"THE ART OF SCIENCE"
SHOW 804

TEASE

ALAN 2.0 I'm Alan Alda 2.0

ALAN ALDA (Narration) Meet my digital twin -- and find out how we made him.

BEN FRANKLIN I completed the instrument in '62.

ALAN ALDA (Narration) We pick up where Ben Franklin left off.

ALAN ALDA Is it going to begin coloring now?

ALAN ALDA (Narration) We join a robot painter at work. I get to drive a musical instrument. And we rediscover a sculptor's heroic vision. ALAN 2.0 Join me for the Art of Science on Scientific American Frontiers.

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EPISODE OPEN

ALAN ALDA A typical science lab, right? Packed with formidable-looking equipment devoted to measuring and probing and analyzing. The surprise, though, is that this particular science lab is in the middle of the National Gallery of

Art in Washington DC. Just step across the hallway with me... This is where the National Gallery's paintings are pampered and preserved -- where the painstaking work is done to ensure their survival for future generations to marvel at. The work here is a marriage between science and art -- where the knowledge of materials like pigments and varnishes that's gained across the hall is applied with an understanding of the artists' intentions and a dedication to keeping them alive. For a long time I've been struck by how much scientists and artists have in common. At their best they're both playful, precise, creative, inspired revolutionaries. In this show we'll be looking at the interplay of science and art -- and how each benefits from an appreciation of the other.

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BEN FRANKLIN'S HARMONICA

BEN FRANKLIN My name is Dr Franklin. I'm a Boston boy. And it's my happy office to bid you welcome to my home town

ALAN ALDA (Narration) Benjamin Franklin, the very definition of an inspired revolutionary, would have seen nothing odd about science and art rubbing shoulders. In a 20th century reincarnation, he's here presiding over the 1997 International Glass Music Festival. The most popular glass instrument -- today as in Ben Franklin's time -- is an array of glasses, tuned by the amount of water they contain, and played by rubbing a moistened finger around the rim. The story goes that while in London as Colonial Envoy, Benjamin Franklin in 1759 attended a recital of musical glasses. Entranced by the sound, Franklin invented a mechanical version.

BEN FRANKLIN And the idea quite near leaped into my head by way of an epiphany, the mechanizing of them. So in '59 came the idea, I completed the first instrument in '62, or '61.

ALAN ALDA (Narration) This is Franklin's invention -- the glass harmonica: the glasses are now bowls, tuned by their size, tipped on their side and nested inside each other on a constantly rotating spindle. The result is that the performer can now touch several glasses at once, and so play chords. Her instrument was made by this man, Gerhard Finkenbeiner. Like Ben Franklin, he combines a love of music with an inventive technical mind. His fascination with the glass harmonica began over 40 years ago, when -- in a Paris museum -- he saw one of the few instruments to have survived a century and a half of oblivion.

BEN FRANKLIN Did you hear it played?

GERHARD FINKENBEINER I heard it in my spirit. I heard a beautiful sound. So I got very, very interested, and promised myself that one day I'm going to make one. And it took about 20 years.

BEN FRANKLIN A short time to make the voice of angels, isn't it?

ALAN ALDA (Narration) Gerhard learned glassblowing in Germany. Later he took his skills first to Paris then to Massachusetts, where he began manufacturing complex scientific glassware. Making a glass harmonica remained a dream, until one day he realized he had the beginnings of an instrument right there in his shop.

GERHARD FINKENBEINER We had a job for IBM. And the job was furnace tubes. And I think I have one right here.

ALAN ALDA This is the tube you were making for IBM?

GERHARD FINKENBEINER Yes, it was closed on both sides first, like this. And then one side had to be opened. So what we did, we just cut it, and the piece that remained -- we cut it here -- looked just like a glass harmonica cup.

ALAN ALDA This part would come off, this top part?

GERHARD FINKENBEINER Yes, and we'd throw it out you see.

ALAN ALDA And you realized at that point, because you'd seen the glass harmonica...

GERHARD FINKENBEINER Yes, I saw it... And it had a very good sound when I tapped it. It sounded beautiful already.

ALAN ALDA (Narration) That first glass harmonica sold for $3000, and slowly orders came in for more. So Gerhard started building them from scratch, still using the same high quality glass of the IBM furnace tubes, but now shaping the cups to be more like Dr Franklin's original design. This will become a pair of cups once it's sliced through the middle. Gerhard can't predict the exact pitch each cup will have, so he sounds each one to find what note is closest.

TIM NICKERSON Well that note is about 15 cents flat.

ALAN ALDA (Narration) Fine tuning is done by his assistant

TIM NICKERSON, who grinds the front of the cup to raise its pitch. Tim's going to demonstrate how the cup make its ethereal sound.

TIM NICKERSON We're going to put this cup in this device, which actually uses an audio feedback loop to sustain the vibration of the cup. If you turn on the strobe light, you'll be able to see how much that wall is actually moving.

