

"SPECIAL FROM FRANCE"
SHOW 204

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EPISODE OPEN

WOODIE FLOWERS I'm Woodie Flowers, host of Scientific American Frontiers. Welcome to our special French edition - and where else would we come to open the program but Paris? Take a look around. La Defense. Not quite the familiar Paris of sidewalk cafes and tree-lined boulevards, is it? It's called La Defense - a vast complex of skyscrapers, shops and office buildings including this giant arch. Here we are on top of the arch, which is supposed to line up with some of the famous Paris landmarks off in the distance - the Arc de Triomphe and the Louvre Palace. Of course, Parisians say that the arch was built in the wrong place, that it really doesn't line up. But I kind of like the place. Its aggressive feel matches the French attitude to the modern world - and that's what's led to the kind of scientific successes we're going to see in the next hour. In science, though, you need more than the right attitude - you need good ideas. And that's what's behind our first story - one really terrific idea. The story begins about thirty miles from here, on the other side of Paris.

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BONES FROM THE OCEAN

NARRATION This is sixteen-year-old Raschad. He's surrounded by the bustle of a typical French Sunday morning street market. But what's on Raschad's mind is the coming week - finally, the problem he has with his leg is going to be sorted out.

RASCHAD EL-AIAM NARRATION (V.O. TRANSLATION) It's been a bit less than a year. Day after day it's hurt. More and more. At first it was only at night, but after four or five months, the pain was pretty unbearable. Help for Raschad's leg is going to come from here, a South Pacific coral reef. Every few months, selected coral heads are gathered for shipment back to France. But they're not going to end up as some coffee table ornament. Professor Pouliquen will be using some of that coral, after he removes the tumor that's growing in Raschad's

leg. It shows up here as a dark patch. The tumor will be cut out, and the space filled with a cylinder of coral.

POULIQUEN (V.O. TRANSLATION) I can ask the laboratory to make the exact size of the coral cylinder. But because the measurements we make aren't precise, we're going to ask for three different cylinder sizes, to be sure to have the right one during surgery.

NARRATION Here's where they shape the coral into spare parts for the human skeleton. Thin wedges are used for eye socket reconstruction, for example. But why use coral? Here's one reason. This is human bone. Under the microscope it's full of interlocking passageways. Cory structure, on the right, is just the same - perfect for new bone cells to grow back into. It's time to make the parts for Raschad's surgery. From the twenty five hundred different corals in nature, they use just three types. This is common bryn coral - its structure closely matches human leg bone. The first of the three cylinder sizes is drilled out. Then it starts on a long process of cleaning and sterilization. By the time these pieces appear in the operating room, they will be completely pure coral. It's the day of Raschad's surgery. Early in the morning there's an injection of a weak radioactive tracer material which will be absorbed by the tumor - by the lesion, as doctors call it.

DR. WIOTAND So we can't see the femur here and the lesion is here in white. I think it would be easy to locate this lesion now.

NARRATION With the tumor marked like a kind of beacon, Raschad heads out through the streets of Paris to Professor Pouliquen's specialized orthopedic operating rooms. France pioneered the use of coral implants for bone, and it's beginning to catch on in other countries - but right now, Professor Pouliquen is probably the world's most experienced surgeon in its use. Raschad, blissfully unaware, is watched over by a bank of automatic monitors. The first task - pinpoint exactly the tumor's location. They use a detector to pick up the radiation injected early this morning.

DR. WIOLAND We tried to locate the center of the lesion, which was found when the signal was highest.

POULIQUEN (SUBTITLES) Yes, it's there. No problem. Are you certain you found it? Yes, I know.

NARRATION With the tumor located, Pouliquen can go ahead and cut it out.

POULIQUEN (SUBTITLES) Here's the piece!

NARRATION The cylinder of bone is checked for radiation. If it shows up, then there's no doubt they removed the tumor.

POULIQUEN The lesion is removed, and there on the table, and not in the bone of the patient.

