[HORNS]

NARRATOR: In the Electrical Engineering Laboratory at Massachusetts Institute of Technology, Professor H.E. Edgerton perfects a new high speed movie camera, which shows the eye of man things that happen too quickly to be seen. [TAPS] Here we are.

[GUNSHOT]

HAROLD EDGERTON: Your eyes aren't designed for speed. You shoot a bullet from here, you won't even see it. You won't know anything about it at all. So you have to have strobe.

NARRATOR: Just how fast is fast? Harold Doc Edgerton-- engineer, photographer, and educator-- spent a lifetime discovering answers to that question. Intrigued by what he couldn't see, Doc brought a belief in hard work, a playful joy in living, and a passion for learning to his life's work of analyzing motion and extending our perception of time.

PHOTOGRAPHER: Three, two, one. Shoot.

NARRATOR: These photographs in movies were all made with a stroboscopic light or strobe-- developed by Doc Edgerton in the 1930s. In his work, the science of electricity met the art of photography. Doc built on the work of others who had been trying to capture on film movements too fast for the eye to see.

HAROLD EDGERTON: Well, high-speed photography really started a long time ago-- the first photography that was ever done was by a fellow in England named Fox Talbot.

NARRATOR: In 1851, William Henry Fox Talbot fastened a printed paper onto a disc, set it spinning as fast as possible, and then discharged a spark to expose a glass plate. The words on the paper could be read on the photograph. 20 years later, Eadweard Muybridge led the way in photographing natural motion outside of the laboratory. As the legendary story goes, Muybridge was hired to settle a bet. Did all four hooves of a galloping horse simultaneously leave the ground. In 1978, Muybridge answered the question with a series of photographs of running, airborne horses.

Others shared Muybridge's interest in movement. French physiologist, Etienne Jules Madre, turned to photography to study the action of living things. To do this, Madre designed a photographic gun that used a rotating glass plate negative. He also made multiple exposures on a single plate. To emphasize motion Madre dressed his subjects in black and attached white lines to their arms and legs. Through the late 1880s and 1890s, laboratory experimenters tried to photograph ever faster movements by using electric sparks.

In Germany, Ernst Mach photographed bullets in flight. In England, Arthur Worthington studied splashes of all sorts. Turn of the century research into the principles of electronics led the way from open air sparks to electronic flash tubes. Setting the stage for Edgerton's strobe.

Harold Eugene Edgerton was born in Fremont, Nebraska in 1903. His parents, Frank and Mary, moved the family to Washington, D.C for a while but most of Harold's youth was spent in Nebraska. And the Edgerton's settled down in Aurora. As a child, Harold was fascinated with how things worked. From his uncle, Ralph Edgerton-- a studio photographer-- Harold learned his way around a dark room. And his father helped him get an after school job at a local power plant to give him some practical experience in what was turning out to be his first love-- electricity.

HAROLD EDGERTON: After graduating high school here, I went down to the University of Nebraska because I was interested in electricity. I intended to go back and work with the electric light people here. And my father set out to go east and go to MIT. Well, I never heard of the place but I asked a student from Aurora who had gone to Harvard whether he'd heard of it and he said, oh yes. Looked me in the eye and said, they only take smart people. I didn't take the hint.

Well, it seems like yesterday that I came over here in 1926. To look over MIT. I'd been working in Schenectady, New York at the General Electric Company and was admitted as a graduate student in electrical engineering to work on motors.

NARRATOR: As a graduate student at MIT, Edgerton studied the large, electric motors found in power plants. He was interested in what happened when a sudden change-- like the surge caused by lightning striking the power lines-- reached the motor. But parts of the motor spun so fast that his eye could not see what was happening. Then he noticed that a tube that he was using to send power surges to the motor, flashed brightly as the power peaked. When the flash of a light synchronized with the motor's turning parts, it made them look like they were standing still.

HAROLD EDGERTON: Well, I had to have it to measure this motor because it things happen so quickly that I couldn't record them. So this thing took pictures in 10 microseconds at controlled intervals of time. And once you had it, everything was easy.

NARRATOR: By 1932, Edgerton had moved his experiments with flashing mercury arc tubes out of the laboratory and into industry. He ventured into selling strobe a scopes meant primarily for observing machinery in motion. The strobe a scope could also be used with a high speed motion picture camera. With Edgerton's stroboscopic movies, operators of all sorts of machinery saw faults that were obvious only when the machine was working. But Doc didn't reserve the strobe for purely technical uses, he turned his light on everyday events and common sites. All of which revealed an uncommon beauty and wonder under his scrutiny.

