

"CRIME AND INVESTIGATION SPECIAL"
SHOW 404

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EPISODE OPEN

ALAN ALDA (ON CAMERA) In New York, the cops that cops call when they need help come from the Emergency Services Unit. Today, they're trained not only by rescue and weapons experts, but by psychiatrists, too. One of the stories in an hour devoted to the science of emergencies.

ALAN ALDA (NARRATION) We'll also see an ant rescue squad called by caterpillars in trouble. How a murder was solved by taking the fingerprints - of a tree. And we'll watch an airplane engines explode and cars crash - to make both safer.

ALAN ALDA (ON CAMERA) I'm Alan Alda. Join me for a special emergency edition of Scientific American Frontiers.

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CAR CRASH TESTING

ALAN ALDA (ON CAMERA) Today the leading cause of death for Americans under the age of 34 isn't guns or disease, or drownings, or fires, it's this....

ALAN ALDA (NARRATION) Automobile accidents kill 40,000 Americans a year. And here at the Insurance Institute for Highway Safety in rural Virginia, engineers are trying to cut that number by making cars safer - testing anti-lock braking systems, for example, that reduce the danger of skidding on slippery roads.

ALAN ALDA (ON CAMERA) You know, until I saw you do that I never realized how important anti-lock brakes are.

CHRISTINA ESTEP It's quite a dramatic difference.

ALAN ALDA You're able to spin around in this car out here and it's really impressive. What's the relationship between what you do out here and what you do inside?

CHRISTINA ESTEP Well, outside we're trying to prevent accidents and inside we're looking at the injuries that occur in accidents and trying to prevent them.

ALAN ALDA (NARRATION) Christina Estep is an engineer here. Her main job is caring for the Institute's dummies - though perhaps "caring for" isn't quite the way to put it. These dummies are the front line troops of crash safety research - men, women and children made of plastic and metal, whose job it is to be as much like us as possible -without the pain.

ALAN ALDA (ON CAMERA) What's this one in particular do?

CHRISTINA ESTEP This is the thorax impact test, where we take a fifty pound pendulum and swing it into the thorax and make sure that the dummy's ribs compress the way they're designed to compress.

ALAN ALDA (NARRATION) Every dummy has to go through this harsh physical exam before it gets its next assignment.

ALAN ALDA (ON CAMERA) What did you get?

CHRISTINA ESTEP We got the correct velocity, the correct resisted force. The internal hysteresis is ok, but our sternum displacement seems to be a little high.

ALAN ALDA (NARRATION) Christina can tell all this because under his rubber skin, the dummy has metal bones and ribs, that are fitted with sensors measuring force and acceleration. There's even an on-board memory to record what happened.

ALAN ALDA (ON CAMERA) So this is where you collect the data. How heavy is this guy?

DAVE ZUBIE About a hundred and seventy-two pounds.

ALAN ALDA (NARRATION) This is your average male dummy ... but they come in all sizes, sexes, and ages.

DAVE ZUBIE Just put him on the seat and then we'll ...

ALAN ALDA I can't get this hook under his arm.

ALAN ALDA (NARRATION) Each dummy costs a quarter of a million dollars. Even his legs and arms are able to record whatever happens to them.

ALAN ALDA (ON CAMERA) Hold this, will you? Well, we're just going for a little ride, I think you'll enjoy this.

ALAN ALDA (NARRATION) This is the dummy's reason for being of course - to sit in for real people during a crash test - here 30 mph into a concrete wall. The government mandates this test for all new cars - and today's cars do well in it. The structure under the hood is designed to absorb the energy of the impact of the crash across the whole front of the vehicle. There's just one big problem....

ALAN ALDA (ON CAMERA) How often does that occur in real life?

BRIAN O'NEILL It's a very rare event in the real world. The kind of damage you see in a flat barrier crash you virtually never see in the real world. This is what you get... this is a real world crash.

ALAN ALDA (NARRATION) Here's the car we were looking at - and the crash it was in. Not quite "real world", because it happened here on the Institute's brand new indoor crash track. But this sort of 2 car collision, where the vehicles hit off-center, is a common kind of accident on America's roads - and causes very different damage than the flat barrier test that the government mandates.

ALAN ALDA (ON CAMERA) What does this do to you that the front-end barrier crash doesn't do?

BRIAN O'NEILL Well, if we move back here. The main thing it does is it loads the structure in different places than the flat barrier which loads the whole of the front end. Because we get localized loading that means we've got much more potential for deformation. If you look at where the foot would be and you think about the situation where you've jammed on the brakes just before an accident. You're pushing hard in one direction and the floor is coming up and buckling and tending to want to capture and trap your leg down in there. And we are seeing very serious leg injuries, ankle injuries, multiple fractures in serious frontal crashes, from this kind of intrusion where the safety cage is in effect failing.

ALAN ALDA (NARRATION) The irony is that its only because of the success of the flat barrier test in helping develop seat belts and air bags that these lower limb injuries are coming to light.

BRIAN O'NEILL We're eliminating a large number of the upper body injuries, a lot of the injuries that cause death.

ALAN ALDA (ON CAMERA) But now we're suddenly faced with these lower body injuries and we have to live with those now. Previously the injury would have been so great we wouldn't have had to live with it.

BRIAN O'NEILL That's correct.