ALAN ALDA (Narration) The strobe light appears to slow the vibrations so we can see them.

ALAN ALDA That's amazing. So is this circle at the top of the bowl getting bigger and smaller, or...

TIM NICKERSON No, it's just changing shape, like from a circle to an ellipse, to an ellipse in the opposite direction.

ALAN ALDA I see.

ALAN ALDA (Narration) Only glass made of the purest quartz can withstand these vibrations. Here's a bowl made of ordinary glass. In the years after Franklin invented it, the glass harmonica became a big hit in Europe, where even Mozart wrote music for it.

ALAN ALDA But at a certain point the instrument became unpopular. Do you know why?

GERHARD FINKENBEINER Yes, I think there were several reasons. During a concert in a town in Germany, a child died, during the concert. And the police banned it in that particular town. They thought the instrument was the cause of the child dying.

ALAN ALDA Why would they do that? That's an odd thing. If someone died at a concert you wouldn't blame the piano, nowadays, or the saxophone. Why would they have blamed the glass harmonica, do you think?

GERHARD FINKENBEINER Because there were rumors already known that it had supernatural powers, and when you played it a midnight, the ghosts will come out. It's clearly stated in one of the books.

ALAN ALDA Wow!

GERHARD FINKENBEINER It's very thin, it does not cut.

ALAN ALDA It's glass... It's like cellophane.

ALAN ALDA Well, as you can imagine, I'm going to be playing this thing. But they won't let me play it until my hands are completely clean, so clean that they squeak. I don't know if I get a squeak yet. All the oil has to be off the fingers, otherwise you don't get a good sound. I think I hear it squeaking. It's probably the only instrument in the world, in the history of musical instruments, where you pour water in a... oh, excuse me!

ALAN ALDA (Narration) Thomas Bloch has come from his native France, bringing his own special water with him, to give me a demonstration of the instrument, and my first lesson in playing it. The water comes from a particular cave in southern France, and is rich in talc, to improve the contact between Thomas' fingers and the glass.

THOMAS BLOCH Touch on the top of the glass, the glass you want to play, this one, this one...

ALAN ALDA I'm not getting a sound at all.

THOMAS BLOCH It doesn't sound?

ALAN ALDA You hear something?

ALAN ALDA (Narration) Thomas' special water doesn't seem to be working for me.

THOMAS BLOCH Ah, it comes, it comes.

ALAN ALDA That's pathetic!

THOMAS BLOCH It begins to cry... Don't push...

ALAN ALDA This is worse than when I tried to learn the trumpet. Don't push too hard?

THOMAS BLOCH No...

ALAN ALDA (Narration) Then suddenly, with just the right pressure...

THOMAS BLOCH So now you can play with five fingers if you want.

ALAN ALDA A minute ago, I couldn't play at all!

THOMAS BLOCH Tres bien, tres bien.

ALAN ALDA Ah, merci!

ALAN ALDA (Narration) Thomas Bloch is one of the world's leading glass harmonica players. Thanks to him and Gerhard Finkenbeiner, for a few moments we were listening again to the sound Ben Franklin himself had invented. For the record, nobody died, and we saw no ghosts.

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ALAN 2.0

ALAN ALDA (Narration) In movies these days, the most spectacular special effects owe more to the computer than they do to the camera. But the movie Titanic takes computer-generated effects into new territory. Because not only are many of the objects you see on the screen digital rather than real, so too are many of the people. Faced with the problem of populating a ship that doesn't exist, the movie-makers turned to people who don't exist. Everyone on deck here, for instance, is a digital extra. Take this man, striding purposefully past a woman and child. His digital life began with a real life actor in the studios of Digital Domain, the Hollywood company that did most of Titanic's special effects. The white balls on his body are picked up by infra-red cameras. Once his movements have been captured in 3-D like this, the flesh-and-blood actor's job is done.

ROB LEGATO Motion capture allows you to actually create or animate somebody in a very naturalistic way. And then once they are in the computer you can take them and place them on any part of the miniature ship that you wish.

ANDRE BUSTANOBY We've populated the deck of the Titanic with these people, and we've done it in such a way that no-one will notice that they're fake.

ALAN ALDA (Narration) The white dots are converted into fake people by first turning them into three dimensional stick figures, which can then be looked at from any angle you choose. The stick figures then have virtual bodies draped over them... and these in turn are given faces and clothes. The result -- that man we saw strolling on the deck. This is the mother and daughter he passed. And here are a couple of other virtual actors struggling with a virtual wind. That fly-over of the Titanic was put together from a camera move over a model ship...with a digital ocean and digital ship's wake...scores of digital people...the odd digital seagull...and a little digital smoke. Impressive as they are, Titanic's digital characters stay strictly in the background. But they got us to thinking: what would it take to create a digital character believable enough for a speaking part?

WALTER NOOT Alan, this is Erin.

ALAN ALDA Erin, hi.

ERIN KILLACKEY Hi, nice to meet you.