NARRATION It's time for the coral implant. It'll be fitted into Raschad's leg bone - skeletons of primitive marine organisms, becoming part of a human being. Within a few minutes, the procedure's finished - there'll be good news for Raschad when he comes round.

POULIQUEN (SUBTITLES) Everything went well.

POULIQUEN (IN ENGLISH) Exactly as we hoped.

NARRATION Here's the implant in position. Soon, Raschad's own bone cells will spread through the coral passageways. In two or three years, the implant will be gone - replaced by new natural bone. But if coral becomes popular in surgery, couldn't this threaten the world's coral resources? Professor Pouliquen took some advice on that.

POULIQUEN (V.O. TRANSLATION) I have no hesitation at all in using coral because Commander Cousteau - who everybody knows - says that if every orthopedic surgeon in the world used coral, they would do less damage in ten years than a single fishing boat in one day! And it seems nice to me that the oldest animal in the world is helping the newest!

WOODIE FLOWERS (V.O.) We're back at La Defence - which Parisians make good use of. Clustered around the plaza, there's a whole bunch of high-tech companies.

WOODIE FLOWERS (ON CAMERA) This is sort of a showcase for France Telecom, the government run phone company. And this is Minitel. It's an electronic yellow pages. Or you can make travel reservations. Believe it or not, there are 15,000 services available through this thing. There's nowhere else in the world that a computer service like this is available ~o everybody as a matter of course. In fact, we used it a lot when we were doing the research for this program, but the Minitel is old technology, now. Let's take a look at what's coming next.

WOODIE FLOWERS (V.O.) It's called Numeris - France's new high-speed data network. It allows transmission of high quality images - for remote medical diagnosis, for example. Or how about sending out your resume?

VOICE My experience as an executive secretary...

WOODIE FLOWERS (V.O.) You can include C.D. quality sound, too. Like Minitel, the Numeris network is available to all; and like Minitel, lots of new businesses are springing up around it.

VOICE ...on this computer.

WOODIE FLOWERS Now this is the part most people are going to love or at least have a strong opinion about. It's a genuine videophone. Telephone calls with sound and a picture. It's not science fiction. It'll be on line within a few months.

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HAPPY HENS

WOODIE FLOWERS When you get out into the countryside, you're reminded that France is still very much a farming nation - with easily the richest agriculture in Europe. Here we are in a fairly typical French farmyard - a couple of dogs, some cows, and scratching around in the dirt, about a dozen hens. These hens look pretty happy, don't they? That's because over the course of several thousand years, farmers have, almost unconsciously, selectively bred from the birds that are content in these conditions. But now, all over the industrialized world, most hens are not raised in a farmyard. Their surroundings are dramatically different. So are hens still happy?

NARRATION This is an average size hen house - a mere 48,000 hens. In France, hens have European regulation size cages - seven by ten inches per bird. In the U. S. it could be smaller. There's automatic feeding. It's an egg factory. But it still takes two pounds of feed to produce one pound of egg. And a hen won't lay every day, but on average every 1 1/3 days. Farmers want more productivity maybe they could get it with happier hens. This is a French TV program about the treatment of animals. While farmers are worried about production, the European public is more and more concerned with animal rights. And there are some powerful voices speaking out.

BRIGITTE BARDOT (SUBTITLES) This fourth "SOS" program I'm presenting for the sake of the animals we eat if that has to be their miserable destiny. So their existence can at least be clean, without pain and without nightmares. Today, that's still far from being the case. The conditions of veal calves, pigs and chickens are pitiful. They never see daylight in their batteries!.. Here at this agricultural research station, three hens of a common commercial egg laying breed are being placed in a rather special cage. Hens always peck things. And in

this case pecking brings a reward - the food trough slides into reach. But then, it slides right back again. Unless, that is, the correct button is pecked again. Very rapidly, the hens get the idea, and then they'll keep up a constant barrage of button pecking. Enter animal researcher, Jean-Michel Faure.

