000 years.

MICHAEL B. McELROY, Harvard University: When you look at a 450,000-year record, and the last 100 years, 150 years, stands out like a sore thumb, there's not much question that we're involved in some way or another. And truly, that's not surprising. I mean, we are such an incredibly powerful force on this planet - our species. I mean, most of the land area of the Earth that is habitable, that is cultivable, we've cultivated or we've inhabited. We've moved mountains. We've redirected rivers. We've mined all this coal. We're a global force.

FRED SINGER, George Mason University: I have no doubt that an increase in carbon dioxide in the atmosphere should lead to some increase in global temperatures. The question is, how much? And how can we be sure that any temperature increase that we do find in the record is, in fact, due to this additional carbon dioxide? Since we know that the climate also changes naturally - it warms, it cools - how can you distinguish a warming produced by an increase in carbon dioxide from a warming produced by
some other cause, let's say by the sun?

NARRATOR: The argument that fossil fuels are changing the climate has alarmed coal, gas and oil producers. Because so much is at stake, the energy industry have been following the scientific arguments closely.

FRED PALMER, Western Fuels Assn., Inc: I understand that people get uneasy over the concept of more CO2 going into the air, but you can't live your life based on speculation. And we know today that using fossil fuels is a good thing. It leads to economic growth. It allows more people to live longer on Earth. These are- there are positive goods that come from using fossil fuels. There's a speculative "bad" that people are holding out there, saying, "Therefore, let's stop using fossil fuels." And I think that's an imprudent approach.

NARRATOR: The coal industry has mounted an aggressive challenge to the whole idea of human-induced climate change. Its high-powered public relations campaign argues that CO2 has been unfairly characterized as a pollutant.

FRED PALMER: In the past, we've had these great struggles over pollution in the United States. Sulfur dioxide is a pollutant. Nox (sic) is a pollutant. Carbon dioxide is a benign gas required for life on Earth. It is not a pollutant. It is not regulated. There are no state laws dealing with CO2. There are no congressional laws that give an agency the right to regulate based on CO2.

NARRATOR: Far from being a pollutant, the coal industry argues, CO2 is a powerful plant fertilizer, so producing more of it will green rather than pollute the planet. Its video The Greening of Planet Earth maintains that industrial CO2 will fertilize the Earth, and the enhanced forests will eventually soak up the excess greenhouse gas.

ANNOUNCER: ["The Greening of Planet Earth"] Grasses will grow where none grow now, and great tracks of barren land will be reclaimed.

NARRATOR: It argues that horticulturists pump CO2 into their greenhouses - time times current atmospheric levels - to make the flowers and vegetables grow faster. And indeed, the plants thrive. The industry believes that characterizing CO2 as a fertilizer rather than a pollutant turns the controversy on its head.

FRED SINGER: The only thing we are concerned about is carbon dioxide levels becoming too low because if carbon dioxide levels were to fall below, let's say, one half of the present level, as they almost did during the last ice age- if they were to fall below one half of the present level, then plants would be in real trouble. After all, carbon dioxide is plant food. Without carbon dioxide in the atmosphere, plants would disappear.
NARRATOR: While it's accepted that CO2 is a plant fertilizer, it's not known just how the world's forests will react. Will they be able to keep up with ever-increasing CO2 emissions? In a remarkable series of federally funded experiments, scientists are trying to test the greening hypothesis. In 50 years, if current trends continue, CO2 concentrations will be double the pre-industrial level. And that's just what this forest is getting.

WILLIAM H. SCHLESINGER, Duke University: Our experiment is an attempt to grow an entire forest at 560 parts per million. In other words, we're replicating the growth of forest 50 years from now around the world, when all forests will be bathed in that atmosphere. We're essentially jetting CO2 into the forest.

NARRATOR: Doing science on this scale is a massive undertaking.

WILLIAM H. SCHLESINGER: Each of the experimental plots consists of a row of towers that inject carbon dioxide 24 hours a day, 365 days a year.

NARRATOR: As the trees grow, carbon dioxide flows in and out of the forest, some carbon getting locked up as wood, some decaying back into the atmosphere. So everything in this forest of the future must be carefully measured.

Only two years into the experiment, the scientists can already see some changes.

WILLIAM H. SCHLESINGER: As a result of the first two years of the experiment, the 1997 and 1998 growing seasons, we found a 25 percent growth rate increase in the loblolly pine exposed to high carbon dioxide in the forest. Whether or not that continues is a real source of interest to us.

NARRATOR: So is the coal industry right? Will this enhanced growth help suck up the excess CO2? Only, say scientists, if the CO2 stays out of the atmosphere.

PIETER TANS, Nat'l Oceanic and Atmospheric Adm.: The forests might sequester CO2 for 50 years, 100 years. And then at a certain point, it comes more or less into balance because enough organic matter in the forest has been built up that decay starts to catch up with photosynthesis. If we chop down the old tree, we have to make sure that most of that tree is put into a usable product that has a long life. And what happens then? Eventually the lumber rots or gets burned.

NARRATOR: Eventually, within a century or less, the carbon locked in wood will find its way back into the atmosphere as CO2. And there's another reason for believing that plants alone can't absorb all the CO2: the vast size of the fossil fuel reserves.
PIETER TANS: When you look at the amount that is potentially available in coal, it's such an overwhelming amount. If you were to store all that in plants, the terrestrial biosphere would be four or five times the mass that it is now. Hard to conceive how plants could keep this up, you know, over centuries.

NARRATOR: But even without the "Greening of Planet Earth" theory, the fossil industry is unwilling to concede that increased CO2 will translate into major climate change.

FRED PALMER: There are reasonable people that have speculative fears about more and more CO2 going into the air and impacting climate. But there is no basis, no mechanism that anybody can point to or look at to say that more CO2 in the air is going to lead to catastrophic global warming or apocalyptic global warming, as opposed to some mild warming, which is nothing to be concerned about at all.

NARRATOR: It's not disputed that CO2 levels are a third higher today than before the industrial revolution and will double and perhaps triple in the next 100 years. The real crux of the issue is how precisely this rapid rise will affect the Earth's climate and whether those changes will be bad or good.

The National Center for Atmospheric Research, NCAR, in Boulder, Colorado, is one of the world's top centers for climatology. Inside, there are scientists whose job is far harder than any weather forecaster. They must try to predict the climate a century into the future.

Tom Wigley is one of NCAR's climatologists. Wearing special 3-D goggles, Wigley and colleagues can look at models of possible future climates.

RESEARCHER: The white is showing cloud ice and the colored surface in the center is relative vorticity, and it's being colored for temperature. So we have an iso-surface vorticity, and then temperature colored on top of it.

NARRATOR: The pictures on the screen are conjured up by supercomputers. These high-tech crystal balls offer the only means of thinking through the climate consequences of a world in which CO2 levels are double or triple what they are today.

A climate model starts by trying to capture all the many factors, natural and human, which can affect or force the climate system, either trapping or reflecting energy.

TOM M.L. WIGLEY, Nat'l Center for Atmospheric Research: There are really three categories of factor that one has to consider. One is the influence of human activities, the build-up of carbon dioxide in the atmosphere and other greenhouse gases, and also the effect of sulfate
aerosols. Aerosols are very small droplets that are primarily made of sulfuric acid or ammonia sulfate that are suspended in the air. And they arise from fossil fuel combustion, and those particles have a cooling effect.

The next important issue is what about natural external factors that might cause temperature to change on a global basis. We know from satellite measurements that the sun changes on a decadal time scale. The other external influence is volcanic eruptions, and the prime example there was Mount Pinatubo, that erupted and caused for a year or two a substantial amount of cooling.

In addition, there are other interactions that are going on purely internally within the climate system. As the amount of heat in the atmosphere is transferred to ice masses or to the ocean, that could cause, for example, the globe to warm by one or two tenths of a degree or cool by one or two tenths of a degree over a 100-year period.

NARRATOR: The many processes which push and pull the climate system are fed into the supercomputers. Then things get even more complicated. The climate's ultimate response depends on a complicated chain of feedbacks that can either amplify or diminish the original warming or cooling.

TOM M.L. WIGLEY: We are at the point now where the amount of carbon dioxide is roughly double the present level and-

If we were to add carbon dioxide to the Earth's atmosphere and cause warming, then the oceans would warm, and the amount of water evaporating from the oceans would increase. And it happens that water vapor is also a powerful greenhouse gas. So that by putting carbon dioxide into the atmosphere, we increase the amount of water vapor, and so we increase the total amount of greenhouse gases in the atmosphere and amplify the effect of carbon dioxide alone.

RICHARD C. J. SOMERVILLE, Scripps Institution of Oceanography: Here's a straightforward example. You first warm the climate for whatever reason, and then the chain is, snow and ice melt, a darker surface is exposed. That darker absorbs more sunlight than did the snow and ice that was there before, and therefore the climate warms even more. It's a positive feedback. It's as though you had the thermostat in your house set so that when the house warmed up, it turned on the furnace and warmed it up still more.

NARRATOR: But some feedbacks, like clouds, are more complex.

WARREN M. WASHINGTON, Nat'l Center for Atmospheric Research: If a low-level cloud is generated, then that shields the surface from the sun, so that you get less solar radiation arriving at the Earth's surface. So that's a negative feedback. However, if you generate more high clouds, then those higher clouds can actually help to trap the infrared

http://www.pbs.org/wgbh/warming/etc/script.html
radiation leaving from the surface and warm up the system.

