Katz

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After briefly reviewing his upbringing and education in the physics field, Katz (b. August 15, 1915) discusses his career from 1940 to 1954 at Wright Field. He covers, among other things, his initial work in the photo lab during World War II; relations with George Goddard, James Baker, and others; work immediately after the war heading the photo unit at the Bikini atomic tests; and subsequent involvement in such projects as balloon photography. Katz then describes certain aspects of his career at RAND beginning in 1954, including his work on reconnaissance projects. He next discusses the art of photo interpretation, his collection of photographic materials, and key developments in the late 1940s and 1950s in the development of a US reconnaissance capability.

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Interviewee: Mr. Amrom Katz

Interviewers: Dr. Joseph Tatarewicz and Martin Collins

Location: Mr. Katz's home, Santa Monica, California

Date: July 24, 1986

TAPE 1, SIDE 1

Dr. Tatarewicz: We like to start way back, for our biography questions, and ask you where you were born and who your parents were.

Mr. Katz: I was born in Chicago on August 15, 1915, in the Lying In Hospital. My dad was named Max Katz. My mother, Lena. I was less than a year old when we moved to Milwaukee, Wisconsin, where I spent my early years.

Tatarewicz: What were their occupations?

Katz: My mother was a housewife. My dad had several different occupations during his career. He wound up as a building manager, minding his and others' properties. He had a terrible accident when I was about two or three years old, got his leg caught in an elevator which was not up to the primitive safety standards of that time, between the elevator and the floor, lost his leg, not unless you knew him, you'd never tell that he had this handicap. He had the most marvelous sense of humor of anyone I've ever known.

I grew up in Milwaukee, did all the normal things, lived in a community where nobody who I knew had a car. People were poor, but it wasn't till years later that I realized that we were poor. It came to me as a revelation. I figured it out later, that the peculiar constraints I had at the time meant that I must have been poor.

Tatarewicz: Were there any brothers and sisters?

Katz: I have three younger brothers, younger by five and ten years respectively. One of them now lives in Bellingham, Washington. And the younger of the two brothers lives in Milwaukee.

I went to school in Milwaukee, graduated from West Division High School.

Tatarewicz: Just to back up a little bit, did you read very much as a child? What sorts of childhood interests did you have?

Katz: I was interested in everything, as I recall. I read books like mad. I still read at a very high speed. Not at the Evelyn Woods' speed. That speed is desirable to have you read stuff fast, that never should have been written in the first place.

Tatarewicz: What kinds of books did you read?

Katz: I read a lot of history, a lot of travel, not much science, I wasn't particularly interested in it as a kid. In high school, I was an associate editor of the school paper, and this impressed me so much that I thought of going into journalism.

I entered college my first year in '32, '33. I went to school at the University of Wisconsin Extension Division in Milwaukee, which was only about six blocks from my home.

Tatarewicz: How did you choose that, was it proximity, location?

Katz: There was no big choice of schools. It was the closest and cheapest one. You were lucky to get in there. It was the middle of the Depression. The Depression affected us all. I had plenty to eat, clothes, heat in the house, so I quess we weathered the Depression if not comfortably, certainly far better than million of other Americans.

Tatarewicz: Did your brother go the college also?

Katz: Yes. My second brother, five years younger than I am, went to school at the University Extension for a year or two, then to Madison, and then he got drafted. He was a meteorologist/climatologist. He got out of the Army and took his Master's degree in meteorology, at Penn State.

My younger brother, ten years younger than I, went to school in Madison. When he finished there--he took a degree in optometry at the Northern Illinois College of Optometry, practiced in Milwaukee for a few years, and got into the real estate business and has been a very successful contractor and real estate manager.

Tatarewicz: When you were leaving high school and going into college, besides journalism, were there any other strong interests that you had?

Katz: The last year of high school I got interested in astronomy. I hooked up with some amateur astronomers, and became active in that, built a telescope. That led me in turn to an interest in physics. I was fortunate in that the University Extension in Milwaukee had some full professors that did mostly teaching and not research. This University Extension was so structured that freshmen taking physics courses could have the benefit of listening to a full professor in physics who was a marvelous teacher. As a result, I switched my major from journalism to physics and math.