ALAN ALDA He's all set to go?

DAVE ZUBIE Should be ready to go.

ALAN ALDA (NARRATION) So the new assignment for the dummies and engineers here, is to come up with a crash test that car makers can use to help reduce the lower body injuries caused by typical head-on crashes. But because crashing 2 cars in a standardized test is difficult and expensive, they're trying to give the dummy the experience of a 2 car crash, using only one.

ALAN ALDA (ON CAMERA) What can you find out from this screen here?

CHRISTINA ESTEP This is the plot of the Y- moment.

ALAN ALDA The plot of the Y - moment?

CHRISTINA ESTEP The Y - moment of his head. This is the pitch of his head. So if you pushed his head backwards you could see that in this graph.

ALAN ALDA But actually during the crash it would probably go like that.

ALAN ALDA (NARRATION) Today's test crash will be run at 40 mph. It's the first time they're gone this fast, and no-one is sure how the car or dummy will do. To get up to speed, they need an approach the length of a football field. The car has been drained of gas to reduce the risk of fire, so it will be towed down the track by a cable that accelerates the car to exactly the right speed.

BRIAN O'NEILL So if we're seeing a 40 mph crash then the specifications are that it should be within 39.9 or 40.1 miles per hour.

ALAN ALDA (ON CAMERA) We're almost ready.

BRIAN O'NEILL We're almost ready.

ALAN ALDA (NARRATION) Every crash is filmed in slow motion. The barrier has a deformable face that acts like the hood of the other car. Milliseconds later the test car hits the steel barrier and pivots around. From above, the single car crash

does appear to cause the same sort of damage as a car-to-car collision. The big question, of course, is how our friendly dummy made out.

BRIAN O'NEILL See how the knees are jammed up here against the dashboard. In fact this whole dashboard is moved back. You see how it's distorted. There's been tremendous force applied to the lower leg. Certainly one would anticipate significant knee and leg injuries. That would be my guess. But the reason we take all the measurements is we don't guess, we're going to use the data to tell us.

ALAN ALDA (NARRATION) Christina and her colleague Dave Zubie get their first quick look at the data.

ALAN ALDA (ON CAMERA) If this was a person, did the person survive?

DAVE ZUBIE Based on what we've seen so far he probably survived. We can check in just a second here to see what kind of loads were acting on his legs. As one might guess he may very well have suffered severe lower leg fractures and other debilitating injuries, if not life-threatening.

ALAN ALDA Now you have to get back this dummy back into the lab and fix him up and make him ready for the next crash.

CHRISTINA ESTEP Prep him for the next one.

ALAN ALDA What a life.

ALAN ALDA (NARRATION) As these tests go on, car makers are working on designs that will help prevent leg injuries. One way is to strengthen the foot well with thicker and stiffer materials. Another idea is to add a cross-piece between the structural members up front. When one side is hit, this cross piece redirects the force - which now increases the car's spin instead of heading into the passenger cabin. Meanwhile, engineers and dummies continue their collaboration.

ALAN ALDA (ON CAMERA) Christina, you work with these dummies all the time and you observe them during these crashes. When you're in the car driving, does this go through your head? Do you ever think about this?

CHRISTINA ESTEP I've adjusted my headrest. I've slowed down my driving speed. It makes an impact.

ALAN ALDA To put it mildly!

CHRISTINA ESTEP No pun intended.

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PANAMA PROTECTION RACKET

ALAN ALDA (NARRATION) The rain forests of Panama. Serene and beautiful. But it's a jungle out here. And these are some of the biggest heavies around. Ants will take on practically anything - from vicious wasps that like to lay their eggs in the living bodies of their victims...to lightning quick poisonous spiders.

Phil Devries has been investigating a tangled web of jungle relationships, involving murder, protection rackets, payoffs and secret messages. And at the heart of the story - ants.

PHIL DEVRIES If you think about ants whether you're going out on a picnic, everyone knows that as soon as you put down the food and the ants come and you start complaining because the ants are biting and stinging you. Well that's typical of ants. Ants don't like to associate with other species.

ALAN ALDA (NARRATION) Every crime story needs a victim, and in this case it's a caterpillar. These juicy prizes are often the targets of jungle predators, so they adopt defenses - like masquerading as a dead leaf. Or rolling up a leaf to make an armored shield. Or growing poisonous spines that predators learn to avoid. Phil was amazed when he saw something the law of the jungle should not permit - a defenseless caterpillar. Not only defenseless, but apparently living in perfect harmony with one of the most vicious kinds of ant in the neighborhood. Somehow, these innocent potential victims have persuaded the bad guys to be on their side. To investigate the relationship between ant and caterpillar, Phil set up an ant exclusion experiment. The idea was to see what would happen as new caterpillars hatched and then had to live without ants. First he cleared the vegetation from around a series of plants, so ants couldn't jump onto them. Then he covered the stems with a sort of ant-trapping glue. Finally, he removed the remaining ants, leaving the plants ant-free. Over the next year, Phil seldom found caterpillars on the ant-free plants. Whereas there were always plenty of caterpillars on the plants with ants. So for some reason, these caterpillars need ants. With some close surveillance, Phil figured out what was going on - a protection racket.