JEAN-MICHEL FAURE (SUBTITLES) There is a very emotive feeling in the public about the cage. It looks like a jail usually. And this is the feeling of people. What we are trying to do with this experiment is to know the feeling of the hens.

NARRATION In his imaginative experiment, the hens now have constant access to food. But they've already been taught to associate button pecking with a reward. And right there in the cage, there are buttons to peck. So what happens when a hen pecks a button? What happens is the cage gets larger - by a few inches per peck. And there's plenty more cage to be opened up, if the hens so choose. The movable cage wall slowly works its way back over the course of about five minutes, so the hens have to peck again to keep the cage enlarged. By asking the hens in this way, Faure has come up with an awkward result.

JEAN-MICHEL FAURE (SUBTITLES) From this size they are no longer working to enlarge their cage. Whereas from there, they do which means that in fact, their preference is probably in; this area.

NARRATION Neither farmers nor animal rights advocates will want to hear that - it seems the hens don't want unlimited freedom, but they do want a cage twice the legal minimum. Faure's next experiments are with these baby Japanese quail. He's trying to breed animals that will be happiest in crowded conditions. Here's a way to measure how much a bird likes crowds. This one doesn't seem so interested in its companions - low social motivation, as he calls it.

JEAN-MICHEL FAURE (SUBTITLES) It moved a bit towards the others, but you see it moved very few. Now you see its going the other direction and it moved very slowly. So this is called very low social motivation.

NARRATION In contrast, by selectively breeding from the most friendly birds, Faure has been able to produce behavior like this.

JEAN-MICHEL FAURE (SUBTITLES) This one is high social motivation. And you saw it running a lot and very quickly to go to the others. And now when the belt is not moving he's staying very close to the others with from time to time some pecking behavior which is a social interaction.

NARRATION Here's another behavior test. This bird's showing the natural 'freezing' response that many animals use when a predator threatens them. It's essential for survival in the wild, but in domestic animals Faure believes it just

produces unnecessary nervousness. Some animals continue this fear reaction for minutes at a time, before coming out of their trance. Less nervous animals would be better off, the animals will be better off, he says.

JEAN-MICHEL FAURE (SUBTITLES) Low fearful animals will be upper in any condition. And in fact, what was done during the process of the investigation was to reduce the fear reaction of the animals.

NARRATION Faure's been able to breed very non-nervous birds.

JEAN-MICHEL FAURE (SUBTITLES) It was very short. One second.

NARRATION They show practically no 'freezing' response at all.

JEAN-MICHEL FAURE (SUBTITLES) One second.

NARRATION The next step will be to extend the idea of breeding happier animals to other species - first chickens, maybe even pigs or cows. So if animals have to be kept in intensive conditions, and if a happy animal is a productive one, then Faure's approach could have real benefits - for farmers, and for animals.

WOODIE FLOWERS We are really screaming along! This is the TGV Atlantique - the latest high speed rail line open between Paris and Bordeaux. It won't be long before a high speed rail network will cover ail of Western Europe. We Americans have fallen sadly behind the Europeans and 7apartese in rail travel. In fact, this TGV Atlantique technology has recently been chosen for a future line to be built between Houston and Dallas. There were no American systems to consider. Let's go find out how fast we're going.

WOODIE (SUBTITLES) How fast are you going?

JACQUES COUSTET (SUBTITLES) We're going at 300 kilometers an hour. 300 kilometers an hour - that's five kilometers a minute. One kilometer every 12 seconds!

WOODIE FLOWERS (SUBTITLES) ...faster than you can do it in a plane.

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BROADER HORIZONS

WOODIE FLOWERS It's called boules. The idea is to get as close as possible to the little marker ball there. It is played in town and village squares all over France, not necessarily in such a magnificent setting as here in the center of

Paris. Although I'm not a champion boules player... one thing I don't have to worry about is whether my eyes can judge the distance about right, whether my arm will make the right throw when I want it to, or whether or not I can balance upright when I try. Those kinds of actions are completely automatic and unconscious - for most of us. But imagine what it would be like if we could not take such basics absolutely for granted.