Tatarewicz: Who was this teacher?

Katz: This was a chap named Miles J. Martin. I ran into Martin once after the war. I had no idea where he or what he was doing.

I had a full professor in German. I had a full professor in chemistry. These were great teachers. So it was a remarkable introduction to college life. I went to the Extension for three years, instead of the normal two. They wanted me to take a few extra math courses. I enrolled in the CCC (Civilian Conservation Corps) in the summer of 1935 and worked in the north woods of Wisconsin. I didn't know whether I would be going to Madison (U. W.) but my folks saved up enough money for me to get started. Then the following fall in '35 I went to Madison, where I found a complicated deal which enabled me to be in the graduate school as an undergraduate. I took lots of graduate courses, never took a graduate degree.

Tatarewicz: This is the graduate school in physics at Madison.

Katz: In physics. Yes.

Tatarewicz: Before we move on to the graduate courses, how did you support yourself or how were you supported during this time? Did you have to work or was there any kind of aid available?

Katz: I worked for NYA, National Youth Authority, for awhile, and got paid 35 cents or 40 cents an hour, my first paying job. But that wasn't my major support. My major support came from my folks directly. I didn't have any other jobs, to support myself.

Tatarewicz: OK, so you arrived at Madison and you're taking graduate courses but you're not exactly a graduate student,

you're not on a degree track?

Katz: Not on a degree track. I eventually spent four years in Madison, and on the way out I took my bachelor's degree. So I spent seven years in college and I got a bachelor's degree. I found that a PhD is not really required. The only time you ever need the degree is when you're being introduced to give a speech, and then you get it automatically.

Tatarewicz: Through this time, were you considering career choices at all?

Katz: This is odd. I've thought about this often, when I talk to my kids and other kids, and to other people who were in college the years I was there--I must admit that I didn't have any career in mind. I didn't know what a career in physics was like. I had nothing to look at. No data was available. The only thing I knew was, people who take physics teach physics. So the only career that seemed to open up was teaching, and it opened up in a loose sense. I hate to say this, but I really didn't have anything in mind. I had no plan, nothing. There was a lot of unemployment in the thirties. A few years later, I was at Wright Field, in Dayton, with the U.S. Army Air Corps, (later to become the Air Force). When Pearl Harbor was bombed, they commissioned civilian engineers who were working at Wright Field. In those years, they had never heard of physicists, it was still a rare item, believe it or not, so physicists were about to be drafted as privates, and engineers were to become lieutenants. It wasn't until a little while later, '42 or '43, that physics became a noticed subject and people paid particular attention to physicists. As I said, I had no career in mind, and in fact, my first job was with the government in Washington, in the Census Bureau. It's unbelievable, how I got there, along with everybody else.

What happened was this. In the spring of, fall of '38 or January '39, some time like that (this date is recoverable), an announcement of a civil service examination was posted in post offices around the country, for a Student Fingerprint classifier with the FBI. I believe almost every college senior in the United States took that exam--140,000 people were on that civil service register. There were two jobs! Then the two jobs were filled, I guess. No one ever heard from the FBI. But there was this register sitting with all these names, and along came 1940, with the 1940 decennial census on the agenda. There was the requirement to hire a large number of temporary people, so the Census Bureau had the bright idea of picking up this register, and they started hiring off the top. It became a joke that all one had to

know was your grade. They knew what day you reported for work and vice versa. There was a one to one correlation, between your score on the exam, and the date you were hired, so a status system was set up related to date of hire. As I recall my score on that exam was 97.7. There were some people who were already working at the Census Bureau before I got there, they had done 98.2. Some guys came weeks after I did, they did 96.7. The pecking order was set up.

Tatarewicz: You were all aware of this

Katz: Sure.

Tatarewicz: And there was this hierarchy.

Katz: This hierarchy, where what everybody wanted was status. We were classified as CAF 3. CAF was a civil service classification for Clerical, Administrative, Fiscal. Not professional. CAF 3. We thought that was pretty hot stuff, because we had jobs and were paid. We were paid $3.95 a day. It sounds ridiculous but it turns out to be $1440 a year. And we got the jobs, and the next thing we were after was permanent civil service status. There is a P list, Professional 1,2,3,4,5, that's GS now. P1 was equivalent to GS 5, and titles went with this, like in royalty. Junior physicist, assistant physicist, associate physicist, physicist, senior physicist, principal physicist, chief physicist, and I don't know what the hell the others were, nobody ever heard of them.