PHIL DEVRIES What these ants are doing is they're protecting the caterpillars against enemies. They're like guard dogs, if you will. If you can see if I touch this stick to this ant here, it will eventually run out and perhaps - there, see that thing biting me? And so what happens is that if a predator comes in to get the

caterpillar, what happens is that these ants will attack it, they'll bite it and drive off the enemy.

ALAN ALDA (NARRATION) Here's that vicious predatory wasp again. Again and again it's driven away from its intended victim by the protector ants. Finally the confrontation ends when an ant uses its lethal sting against the wasp. Pretty good protection for the caterpillar. Now there's no protection racket in the world without a payoff. So what's in it for the ants? The investigation moved into the lab, at the Smithsonian's Panama Research Center. Phil set up a captive colony of caterpillars and ants so he could observe their behavior close up. And he managed to catch the payoff as it happened. At regular intervals, ants saunter up and start to feed on a juice produced by the caterpillars. The ants clearly find this nectar irresistible - maybe even addictive - often battling head to head over it. But we're not done yet - the plot thickens. Somehow, in the vastness of the jungle, the ants have to locate their suppliers of nectar - and Phil discovered how they do it. Each caterpillar has two small dark rods sticking out above its head. They vibrate up and down as the caterpillar moves.

PHIL DEVRIES Just from watching them for a long time, it occurred to me that they might be producing a sound that was detectable by the ants themselves. And what I did was I took one of these caterpillars and examined it under a scanning electron microscope.

ALAN ALDA (NARRATION) Magnified one thousand times, the rods were shown to have deep rings along their length, and the caterpillar's head just under the rods was covered in jagged points.

PHIL DEVRIES It suggested that these could in fact be a sound producing system or an organ because it looks like a file. If I ran my finger - it was very large - if I ran my finger doing it would produce a simple sound.

ALAN ALDA (NARRATION) Phil set himself up in a soundproof room at the research center, so he could listen in on the caterpillars. A miniature microphone was arranged to pick up any faint vibrations that his subjects might be producing.

PHIL DEVRIES Oh yeah....

ALAN ALDA (NARRATION) So far so good, but now Phil had to see if the caterpillar sound has any effect on the ants. So next he set about creating a few silent caterpillars.

PHIL DEVRIES It's not a very delicate operation. As the papilla beats up and down, the real trick is trying to grab it with the forceps. And once you get it, it's like tugging out a hair.

ALAN ALDA (NARRATION) The mute caterpillars were marked with a spot of blue dye. Phil headed back into the jungle, to mix these silent caterpillars in with groups of their normal, rowdy companions. Over the next few months, he came back to see how the two types were getting along.

PHIL DEVRIES What I found is that the caterpillars that produce a call always have more ants on them than the ones that are mute. And what I conclude from this is simply that the ants are actually attracted to the call produced by the caterpillars, and of course this translates into protection. If you're a caterpillar and you have more ants around you, you're certainly protected much better from predators than if you're a caterpillar that has fewer ants around you.

ALAN ALDA (NARRATION) And so our jungle story of protection and payoffs has a final twist - the caterpillar siren song that makes it all work.

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TREE FINGERPRINTS

ALAN ALDA (ON CAMERA) Our next story is about what may be the most unusual use ever made of science to solve a crime. Often the key piece of evidence that links a suspect to a crime, is something that carries a unique pattern. Something that can only be found in one person, or one weapon, like fingerprints. But here at the F.B.I. in Washington, the pattern found in the tips of our fingers is just one of many kinds of fingerprints that is used to help solve crimes.

ALAN ALDA (NARRATION) Fingerprints themselves have been used in crime busting for over 80 years.

ALAN ALDA (ON CAMERA) So Jim, have you looked at this note already to see if there are prints on it.

JIM Yes, I did a visual examination...

ALAN ALDA (NARRATION) And nowadays, there are ways to find fingerprints on almost anything. Jim Ridgely showed me how prints that are otherwise invisible can sometimes show up under a laser beam.

ALAN ALDA (ON CAMERA) "Give me all the money. No alarms. No false moves or you die". That looks very real.

ALAN ALDA (NARRATION) The intense light of the laser can under some circumstances cause a fingerprint to fluoresce - so seen through a filter that cuts down the light of the laser, the fingerprints themselves shine brightly.

ALAN ALDA (ON CAMERA) Look at those prints there, that's incredibly clear, and there were no prints on that to be seen.

ALAN ALDA (NARRATION) The laser is just one of a dozen or so ways of spotting prints if a criminal is careless enough to leave one. And sometimes avoiding an obvious mistake can simply lead to another...

JIM One case that really comes to mind was where a individual burglarized a residence, and he was very much aware that his fingerprints could be identified. So what he did was he took off his shoes and socks and he put his socks over his hands and entered the residence. But the only thing was they were able to develop his footprints on the floor and we identified him anyway.

ALAN ALDA That's really using his noodle.

ALAN ALDA (NARRATION) Of course, finding a fingerprint is only the beginning of finding its owner. At the F.B.I. that search begins by marking on a computer screen the tiny details -often the end of a ridge or where a ridge divides in two - that give a fingerprint its unique identity. The computer then searches for a match among the fingerprints the F.B.I. has on file. And when you see that file, you realize why the computer is so valuable. There are over 25 million fingerprints stored away here. The computer search narrows that number down to a list of 20 or so. Then the final match between the crime scene and the fingerprint on file is made the old-fashioned way - by eye.