NARRATOR: NCAR is just one of a dozen scientific groups who have tried to incorporate all these feedbacks into their computer models. Under pressure from policy makers, they have tried to predict what will happen to the Earth's climate when CO2 doubles in the atmosphere. All the models predict the Earth will warm, but the wide range of predicted temperature increases has drawn criticism from greenhouse skeptics.

FRED SINGER, George Mason University: These models are all produced by very competent people, excellent meteorologists, fantastic computers. Why do they not agree? Why do some models predict a warming for a doubling of CO2 of, let's say, 5 degrees centigrade, which is 8 degrees Fahrenheit, and why do other models predict something like 1 degree?

NARRATOR: The different predictions reflect real gaps in knowledge about the Earth's climate. If the water vapor and cloud feedbacks are strongly positive, as some modelers assert, then a huge climate change of up to 8 degrees Fahrenheit is to be expected. If this feedback is weak, as some skeptics argue, then a rise of only a degree or so will occur.

RICHARD S. LINDZEN, Mass. Institute of Technology: If you didn't amplify what CO2 did with having water vapor and clouds go along with it, you'd only at most get a degree or so.

INTERVIEWER: With a doubling?

RICHARD S. LINDZEN: With a doubling. And tripling would not do much more. And people have pretty much accepted this would not be a major change in the world as we know it.

NARRATOR: The computer models tell of possible futures, some scary, some less so. Which is true? Currently, there's no way to know.

JAMES TREFIL, George Mason University: Computer models of climate are the most complicated, ingenious computer systems I've ever seen. I mean, they really are good. But in the end, you have to just face the fact that they are not going to be able to give you precise, certain answers. They're going to give you, "We think this is what's going to happen, and here's the limits of error." And that's the uncertainty, and you have to choose.

NARRATOR: If the scientists are uncertain about the precise global temperature increases, they know even less about the specific effects the warming will produce. Of greatest concern is sea-level rise caused by melting glaciers and thermal expansion of warmer water. Coastal areas from Venice to California would then be vulnerable.
KEVIN E. TRENBERTH, Nat'l Center for Atmospheric Research:
Off the coast of California during El Nino events, the sea level rises. And in the last El Nino event, it was about eight inches above the normal value. And what we saw was a lot of coastal erosion, houses toppling into the sea. And so that's sort of an indication as to what increases in sea level can do.

We can adapt to a climate change, as long as it occurs slowly enough. But if it occurs too rapidly, then it disrupts the assumptions that we've built into the way in which society works, whether we are planning agriculture, whether we're planning a building with its heating requirements, whether we're planning a dam.

NARRATOR: If such human-induced climate effects occur, rich nations may be able to adapt and build sea walls. But for some countries, this isn't an option, like the 1200 low-lying Maldives Islands, isolated in the Indian Ocean.

ISMAIL SHAFEEL, Gov't Official, Republic of Maldives: All of these islands are totally flat. The average height above sea level is about a meter. And they're totally exposed to the sea. If there is even a minute change in the level of the sea, or a change in the size of the waves that come into our shores because of increased incidence of hurricanes, typhoons, we are all dead. The impact of global warming and climate change can effectively kill us off, make us refugees, lose every bit of land that we have available to us right now. [www.pbs.org: What other land could be submerged?]

NARRATOR: But greenhouse skeptics think such scenarios are alarmist. Modest warming, they argue, may even be good.

FRED SINGER: We have to ask what are the impacts of a warmer climate? What is the impact on agriculture? The answer is, it's positive. It's good. What's the impact on forests of greater levels of CO2 and greater temperatures? It's good. What is the impact on water supplies? It's neutral. What is the impact on recreation? It's mixed. You get, on the one hand, perhaps less skiing. On the other hand, you get more sunshine and maybe better beach weather.

Let's face it, people like warmer climates. There's a good reason why much of the U.S. population is moving into sun belt, and not just people who are retiring.

NARRATOR: But most climate scientists are less optimistic.

STEPHEN H. SCHNEIDER, Stanford University: We're talking about humans modifying the climate so that, if we're lucky, we only get another degree in the next century. And it could be several degrees per century, is our best guess.
Compare that to the degree per millennium of history, and now ask one more factor. How are the species of trees, for example, and birds and so forth—how are they going to migrate? In history, they just migrated. Now they have to cross factories, farms, freeways and urban settlements.

So if you have the combination of fragmented habitats with nature getting into smaller and smaller patches, now you've changed the climate 10 times faster than the history for which they have experience. This seems to me an absolute prescription for an extinction crisis.

NARRATOR: And some scientists caution there's a possibility that even modest warming might trigger major climatic changes by destabilizing the currents of the oceans.

The oceans are the wild card in the climate system. By carrying warm water from the equator to the north Atlantic, currents like the Gulf stream have a tremendous impact on the Earth's climate. By the time the Gulf stream has reached the north Atlantic, the water has given up its heat. The now cold and salty water is so heavy it sinks to the bottom and returns to the equator to form a closed circulation.

RON PRINN, Mass. Institute of Technology: These circulations are responsible for taking water from the top of the ocean down to deep levels in the ocean, in some cases right to the bottom. In doing so, in the present circumstances, this is a way of getting heat into the ocean and also a way of getting carbon dioxide buried in the deep ocean. So it's doubly important, this circulation, for the climate issue.

NARRATOR: But for this, the climate in Europe would be very different.

MICHAEL B. McELROY, Harvard University: Think of the climate in the British Isles or in southern Norway. It's a mild climate. You can play golf in Scotland in January. But what's the latitude of northern Scotland? I mean, bring it over to the United States and you're are sitting in the middle of Hudson's Bay.

NARRATOR: What worries some scientists is that in the past, this circulation appears to have stopped. A close examination of polar ice cores reveals about 10,000 years ago, while the Earth warmed up from the last ice age, the climate suddenly switched back into a cold state. Temperatures fell nearly 10 degrees in a decade. Some scientists believe it was caused when fresh water from melting glaciers flowed into the north Atlantic and disrupted the ocean circulation.

What might happen if today's global warming caused the circulation to stop?

RON PRINN: First, the north Atlantic would get much colder than it is today. That would mean Europe, northern Europe, would cool down very
rapidly. If that kept up over time, one would get more and more snowfall over time. And one of the hypotheses for going into an ice age is a shutdown of just that circulation, leading to more and more snowfall. Then it accumulates. It lasts over the summer. And steadily, over hundreds, thousands of years, you can build up glaciers on land that was previously, you know, vegetation-covered.

Paradoxically, a warming, in that case, would be leading to a catastrophic cooling of some parts of the world.

NARRATOR: The mighty oceans, some scientists argue, are the biggest uncertainty in the climate system, capable of dramatic climate surprises.

After decades of research, climate scientists have presented many possible scenarios for the future of the planet. Because of uncertainties about effects of all the feedbacks - involving atmosphere, ice caps and oceans - they still can't say precisely what will happen.

STEPHEN H. SCHNEIDER, Stanford University: I can imagine so called feedback processes where you if you warm up the Earth, you melt snow and ice, which adds further warming. If you do that, it makes the clouds taller, which makes them trap more heat, instead of wider. And if I conjure up these feedbacks, I can end up expecting that we could have climate change that's catastrophic in the next century.

I can also conjure up another set of feedbacks, the clouds get wider, that it gets drier in between the clouds. There are a number of feedbacks that we can conjure up which makes it warm up only a degree or so, at the relatively mild end of the spectrum.

Well, most scientists would argue that these very mild and very catastrophic outcomes are plausible, maybe even a 10 percent of each of them. But the bulk of the likelihood is somewhere in between the end of the world and the "good for you" scenarios that you see all the time in the newspapers and in the congressional debates.

NARRATOR: While scientists remain unsure of how the climate will change if CO2 continues to rise, they're certain we have already altered the composition of the atmosphere. Continued burning of fossil fuels now poses a credible threat to the climate. And since there are vast untapped supplies of fossil fuels in the Earth's crust just waiting to be exploited, today's greenhouse emissions might be eclipsed by what is to come.

PIETER TANS, Nat'l Oceanic and Atmospheric Adm: If we burned all the coal in a couple hundred years, we would very likely increase the atmosphere in CO2 concentration by more than a factor of 10. That's huge. There would be no debate about anthropogenic climate change, man-made climate change. It would be clear as a bell.
Once we have driven up CO2 levels in the atmosphere, for it to come back down, it would take a very long time. My timescale for that is thousands of years.

RICHARD C. J. SOMERVILLE, Scripps Institution of Oceanography: If a skeptic says that he or she is not worried about doubling, ask them about tripling or quadrupling. And ask them about all the other gases besides carbon dioxide, some of which are increasing faster then CO2. There comes a point when you can’t escape the idea that you're having serious climatic consequences. And so the issue becomes one of guessing whether we get wise before that day, or whether we have to wait for some perhaps quite unanticipated climate surprise that wakes us all up.

NARRATOR: The emerging consensus among climate scientists that global warming was real became the fuel for a growing political movement to reduce greenhouse gas emissions. The White House was at the center of this movement. In October, 1997, Clinton and Gore invited 110 T.V. meteorologists to a global warming briefing, hoping to recruit them as foot soldiers in the campaign.