ALAN ALDA (Narration) Luckily, we have an actor on hand who's reckless enough to let himself to be digitally cloned.

ALAN ALDA How does this work...

ALAN ALDA (Narration) We're at Viewpoint DataLabs in Venice, California, where

WALTER NOOT is about to make me digital.

WALTER NOOT ...and then a laser beam comes across your face. And you probably won't even see the laser. It's very, very slight.

ALAN ALDA So the laser beam is bouncing off here, then here, then here, then it goes further in here and then it comes further out here, and it knows where it is, how far in or out it is? It comes here and goes back and measures the distance?

WALTER NOOT Yeah, and sometimes it gets lost, it hits your hair and it gets lost in some of those areas. But the first facial expression we want is we want your eyes open and we want a big smile, a pretty extreme smile.

ALAN ALDA I can't do that. I can't, I can't. I'm well known for smiling with my eyes closed. This is my whole life. This is what made me famous. People say, let's go see that guy who can't smile with his eyes open. In fact, what I'm counting on for you is to give me a picture of myself with my eyes open and smiling and then I'll get much more work! Erin Killakey We need to turn the lights off to do the scan.

WALTER NOOT Chin up a little bit.

ALAN ALDA (Narration) Our plan is to see if it's possible with today's technology to make a digital facsimile of my head that can talk -- doing and saying things that the real me has never done or said. Our code name for the project is ALAN 2.0. The job of the people at Viewpoint is to begin the process by generating the data needed to create the 3-D model.

ALAN ALDA This is going to look grotesque.

ALAN ALDA (Narration) Here it is -- 250,000 points of data that -- made to look solid -- generate what looks like a marble bust that would be right at home in a museum. But then the computer came up with this weird-looking monster.

ALAN ALDA Who's this?

ERIN KILLACKEY This is you. This is your texture, cut open and laid flat. And what we can do is eventually take this texture and wrap it back around the model of your face.

ALAN ALDA That's my texture? You've filleted my face.

ERIN KILLACKEY We cut you open and laid you flat.

ALAN ALDA (Narration) Suddenly, creating ALAN 2.0 didn't seem so far-fetched.

ALAN ALDA Have we reached the point now where you can take a couple of pictures of me and then build a performance for me in a movie and I don't have to show up for work? There I am, in the movie, and I don't have to show up?

WALTER NOOT Yeah, we're at that point.

ALAN ALDA Yes! I mean, can you show someone in close up like this?

WALTER NOOT Yeah, using this kind of technology, you can.

ALAN ALDA (Narration) With Viewpoint's digital data in hand we turned to the people whose job it will be to bring ALAN 2.0 alive -- to animate it -- something they already do for another well known actor.

LARRY LAMB ...it could be a spokesman...

ALAN ALDA (Narration) This job, though, they think might be trickier.

LARRY LAMB The most difficult thing is that when you look at it, you've seen him so often, you know exactly what he looks like, so you can see all your flaws. Conversely, that's the most fun part.

ALAN ALDA (Narration) Jim Russell is one of the team at Lamb and Company. The first thing he does is replace the hair the laser scanner missed. Then he lays my filleted face over the model and starts work on getting the hair the right shade of gray. Next he gives ALAN 2.0 some eyeballs... and starts yanking bits of the face around to create some expressions.

JIM RUSSELL This is a lot of small steps. And it's sort of like sculpting. Here I've grabbed a point in the middle of the mouth. I can pull the mouth up a little bit, say if I was going to make an "O" or something.

ALAN ALDA (Narration) Jim spent hours tweaking away at the digital Alan, and he tried especially hard to make it smile with its eyes open. In all the Lamb team built some 60 expressions as the building blocks for what will eventually be an all-digital performance. But meanwhile there was the little matter of making ALAN 2.0 talk. Just as they needed a sample of my face, they needed a sample of my voice. They wanted it as lively and expressive as possible. I came up with this.

ALAN ALDA Actually, you know, I think it's a good idea to make a digital version of me that they can send to different parts of the world on this program where I don't really want to go. I mean, they had me doing... The producers of this show have me wrestling sharks, catching rattlesnakes, they, they... We did a story once where I had to climb up to the top of Mount Vesuvius. So let them send some, you know, digitized version of me. That would be great. I hope you do a good job with this. I'll be watching.

NICK CAMPBELL (Speaking Japanese)

ALAN ALDA (Narration) This is Nick Campbell, who works for a company called ATR Research in Kyoto, Japan.

NICK CAMPBELL (Speaking Japanese)

ALAN ALDA (Narration) Nick has pioneered a way to digitally sample a voice, then use those bits to make that voice say anything he wants it to. The first thing he did when he got the tape of my voice was to feed it into his computer...

ALAN ALDA'S VOICE I think it's a good idea to have a digitized version of me that they can send out...

ALAN ALDA (Narration) ...along with thousands of other words I've spoken in previous episodes of Frontiers.