HAROLD EDGERTON: I suddenly realized, there's a lot of things in the world that moves. I looked around, there was a faucet over there, right next to where I was working. So I just moved the strobe over and took a picture of this water coming out of the faucet. That was the first picture I ever took. Except for the motor.

[PIANO PLAYING]

NARRATOR: Thanks to Edgerton's flair for promotion, his photos began to reach a mass audience during the 1930s. Eager to explore new uses for his strobes, Doc went on the road capturing detailed images of popular, cultural, and sporting events. These pictures caught the imagination of news photographers nationwide. When a photo taken with Edgerton's strobe during a 1940 track meet was released over the wire, photojournalism entered a new era. A visitor from Hollywood soon came knocking on Edgerton's door.

HAROLD EDGERTON: And he said, I want a movie of throwing a custard pie through an electric fan. Well, I said I'm a serious scientist. I'm not going to fool with any custard pies. But let's compromise on an egg, what do you say.

NARRATOR: *Quicker'n a Wink* won an Oscar for MGM.

ACTOR: I always thought that my cat, in lapping her milk, curled her tongue up but now it's revealed that she curls her tongue down. See. In other words, she brings the milk up on the underside of her tongue. Now see how smart you get when you go to the movie?

NARRATOR: But the bright lights of Hollywood were being out shown by the flashes in the darkness that Edgerton created in World War II. In the summer of 1939, Major George W. Goddard paid a call on Edgerton and his colleagues at the strobe lab.

HAROLD EDGERTON: Well, one Saturday afternoon we we're down in the lab here working and a fella come in and said, where is it blinging light that I hear about. I said, it's right there.

NARRATOR: Goddard asked Edgerton if a strobe lamp could be build that would be powerful enough to take photographs at night from the height of a mile.

HAROLD EDGERTON: So I got my computer out and I calculated, well that will weigh two tons and so and so. And I said, yes we can do that. I'm sure we can do it. We haven't got a house but we can do that.

NARRATOR: In April 1941, the first experimental unit was mounted in the Bombay of a B18 and tested over Boston. The system's most famous test came on the evening of June 5, 1944 when the night time reconnaissance planes took off for Normandy. They were followed shortly by a flying army in C47's headed for the invasion of France. Photographs of the quiet night time landscape revealed that the enemy forces would be taken completely by surprise.

[EXPLOSIONS]

HAROLD EDGERTON: The clouds were down about 1,000 feet. And the flash bulb couldn't be used at all because they were designed to be working at 10,000 feet. So those pictures were useful. They were used all during the war.

NARRATOR: Ironically, the device that ended the war provided Edgerton with his next chance to photograph the un-photographable. The war came to a dramatic conclusion in 1945 but the work on nuclear devices had only just begun. The newly created Atomic Energy Commission asked Edgerton and two of his former students turned partners, Herbert Greer and Kenneth Germeshausen, to formalize their working relationship.

HAROLD EDGERTON: That was where it started. E. G. & G. Incorporated started right after the war as a in house captive thing for the nuclear energy. And we hired a lot of people and we set off a lot of atom bombs and did a lot of experimental things. If you working with anything, anything, you want to understand it. You got to see it and record it. Learn all about it. If you blow up an atom bomb, it happens instantly. Most shutters are way too slow so we built some magneto-optic shutters that worked in a millionth of a second. And then suddenly, one day we had an agreement with the Russians not to have any more atom bombs.

All my friends came around here and said, oh it's too bad. You're company is going down the drain. Because the Russians and Americans are going to not do anything anymore. And I said, oh yes? I learned long ago not to get excited when people panic. Well that was the best year we ever had because all the people got up early in the morning and started thinking about other things to do. And was all kinds of things to do.

NARRATOR: Throughout his career, Edgerton used strobes to record and study natural phenomena from freezing the motion of a hummingbird's wing to accelerating the wanderings of sand dollars along the ocean floor. In the early 1950s, Doc began experimenting with strobes for underwater, time lapse photography.

HAROLD EDGERTON: I built three units. We were going to go out and study the sediments in the harbor because every day the tides are going in and the tides coming out and taking the mud, moving it around. And low and behold, these movies were OK. They showed starfish and all kinds of things walking around on the bottom. The human being is no good for looking at starfish. If you look at a starfish sitting on the bottom, he just sits there. He's actually moving very slowly. When you speed him up about 200 times, he's going around doing all kinds of things.