Pres. BILL CLINTON: We have to say there's a challenge out there. We have to respond to it. Here's the principles we want in our response. And then we have to get after it. But we can't do it until we build the awareness of the American people.

NARRATOR: But the White House point man on the issue, who had championed it for decades, is Vice President Gore.

Vice Pres. AL GORE: This is coming, and we've got to do something about it. Are we going to be a part of the problem or a part of the solution? If we sit back and do nothing and allow this to happen without change, then what the mainstream scientists from every country in the world are telling us is that it's going to have profound changes in the pattern of climate and-

NARRATOR: Gore was trying to build public support because international negotiations about global warming had reached a critical stage. In December, 1997, representatives from 160 countries met in Kyoto, Japan to attempt to limit world greenhouse gas emissions. Environmental groups were out in force, hoping that this meeting would begin a radical transformation.

DAN LASHOF, Natural Resources Defense Council: If we're going to solve the problem of global warming, the United States has got to be a world leader, just as we are on just about every other international issue. It's not a problem we're going to solve overnight, but what we can do is change the direction. Now every year emissions are higher than they were the year before. We've got to turn that around and get into a situation where gradually but steadily we're reducing our emissions of carbon pollution and other heat-trapping gases. I think we can do that.
NARRATOR: Out of this meeting, it was hoped, would come binding agreements to limit greenhouse gas emissions.

CONFERENCE DELEGATE: We know what we must do. We know it can only be done together. So let us get on with-

NARRATOR: The fundamental issue at stake was the world’s use of fossil energy. Because the United States uses more energy than any other nation, it would come under the greatest scrutiny. More than any other country, the U.S. is accustomed to cheap energy on demand.

FRED PALMER, Western Fuels Assn, Inc: We are criticized for being the highest per capita consumers of fossil fuels in the world. It’s a positive good. There’s a correlation between our energy consumption and our success. We don’t succeed in the United States in spite of energy consumption, we succeed in the United States because of energy consumption.

NARRATOR: Americans use one quarter of the world’s energy. A vast infrastructure delivers energy whenever and wherever it’s needed. It works so seamlessly that Americans have stopped thinking about where energy comes from.

Most of it, in fact, comes from burning fossil fuels. Every time we turn on a light, the odds are that the energy comes from burning coal. Close to 60 percent of all U.S. electricity comes from coal, so power stations must be supplied 365 days a year with this most abundant fossil fuel.

FRED PALMER: People don’t think a lot about coal, and they are not required to think about coal. But Coal in the United States is the major driver of our economy, in that it supplies 56 percent of electricity. One 1,500-megawatt coal unit supplies electricity for a million and a half people.

NARRATOR: Coal generation is supplemented with other carbon-emitting fossil fuels like oil and natural gas. Some sources of electricity produce no greenhouse gases—hydroelectric power, solar energy, the power of the wind, and the largest carbon-free source of energy, nuclear power, which currently supplies over 20 percent of U.S. electricity. All these sources flow into electricity grids, like this one managed by Northern States Power in Minneapolis.

What few people realize is how much energy is being consumed 24 hours a day. Even at 3:00 in the morning, 55 percent of the load is operating.

AUDREY ZIBELMAN, President, NSP Energy Marketing: Nothing totally shuts down, and even at 3:00 o’clock, you have the street lights on. You have factories that are working on a 24-hour period. And what we’ll do at the night time is run our cheapest units, our coal and our nuclear units. And those are the units we call our baseload units that we use all the
time. And they produce the lowest-cost energy.

About 7:00 o'clock, our load will start to pick up as people get up and go to work, and buildings start opening up and air conditioners go on. What we'll do is turn on different generating plants as demand increases.

NARRATOR: All over America, the scene is the same. As the day gets going, the demand for energy ramps up. And since most of this energy comes from fossil fuel, it all adds greenhouse gases to the atmosphere.

Take the simple act of making toast. Over the course of a year, a toaster on average consumes about 39 kilowatt hours of electricity. And each one of those kilowatt hours sends about half a pound of carbon into the air.

JONATHAN G. KOOMEY, Lawrence Berkeley Nat'l Laboratory: When you multiply that out, what you get is about 8 kilograms of carbon per year for toasting bread every day. And if we convert it to pounds by multiplying by 2.2, we get about 20, 20 pounds of carbon per year associated with using a toaster.

NARRATOR: Or consider central air conditioning.

JONATHAN G. KOOMEY: A typical home in the South would use about 4,000 kilowatt hours for air conditioning. If we convert that to carbon emitted, we get about 800 kilograms of carbon emitted per year for a central air conditioner. And that's about 1,800 pounds, which is more than the weight of a small car like a Toyota Corolla.

NARRATOR: Since each pound of carbon entering the atmosphere combines with oxygen to form nearly four pounds of carbon dioxide, America's contribution to greenhouse gas build-up is even more striking.

Taking a shower each morning produces 550 pounds of CO2 in a year. Using a computer 40 hours a week produces 600 pounds of CO2. Lighting an average house for a year emits 2,000 pounds. Lighting an large office building not surprisingly produces much more, 2.5 million pounds of CO2.

And about one third of all American greenhouse emissions come from automobiles.

JONATHAN G. KOOMEY: People drive, on average, about 12,000 miles per year, and a typical new car gets roughly 28 miles per gallon. That means that you will use about 430 gallons per year. And so over the course of a year, the person driving this new car will emit roughly 2,200 pounds of carbon per year. That's roughly the weight of the car itself. Now, if you have an SUV, which only gets 14 miles per gallon, you're emitting 4,400 pounds per year, essentially the same as having two cars on the road instead of one.
NARRATOR: Apart from the energy we use to live, enormous amounts of power are required to manufacture all the things we buy. Grede Foundries in Minnesota needs as much electricity as a small town. And it needs this power on demand.

WILLIAM NESTEL, Grede Foundries: Grede makes all steel and iron parts. We make the rear end for the Dodge pickup trucks, and we make approximately 3,200 of those a day. We also make a powertrain component for the G.M. vehicles, and we make about 10,000 of those a day. If we lose electricity, we are dead in the water and we can't do anything.

NARRATOR: On any given day, Minneapolis-based Northern States Power directs up to 8 billion watts of power to homes and businesses. It's the same in most U.S. cities. Because of this energy consumption, each American on average, directly or indirectly, puts over 20 tons of CO2 into the air each year, collectively one quarter of the world total.

The energy use of industrialized nations like the US is responsible for the dramatic one third increase of CO2 in the atmosphere. But that's nothing compared with what is to come. The future of global warming will be determined by what happens in the developing world, nations like Brazil, India and China, where three quarters of the world's people live.

HENRY JACOBY, Mass. Institute of Technology: In the developing world, you have both higher rates of population and higher rates of economic growth, which means that they have a huge potential growth in greenhouse emissions, as they develop their electric power systems, their transportation systems and the like.

If you're living in a hot Chinese city, first you want a television set, and then you want a fan, and then you want an air conditioner as you get more wealthy. And you would want to do that. I would want to do that. And once you have an air conditioner, then, and a television set, then you'd like to have a car. And it's going to be very difficult for those countries to take a path that is dramatically different from the one we took.

NARRATOR: In India, each person currently produces only one 40th as much CO2 as an American. But India's population is so large and its growth so rapid that it will soon surpass the U.S. in greenhouse emissions.

R. K. PACHAURI, Tata Energy Research Institute, Delhi: The country today has about a billion people, and it's growing. In fact, the expectation is, by about the middle of the next century, India will have the largest population of any country in the world, larger than China.

We must remember that this is still a very, very poor country. You're talking about people essentially earning a dollar a day. And given the fact that 70 percent of our population lives in rural areas, we have a long way
to go.

NARRATOR: India has aspirations. Indians like Mr. Audyah want their children to have the possibility to leave the villages. Over the next century, India plans to transform itself from a largely rural agricultural society into an industrial powerhouse. And the energy driving that transformation will come largely from fossil fuels—in countries like India and China, mainly coal.

R. K. PACHAURI: Even to produce the basics of life, whether it's food or steel or automobiles, whatever, you need large factories. And those large factories need large power plants that would need large refineries and the like. And you know, those are things that we can't get away from. They have to grow if this country is to get rid of poverty.

NARRATOR: If rapidly growing developing countries like India simply follow in the footsteps of the West, greenhouse emissions will soar as their populations and energy consumption increase. To solve the global warming problem, therefore, would clearly require the cooperation of the developing world.

RON PRINN, Mass. Institute of Technology: What if the developing countries did not take part, and we wanted to achieve this target of twice pre-industrial levels? Then it would require the rich countries to have negative emissions by about the year 2045 or 2050. In other words, they would have to be pulling carbon dioxide out of the atmosphere to make up for the growth in carbon dioxide emissions in the developing world.

NARRATOR: Back at Kyoto, confronting these issues polarized the conference, pitching rich nations against poor. What was being negotiated was nothing less than a greenhouse gas allowance for each country which they could not exceed. But the developing nations argued that since they didn't create the problem, they should be exempt.

R.K. PACHAURI: It's essential that the developed countries take the first steps. They consume huge quantities of energy. They have the technological and financial resources to start doing something about this problem. This is the kind of leadership one expects the most powerful country in the world to show.