NARRATION Lydie Pavesi is paralyzed from the waist down. She is on her way to her daily physical therapy session, at this rehabilitation center. Two months ago, an as yet undiagnosed nerve disorder struck her legs. Now she has to make the attempt to re-learn the basics- to bend her knees... or just to stay balanced for a few seconds.

MICHEL PARKER (SUBTITLES) You can lean back. Go ahead. Steady yourself - head straight.

NARRATION This is pretty difficult, especially when you have serious nerve problems. Hugues lost his right leg in a road accident. with an artificial leg. Now he has to learn to walk again. Bathroom scales help him see if he's putting his weight onto the new leg.

MICHEL PARKER (SUBTITLES) He's trying to put maximum of weight on his right side. put all the weight on the good one.

HUGUES MASSE (SUBTITLES) Are you going to take the scales out? Because the tendency is to

MICHEL PARKER (SUBTITLES) Rest a minute then walk a little. I'll take the scales away.

NARRATION For Hugues, as for Lydie, this is grim and hard work. No fun at all. Raphael, another road accident victim, has irreversible brain damage - but still loves to talk.

LYDIE (SUBTITLES) You want to find out why the film crew's here?

BRUNO CASTAING (SUBTITLES) Is it about what Lydie did in therapy?

LYDIE (SUBTITLES) Is it what I did this weekend?

NARRATION Raphael finally gets through.

BRUNO CASTAING (SUBTITLES) Position your feet and push. Wait. Don't move. Push hard on your left leg. Now the right.

NARRATION Raphael has a daily routine as well, which therapist Bruno takes him through. Twenty years ago, patients like Raphael would not have received this kind of aggressive therapy. But now the body's remarkable hidden reserves have been recognized - progress may be slow, but it's real.

BRUNO CASTAING (SUBTITLES) It's an exchange between the two of us. Exactly like a dance. I have an action, he reacts, and that produces another action on my part It's a learning process we go through together. Good morning! We'll make a U-turn to the right.

NARRATION The rehabilitation center happens to be located on a beautiful section of France's Atlantic coast. A few years ago the staff here had a seemingly crazy idea. This morning Hugues, Lydie and Raphael are not heading for their regular therapy sessions. They're going for a sail.

BRUNO CASTAING (SUBTITLES) Now the legs. You let us carry you -- And you walk.

NARRATION Like Bruno, many of the staff here are keen recreational sailors. Why shouldn't the patients take advantage of the area as well, the staff asked. They tried out the idea with borrowed private boats, and it worked so well that, four years ago, they persuaded a local bank to donate the centers own boat. Now every day, weather permitting, a group of patients heads out to sea. As they leave harbor, it soon becomes dear that Raphael and his companions are not just along for the ride.

BRUNO CASTAING (V.O.) It's the first time he'll have tried to steer, on his artificial leg. It's going to be very hard.

NARRATION Meanwhile, the others have work to do.

BRUNO CASTAING (V.O.) You pivot your body back like this. Then you swing forward. Pivot your whole body!

NARRATION Without thinking about it, they're doing the same tasks they do in their therapy sessions. Only now it's natural, they're motivated - there's a job to do. Even someone as severely disabled as Raphael can join in.

BRUNO CASTAING (V.O.) Raphael. I'd like you to hold this in your hand. Pass it to Raphael.

NARRATION And it's not just the physical work that's important.

HUGUES MASSE (SUBTITLES) Every day we see the boat on the sea and we can't go...and imagine... And today we can go on this boat. It's good, very good - yes?

NARRATION For Bruno, it's the very act of getting away from the center to broader horizons that brings the greatest benefits.

BRUNO CASTAING (V.O.) I think that when someone has had an accident, his personal horizon becomes really limited. To show him a new horizon - it's a psychological symbol. It has real psychological impact on his rehabilitation.

NARRATION As the day unfolds, everyone gets their chance to work, and to have a little fun.