One thing just led to another because I got a telephone call that said there was some unknown man came in from France-- a young Frenchman with a big nose and named Jacque-y Cousteau. Nobody ever heard of him but he's here and could he come up and talk to you about underwater diving. Well, I said sure. I'll talk to anybody. So he came in and I found out he had invented the aqualung. He hadn't been at MIT more than a couple hours before we had a tank on his back and he was testing my latest underwater strobe in the swimming pool.

JACQUES COUSTEAU: I needed advice to better illuminate underwater sceneries I was filming. That's why I came to his lab at MIT. When I told him that in the sea, the most colorful tropical fish looked dull and grey. Howard was fascinated and immediately started to design, build, or adapt. And an arsenal of high intensity lamps flashes and strobes, synchronized with the shutter of my camera. From then on, he repeatedly embarked with us on the *Calypso.*

NARRATOR: In murky seas, however, the strobe was worthless. So Edgerton developed sonar equipment that could see with sound.

HAROLD EDGERTON: I was in Athens with Cousteau on the *Calypso,* and he came in one day and said, is that side scan sonar good for picking up a ship that's 1,000 feet long? Think you can find it? Well I said, if I can't, we've got to go home. With a sonar you ought to be able to find it in no time. Then they go down and looked, next time we found it. Was a long way from where anybody ever thought. There it was. Just as clear and sharp. We discovered the monitor with a side scan sonar and that's a sample of the side scan sonar. That's the kind that found it.

NARRATOR: Edgerton's many expeditions took him all over the world but his love of teaching always brought him back to the classrooms and laboratories of MIT.

HAROLD EDGERTON: Now we'll try to find it with the strobe. And you can tell whether the girl's singing flat or sharp or whatever it is. Some people can tell without this strobe. If any of you take particular interest in these things we got here, come on down and run them. Ever since I've been here I've been giving lectures, demonstrations. I drag in all kind of equipment. Run it and let the students see it. My argument is that that's the way to get to the real world is to go out and work with it.

KIM VANDIVER: One of the things Doc was fond of saying is the trick to education is to not let them know they're learning something until it's too late. There are so many students out there who really loved Doc and loved to come back just to see that the lab is still here and the photographs are still in the hallway is because he was very supportive. You came in and said I'd like to try something that I've never had a chance to do this before. And he'd say, what are you waiting for. There's a workbench, there's a soldering iron. Go do it. And he would help people. He helped people financially. He helped people just with materials and equipment and his own time. And gave advice and lots of encouragement.

NARRATOR: Doc's door to his lab or to his home, was always open. Ester, his wife since 1928, would remark that she'd never cut the meat for dinner until Harold came home because she never knew how many people he'd be bringing with him. For Edgerton, teaching wasn't confined to the four walls of a classroom.

HAROLD EDGERTON: Now watch it real close. But your eyes can't tell it. Your eyes are no good for anything that moves fast. I like to see people recognize that they're seen something they never saw before and that they've learned something. Their eyes open up when they're so awed by what they see. That's a good educational shock.

SPEAKER: Is this before the drop hit or is it after the drop hit.

CHILD: After one drop.

HAROLD EDGERTON: People like it because it puts the action into a form that is frozen so that you can recognize what's happening.

SPEAKER: There's also an aesthetic quality about it. Beauty in motion. [INAUDIBLE]

HAROLD EDGERTON: Supposed to be real art. I don't care. If they want to call it art, call it art. Now this picture was a fizzle. I normally throw away all my bad negatives and I just about threw this out and I said, I'll make a print of that. And it's down in the Museum of Modern Art in New York. I really think of myself more as an electrical engineer. I wanted to get the message across. Educational expereince.

NARRATOR: If you weren't actively testing your ideas, you were wasting time. For Doc, learning by doing was most important.

HAROLD EDGERTON: Not every experiment is a success. And the ones that don't work are really more important than the ones that do work because you can check them off. And I think that's one things that students need to learn is that most of the things you do in life are a failure. When you find out what the failures are then you don't do it that way next time. Well, I think having an interest in something is very important in life. You have to get up in the morning and want to do it. And I used to tell people if you don't wake up at 3:00 in the morning and want to do something, you're wasting your time. Time is very precious. We're wasting it right now. I got through to you didn't I?

NARRATOR: Edgerton did get through to us. He revealed worlds we had barely imagined. From the simple beauty in a drop of milk to the unhurried travel of starfish. But Doc gave us much more than the ability to see the unseen. He taught us to believe in our ideas and to enjoy the pursuit of our dreams. His humor, insatiable curiosity, and sense of wonder enlightened us all. The world is a brighter place thanks to this extraordinary man.