HENRY JACOBY, Mass. Institute of Technology: They don't want to do anything unless we go first. They didn't create the problem. They're poor, we're rich. The gases that are up there are not their gases, they're our gases. But it is also reasonable for us to say, "Hey, wait a minute. It doesn't help for us to do this unless we have some kind of an agreement with you that when you get to particular levels of income and ability, you will also join in."

NARRATOR: The arguments went on for days. As time started running out, it began to look like there would be no agreement. Still missing from
the negotiations was global warming's greatest champion, Vice President Gore.

RICHARD BERKE, "The New York Times": There was a real question of whether Al Gore should go or not because there was the sense that this whole thing could collapse. Some of his advisers were saying, "Don't go." Yet, on the other hand, if he hadn't gone, it might have looked like he was scared or shirking an issue that he's talked about throughout his career.

NARRATOR: At the last minute, Gore arrived to try and broker a deal. After a day of intense negotiations, Gore managed to keep the Kyoto Protocol from collapsing. And in an uncompromising speech, he reminded the delegates of what he believed was at stake.

Vice Pres. AL GORE: The human consequences and the economic costs of failing to act are unthinkable- more record floods and droughts, diseases and pests spreading to new areas, crop failures and famines, melting glaciers and stronger storms and rising seas.

Our first step should be to set realistic and achievable binding emissions limits. For our part, the United States remains firmly committed to a strong and binding target that will reduce our own emissions by nearly 30 percent from what they would otherwise be, a commitment as strong or stronger than any we have heard here from any country.

The imperative here is to do what we promise, rather than to promise what we cannot do. For example, in my country, we remember-

NARRATOR: But in brokering the Kyoto treaty, Gore had agreed to let the developing nations off the hook. They made no binding commitments to reduce greenhouse gases. Most developed nations, however, committed to binding cutbacks, with the U.S. agreeing to roll back greenhouse emissions to 7 percent below what they were in 1990, about 20 percent below what they are today.

Reaction in the U.S. was swift

FRED PALMER, Western Fuels Association, Inc.: What the long-term goal of the vice president of the United States is, is to ultimately eliminate all fossil fuel use in the United States. President Clinton, in connection with Kyoto said it was - his words - a "good first step." A first step to what? A first step to eliminating fossil fuel utilization in the United States.

NARRATOR: As Gore left for home, he knew he faced a hard fight on Capitol Hill. The Senate, who would have to ratify the controversial treaty, were far from happy with the deal.

SEN. FRANK MURKOWSKI, (R) Alaska: My problem with Kyoto is
there's no net gain. In other words, if you allow the developing nations to have a free ride, and if you buy their argument, well, they deserve a chance to catch up as the industrialized nations have advanced, then when we're through, have we got any significant net gain? Have we reduced emissions?

NARRATOR: Ironically, most climate scientists were also underwhelmed by the Kyoto treaty.

TOM M.L. WIGLEY, Nat'l Center for Atmospheric Research: If everybody were to come on board with the Kyoto Protocol, then that would slow down the rate of climate change by a very, very small amount. As a best guess, we think that the concentration of carbon dioxide in the year 2100 would be about 700 parts per million, which is roughly double what it is today.

If we enact and follow the Kyoto protocol, then we might reduce the buildup by a few tens of parts per million carbon dioxide. In other words, instead of doubling the amount of carbon dioxide, we might only increase it by 90 percent.

NARRATOR: Computer models show that the provisions of the Kyoto treaty would not stop the rise in atmospheric concentrations. To do this means eventually going way beyond Kyoto and cutting world fossil emissions by a half or more.

How could this be done? Scientists and environmentalists could imagine a whole range of potential solutions, from developing alternative energy sources to expanding nuclear power to simply increasing energy efficiency.

STEPHEN H. SCHNEIDER, Stanford University: The first major thing to do is to get efficiency improved. We are not anywhere near as efficient as we could be. We don't all have the best motors, the best light bulbs and the most efficient cars and industrial processes. We're not perfect. And therefore, if climate policy forced us to be more efficient, we actually would be replacing inefficient technologies with more efficient ones that would cost us less money to buy them than the money we're saving in fuels.

NARRATOR: A lot of energy is simply wasted. If we made our energy go further, we would need less and therefore emit less greenhouse gas.

JONATHAN G. KOOMEY, Lawrence Berkeley Nat'l Laboratory: An important distinction to make in dealing with any of these issues is that there is energy conservation, which is typically defined as deprivation—essentially putting on a sweater, you know, dealing with discomfort in some way. And then there's energy efficiency, using new technologies to do the same thing with less energy.
NARRATOR: Many electronic devices leak energy. Televisions are a prime example. When they operate, they draw about 100 watts of power. But even after they are turned off, they may still draw energy.

JONATHAN G. KOOMEY: Some of my folks actually went to Circuit City and measured all of the T.V.s there. And what they found was a huge range in the stand-by power of these devices. And some of them, not just televisions, but other kinds of appliances, were leaking as much as 20 to 25 watts. And you found other televisions that were less than 2 watts, and there was no difference in price for these devices. It was just that the manufacturers hadn't really thought about it for a long time.

NARRATOR: But as even proponents of energy efficiency admit, human behavior seems to be moving in the other direction. Americans are buying larger homes and larger vehicles.

JOHN B. HEYWOOD, Sloan Automotive Laboratory, MIT: We are buying larger, heavier vehicles, so the average weight and size has gone up. The engines and transmissions we use have got a little more efficient, and the two things are roughly canceling out. So the technology is getting more efficient, but the miles per gallon aren't getting better because we're steadily buying larger- more larger and heavier vehicles. So we have this choice. We could all drive smaller vehicles, and they would use less fuel and put less CO2 into the atmosphere. But that's not our current choice.

NARRATOR: But perhaps the biggest barrier to reducing greenhouse gases is economic growth. American industry uses energy more efficiently than at any time in history. The Andersen Window Company, which makes the top-of-the-line energy-efficient window, is no exception. But ironically, because business is booming, they use more energy than ever before. Because of the economic boom of the 1990s, America enters the new millennium nearly 20 percent above its Kyoto target.

RICHARD L. LAWSON, Pres /CEO, National Mining Assn: In the next 20 years, the nation's electricity requirements will be in creased by 60 percent. We'll go from 3 trillion kilowatt hours presently to about 4.6 trillion kilowatt hours in 2020.

INTERVIEWER: You're talking about America?

RICHARD L. LAWSON: That's the United States.

INTERVIEWER: Why does a rich country like America need to consume more energy?

RICHARD L. LAWSON: It is a matter of all of the things that you and I see around us. A computer on the Internet uses one kilowatt per hour in use. And you think about the explosion of all of those computers not only in the country but in modernized and developing countries around the
world, you begin to get an idea of what tomorrow looks like.

MARTY HOFFERT, New York University: The total energy consumption of all of humankind at this point in time is about 10 terawatts. That's 10 trillion watts. That's the rate at which primary energy is used. That's the rate at which we are burning gas and oil and coal. That's 10 trillion watts. The projections - the so-called "business as usual" projection - is that over the next 100 years, the demand for energy will increase roughly by a factor of 4.

NARRATOR: These projections reveal just how stark the problem really is. The world must somehow stabilize greenhouse gas emissions in the atmosphere at the same time as it is planning to triple, even quadruple, its energy use. By 2100, the world that these children's children will inhabit may need 30 or 40 trillion watts. And to prevent massive greenhouse build-up, most of this must be carbon-free.

MARTY HOFFERT: The magnitude of the job is massive. If you confront the problem honestly - I mean, if you really look at the problem, and you say, "What I want to do is I want to stabilize the amount of carbon dioxide in the atmosphere at some level twice the pre-industrial level of CO2 - it's almost impossible to do that unless there is a truly massive transition in the global energy system away from fossil fuels. That is the bitter pill at the bottom of all of these discussions.

NARRATOR: If America consumes ever larger amounts of energy, and if the developing nations follow in its footsteps, then the world must sooner or later confront an awesome challenge: to find a carbon-free replacement for fossil fuels. Where will this energy come from? Some say the technology has already been invented- renewable energy. Solar power, the energy of the wind, and biomass, the growing of vegetable matter to use for fuel.

DAN LASHOF, Natural Resources Defense Council: I think it is very credible that over a longer period of time, we can get the majority of our electricity from new renewable energy sources.

NARRATOR: Others argue that what we need is an expansion of nuclear energy, which also produces no greenhouse gases. But environmental groups do not want carbon-free energy at that price.

ALEXANDRA McPHERSON, Greenpeace: Nuclear energy has no role in this debate. We have no safe way of putting away radioactive waste. There are cleaner alternatives, and Greenpeace firmly disagrees with the use of nuclear power.

NARRATOR: Hydroelectric power has also recently come under attack.

ALEXANDRA McPHERSON: Large-scale hydropower has been very
disruptive in our rivers, specifically in the Pacific Northwest. We want to put an end to hydropower, and cleaner energy solutions are there. Solar and wind power.

INTERVIEWER: So you don't want coal. You don't want nuclear. You don't want hydro.

ALEXANDRA McPHERSON: Right.

INTERVIEWER: So what's left?

ALEXANDRA McPHERSON: Renewable energy technologies.

NARRATOR: In recent decades, great strides have been made to develop sources like wind power. Buffalo Ridge in North Dakota is one of the windiest locations in the United States. This wind farm has been sending electricity to the Minneapolis grid for over two years now.