BRUNO CASTAING I think Raphael likes very much to drive.
One...Two...three...OK!

BRUNO CASTAING (SUBTITLES) Look. Go a bit to the right. That's fine for now.

BRUNO CASTAING A good progress the second time for this group, it's very, very good.

LYDIE (SUBTITLES) I'll probably throw up.

BRUNO CASTAING Not on me if you don't mind.

NARRATION Procedures on the boat are not quite as casual as they might seem. Bruno is familiar with every patient's case history. So with Lydie he concentrates on her right knee, which shows particular weakness.

BRUNO CASTAING Turn the tiller to the right, otherwise we're going to have a big problem here!

LYDIE (SUBTITLES) Call that a big problem!

BRUNO CASTAING (SUBTITLES) Just a bit.

NARRATION Once they've avoided running the boat onto the rocks, they can return to the real business of the day.

BRUNO CASTAING (SUBTITLES) I'm steadying your knee in the back and front. Nothing to be afraid of. Now I'll tell you something: Lean on your left leg - it's the better one, and I'll control your knee with my hand. Push at the same time.

NARRATION As they head back in at the end of the day, there's one last opportunity that Bruno exploits.

BRUNO CASTAING (SUBTITLES) A bit more to the right still. Look. Follow my finger.

NARRATION As boats enter the harbor, the square panels silhouetted against the roof must be lined up. That puts the boat within the safe channel.

BRUNO CASTAING (SUBTITLES) I'll show you. You have to line them up like this.

NARRATION It's a perfect exercise in visual perception. Something Raphael has to relearn.

BRUNO CASTAING (SUBTITLES) Turn! Turn!

NARRATION Until, that is, it's time to save the boat again - this time from colliding with a fishing trawler. Although by now, the locals are getting used to the somewhat unpredictable boat from the center. In fact, not only have the neighbors gotten used to the center's sailboat, they think it's a great idea. So in what's become an annual event, boaters from miles around have gathered at the center. In the crowd - 130 patients: men and women, boys and girls! At the dock - amateur yachtsmen, fishermen, coast guard, even the local firemen. Here to make the center's special sailing weekend a success. There's even a piper on hand, to play the farewell to departing sailors that's traditional to the area. It's one big party for all concerned. But for the patients it's more than that, it confirms what their own boat has taught them - that reaching for the horizon is something they can do.

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FRANCE ART OF SCIENCE

NARRATION Of course, the "Art, of Science" feature for this episode comes from France. You're going to see world-class animation that's normally used for fancy ads, but this time it's for a different and very interesting purpose. The idea here is to help the public visualize what their part of Paris might look like in the future and so - to help them get in the planning process. Now none of this exists, but you'll see a new university campus, new railroads, even old apartment blocks disappearing to make way for new residential areas. "Here's a vision of the future," the film says. If you want to help shape it, here's your chance. Let's imagine! Let's imagine a world where everything is more exciting. More accessible. More human. Please... imagine! Imagine the Upper Seine region.

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ARGOS

WOODIE FLOWERS I'm a few thousand feet up in the French Pyrenees, the Spanish border is about 20 miles over that way, it's a wonderful day for a hike out here alone in the mountains. Actually, I'm not quite a/one. Every couple of hours my little companion here mites to a French receiver system on board a satellite, as it goes overhead. Then my exact location - it could be anywhere on earth, land or sea - is relayed back to a ground station. I also have 16 different pre-arranged messages that I can send and I've got an emergency channel. Now, say I was in trouble. I'd use it. Let me show you what would happen.

TECHNICIANS (SUBTITLES) You've got an alarm? Okay.

WOODIE FLOWERS (V.O.) My emergency signal comes to the Argos system control center at Toulouse, in southwest France.

WOODIE FLOWERS Actually, the big advantage of the Argos system is that, on the transmitter end, the user doesn't have to do anything at all. Let me show you what I mean.

WOODIE FLOWERS Can you show me the albatross data?