NICK CAMPBELL Let's listen to this one, where he says...

ALAN ALDA'S VOICE Now as anyone who knows me can tell you, the secret to manipulating my emotions is food.

NICK CAMPBELL That's a nice sentence. We'll pull up the waveform for that.

ALAN ALDA (Narration) The waveform of each word is a visual representation of all the little bits it's constructed from. Here's the word "emotions".

NICK CAMPBELL It starts off with an "e", "m", "o", "sh", and then the "n" and there's a "z". OK, so that gives us the word.

ALAN ALDA'S VOICE Emotions.

ALAN ALDA (Narration) From all the words we sent him, Nick has built a library of my speech sounds.

NICK CAMPBELL Let's look at some O's. I'll play you, there are some 50 odd here I've taken at random through the file, but let's listen to some of them.

ALAN ALDA'S VOICE "O", "o", "O" etc.

NICK CAMPBELL OK, I mean they're all "O's", but if you look at them, some of them are loud, some of them are quiet, some of them are long, some are short, some are getting louder, some are getting quieter. "N" is a nice one, the last sound in "emotion", comes up here. Let's listen to some of those.

ALAN ALDA'S VOICE "N", "n", "N" etc.

NICK CAMPBELL It sounds almost like he's singing these things, but these are the speech sounds, they're taken from the speech. Well, now we've got his sounds in the data base, we can pull them out to make new speech that sounds like him. Let's try, how's this..?

DIGITIZED VOICE This is Alan.

NICK CAMPBELL He never said that. I think.

ALAN ALDA (Narration) "This is Alan" in fact came from four different chunks of my speech stored in the computer: THISI, SA, L, and AN.

NICK CAMPBELL Let's try "remarkable".

DIGITIZED VOICE Remarkable.

ALAN ALDA (Narration) This time the computer stitched together five different waveforms, each taken from the huge library at its disposal. From words, it's a short step to sentences.

NICK CAMPBELL Let's try this sentence. "What will science come up with next?"

DIGITIZED VOICE What will science come up with next?

NICK CAMPBELL I think it's intelligible, but it's certainly not natural and it doesn't convey the right meaning. I want him to say something like, well, listen: "What will science come up with next?" Something that's a bit more expressive, like that. What I've done now, is I've given the synthesizer a model of the way I say it, and it's going to come out with his voice, I hope.

DIGITIZED VOICE What will science come up with next?

NICK CAMPBELL It's close. It's certainly much closer to what I wanted.

ALAN ALDA (Narration) Well, it's not how I would have said it --and I have to tell you that it makes me uncomfortable to have my voice serving someone else's interpretation. The next step is to have ALAN 2.0's words emerge from his lips -- and for that it's back to Minneapolis. Here, Lamb's Kelly Schrandt is building the lip movements, sound by sound, to match the speech. KELLY SCHRANDT I scrub through the audio...

DIGITIZED VOICE Alan, Alan. KELLY SCHRANDT ...and I decide where the "A" in Alan begins and ends.

ALAN ALDA (Narration) Here's the "l" sound. And now the "an". Finally the big day. In a suitably grand setting, courtesy of the Museum of Fine Arts in Boston, I was about to confront my digital twin for the first time. He was a little stony at first, but a flick of the switch warmed him up.

ALAN 2.0 Hi, Alan one, this is Alan 2.0. Well, your dearest wish had come true: here I am, in all my digital glory. What do you think? I realize I owe my existence to you, but now that I'm here, the producers and I have started wondering: what have you got that I haven't? So they've asked me to give you the news. You still get the dangerous assignments -- the producers love scaring you -- but the really tasty stories -- like there's this one on the science of pasta -- they're mine from now on. You see, I've promised never to complain. See you next season... maybe!

ALAN ALDA "See you next season." I don't think so.

ALAN ALDA (Narration) No, I don't think so. But in looking at ALAN 2.0, I was brought face to face with a serious question. If you build a performance out of bits, whose job is it to provide the soul?

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AARON THE ARTIST

ALAN ALDA (Narration) This is a portrait of an artist at work. Or perhaps -- and this is the crux of our story -- it's a portrait of two artists at work: a human artist and a computer artist. The human is

HAROLD COHEN of the University of California, San Diego. Some 30 years ago he largely abandoned a successful career as an abstract painter in England. He set out to devise a computer program that itself would create original and striking...well, what?

HAROLD COHEN A lot of people say, "Is it art?" but I've never heard anybody say it isn't. The way the program starts drawing was fixed around 1980. In fact I was trying to simulate the way young children draw...

ALAN ALDA (Narration) Harold Cohen turned to the computer to answer a deceptively simple question: what is it about a mark on paper that makes it an image, that makes it mean something? He got an early clue from watching children draw.

ALAN ALDA OK, so first there's this scribble... This is really extraordinary -- first the scribble and then a circle around it. I never noticed that before.

HAROLD COHEN I noticed it with my own children when they were very young.