ALAN ALDA (ON CAMERA) And its not just fingerprints that can be used to link a suspect to a crime.

ALAN ALDA (NARRATION) A gun leaves its own version of fingerprints imprinted on the head of the cartridge every time it's fired.

ALAN ALDA (ON CAMERA) Are the marks on this cartridge unique?

FBI MAN Yes the marks on the cartridge case after firing a firearm are unique to that firearm.

ALAN ALDA (NARRATION) As the cartridge case is slammed backwards during firing, it's stamped with an imprint of tiny machining marks left from the gun's manufacture.

ALAN ALDA (ON CAMERA) And these are all cartridge cases that you got on file.

FBI MAN That's correct.

ALAN ALDA (NARRATION) Those marks can often link a gun with a shooting - or different shootings can be linked to each other - if only enough cartridges can be compared.

ALAN ALDA (ON CAMERA) Could we see those side by side and see how they compare.

FBI MAN Sure we can do that, we can get that on screen for you.

ALAN ALDA Now this looks like a really good match between these two...

FBI MAN Yeah, this is one....

ALAN ALDA ...these shapes look the same and everything right?

FBI MAN Yeah, this is one of the first matches that were made in the Drug fire system.

ALAN ALDA (NARRATION) The F.B.I.'s new Drug fire project has digitized the images of thousands of cartridges from shootings in the Washington area so that instant comparisons can be made among them.

ALAN ALDA (ON CAMERA) You just have to look at it, those striations are identical. You go across the hairline there....

FBI MAN That's correct. ALAN ...you can just see it.

ALAN ALDA (NARRATION) And in the year the project's been running these gun "fingerprints" have helped solve over 60 shootings.

ALAN ALDA (ON CAMERA) The latest version of the fingerprint to be used for identification, is DNA, the stuff our genes are made of. In the last few years, hundreds of suspects have been convicted, and others cleared by analyzing the unique patterns found in everyone's DNA.

POLICE OFFICER Radio will you advise detectives that we appear to have a 901H.

ALAN ALDA (NARRATION) And in Phoenix, Arizona, DNA fingerprints have recently solved a grisly murder. Except here the fingerprints weren't from a person, but a tree. This is a re-creation of what turned out to be an extraordinary investigation. It began with the discovery of the body of a young women. With no eye witness to her killing, the first detectives on the scene searched for physical evidence. They checked tire tracks on the road nearby. And then they got their first big break. The sound of a pager going off in the grass a few feet from the victim. Twenty four hours later, the pager lead was being followed up by the detective assigned to coordinate the case.

CHARLIE NORTON My name is Charlie Norton and I'm a homicide investigator with the Maricopa County Sheriff's office in Phoenix, Arizona. I've been a detective for about 15 years. When I came into the case, my first assignment was to meet with the man who was determined to be the subscriber of the pager that was found at the scene.

ALAN ALDA (NARRATION) The subscriber's name was Earl Bogan - and he immediately became the number one suspect.

CHARLIE NORTON Mr. Bogan. Hi, I'm Charlie Norton from the Sheriff's Office and I'd like to talk to you about a pager. We found a pager at a crime scene....

ALAN ALDA (NARRATION) But as Norton questioned Bogan, it soon became clear he wasn't the culprit. He owned the pager, but it was his son Mark who used it. A day later, Mark Bogan was brought in for questioning. He had a story that could account for his pager being found with the victim.

MARK BOGAN Well it was about 10:00 at night and I was looking for a phone. To call some friends, I wanted to go visiting. And all of a sudden I hear this tap on the window of the phone booth and this girl came up to me and asked if she could have a ride. And I said hey, sure why not, I'm not doing anything, my friends weren't home. So she got into the truck and we took off down 35th Avenue.....

ALAN ALDA (NARRATION) Bogan admitted picking up the victim - but he claimed they'd parted company while still downtown, following a heated argument.

MARK BOGAN ... she got angry and took her hand and knocked all my things off the dashboard, opened the door and took off with my wallet. I took off after her and got my wallet back, and I just walked back to my truck and went on home.

CHARLIE NORTON Well your pager was found out there at the scene where this girl was found murdered.

MARK BOGAN Well, when she stole my wallet, she must have stolen my pager too because I couldn't find it the next morning. I guess she got it.

CHARLIE NORTON I thought he was a pathological liar.

ALAN ALDA (NARRATION) The detective was convinced Bogan had lost his pager in a struggle at the murder site. But Bogan's version of events was at least plausible. Knowing any such doubts would trouble a jury, Norton returned to the scene of the crime . He was hoping that the original investigation may have missed some crucial piece of evidence that could prove Bogan had been there. He looked for shoe prints - or something like the pager left behind in haste. There was nothing. But then he noticed that a branch of one of the Palo Verde trees alongside the roadway was scarred with a fresh scrape. Suspecting the damage might have been caused by the murderer's vehicle, Norton on an impulse collected a few bean pods from the tree. He had no idea how they could be useful.

CHARLIE NORTON Police officers when they go to an investigation of any crime scene they collect just about anything they can find. Soil samples, leaves, grass and they hope at some time in the future it will help establish that their suspect was at the scene.