PHILIPPE GROS Of course.

WOODIE FLOWERS Wait a minute. Can we zoom in on that, and what am I looking at?

PHILIPPE GROS See the tracks of four albatrosses which were tracked using the Argos system. What's the distance here?

WOODIE FLOWERS About twelve thousand kilometers.

WOODIE FLOWERS (V.O.) In 1989 French biologists took this home video as they strapped tiny, six-ounce transmitters onto albatrosses in the Southern Ocean. For the first time, it was discovered where these birds go on their month-long trips. The Argos system was designed by the French for global environmental monitoring, and now details of ocean currents, weather, or volcanic activity are pouring back to Toulouse.

WOODIE FLOWERS So what was happening in these little tight areas? It stopped near an island, perhaps he was waiting for good winds to continue his

trip. The biologists must love this system. Yes, they were quite astonished by the distance traveled by such animals.

WOODIE FLOWERS (V.O.) Here's another Argos application. This is US Coast Guard video of the North Pacific. In the summer of '91, patrol planes were dispatched to check out Taiwanese fishing boats - which looked like they had American salmon aboard. How did we know that? Because our National Marine Fisheries Service uses the Argos system.

ALAN MAGER Are there we go. We've got all the data now retrieved from Toulouse and this data will show us the locations of the Taiwanese drift net fleet.

WOODIE FLOWERS (V.O.) From Silver Spring, Maryland, Alan Mager keeps track of the boats - which by international agreement carry Argos transmitters. In July, some boats strayed above the permitted area, and right away Alan knew it thanks to the French system.

ALAN MAGER The Coast Guard simply doesn't have the resources to mount a very large monitoring system program. So without this satellite monitoring system it would be an absolute exercise in futility. There's no way that we could tell what these people were doing or where they were.

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TOXIC TESTS

MAN GIVING DEMO (SUBTITLES) As you can see it's very compressed in the bag, and it'll absorb oil better.

NARRATION It may not be everyone's idea of a great show, but this audience has come from all over the world to see it. It's a demonstration to show off the latest in French oil cleanup methods. There are various kinds of absorbents for different conditions. This one's designed for use with a floating skimmer and containment boom system. The French say their ability to respond to major oil spills is second to none - but it's a lesson they learned the hard way. It was 1978. The Amoco Cadiz, a supertanker fully loaded with crude oil, had impaled itself on rocks off France's English Channel coast. Sixty-eight million gallons of oil were released. It was the largest tanker spill ever - six times larger than the Exxon Valdez in Alaska. Today, the coastline of the Brittany region has largely recovered. Although among the many people who make their living from the sea, bitter memories of hundreds of miles of devastation, remain. Yvon Madec runs an oyster farm, a few miles up one of the many bays and inlets that cover the Brittany coast. Now, he's back in business, shipping his prized delicacies out to

markets all over Europe. But in 1978, he was wiped out. And he'll never forget the day it happened.

MADEC (V.O. TRANSLATION) We were expecting the off. But when it arrived it was unimaginable. The bay was like a funnel, and practically everything came into it. Thousands of tons into the bay.

NARRATION Yvon keeps a photo album showing their pathetic attempts to dean up the dying oyster beds.

MADEC (V.O. TRANSLATION) We were without anything. We had nothing to fight with. We were totally disorganized.

NARRATION This salt marsh was submerged in off. It's being inspected by two marine biologists who've monitored the recovery of the coast in the years since the spill.

BERNARD FICHAUT (SUBTITLES) The sectors with the tar mats are there...

BERNARD FICHAUT This is typical of the front part of the marshes, salt marshes, also of the gravel beaches. This is a tar mat, an asphalt pavement. This is the very hard stuff. This is a pavement made of a mixture of oil and sediment. This is very resistant to erosion.

NARRATION Many of these tar mats were actually caused by heavy cleanup equipment that was driven onto the marshes and beaches. It's one of many lessons learned. Sometimes it can be better to leave delicate areas alone - to leave nature to its often surprising ways.