ALAN ALDA And you've observed that children, at a certain point in their development, will go from scribbling to drawing a circle around the scribbling, or some sort of a shape around it?

HAROLD COHEN And it was also my intuition that this was also the stage at which children said, that stands for something. Not long after that they'll leave out the scribble in the middle, just do the enclosed line, and then it's quite clear they're representing something.

ALAN ALDA (Narration) Harold's computer program, called Aaron, also employs a sort of internal scribble when it draws, among other things, trees.

ALAN ALDA What, you said make tree, or what?

HAROLD COHEN No, I just said do it. There we go, now it's started to draw.

ALAN ALDA It's like the basic skeletal shape of what its going to eventually draw.

HAROLD COHEN Yeah.

ALAN ALDA (Narration) From the knowledge Harold has given it about how trees grow, Aaron grows its own tree skeleton, then draws a line around it to create the image.

ALAN ALDA Let's get to something more complicated, a face. How do you deal with it to get it to draw a face that's either pleasing or interesting or worth looking at in some way?

HAROLD COHEN I was hoping you'd stop at getting it to draw a face...

ALAN ALDA (Narration) It turns out that Aaron knows things about faces just as it does about trees -- that a face has eyes, a mouth, a nose -- that there are limits to where they can appear and what size they can be. The trickier task is using these general rules to create a face that persuades you it might actually belong to someone.

ALAN ALDA How does it do that? How does it persuade you of that?

HAROLD COHEN It does it by making use of some of the same kind of cognitive distortions that we use ourselves. If you look at its drawings, you will find that it never has the eyes level with each other, it always tends to do that...

ALAN ALDA Really, and we do that? We see..?

HAROLD COHEN Sure we do that. So does art. Go look at a Cezanne portrait.

ALAN ALDA (Narration) Harold has had Aaron working overnight on several portraits. Each is a unique creation, with the placement of the figures, their faces, their poses, generated by Aaron itself from the knowledge of people Harold has painstakingly programmed into it.

ALAN ALDA Now what about this... I mean she's standing on one leg and her hip is out a little bit and her shoulder is back. The combination of those two gestures really says a lot, they go together.

HAROLD COHEN Yes

ALAN ALDA Now how did those two things happen to come out together like that?

HAROLD COHEN They didn't happen to...

ALAN ALDA It knows when the hip is back the shoulder should be back, or what?

HAROLD COHEN It knows a fair amount about posture.

ALAN ALDA How does it know that?

HAROLD COHEN I told it.

ALAN ALDA (Narration) Harold has also told the program about the range of colors it's sensible to choose from when painting people, and Aaron makes its own decisions here too. But Harold isn't satisfied with the pallid blandness of a computer screen... Which is where his latest creation comes in -- a robot painter that starts, sensibly enough, by filling its own paint pot.

ALAN ALDA Ha, I'm sorry, that's kind of funny to me.

HAROLD COHEN You wait till you see it wash it out.

ALAN ALDA (Narration) The robot also selects the right brush to use, employing a brand new mechanical arm that's today getting its very first tryout. Aaron's had earlier robots working on its creations, but this one is by far the most sophisticated. Right now the robot's turning into paint on paper one of the several images Aaron generated last night.

ALAN ALDA Does it know it's out of paint?

HAROLD COHEN No it just knows how many inches of line it's drawn.

ALAN ALDA So it knows one dip is good for a certain number of inches?

HAROLD COHEN Exactly.

ALAN ALDA (Narration) Despite all I'd learned about how Aaron generates its pictures, I was still having a hard time with the notion that each one is Aaron's own idea.

ALAN ALDA How many overall choices does it have?

HAROLD COHEN Oh, God knows, thousands.

ALAN ALDA No I mean in terms of subject.

HAROLD COHEN Oh, very few. Because it knows about very little. It knows about people, it knows about plants, it knows about decorating the background, and that's about the limit of what it knows... It knows how to make table and pots and things...

ALAN ALDA It wouldn't ever put a tree in a pot, or a person in a pot?

HAROLD COHEN No, it would never put a person in a pot. It's a nice idea though!

ALAN ALDA That's what I want to see it do. I want to see it get a little sillier!

ALAN ALDA (Narration) Using a palate that is actually a row of bottles containing fabric dyes, the robot mixes its own colors, and selects the brush most suitable for the next area to be painted.

ALAN ALDA Is it going to begin coloring now?

HAROLD COHEN Yeah.

ALAN ALDA How long will it take to color the whole painting?

HAROLD COHEN Oh, I'd guess with drawing probably about four hours.

ALAN ALDA (Narration) So while the robot worked, we took our conversation to a quieter spot.

ALAN ALDA Why do you want the machine to physically lay down color on the paper?