ALAN ALDA (NARRATION) The next day, Norton's instinct to collect the bean pods began to pay off. Evidence technicians had been inspecting Bogan's pickup for hours - unable to find anything that could place it at the murder scene. But then, while taking an inventory of the back of the truck, their luck changed.

CHARLIE NORTON This seemed like something out of the ordinary. Something that we needed to pay attention to.

ALAN ALDA (NARRATION) To Detective Norton, it made sense. After the murder, Bogan's truck scraped the tree, shaking loose the bean pods. But the problem with the theory was obvious. There are tens of thousands of Palo Verde trees growing around Phoenix. The pods in Bogan's truck could have come from any one of them. It was Norton's boss who came up with the suggestion that would eventually break open the case.

JORDAN What if there's a DNA test for the bean pods. And when I say a DNA test, it may be an experimental thing. You're going to have to research it. Someone could already doing DNA testing with plant life. And we don't know it.

CHARLIE NORTON I thought it was a silly idea, to tell you the truth. I was vaguely familiar with DNA as it applies to criminal cases in say humans for

example. But I really had no experience and really didn't have any idea that there was such a thing as DNA in plants.

ALAN ALDA (NARRATION) But Norton did what his boss suggested - and began hunting for a scientist who might be able to use DNA to link the truck's pods with the tree at the crime scene.

TIM HELENTJARIS Hello, Tim Helentjaris here.

ALAN ALDA (NARRATION) Tim Helentjaris was the fifteenth geneticist Norton contacted - after 14 had said a DNA comparison was impossible or way too costly.

CHARLIE NORTON We found two bean pods in the back of our suspects truck. And I want to know if it might be possible to do some DNA testing on the pods and see if it would come back to a particular tree?

TIM HELENTJARIS Well theoretically if we analyze the DNA from the pods and from the tree we should be able to show if they match or not. The important question would be how much variation there is between individual Palo Verde trees. And so we might need to run a few tests first just to see how different Palo Verde trees are from each other.

CHARLIE NORTON Well, what would I have to send to you then in order for you to go ahead and do the DNA testing?

TIM HELENTJARIS Well probably what we need first is a number of different Palo Verde trees.

ALAN ALDA (NARRATION) The geneticist's concern was that some plant species are so genetically uniform that a DNA test couldn't tell individual plants apart. So the critical question was: how unique is any one Palo Verde tree's DNA fingerprint? To find out, Detective Norton mobilized members of the Phoenix volunteer "Sheriff's Posse" to collect bean pods from trees through out the county. The posse collected 38 samples in all. And within a week, they were all in the hands of Tim Helentjaris here at the University of Arizona in Tucson. His first task was to see if different Palo Verde trees had different DNA fingerprints. Only then could he hope to prove the pods in Mark Bogan's truck matched the tree at the crime scene. The analysis began by removing the seeds - which would have confused the results.

TIM HELENTJARIS The seeds have DNA both from the mother tree and other trees that would have pollinated it. So we need to get rid of those and just use the pod material which would only have DNA from the mother tree.

ALAN ALDA (NARRATION) Next the pods were dunked in liquid nitrogen making them brittle and easy to grind up. But then Helentjaris ran into a problem that threatened to jeopardize the entire case.

TIM HELENTJARIS I almost quit a couple of times because we had problems extracting the DNA from the pods -- since they were quite woody. But when I would talk to the detectives and they kept re-emphasizing how important it was, I went back and tried another procedure and then another until we finally got it to work.

ALAN ALDA (NARRATION) The pods eventually yielded up their DNA. But weeks of work still lay ahead. The task was to find within each tree's DNA a few small pieces that would be different from tree to tree - so that when their fragments were run through an electric sorter, the trees could be easily compared. Here's what a DNA fingerprint looks like - a series of bands that light up orange under ultraviolet light. Using the fingerprints, Helentjaris was able to make the critical comparison. The two pods found in the truck matched each other - and they also matched perfectly the pods taken from the tree at the crime scene. On the other hand, every other tree had a completely different DNA fingerprint. It was just what Charlie Norton had been hoping for.

CHARLIE NORTON I couldn't believe it. I thought it was just a miracle really. First of all he could do it, and then the added elation that this is going to make our case against Mark.

ALAN ALDA (NARRATION) On May 27th, 1993, Mark Bogan was found guilty of first degree murder. It was the first time the DNA fingerprint of a plant was used in a criminal trial. Undoubtedly it won't be the last.

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FIGHT A FIRE - SAVE THE OZONE

ALAN ALDA (NARRATION) It's our worst nightmare...everything seems to be fine. PILOT Rotate

ALAN ALDA (NARRATION) But what we don't know is that there's a serious problem. Suddenly... PILOT Fire. We're not going to make it. We gotta get out.

ALAN ALDA (NARRATION) This 1980 film probably had it wrong. Since the 50's all jet engines have used an extremely effective fire extinguishing chemical called halon. But in 1993 production of halon was banned because it contributes to the destruction of the earth's protective ozone layer. We're at a Federal Aviation

Administration research center in New Jersey. In the search for a halon replacement the first task is figuring out how to start a typical fire. They've devised a test rig using an old jet engine. One of the engineers is Harry Webster.