BERNARD FICHAUT (SUBTITLES) I suppose that there are crabs in these burrows here. Here, there is a little one here. Get out.

NARRATION These banks were very oily after the cleanup and the crabs digging burrows are one of the main agents that participate in cleaning up the mud because they release oily mud in the water. And I bet, here is some - you see here for instance, this area. There is a sheen on the mud and this sheen is coming out from the green crab burrow which is right here. Right now, nobody really knows how important the remaining oil is, or whether the productivity of the coast has been permanently damaged. They are sure, though, that things like this - a waste heap forgotten by cleanup workers - could have been avoided. They're certain they could have done many things better - if they'd been prepared, and organized.

BERNARD FICHAUT This is not a desert area. Here there are places for hundreds of years, each one is a chief or tends to be the chief on his area. And we had plenty of kinds of dean-up and despite the fact that the state was trying to centralize a dean-up, we had different approaches in each village in fact. To be efficient we have to be super organized.

NARRATION And super organized they are here, in the Mediterranean. We're on board a ship from the national marine pollution agency that France set up after the Amoco Cadiz. Their latest research is not about oil, but it's to prepare for gas or chemical spies. The balloons may look festive, but they are deadly serious. They're for an experiment that will simulate a toxic gas release off the crowded beaches of the French Riviera. Oil they now think they can handle - there are stockpiles of equipment prepositioned around the coast. There are plans for running booms across every sensitive inlet. And there are trained people. But they're determined not to get caught again with the newer gas and chemical threats. Inflatables equipped with helium balloons and gas detection equipment fan out around the anchored test ship. The balloons will be used to suspend a hollow plastic gas sampling tube above each inflatable.

RADIO VOICES (SUBTITLES) Duplex from Albacore. You are in position. Remain lined up with the boat. And Riviere from Albacore. You can stop there.

NARRATION With the boats in position, the gas is slowly released. It's completely harmless, but it will disperse just like a poisonous or explosive gas. They'll be able to measure it from the surrounding inflatables. Running the experiment up on the bridge is Roger Kantin. He's watching the computer they'll use to predict how the gas should move. If the predictions agree with the actual measurements, the computer could be a lifesaver in an emergency.

KANTIN (SUBTITLES) The computer gives what the extent of risk is, in terms of risk of explosion, risk of toxicity during inhalation, and we can give recommendations in terms of response emergency.

NARRATION If this really was a leaking tanker, two miles off a crowded coast, then a computer model telling you where the gas was going would come in handy. Radio Voice Duplex from Albacore. Reposition your balloon at 40 meters. We're going back up.

MAN IN BOAT (SUBTITLES) Forty-two point four. Albacore from Duplex. Okay. Received. Confirm forty-two point four.

KANTIN We are running the model according to the information we receive. And we are comparing the provision in terms of vertical extent of the cloud, comparing

with the results given by the experiment. The model is derived to predict with good precision the shape of the cloud.

NARRATION The next test involves one rather large navy helicopter. Emergency responses at sea frequently involve the use of helicopters. So the question is, how safe would it be to fly over a leaking ship? On board the helicopter, the scientists have lowered another plastic sampling tube. It's thrashing around in the down wash, while below the simulated toxic release is turned on. Above, there's some disturbing news. The gas concentrations are very patchy - low one second, high the next. Everybody on board would have to be in breathing apparatus. And it's not just the turbulent air kicked up by the rotor blades that is the problem. When the scientists took another look at their measurements, after the day's tests, they found that even without the helicopter, the gas cloud around the ship had the same dangerous patchiness. Although there's a lot more work to do, the French have obviously learned the lessons of the Amoco Cadiz. Their coastline's going to be better off as a result.

WOODIE FLOWERS That's all for our special French edition of Scientific American Frontiers. Next time, we'll be back home - with stories about how smart animals are.., can computers pretend to be people and get away with it.. saving woodpeckers from hurricanes.., and the world's scariest roller coaster. Hope you can join me.

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