HAROLD COHEN I'm old fashioned enough I like my images to stay around for a while. I don't like them sort of whee... now they're here, now they're not. Also, I actually almost never use the machine in my studio, it's used mostly in exhibitions. An exhibition is a theatrical event to some degree, and the machine is part of the theater of the thing. You'd be amazed how much more people are interested in the fact that it empties its own cups for example than in the drawing it's making.

ALAN ALDA (Narration) During our conversation , it turned out I wasn't the only one to have trouble figuring out the relationship between Harold and Aaron.

HAROLD COHEN You'd be amazed how difficult people find it to believe that it's made by a computer. You can tell them over and over again that I did not make

this drawing and they'll still walk out believing that you made this drawing and put it into the computer.

ALAN ALDA Yeah, but when I press you on this, you did make the drawing you say. You went through a number of circuitous routes getting the machine to do it for you, but...

HAROLD COHEN No, but there's a difference between writing a program that knows how to draw and writing a program that knows how to make a particular drawing.

ALAN ALDA So that really gets down to the notion of artificial intelligence. You've created a little bundle of artificial intelligence there.

HAROLD COHEN Well I suppose. To the degree that it would require somebody of marked intelligence and actually marked talent to do the things the machine can do autonomously, yes I suppose I have to say yes it is. But it is problematic. I mean, you know, we've never seen this happen before in human history.

ALAN ALDA (Narration) As striking and original as the computer's work may be, the question of whether Aaron or

HAROLD COHEN is the artist has an answer in one respect. It's Harold who selects Aaron's work for exhibition: Aaron itself has no mechanism for looking at what it produces, or for making a judgement about it. To become an artist in its own right, the computer is somehow going to have to learn what every human artist has to learn -- that it likes what its doing enough for it to call it art.

ALAN ALDA Does this mean that the computer program is going to have to be able to have some impression of itself, and is that possible?

HAROLD COHEN In principle I think it is, yes. I just don't know how to do it. That doesn't mean that I'm not going to wake up one morning soon and think, of course I know exactly what I should be doing. That's how things happen, isn't it?

ALAN ALDA Yeah, yeah... And one day the machine will wake up...

HAROLD COHEN And one day the machine will wake up and say, what, are you stupid, why didn't you think of it?

ALAN ALDA Harold, I have news for you...

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RETURNED TO GLORY

ALAN ALDA (Narration) It's early morning , May 28, 1997. Today an event is being re-enacted that was a turning point for black Americans: the mustering of the first all black volunteer regiment in the US Army, the 54th Massachusetts Volunteers. Lead by a young white officer, Colonel Robert Gould Shaw, the 54th fought in the battle for the Confederate held Fort Wagner in South Carolina. Shaw and 87 of his men were killed. The heroism of the 54th inspired the recent movie "Glory". A hundred years ago it inspired another monument -- a bronze statue that has been called the finest memorial sculpture ever created in the United States. The artist of the Shaw Memorial was Augustus Saint Gaudens, and today's ceremonies are to commemorate the unveiling of his masterpiece on Boston Common. Among the speakers here to hail the sculpture -- and the men it immortalizes -- is General Colin Powell.

GENERAL COLIN POWELL I'm so very honored to be with you on this 100th anniversary of the dedication of this marvelous memorial. I doubt if bronze has ever spoken so eloquently than in this celebrated work by Augustus Saint Gaudens. What a powerful image we see before us, the proud young fatalistic Col. Robert Gould Shaw and his Negro soldiers, heads high, rifles on their shoulders, resolution in their every step, marching southward with fortitude, looking just as they did when they passed this spot on May 28 1863 on their way to hope, on their way to glory, and for many of them, on their way to death....It was an occasion of apocalyptic imagery, worthy to be forever remembered in bronze. And we give thanks to the artistry of Saint Gaudens, which has well stood the test of time...

ALAN ALDA Saint Gaudens' artistry may have stood the test of time, but his masterwork hasn't done so well. A few years ago, it was in danger of collapsing altogether before funds were raised to restore it. But this bronze version of the Shaw Memorial isn't the only one Saint Gaudens made.

ALAN ALDA (Narration) He also created a version for himself, made of plaster. The last hundred years haven't been kind to Saint Gaudens' personal copy of the Shaw; but like the bronze, it too is to be returned to glory.

CLIFF CRAINE I think it's a great work of art because of its content, because of sort of the power of the conception, and what it means historically. It's also a great work of art because of the artistic concept, a very deep relief, very freely modeled. It's just an incredibly grand conception, and carried out with a great deal of I think love and attention to detail.

ALAN ALDA (Narration) That detail here on the plaster Shaw has been obscured by layer after layer of paint, acquired during an extraordinary century of wandering. The sculpture has been to Paris and back, received both accolades and neglect during 40 years in Buffalo, and for the last 50 years has been in the care of the National Park Service at the artist's home in New Hampshire. It's now Cliff Craine's job to restore the plaster Shaw to the condition Saint Gaudens himself left it in.

SHELLEY STURMAN Hey, Cliff.