HARRY WEBSTER What we've done is install a Plexiglas window in the side of the engine nacelle. The fire itself is generated by this little oil burner that's basically the same as what you use in your house. As you can see by all the plumbing and duct work it's a very complex environment to put a fire out in.

ALAN ALDA (NARRATION) On the rig, the fire fighting chemicals are contained in these pressurized tanks. Normally they'd be built into the plane. To add to the realism, a second engine will be used to blow high speed air through these tubes, directly into the test engine. It'll be like flying at over 400 miles per hour. The control room is safely separated from the whole arrangement. Today it's really the rig that's being tested, and they'll be using halon. The air-blowing engine is run up.

HARRY WEBSTER 3...2...fire number one.

ALAN ALDA (NARRATION) With the push of a button, a major fuel leak is started. And then... In a fraction of a second the halon snuffs out the fire. It's this performance that replacements will have to match. This is the baggage compartment of a commuter plane. The ground crew loads up - without forgetting to include this handy suitcase igniter. The passengers are unusually well prepared on this flight - because of course it's another test rig, this time for hand-held fire extinguishers. They let the fire get well established - and then they'll use a single, small, hand-held halon extinguisher like those currently carried on all commercial flights. Even though the firefighters can't get close to the fire, once again the halon is completely effective... ..and it's non-toxic...and it doesn't damage delicate electronics or control systems.

HARRY WEBSTER Halon's good stuff. We're going to be sorry to see it go.

ALAN ALDA (NARRATION) This is why halon has to go. As most things burn, they give off a highly reactive form of hydrogen gas. The hydrogen feeds back into the fire, making it burn all the stronger. Halon contains bromine, which combines with the hydrogen, breaking the cycle and extinguishing the fire. But then the bromine floats off into the upper atmosphere, where it combines with ozone - destroying it. The very thing that makes halon so effective at putting out fires, also endangers our environment. And that's a problem because halon fire systems are used in every jet plane that flies. They're used in computer rooms...on oil rigs in Alaska...even on the space shuttle. So now the race is on to find a replacement. Every race needs judges and

MIKE BENNETT is one of them. At Wright Patterson Air Force Base in Ohio, he's devised one of the toughest tests for new fire fighting chemicals.

MIKE BENNETT Destruction is our middle name and a lot of people envy us because of the work that we do here. Basically every day consists of building things and blowing them apart.

ALAN ALDA (NARRATION) Like Harry Webster with his engine fire rig, Mike Bennett's after realism. For the Air Force, that means simulating air combat.

MIKE BENNETT This fixture right here is designed to simulate the side of an airplane. Our main area of concern is right around here where the airflow would interact.

ALAN ALDA (NARRATION) The air flow comes out of this duct.

MIKE BENNETT On the other end are jet engines that we use to generate about 400 knots--450 miles an hour of air flow to actually simulate the airflow of the aircraft in flight. It'll actually blow over this test fixture over here to simulate airflow blowing over the outside of a plane. It will dramatically effect the fire inside. This is ground zero--this is where we aim our gun at this target point and this is where the whole action begins.

ALAN ALDA (NARRATION) What Mike means by "whole action" is a tremendous fire - because there's a tank of jet fuel behind the target. Right above - two tanks of fire suppressant chemicals.

TECHNICIAN Set up for the first shot...

ALAN ALDA (NARRATION) In the range control room, the team prepares to run the rig for the first time with air flow. In case things get out of hand, there's a backup system. This will suppress the fire by flooding the entire building with carbon dioxide. And these are the explosive shells that get the whole thing going.

BRETT POOLE This is a Soviet 23 mm HEI round. It's Korean war era and it was used by the Soviets for air to air combat.

ALAN ALDA (NARRATION) A home made gun is aimed at the target, in front of the tank of jet fuel. The first thing for Mike to establish is whether halon itself can cope with such an extreme test. The high speed air through the target area is run up.

TECHNICIAN Attention all personnel. Stand by for 21 second countdown on range 3 starting now. 20 seconds....fifteen...10-9-8-7-6-5-4-3-2-1-0.

ALAN ALDA (NARRATION) The halon is released, but the fire burns out of control. Before the rig itself is damaged, they have to use the backup carbon dioxide. So the rig is re-set for another shot - doubling the amount of halon, to 2 pounds.

TECHNICIAN 5-4-3-2-1-0.

ALAN ALDA (NARRATION) This time the fire seems to barely get started - perhaps the rig is not functioning right. But viewed in slow motion, it's clear there had been a fierce fire ball which the halon suppressed in less than half a second. Of the dozens of possible halon replacements screened by Mike's team, three look promising. Now they can begin the first tests of those three, under these rigorous conditions.

TECHNICIAN This is FE25. Two pounds mass. It'll be the same mass as the halon shot that we did previously.

MIKE BENNETT That's the chemical from DuPont, right?

TECHNICIAN That's correct. 3-2-1-0

MIKE BENNETT Pretty large fire there.

TECHNICIAN Didn't touch it.

ALAN ALDA (NARRATION) We won't be flying with that chemical in the near future.

MIKE BENNETT We didn't see very good performance of the chemical at least this time. It didn't really seem to effect the fire at all. So it looks like we're going to have to go quite a bit...in fact it looks like the performance is much worse than what we saw without the exterior airflow. So our original encouraging results are not as encouraging right now once we've added the full scale air flow.