LARRY TAYLOR, President, NSP Electric: Southwestern Minnesota has some of the best wind characteristics of any site in the United States. The problem with wind is that the wind, on the average, blows 25 percent of the time. And it blows the strongest in the spring and the fall, when our loads are the lowest. At our peak times, in the peak summer, peak winter, it generally- a lot of times it produces zero. We can't count on it being there. We have to wait for the wind. If the wind's there, great. If it isn't, then we'll have to open the throttles on something else.

DAN LASHOF, Natural Resources Defense Council: They're not going to all be in one place. They're going to be spread around. So the wind may not blow in North Dakota, but it'll blow in northern California. And that's when it will start to become predictable, as the utilities get more experience with it.

ALEXANDRA McPHERSON: The experts that we have been working with have quoted that South Dakota, North Dakota and Texas have enough wind power annually to meet the United States' electricity demands. Now, if the wind starts blowing, then we would have, you know, back up resources, you know, solar energy.

NARRATOR: In business for 15 years, Sunray, in southern California, is one of the longest-running solar plants in the world. Its 30-acre field of mirrors captures the energy of the sun and turns it into electricity without emitting greenhouse gases. But it can only generate power when the sun shines.

BRETT HOOVER, Sunray Energy, Inc.: The coal plant can generate year 'round, 24 hours a day. You know, here, you know,, we can just kind of run when the sun's out, which is out quite a bit. You know, we get about 265 days of sunshine here. But if you get any kind of high stratus
clouds or anything like that, you’ll see your power just go right off the grid.

NARRATOR: When the sun’s out, Sunray produces 30 megawatts of electricity. While impressive, it can’t yet compete with the coal plant next door, which produces nearly 800 megawatts, 24 hours a day, 365 days a year for a quarter of the cost.

Solar power has shown that it can play a valuable role in specific locations where the sun is plentiful, especially in the developing world, in areas remote from the electrical grid. The issue is whether renewables can be scaled up to generate the massive amounts of energy that coal and nuclear do, whether they can one day produce the trillions of watts the world’s cities need, whether they can ever replace fossil fuels.

MARTY IHOFFERT, New York University: Most people want to turn on the lights at night, and the sun isn’t shining at night. Renewables tend to be very episodic. That is, they’re not always there. And the power density is low. That is, the number of watts per square meter is pretty low.

NARRATOR: And this may be a crucial weakness. Because the energy density of solar, wind and biomass is low, very large areas of land will be needed to produce significant amounts of power.

MARTY IHOFFERT: There’s going to be a certain inevitable amount of land use issues associated with renewable energy, in that you’re going to need a lot of area. If you wanted to supply 10 terrawatts of power and you wanted to do it with biomass energy, you would need an area of the Earth equal approximately 10 percent of the Earth's surface, land surface area. And that’s a huge amount of land. That’s all the land that’s used in human agriculture right now.

Now, if you needed 30 terrawatts and you wanted to do it with biomass, you would need three times as much. So you could sort of imagine a world where the only things on the planet would be human beings and wheat, and we would eat the wheat and we would use the wheat to make alcohol for our vehicles, but there wouldn’t be any other biological diversity because we would have appropriated all of the land surfaces to do that. That’s the kind of issue that you have to deal with when you seriously talk about stabilizing CO2 in the atmosphere.

NARRATOR: Land use and siting issues have even tempered some environmental groups’ enthusiasm for wind energy. Recently, the National Audubon Society opposed the expansion of wind farms in certain parts of southern California because of threats to bird populations.

ALEXANDRA MCPHERSON: Greenpeace would not want to see, you know, every bit of open space covered with windmills. That’s not the issue, and that’s not the case that needs to be. The effects of building wind farms on our land, compared to drilling in our oceans for oil or drilling-taking off mountain tops for coal, is nothing compared to building wind...
farms or looking at solar plants.

NARRATOR: The challenge of replacing fossil fuels in power stations is hard enough, but roughly a third of fossil emissions come from our vehicles. Because every gallon of gas releases 20 pounds of CO2, engineers have looked for alternatives to petroleum. Some manufacturers imagine one day cars might work like this model and run on hydrogen.

Instead of an internal combustion engine, this car uses a fuel cell, a kind of battery, which combines hydrogen with oxygen to make electricity. The waste product is simply water. Prototype vehicles already exist which can run on hydrogen. The challenge to this vision of the future is where, exactly, will we find the hydrogen.

JOHN B. HEYWOOD, Sloan Automotive Laboratory, MIT: Well, petroleum comes out of the ground. Coal comes out of the ground. Natural gas comes out of the ground. It's down in the ground, and we bring it out and use it. There's no hydrogen stored in the ground. We have to make it.

NARRATOR: The good news is that you can extract hydrogen from natural gas. The bad news is that CO2 is released in the process.

JOHN B. HEYWOOD: So if you take natural gas and you produce hydrogen, you've taken the hydrogens from the natural gas, the hydrogen atoms, but the carbon atom is going to come off as CO2.

NARRATOR: To mitigate the greenhouse gas problem, the hydrogen would need to be made not from fossil fuels, but by splitting water molecules, using carbon-free energy. And it's hard to see how renewable sources like solar and wind can do this on the scale required, especially if they're expected to generate the world's electricity at the same time.

RON PRINN, Mass. Institute of Technology: We need to think of the renewables as nice augmentations. They're not going to fill the great demand. The sensible thing to be doing now is to broaden all of the energy options that we have. We need to look much more carefully at nuclear as a serious option going into the future.

NARRATOR: While enthusiasts once dreamed nuclear energy would run the world, no new plants have been built in the U.S. since the '70s. Plagued with controversy, many of the nation's plants will be decommissioned in the next 20 years. But given the grim realities of greenhouse gas build-up, some climate scientists are saying we should give nuclear another chance.

MICHAEL B. McELROY, Harvard University: I think that the mistake that we have made is, again, we've made an irrational choice. The public has decided that nuclear power is somehow or another dangerous, and more dangerous compared to other forms of energy that we use. They
are confused about the differences between generating electricity with nuclear power, as compared to building bombs and killing people with nuclear energy.

NARRATOR: But even assuming public fears could be erased, could a greatly expanded nuclear program replace fossil fuels? Nuclear reactors use uranium, a naturally occurring metal. How long would current reserves last if they had to run the world at the current rate of 10 trillion watts?

MARTY HOFFERT, New York University: You only have about 10 years of U235 power from all of the cost-effective uranium reserves. Even if you look at reserves which are more expensive now, by this time, the nuclear power would be getting considerably more expensive. You might have 30 or 40 years at 10 terrawatts. And what if we need 20 or 30 or 40 terrawatts for 100 years? Now you're done.

NARRATOR: Conventional reactors cannot solve the problem. But there is one possibility. Breeder reactors, which turn a more abundant form of uranium into plutonium, can potentially extend nuclear's lifespan as a fuel source for hundreds of years. But breeders are a very complex technology, and because they produce plutonium, they raise serious issues about nuclear proliferation. So today virtually no research is being done.

HENRY JACOBY, Mass. Institute of Technology: A high priority, and one that's now not being followed in the United States, is to find a socially acceptable version of nuclear power. I think one of the great tragedies of the current R&D - it's not a tragedy in that necessarily we are not building more nuclear power because there is a lot of social reasons to worry about nuclear power. The problem is we're not doing the research that would be needed to search for a nuclear power option that would be socially acceptable.

NARRATOR: Today there is no known energy technology capable of delivering the amounts of carbon-free energy to stabilize greenhouse gases in the atmosphere. The most commonly cited cures for global warming - efficiency improvements, renewable energy and nuclear power - appear not to be up to the challenge. But not everyone's demoralized.

MARTY HOFFERT: Try to imagine what the world was like in 1899 compared to today and what the technologies were that were being envisioned by even scientists and engineers and what actually happened. They missed the movies. They missed airplanes. They missed automobiles. They certainly missed space travel with nuclear power and radar and lasers. And so there's really an issue of sort of timidity in the way that we've been projecting the technologies that might mitigate the fossil fuel greenhouse effect.

NARRATOR: Hoffert argues that many of today's energy technologies - like nuclear and solar - came out of government-funded military and space
research. So perhaps we need a Manhattan Project to find the technologies
to combat global warming, technologies which might capture the sun's
energy in space and beam it to Earth, technologies like nuclear fusion,
offering limitless carbon-free energy. even technologies which extract the
carbon from burning fossil fuels and sequester it back into the ground, and
other technologies which today are simply unimaginable. [www.pbs.org:
Technologies "beyond fossil fuels"]

MARTY HOFFERT: But we haven't been doing any serious research
on this problem. When I say "this problem," on the problem of how do we
power the world on a long-term basis with carbon-free energy?

NARRATOR: If the technological obstacles to combatting greenhouse
gases seem difficult, the political challenges might be even greater. Even
before the Kyoto conference started, the idea of U.S. cutbacks was in
trouble in the Senate.

SEN. CHARLES HAGEL, (R) Nebraska: It is the developing nations
which will be the biggest emitters of greenhouse gases during the next 25
years. It is complete folly to exclude them from legally binding emission
mandates. How could any treaty aimed at reducing global emissions of
greenhouse gases be at all effective when it excludes these 130 nations?