ALAN ALDA (Narration) And it's Shelley Sturman's job to find out what that was: to rediscover Saint Gaudens' vision.

SHELLEY STURMAN These must be the patches...

CLIFF CRAINE These are the patches, at least some of them, there are a couple that aren't done yet...

ALAN ALDA (Narration) The patches are examples of how Saint Gaudens may have treated the Shaw's surface. Cliff has already cleaned off most of the century's worth of paint, but before he did, Shelley had samples taken from various places in an attempt to discover the finish Saint Gaudens himself had applied.

CLIFF CRAINE ...and these are under a fill...

ALAN ALDA How did science figure in the restoration here? What were all the scientific things you had to do?

SHELLEY STURMAN We got heavily involved in science in terms of trying to figure out how the piece had been treated and restored over the past hundred years. And we were very, very excited to find that there were actually areas on the piece that had the entire history of restoration. We found 25 layers of paint and gold leaf and brass leaf and new plaster...

ALAN ALDA Twenty five layers...

SHELLEY STURMAN Twenty five layers.

ALAN ALDA ...and that made up the history of restoration.

ALAN ALDA (Narration) That history is now going under the microscope at a laboratory at the National Gallery of Art in Washington DC.

MICHAEL PALMER That is our first metal application

SHELLEY STURMAN This little spot... so that's below the yellow.

ALAN ALDA (Narration) Shelley and her colleague

MICHAEL PALMER are peering back through the 25 layers of restoration to find the very bottom layer, next to the plaster itself.

MICHAEL PALMER It's right there. If we start at the top and work our way down, the very lowest metal application that we find is right here.

ALAN ALDA (Narration) The lowest layer is greenish paint, with here and there a metal flake above it, then a layer of darker toning. This is what Saint Gaudens himself must have applied to the plaster before he proudly unveiled it at the grand Exposition Universelle in Paris in the year 1900. There it was admired by many, especially for its bronze-like finish. Here under the microscope are the last traces of that finish.

SHELLEY STURMAN Do you have an idea of what kind of color green this would have looked like? Light green, dark green?

MICHAEL PALMER It's a very muted gray-green, quite light gray-green.

SHELLEY STURMAN Which is a traditional color that a sculptor would have put on a plaster. And this little bit of brass leaf would probably have been some highlighting. In fact, there's a wonderful quote by the director of the Paris Exposition saying that he watched, at the very last minute, watched Saint Gaudens directing his men to rub it down and make it lighter.

ALAN ALDA (Narration) After his triumph in Paris, Saint Gaudens had his Shaw taken apart again and shipped back to the United States for another exposition, this time in Buffalo. And it was at some time after this that the Shaw underwent its first transformation. It's visible in the cross section -- a thick layer of yellow paint, topped by a thin layer of metal. To identify the metal,

MICHAEL PALMER turned from the light microscope to an electron microscope. By zooming in on the metal layer, he can read its signature in the spectrum of X-rays it gives off. In most places the metal is gold -- in a few places, brass.

ALAN ALDA Was it clear to you from looking at the layers when this golden surface was put on there?

SHELLEY STURMAN I for the longest time thought that any of the gilding had been after Saint Gaudens' lifetime, after he had died and a restorer had decided to gild the piece or put brass leaf on the piece in emulation, in simulation, of a gilded layer. So it was an eye-opener to me when we were able to get all the way back to find that the gold layer was actually this mixture of gold and brass and seemed to date to Saint Gaudens' lifetime. And that's where we are, are we going to try to recreate the turn of the century vision or Saint Gaudens' final vision of the piece?

ALAN ALDA (Narration) Cliff Craine began the painstaking work of reassembling the plaster Shaw even as debate about how to finish it went on. Should it have the much admired bronze look of its first appearance, in Paris? Or should it have the more golden look the sculptor gave it in Buffalo, just before he died?

CLIFF CRAINE Ready Michael?

MICHAEL PALMER Yep, nice and easy...wait wait wait...go back a little more...

ALAN ALDA (Narration) In late August 1997, the Shaw arrived at its new home, one befitting a great national monument-- the National Gallery of Art. It's now just 10 days before it will be unveiled to the public, and the decision as to how it should look has been made -- almost. Cliff Craine has painted the entire surface of the plaster a golden yellow. Now he and his team are adding a darker glaze to bring out more of the surface texture. But while the Shaw will look more like Saint Gaudens' second vision than his first, its exact finish is still not quite settled.

NICK CIVOKSKY Well, it's complicated, and you know in frightful candor I would say that we don't exactly know until we get there. We're trying to adjust it to a setting in which it's never been. Not merely a room that it's never been in, but an interior space, in an art museum, with natural lighting, with artificial lighting, to make it look metallic without making it look like an imitation of something it isn't. So we're doing layer by very thin layer by very thin layer, and I hope we'll know when we get there.

ALAN ALDA (Narration) They got there, after two more layers of glaze, a few days before the official unveiling.