ALAN ALDA (NARRATION) Ideally, tests like this will eventually help find a single new chemical that will fight a whole range of fires: in military combat, civilian jet engines, cargo holds, and computer rooms. If we save the halon that's now in storage for the most critical uses - like an aircraft -it can last for several years. So how long before a replacement is found? That's what nobody knows.

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COP PSYCHIATRISTS

ALAN ALDA (NARRATION) When people are in trouble they call the cops. But in New York, when the cops are in trouble they call the Emergency Service Unit.

ALAN ALDA (ON CAMERA) This is a specially equipped truck used by the New York City Police Department's Emergency Service Unit. It's pretty much ready to do anything. You're going to have to meet

SERGEANT MIKE CROWLEY and

OFFICER JACK GRIFFITH to explain some of this to me. Mike, here's the first thing I want to know about, what is this, what are pig tails?

SERGEANT MIKE CROWLEY Pigtails are nothing more than electrical connections that we use when we string lights out.

ALAN ALDA Jack what were you working on, what is this thing?

OFFICER JACK GRIFFITH This is the jaws of life. We call it the Hurst tool. We use these to extricate people from vehicle accidents.

ALAN ALDA What is this here, what do you use this for - animals?

OFFICER JACK GRIFFITH Yes, this is our animal control system that we use. In this city we have a lot of pitbulls, and sometimes possums, raccoons.

ALAN ALDA You guys go under the water, you go on top of buildings, you come out of helicopters.

SERGEANT MIKE CROWLEY Some of us even repel amphibiously into the water.

ALAN ALDA Into the New York City rivers. Now that's brave.

ALAN ALDA (NARRATION) But equipment isn't always enough. In 1984 Emergency Services faced Eleanor Bumpers, an emotionally disturbed woman barricaded in this apartment. They broke through the door and tried using a restraining bar they had invented. But, knife in hand, she escaped the bar and rushed the officers.

DEPUTY CHIEF JOHN LOWE She was coming at the officer who had a hand shield, and she was able to get her hand over that, and about to stab him, when one of the police officers, with a shot gun fired two rounds, both of them hitting the woman.

ALAN ALDA (NARRATION) Eleanor Bumpers was dead, the police officer indicted. And the city knew it needed a new tool to handle the mentally ill.

BENJAMIN WARD, POLICE COMMISSIONER We're sorry. We'll try to do better. I think, we can do better. We invented the t-bar. The rest of the nation is using it. We'll try to invent something else. And hopefully this won't happen again.

ACTRESS Nobody treats me that way, nobody treats....

ALAN ALDA (NARRATION) This is New York City's new invention. It's not a piece of equipment, but it is a tool - for the mind.

ACTRESS You're dealing with me, you're dealing with Madonna.

ALAN ALDA (NARRATION) It's a class at John Jay College where professional trainers guide the officers through the psychiatric disorders that they'll see on the street.

ACTRESS I gotta go.....

ALAN ALDA (NARRATION) A specially trained actress is showing the classic rage and delusions of mania.

POLICE

OFFICER Can you tell me what he did to you?

ACTRESS He didn't treat me like a lady.

ALAN ALDA (NARRATION) Then there's the psychopath.

PSYCHOPATH Aren't I good enough for a duty captain?

ALAN ALDA (NARRATION) Intelligent and manipulative, he gains control of the situation.

PSYCHOPATH Quick question, Sam, who's in control?

POLICE OFFICER You're in control

SCHIZOPHRENIC I didn't do nothing, I didn't do wrong, it was my wires....

ALAN ALDA (NARRATION) And they learn to recognize the schizophrenic through her hallucinations and garbled speech.

SCHIZOPHRENIC He didn't want the wires, he said no more wires, no more wires. No more yelling, no more yelling, no more wires, no more yelling....

JOYCE ST. GEORGE One of the things that we're trying to do with the program, is help you to understand what different diseases do to different people.

ALAN ALDA (NARRATION) Joyce St. George leads the training.

JOYCE ST. GEORGE ...one more tool so that if this person is doing word salad, if this person is delusional, if this person is talking to him or herself. If it 95 degrees out and she's got a ski jacket on, they might be indicators that there is schizophrenia going on. If that's the case, that might help you determine how to work with that person.

PROFESSOR RAY PITT A lot of people on the street now...

ALAN ALDA (NARRATION) Professor Ray Pitt and Sergeant Mike Crowley help run the class.

ALAN ALDA (ON CAMERA) How technical do you get about your evaluation of what's going on with the other person. Do you in your head say, this person is this kind of psychotic. Do you actually get clinical about your evaluation?

PROFESSOR RAY PITT It's important for the officer's to know whether, if a person is delusional, whether he's maybe schizophrenic, or maybe he's manic, or maybe he's suffering from cocaine psychosis.

ALAN ALDA And you have a different technique to use with each of these people.

SERGEANT MIKE CROWLEY Just the other day we knocked out a peep hole and I looked in, and the worst scenario is that we had a barricade, who had offed his mother inside. And I could see that this guy had all the symptoms of schizophrenia. It was 92 degrees and he had a ski hat on, and he was inappropriately dressed, and he was mumbling. I could also tell from his demeanor, and from what I've learned, that schizophrenic of this type are probably not violent. And I told the captain, I said we have a classic schizophrenic here. I said everything I know about schizophrenia, this is him, and he's probably not violent. And it encouraged the captain to enable us to pop the door and go in and he went like a lamb.