NARRATOR: Remarkably, even liberal Senators concerned about global
warming had concluded that voting for Kyoto was political suicide.

SEN. RON WYDEN, (D) Oregon: The fact is, our country can control
global warming without causing an economic meltdown! Now, there are
really three approaches-

RICHARD BERKE, The New York Times: You can't underestimate
that power of interests on Capitol Hill that are opposed to this, between the
business interests and the labor interests and so forth. Even Republicans
these days are much more apt to call themselves green and to say they're
fighting for environmental issues, but they'll only go so far because you
don't want to run into danger with the business groups that are crucial to
funding a lot of these campaigns.

NARRATOR: In a rare display of unity, the Senate voted 95 to nothing
declaring their opposition to Kyoto.

SENATE PRESIDENT PRO TEM: The yeas are 95, and the nays are
0, and the resolution is approved.

NARRATOR: Climate scientists, who had seen the treaty as a small first
step, were stunned.

MICHAEL B. McELROY, Harvard University: I can't imagine that 95
United States senators believe that a rich country like the United States
should take no leadership role unless poor countries like India and China have taken equal responsibility. I can't believe that 95 United States senators really believe that. I mean, if you believe that, then you would have to say that we have embarked on an incredibly selfish view of leadership.

NARRATOR: In the two years since Kyoto, nothing has happened. Facing certain defeat, the White House has not even submitted the treaty to the Senate for ratification.

FRED PALMER, *Western Fuels Assn. Inc.*: There is no chance of Kyoto being ratified. We are not going to do it as a society. The notion of reducing carbon dioxide emission levels in the United States 7 percent below 1990 levels by the year 2010 is a complete fantasy.

NARRATOR: While the Senate and the White House are stalemated, what do the American people think - and what do they know - about global warming?

HANK C. JENKINS-SMITH, *University of New Mexico*: People in general tend to know relatively little about this question. They know that auto emissions or coal emissions generate greenhouse gas in fairly large percentages. But there's an enormous amount of confusion, as well. Our own studies show that 50 percent of the populace, approximately, would attribute some global warming cost to nuclear energy, for example, which is kind of a scary finding in this particular context.

NARRATOR: Hank Jenkins-Smith is a political scientist who studies public opinion on environmental issues.

HANK C. JENKINS-SMITH: If you ask people in general, "What do most scientists believe?" majorities get it right. On the other hand, it doesn't take much to upset it. One or two cogent arguments about the problems with the science associated with climate change is enough to create substantial skepticism.

FOCUS GROUP PARTICIPANT: There's so much range in the natural fluctuations of all of the attributes of the Earth that I don't think they can get a computer model to handle all of it.

FOCUS GROUP PARTICIPANT: You know, you can't predict what's going to happen, you know, with the climate. Nobody can. That's my opinion. It's like, they say one thing one day, and the next day something else happens.

FOCUS GROUP PARTICIPANT: The Iraq war, with the oil wells burning out of control- they were telling us we're going to have a nuclear winter because of all of this soot.
HANK C. JENKINS-SMITH: It appears that it's going to take some convincing to get people to believe that this is a serious issue to which they should devote some attention, let alone resources.

FOCUS GROUP PARTICIPANT: What, are you kidding?

FOCUS GROUP LEADER: Suppose that you were able to vote on a national referendum to impose a tax on - just to keep it simple, let's put it on gasoline - which would put money into a fund to study this question. Would any of you vote for that kind of a referendum?

FOCUS GROUP PARTICIPANT: Absolutely not.

FOCUS GROUP LEADER: You would not vote for it at any price.

FOCUS GROUP PARTICIPANT: I would want to know why the average consumer was being asked to pay for that. I mean, that would be my question. "Is this the only place that this funding can come from?" It's a question we need to answer, but do we need to pay for it?

FOCUS GROUP PARTICIPANT: For a mother with four children, 50 cents, you know, or even anything on the dollar adds up really quickly.

FOCUS GROUP PARTICIPANT: And then you don't really know if it would get used on that. I'm kind of skeptical as to where it is going to be used.

NARRATOR: The argument that the rich nations should take the first step had not swayed the U.S. Senate. Does it resonate any better with the average U.S. voter?

HANK C. JENKINS-SMITH, University of New Mexico: It doesn't seem to. First off, remember that people can quickly retreat to the idea that, "Well, we don't really know that it's that bad." And as long as they can retreat there, then you don't have much moral point. You can make a moral point if they begin to accept that these things are, in fact, having these potentially harmful effects. And we're just not there yet.

NARRATOR: During the presidential primary campaign, some observers began to wonder whether even global warming's most ardent advocate was backing off from the issue. In his presidential announcement speech, for example, Gore uttered only one brief sentence about global warming.

RICHARD BERKE, The New York Times: He hasn't really talked about it hardly at all since Kyoto. There is some talk that his advisers fear it's a no-win issue politically. This is the practical reality of running for president. When you're a lone U.S. Senator writing a book, you can do more of what you want and say what you want and say, "This is what I'm fighting for. We got to have it. Win or loose, this is what I want."
But when you're in a position where you can make things happen, when the spotlight is on you, when you want to be the next president of the United States, you have to be a lot more careful.

NARRATOR: Then just last week, Gore suddenly seemed to openly embrace global warming once again, reissuing his controversial 1992 book on the subject and saying we must now take urgent action.

At Mauna Loa in Hawaii, scientists continue measuring the greenhouse gas buildup in the atmosphere. Most climate scientists are now resigned that Kyoto has failed. One thing, however, is certain: The amount of CO2 entering the atmosphere will continue to rise. And in time, the impact on the climate will become clear.

TOM M.L. WIGLEY, Nat'l Center for Atmospheric Research: What we are afraid of is that if the planet warms too much, we're going into unknown territory. If we were to warm the world by five degrees, then I strongly believe that large parts of the Antarctic ice sheet would flow into the ocean and melt and cause sea level to rise by many meters.

NARRATOR: Beyond sea level rise, many other serious effects may occur. Increased frequency of intense storms, the spread of infectious diseases throughout the world, major droughts, crop failures and famines, the destruction of species and habitats- all these things are possible.

But it's equally likely that change will be more modest.

KEVIN E. TRENBERTH, Nat'l Center for Atmospheric Research: I certainly think 50 years from now we will be seeing clear evidence of human climate change. We will have a better knowledge of where it is in this range that we've been talking about as to whether it is going to be huge or smaller. Whether we will have clear evidence 20 years from now is not so clear to me. I still think there will be substantial arguments. There will still be people who will argue that this is natural variability, for one reason or another. But gradually, with time, I think people will recognize that something weird is going on with the weather, and maybe we should do something about it.

HENRY JACOBY, Mass. Institute of Technology: It is distant, and for that reason difficult. But it's not so distant. If I have a grandchild today, my grandchild born today will not be as old as I am until 2062. It's not that far away, in terms of generations of people around. So you can care about this issue because of people you know.

MARTY HOFFERT, New York University: We're in the fossil-fuel era of human history. If humankind is going to have a future on this planet, it is absolutely inevitable that we are going to have to find another energy source. The thing that's happening to us now is that we have to make that decision in the 21st century, whereas we may have been able to postpone
it to the 22nd century, if not for the greenhouse effect.

HENRY JACOBY: I think this is a very difficult problem, and I wouldn't bet we can solve it. I think it is extremely, extremely difficult, but it's worth our effort to really work hard to try to find a way to solve it because the potential is that we're changing the face of the Earth for all future generations.

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ANNOUNCER: For more on the climate and where we might be headed, visit our Web site. Examine the debate over the new consensus on warming, tally your own carbon energy use, see how ice cores are a history book on key climatic events, check out radical ideas to combat global warming, access a teacher's guide and join the discussion at pbs.org or America On Line keyword PBS.

Next time on FRONTLINE:

CLIFFORD BOGGESS: Welcome to death row.

ANNOUNCER: His name is Clifford Boggess. He lives on death row. He killed two people.

CLIFFORD BOGGESS: I leaned forward and shot him a second time in the chest.

ANNOUNCER: Now he wants forgiveness.

CLIFFORD BOGGESS: I'm sorry. You didn't deserve what I did to you.

ANNOUNCER: And the state of Texas wants his life.

CLIFFORD BOGGESS: The execution date has been set-

ANNOUNCER: FRONTLINE takes a journey into the mind and soul of a killer.

PRISON OFFICIAL: Mr. Bogus was pronounced dead at 6:11.
ANNOUNCER: The Execution on FRONTLINE.

Next time on NOVA: The next great adventure in space has begun.

EXPERT: Well, the space station is going to result in the largest single object that we've ever had in Earth orbit.

ANNOUNCER: But the most ambitious construction site in the cosmos is being held hostage.

EXPERT: Every promise has been broken.

ANNOUNCER: Will politics sabotage our future in space? Stationed in the Stars next time on NOVA.

To order the two-hour special What's Up With the Weather for $19.95 plus shipping and handling, call WGBH Boston video at 1-800-255-9424.

Major funding for NOVA is provided by the Park Foundation, dedicated to education and quality television.

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Cnet.com, helping you find the right technology products.