ALAN ALDA Oh, this is great, to see it like this through the doorway...

ALAN ALDA (Narration) I went to see it two days later.

SHELLEY STURMAN ...this perfect space in the whole building, where you've got this five gallery approach.

ALAN ALDA It's a great effect.

SHELLEY STURMAN And you come in and you're overwhelmed by the piece.

ALAN ALDA And you really get the effect of those faces. It's wonderful.

ALAN ALDA (Narration) Saint Gaudens modeled his soldiers' faces after real people -- and here, even more than in the bronze version, the dignity of these men marching into history is vividly apparent. This, so far as scientific and historical research can tell, was how Saint Gaudens wanted his Shaw Memorial to be remembered.

SHELLEY STURMAN I think that Saint Gaudens was such a wonderful artist that it comes through in all of the pieces...

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BRAIN MUSIC

ALAN ALDA (Narration) I'm about to try out a musical instrument unlike any I've encountered before.

TOD MACHOVER This is what we think of as a music videogame, actually. It's called harmonic driving. The idea here is that it's a piece of music that you actually drive through, and by the way you drive and the decisions you make while driving, the piece actually changes. You want to give it a try?

ALAN ALDA Yeah, if I crash, this piece is over, or what?

TOD MACHOVER Oh, it's a terrible thing that'll happen...

ALAN ALDA Oh all right, let me see. Let me do it...

ALAN ALDA(Narration) Called a hyperinstrument, its one of several musical machines being developed at MIT's Media Lab by a team headed by Tod Machover.

TOD MACHOVER Hey, all right. We start by building special instruments for the world's best musicians, like Yo Yo Ma, and Peter Gabriel and orchestras. For the last five years or so, we've been trying to build instruments for audiences.

ALAN ALDA Where the audience makes the music?

TOD MACHOVER Where the audience in the very least experiments with the music, sometimes performs the music and makes the music. These are sensors, one, two, three, four, and then under each of your feet, those are measuring how much electrical current is being picked up from your body. So as you move, it knows where you are in this field.

ALAN ALDA This, can I make the same... if I go to the same place, it does the same thing every time?

TOD MACHOVER The exactly...

ALAN ALDA So it's really like playing an instrument. There's no randomization involved.

TOD MACHOVER No randomization, plus right in the middle there's supposed to be a sort of cymbal sound.

ALAN ALDA (Narration) This sensor chair, like the other hyperinstruments here, was being readied for an appearance at New York's prestigious Lincoln Center Festival, just a few weeks after my visit. Luckily, it was still just a prototype...

TOD MACHOVER You broke it! If you want to come over for a second to what we call the rhythm tree, that's a different idea. That's one that's designed to have something physical that you hit that gives you a sound exactly when you hit it.

ALAN ALDA OK.

ALAN ALDA (Narration) The performance Tod Machover and his team are preparing is called The Brain Opera, and several of his hyperinstruments - designed to be played by the audience - look like bits of brain.

TOD MACHOVER This one is, you really have to work to get the kind of regular rhythm that you got with the sensor chair. Why don't you give it a try?

ALAN ALDA Right. Hello? Ladies and gentlemen, my fingers never left my hands.

ALAN ALDA (Narration) Teresa Marrin has invented a hyperinstrument called the digital baton, which makes different orchestral sounds depending on where it's pointed.

TERESA MARRIN Electric guitars, trumpets down here.

ALAN ALDA What's this again?

TERESA MARRIN That adds string sounds.

ALAN ALDA (Narration) An infrared detector follows the tip of the baton in space.

TERESA MARRIN I like that. Now take it down there, you'll get some strobe bass.

ALAN ALDA (Narration) Now on this instrument, supposedly the better I sing, the louder my angelic accompaniment.

TOD MACHOVER That was really good.

ALAN ALDA I think I just wrote Chariots of Fire.

ALAN ALDA (Narration) Three months after my visit to the Media Lab and

TOD MACHOVER and his band of hypermusicians and hyperinstruments were ready to meet the public. By now the heavenly choir was accompanied by angelic video images. The idea of The Brain Opera is that audience member first get to generate their own hypermusic on what were now fully-tested hyperinstruments.

ALAN ALDA The original was like being inside a skeleton and this is like being inside the real thing. It really does change the quality of the music.

ALAN ALDA (Narration) Tod Machover's vision for the Brain Opera is that the sounds generated here by the audience will be incorporated into the performance that follows.

ALAN ALDA It's hard to believe that this is going to become a symphony. In just ten minutes.

ALAN ALDA (Narration) Despite the plan to employ some of the audience's input in the performance, I can't say I noticed any input from my own earlier efforts in the lobby. I listened in vain for my perfectly sustained E-flat. But at one point in the performance, an even wider audience had their say when Teresa Marrin used her digital baton to select contributions from people listening in over the Internet. Since the Brain Opera's premiere here in New York, audiences in Austria, Denmark, Japan and Portugal have also had their say in its performance.

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