OFFICER ED RUSH There's no problem, there's no problem...

ALAN ALDA (NARRATION) The science of the classroom meets the chaos of the street. The officers have to make a diagnosis -- here Sergeant Crowley thinks it's a drug induced problem, called cocaine psychosis.

OFFICER ED RUSH There's no trouble, just come out, and talk to us and that's it.

SERGEANT MIKE CROWLYE He's barricaded, he's intoxicated with apparently crack, and he's highly agitated. The family in there is just making it worse. He's like wildly fearful.

OFFICER ED RUSH Aaron, there is nothing to be afraid of.

ALAN ALDA (NARRATION) The officer's threatening tone is not getting him the results he wants.

OFFICER ED RUSH Aaron, you're not in trouble Aaron, open the door.

SERGAENT MIKE CROWLEY We try to avoid getting into power struggles, where we say Aaron come out, and he says no, and we say Aaron come out, and he says no, Aaron come out. When you find yourself in a power struggle like that, one of the points that we review in the course, is to try and take a different tack. Tell him your name, ask him what's on his mind instead of constantly telling him we're not going to hurt you, ask him what he's afraid of. Maybe we're doing something to make his fear worse. To me he looked like a deer who was looking into head lights. He was in complete panic. Tell you what, let me take a shot at this....Hey Aaron, can you hear me? Aaron, my name is Mike. Can you hear me? We're not here to hurt you. Listen, I appreciate your attention. The ambulance is out here.

ALAN ALDA (NARRATION) Sergeant Crowley tries to ease the situation.

SERGANT MIKE CROWLEY O.K. listen. Let him come out. Lets not push it. He's got to many place to go.

ALAN ALDA (NARRATION) But violence erupts inside. It's not a textbook ending, but with the attempt to talk first, it's at least a beginning.

SERGEANT MIKE CROWLEY We can learn a lot from Aaron, if our minds are open to the possibilities. Maybe ten years ago, it might have been the same tactics, the same outcome. But he would have been just another psycho, ten

years ago. Whereas today, we can take our experience with him, and try to analyze what his behavior indicated. And maybe that will help us in future jobs.

OFFICER KOBEL What's your name ma'am?

LADY I don't want any...Helen Harris.

OFFICER KOBEL Helen, why don't you come out here and talk to me. LADY Don't you call me Helen, my name is Mrs. Harris. I'm Mrs. Harris...

ALAN ALDA (NARRATION) Back in the classroom, Officer Kobel is learning about land mines - the verbal kind.

OFFICER KOBEL Mrs. Harris, you want to call me John, you can call me John.

JOYCE ST. GEORGE The first big land mine was when you called her Helen, right? And how did he get out of that one? He let her walk it through, do the whole course. Then he apologized. I'm sorry, I'll call you Mrs. Harris, you can call me John. So you're always going to hit the land mines, its what you do with them that's gonna make a big difference. A lot of people will get into a power struggle.

OFFICER KOBEL Have you eaten lately?

LADY No.

ALAN ALDA (NARRATION) It's an approach that may seem to go against traditional policing, but when it works, it avoids the use of mace, laser stun guns, or worse.

JOYCE ST. GEORGE Four years ago, it was not uncommon for us to have to battle it out about why you don't have to laser her. Now, it's a given that your gonna talk it through. That she is a danger as long as she has that bottle she's gonna be a risk. But we do have the time, at least right now, to try to deal with it on a verbal basis, on a non-tactical. So there is some good stuff going on.

SERGEANT MIKE CROWLY That's one of the revelations about this kind of training. That we're actually gonna start to deal with someone who is acting crazy.

ALAN ALDA (ON CAMERA) What's the percentage though, of calls that you get, that force you to deal with people with emotional problems.

SERGEANT MIKE CROWLEY We were dispatched to somewhere between 38-40,000 of them in the five boroughs in 1992.

PROFESSOR RAY PITT What percentage of your workload would that be, Mike?

SERGEANT MIKE CROWLEY Taking all of those calls into consideration, it approaches 40% of our workload.

ALAN ALDA So they really need this training.

ALAN ALDA (NARRATION) A hostage job for Emergency Service. A severely disturbed man is holding his four children at gun point.

POLICE OFFICER We came up to the door, took control of the door by trying to open the door. My partner Steve Green took the point, with a shield and a nine millimeter and started negotiations.

OFFICER STEVE GREEN He's at a certain level of aggression, the last thing I want to do is raise that. His children could be in definite peril. So the class was very good at giving us somewhat of a guideline to work by. What to listen for in him, what might set him off, what could possibly steer him in the direction we want.

SERGEANT MIKE CROWLEY In his demented way of thinking, he might be of the opinion that what he's doing is in the best interest of the children. But if we could somehow let him know that we are on his side, that we also have the welfare of the children, and convince him that that's true, well then our battle is half won.

ALAN ALDA (NARRATION) And in this case, the battle is eventually fully won - without violence. Since the class started, seven years ago, New York has seen negotiated surrenders, like this, go up by nearly 40%. That's all for this episode of Scientific American Frontiers. See you next time.

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