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Appendix 3:

Appearance Release Forms
Standard Appearance Release

Person Appearing:_________________________________________

Project:__________________________________________________

Production Date:___________________________________________

Production Location:________________________________________

I authorize PRODUCTION COMPANY INC. to use, in whole or in part, my name, likeness, image, voice, biography, interview and performance in connection with the Project, in all manner and media, as PRODUCTION COMPANY INC. shall determine in its sole discretion. PRODUCTION COMPANY INC., and its successors and assigns, shall own all right, title and interest, including the copyright(s), in and to the Project, to be used and disposed of throughout the world in perpetuity without limitation as PRODUCTION COMPANY INC. shall determine in its sole discretion.

Signature:__________________________________________________

Address:__________________________________________________

Date:______________________________________________________
Standard Appearance Release for Minors

Minor Appearing: ____________________________________________

Project: _____________________________________________________

Production Date: _____________________________________________

Production Location: __________________________________________

I authorize PRODUCTION COMPANY INC. to use, in whole or in part, my child’s or legal guard’s name, likeness, image, voice, biography, interview and performance in connection with the Project, in all manner and media, as PRODUCTION COMPANY INC. shall determine in its sole discretion. PRODUCTION COMPANY INC., and its successors and assigns, shall own all right, title and interest, including the copyright(s), in and to the Project, to be used and disposed of throughout the world in perpetuity without limitation as PRODUCTION COMPANY INC. shall determine in its sole discretion.

Signature of parent or legal guardian: _____________________________

Address: ____________________________________________________

Date: _______________________________________________________
Standard Location Release

Program Title: ____________________________________________________________

Location: ________________________________________________________________

Location Owner: __________________________________________________________

Date(s) of Recording: _____________________________________________________

I agree that person designated by the PRODUCTION COMPANY INC. may be in, on or about the above location on the date(s) indicated above, for the purposes of preparing or making a video and sound recordings (the "recordings") on film, tape or otherwise in connection with the Program/Series.

PRODUCTION COMPANY INC. shall hold me harmless from and indemnify me against any damage to the above location caused by any persons designated by PRODUCTION COMPANY INC. to be on the location or against any injuries occurring to persons designated by PRODUCTION COMPANY INC. to be on the location.

I authorize PRODUCTION COMPANY INC. to edit the recordings as desired and to incorporate them into the Program/Series and related materials. PRODUCTION COMPANY INC., shall own all right, title and interest, including the copyright, in and to the Program including the recordings, to be used and disposed of without limitation as PRODUCTION COMPANY INC. shall in its sole discretion determine.

I represent and warrant that I have the right to enter into this agreement and that the rights I have granted hereunder will not conflict with or violate any commitment, agreement, or understanding I have or will have to or with, nor infringe upon any rights of, any person or entity.

Name: _________________________________________________________________

Address: ______________________________________________________________________

Date: ___________________________________________________________________________
Appendix 4:

Curriculum Vitae
JON PALFREMAN MSc

A veteran of both UK and US television, Jon Palfreman is one of the most experienced television journalists working anywhere in the world. He has made over 40 BBC and PBS documentaries including the Peabody Award winning series “The Machine That Changed the World”, the Emmy Award winning NOVA “Siamese Twins” and the Alfred I. duPont-Columbia University Silver Baton winner “Harvest of Fear.” Palfreman has received many awards honoring the quality and accuracy of his investigative journalism. The only television producer to receive the prestigious Victor Cohn Prize for Excellence in Medical Writing, Palfreman is three-time winner of the American Association for the Advancement of Science science writing prize, three-time winner of the National Association of Science Writers “Science-in-Society” Journalism Award and a winner of the Writers Guild Award for best script. Palfreman has written two books and is an adjunct professor at Tufts University and Boston University.
JON PALFREMAN

EMPLOYMENT HISTORY

Director, Palfreman Film Group Inc. 1996-present
Executive Producer/Producer WGBH, Boston 1989-1996
BBC Producer/Senior Producer 1977-1989
Lecturer in the History of Ideas, University of Hertfordshire 1972-77
Tutor for the Open University 1974-77

TEACHING EXPERIENCE

Adjunct Professor, Tufts University. 1998-present
Part-time Lecturer, MIT 2002-present
Adjunct Professor, Boston University 2004

EDUCATION

BSc. Physics (First Class Honors). University
College, London.

MSc. History and Social Studies of Science, Sussex
University,
PUBLICATIONS: LONG FORM BROADCAST

Producer 2004
FRONTLINE “Diet Wars”
A one-hour investigation into America’s growing obesity crisis.

Producer 2004
INNOVATION “Light Speed”
The story of humanity’s quest to communicate at a distance culminating in fiber optics.

FRONTLINE “The Other Drug War”
A one-hour investigation into the high cost of prescription drugs.

Producer 2001
NOVA/FRONLINE SPECIAL “Harvest of Fear”
A two-hour special about the science and politics of genetically modified food.
•Winner, Alfred I. Columbia-Columbia University Silver Baton for Outstanding Television News

Producer 2000
NOVA/FRONLINE SPECIAL “What’s Up With the Weather?”
A two-hour special about the science and politics of global warming.
•Winner, The National Association of Science Writers “Science-in-Society Journalism Award”
•Winner, American Institute of Physics Science Writing Award
•Winner, Gran Prix Leonardo, Best Film on Climate
•Nominated, Emmy for Outstanding Coverage of a Continuing News Story

Producer 2000
PBS Special “The Battle of City Springs”
A 90 minute special which follows the fortunes of City Springs, a failing inner-city elementary school.

Producer 1998
FRONTLINE “Last Battle of the Gulf War”
An investigation into the bitter controversy surrounding Gulf War Syndrome.
•Winner, The National Association of Science Writers “Science-in-Society Journalism Award”
•Winner, Will Solimene Award for Excellence in Medical Writing

Producer 1997
FRONTLINE “Nuclear Reaction”
An examination of why nuclear power failed to gain acceptance in the United States.
•Winner, American Association of Engineering Societies' Award for
Best Film

Producer 1996
FRONTLINE "Breast Implants on Trial"
A 90 minute examination of the silicone breast implant controversy.
• Winner, The National Association of Science Writers "Science-in-Society Journalism Award"
• Winner, American Association for the Advancement of Science (AAAS) "Science Journalism Award"
• Winner, Will Solimene Award for Excellence in Medical Writing
• Winner, American Medical Association, International Health & Medical Film Competition

Producer 1995
NOVA "Siamese Twins"
A story about Dao and Duan, two conjoined orphaned twins from Thailand (formerly Siam), who travel to Philadelphia where surgeons attempt to separate them.
• Winner, Emmy for Outstanding Background Analysis of a Single Current Story

Producer 1995
FRONTLINE "Currents of Fear"
A critical examination of claims that power line electromagnetic fields cause cancer.
• Winner, Will Solimene Award for Excellence in Medical Writing
• Winner, Institute of Electrical and Electronic Engineers (I.E.E.E) Award for Distinguished Literary Contributions Furthering Public Understanding of the Profession
• Nominated for Writer's Guild Best Script

Senior Producer 1995
FRONTLINE "Waco: The Inside Story"
The definitive story of the standoff between the FBI and the Branch Davidian cult members.
• Winner, George Foster Peabody Award

Producer 1994
PBS Special "AIDS Research: The Story So Far"
A progress report on the continuing war on AIDS.
• Winner, Writer's Guild Award for Best Script

Producer 1994
FRONTLINE, "The Nicotine War"
The story of FDA Commissioner David Kessler's attempt to regulate the tobacco industry.

Producer 1993
FRONTLINE "Prisoners of Silence"
Exposé of Facilitated Communication, a technique that alleged many nonverbal and mentally retarded autistic individuals could read and write and simply needed "facilitating".
• Winner, AAAS/Westinghouse Science Journalism Award for Best Television Program
Senior Producer 1993
FRONTLINE "How To Steal 500 Million"
The story of how wunderkind, Mickey Monas, embezzled millions from the Pharmor drug store chain.

Producer 1992
NOVA "Brain Transplant"
Sequel to "The Case of the Frozen Addicts", in which fetal tissue transplants are given to reverse Parkinson's disease.
•Nominated for Emmy and Writer's Guild Awards

Executive Producer 1991
WGBH / BBC "The Machine That Changed the World"
A five part series on the history and impact of the computer; co produced by WGBH and the BBC.
•Winner, George Foster Peabody Award
•Winner, Ohio State Award

Series Producer 1989
BBC-TV "The Body Matters Road Show"
A six part series chronicling the daily events in six major medical centers.

Producer 1988
NOVA "Decoding the Book of Life"
An 60 minute film on the birth of the Human Genome Project. Broadcast in the US as part of the NOVA series.
•Winner, Blue Ribbon Award of the American Film Festival

Senior Producer 1988
Antenna, BBC-TV "Linus Pauling"
A film portrait of the great chemist.

Producer 1987
NOVA mini-series "Pioneers of Surgery"

Executive Producer 1986
BBC-TV "Doctors to Be"
Began a twenty-year television project to follow the careers of a group of British medical students from their selection interview for medical school throughout their professional lives.
Producer

NOVA "The Case of the Frozen Addict"
A story of how a drug tragedy in California led to a breakthrough in the treatment of Parkinson's disease.
• Winner, Television Award, British Association for the Advancement of Science
• Winner, AAAS/Westinghouse Science Journalism Award
• Winner, Television Award, Glaxo Science Writers Award
• Winner, Red Ribbon Award, American Film Festival
• Winner, Sci-Tech Festival, Best Medical Film Award
• Winner, Certificate of Merit, Pearl Assurance Medical Journalist Award

Producer
Horizon, BBC-TV "Conquest of the Parasites"
Coproduced with NOVA, this film examines how the latest research into molecular biology is being used to battle tropical diseases such as malaria and bilharzia.
• Winner, Television Award, British Association for the Advancement of Science
• Winner, Certificate of Merit, UK Medical Journalists Award

Producer
Horizon, BBC-TV “Genesis”
An hour long documentary about advances in embryology. This film was broadcast in the US as part of the NOVA series under the title “How Babies Get Made”.

Producer
Horizon, BBC-TV “A Mathematical Mystery Tour”
A 60-minute film about the abstract world of pure mathematics. Coproduced with NOVA.

Producer
Horizon, BBC-TV “A Mission to Heal”
An hour-long film about an African mission hospital.

Producer
Horizon, BBC-TV “A Child's Guide to Languages”
A 60-minute film about the failure of modern language teaching and how research into the way in which young children acquire natural language may provide a new approach.

Producer
BBC-TV / QED “Bugging in Six Easy Lessons”
A 30-minute film about eavesdropping technology.

Producer
BBC-TV / QED “The Riddle of Sleep”
A half hour program about the mysteries of sleep and sleep disorders such as narcolepsy and apnea.
Producer 1983
BBC-TV / QED "Music, Music, Music"
A 30-minute film about why music makes people happy or sad.

Producer 1981
Horizon, BBC-TV "The Race to Ruin"
A 60 minute film about the defense build up between the USA and USSR and how it is based on incorrect perceptions of Soviet technological sophistication. A co production with FRONTLINE.

Producer 1980
Horizon, BBC-TV "Science for the People"
An hour-long examination of Soviet science and technology.

Producer 1980
Horizon, BBC-TV "No One Will Take Me Seriously"
A 60 minute film about how highly unusual scientific theories are handled by the scientific community.
PUBLICATIONS: NON BROADCAST EDUCATIONAL

Producer 2002
"Reading Mastery"
A series of 12 videos and DVDs to help train teachers to use Direct Instruction's Reading Mastery Program, a research-based curriculum that has proved highly effective in teaching at-risk inner-city children to read. Using five master teachers as guides and authentic classroom performance to illustrate good technique, this series enables novice teachers to become highly effective reading teachers (distributed by SRA-McGraw-Hill).

Producer 2002
"Thriving on Excellence"
A 25-minute video for the US Department of Education dealing with the challenge of achieving excellence not just in isolated schools, but across an entire district. By focusing on three school districts located in poor at-risk areas, this video outlines the steps that ensure success.

Producer 2001
"Coaching for Success"
A now discredited reading curriculum called "Whole Language" has left thousands of middle and high school students unable to read. This video helps train reading coaches to correct this urgent problem by helping middle school teachers teach reading.

Producer 2000
"Cosmic Origins: from Big Bang to Humankind"
A 15 minute video made for the Foundation for the Future, highlighting the major concepts of cosmic evolution, from the Big Bang to the hopes of the future.

Producer 1999
"Understanding Antibiotics: A Parent's Guide"
A 15 minute video produced for the New England Research Institutes which informs parents about the importance of not over-using antibiotics.
- Winner, Health Sciences Communications Association Bronze Award
- Winner, Will Solimene Award for Excellence in Medical Communication

Producer 1999
"Goethe: The Middle School That Could"
A 20 minute video documenting an educational initiative in a seriously troubled Sacramento middle school.

Producer 1999
"Great Expectations"
A 20 minute video featuring a series of successful inner-city schools which have managed to achieve superior results despite poverty and disadvantage. The schools use a radical curriculum called Direct Instruction.
Producer 1999

"Harnessing the Atom"
A 25 minute video produced for the International Atomic Energy Agency to explain its many complex and important responsibilities.
PUBLICATIONS: PRINT

BOOKS


ARTICLES/INTERNET


• “Bringing Science to a Television Audience: too often, visuals-- like mummies and volcanoes--triumph over the reporting of modern science”, Nieman Reports Fall, 2002.


• “Apocalypse Not”, Technology Review, April 1996. (A critical analysis of the alleged adverse health effects of power lines.)


• “From barber's apprentice to hi-tech hero,” The Listener. November 5, 1987, P17-19

• What came out of the heroin that went wrong”. The Listener. April 10, 1986, p9 –10

• “Science in the Soviet Union”. The Listener. November 5, 1981 pp 528
• The séances and the scientists. *New Society*. June 21, 1979 pp 709-711


AWARDS

• 2002, Awarded Kaiser Media Fellowship.

• 2002 Association of Behavior Analysis Award for Effective Presentation of Behavior Analysis in the Mass Media.

• 2001 Victor Cohn Prize for Excellence in Medical Writing. This is a Prize given to a writer who has sustained excellence over a long period. It is judged on a five-year body of work.

Producer/Writer/Director
2001, NOVA/FRONTLINE SPECIAL “Harvest of Fear”
• Winner, Alfred I. Dupont-Columbia University Silver Baton for Outstanding TV News

Producer/Writer/Director
2000, NOVA/FRONTLINE SPECIAL “What’s Up With the Weather?”
• Winner, The National Association of Science Writers “Science-in-Society Journalism Award”
• Winner, American Institute of Physics Science Writing Award
• Winner, Gran Prix Leonardo, Best Film on Climate
• Nominated, Emmy for Outstanding Coverage of a Continuing News Story

Producer/Writer/Director
• Winner, Health Sciences Communications Association Bronze Award
• Winner, Will Solimene Award for Excellence in Medical Communication

Producer/Writer/Director
1998, FRONTLINE “Last Battle of the Gulf War”
• Winner, The National Association of Science Writers “Science-in-Society Journalism Award”
• Winner, Will Solimene Award for Excellence in Medical Writing

Producer/Writer/Director
1997, FRONTLINE “Nuclear Reaction”
• Winner, American Association of Engineering Societies’ Award for Best Film

Producer/Writer/Director
1996, FRONTLINE “Breast Implants on Trial”
• Winner, The National Association of Science Writers “Science-in-Society Journalism Award”
• Winner, American Association for the Advancement of Science (AAAS) “Science Journalism Award”
• Winner, Will Solimene Award for Excellence in Medical Writing
• Winner, American Medical Association, International Health & Medical Film Competition

Producer/Writer/Director
1995, NOVA “Siamese Twins”
• Winner, Emmy for Outstanding Background Analysis of a Single Current Story
Producer/Writer/Director
1995, FRONTLINE “Currents of Fear”
• Winner, Will Solimene Award for Excellence in Medical Writing
• Winner, Institute of Electrical and Electronic Engineers (I.E.E.E) Award for Distinguished Literary Contributions Furthering Public Understanding of the Profession
• Nominated for Writer's Guild Best Script

Senior Producer
1995, FRONTLINE “Waco: The Inside Story”
• Winner, George Foster Peabody Award

Producer/Writer/Director
1994, PBS Special “AIDS Research: The Story So Far”
• Winner, Writer's Guild Award for Best Script

Producer/Writer/Director
1993, FRONTLINE “Prisoners of Silence”
• Winner, AAAS/Westinghouse Science Journalism Award for Best Television Program

Producer/Writer/Director
1992, NOVA “Brain Transplant”
• Nominated for Emmy and Writer's Guild Awards

Executive Producer
• Winner, George Foster Peabody Award
• Winner, Ohio State Award

Producer
1988, NOVA “Decoding the Book of Life”
• Winner, Blue Ribbon Award of the American Film Festival

Producer/Writer/Director
1985, NOVA “The Case of the Frozen Addict”
• Winner, Television Award, British Association for the Advancement of Science
• Winner, AAAS/Westinghouse Science Journalism Award
• Winner, Television Award, Glaxo Science Writers Award
• Winner, Red Ribbon Award, American Film Festival
• Winner, Sci-Tech Festival, Best Medical Film Award
• Winner, Certificate of Merit, Pearl Assurance Medical Journalist Award

Producer/Writer/Director
1985, Horizon, BBC “Conquest of the Parasites”
• Winner, Television Award, British Association for the Advancement of Science
• Winner, Certificate of Merit, UK Medical Journalists Award
PUBLIC SPEAKING

"Engaging with Global Climate Change," address to graduate students in the Bush School of Public Policy, University of Texas at College Station.

"Combatting Global Yawning: overcoming the challenge of environmental reporting", address to Metcalfe Institute, 2004

"How I found the Television Story", Address to Association of Health Care Journalists, Minneapolis, 2004

"Treatment: science and science fiction", Keynote Address, Advances in Treatment of Pediatric Behavior Problems, Cambridge Center for Behavior Studies and University of Massachusetts Medical Center, October 4, 2003


• Videosciencia international festival on science film making, Brasilia, Brazil. Keynote speaker. 1997.

• The Institute of Behavior Analysis (TIBA) conference, Plymouth, MA, March, 1997: "Rehabilitating Behaviorism".

• Annual Meeting for Cambridge Center for Behavioral Studies, keynote speaker "On the continuing unpopularity of behaviorism" November 9, 1996.

• Tufts University, moderator of special ethics workshop: "The Silicone Breast Implant Controversy", October, 1996.

• Videosciencia international festival on science film making, Rio de Janeiro, Brazil. Keynote speaker. 1996.