We used to hold these ratings in such awe and admiration. When I worked in the Census Bureau, we originally worked in the Commerce Department building, the huge building out on 14th Street There was a famous economist working down the hall in the Bureau of Foreign and Domestic Commerce, Bob Nathan. You may have heard of him. As I recall, he's the guy who invented the concept of national income, and GNP, and so on. He was a P-5. That's now a GS 13. When he walked down the hall, the word would be flashed to all the clerks, "There's a P-5 walking down the hall!" We'd go out and look at him.

Tatarewicz: What kind of work were you doing as a clerk?

Katz: I got snapped up by W. Edwards Deming, who was a famous statistician, and from recent newpaper accounts, is still very active. He was one of the few mathematicians and physicists in the stockpile. I heard of mathematical statistics for the first time in my life when I got there. In Wisconsin we didn't know anything about that. There wasn't a course in that given.

The math department didn't have any mathematical statistics courses. It was a new subject in '39 and '40. There had been some people working in it. It was possible at that time to own all the books on statistics and have them occupy a half a shelf. It's no longer possible to do anything like that. There is now a whole library of books. So I took some statistics courses at the Department of Agriculture Graduate School. It was a wonderful school. I learned something about mathematical statistics.

In the Census Bureau worked a guy named Morris Hansen, a very bright self-educated economist, I think. He knew mathematical statistics and was very good at it. I stayed there about a year and a half. I worked on sampling problems, and incidentally, mathematical problems. From Washington I went to Wright Field. The European War was begun close to the day I moved to Washington, September 1st, 1939, within a day or two of that. What turned out to be War II was declared. Then we realized we ought to do something with our statistics or our physics or something. The civil service systems worked in the following way: Somebody in Dayton, Ohio, at Wright Field has a job opening and requests three names. You had to get three at a time, you couldn't hire some guy just like that. You get three names, three guys off the top of the register, and you examine their credentials, you review them, you pick one, and the other two guys get thrown back in the pot. Well, my name went out and I didn't get the job. The job was an X-ray technician, in the materials laboratory. I never found out what the job involved. I didn't get this job. But they didn't send my name back, so I was in limbo, I wasn't available and I didn't have a job, for months. Finally I got another call from Wright Field, proceeding with great caution, to come out for an interview in the photo lab. I didn't know much about photography, I didn't know about film--you unfold a camera, the lens goes out, and you take a picture.

Tatarewicz: Had you still kept your interest in amateur astronomy through these years?

Katz: Yes.

Tatarewicz: Had you done any more in lens grinding, anything like that?

Katz: No. Our major activity as amateur astronomers was with SS Cygni, a variable star--there were big contests among the amateur astronomers to see who got the greatest number of readings on variable stars. That was a big activity in Milwaukee and elsewhere.

Tatarewicz: Were you a member of any formal organization?

Katz: I think I was a member at one time of the Amateur Astronomers of Milwaukee. But I can't prove that. It was a loose orgainzation.

Tatarewicz: Did you submit your observations to the AAVSO?

Katz: Yes. We used to get thank you cards and comments on the observations. I was in the running in the competition. This place where the telescope that we used was sited about an hour and a half streetcar ride from where I lived. Then you go there and wait till it's dark, observing all night, coming home at 5 in the morning--something I couldn't do every day. I'd do it a couple of days a week. It was a great activity. I'd leave the telescope and the amateur astronomers, say about 4:00 am hustle over to a streetcar stop several block away, and catch a streetcar. Now at that time of night, very frequently I was the sole passenger in a double header (two cars, connected by a flexible boat). One night I boarded an otherwise empty car. Getting in at the front, I walked through the empty first car, and sat halfway back in the second car. A few blocks later, a drunk straggered on and with two empty cars available, he carefully made his way to my seat and sat down next to me! This experience contributed to my giving up this activity several weeks later.

Tatarewicz: Did you keep this up while you were in school?

Katz: In college? No. For the first year while I was in Milwaukee Extension I did, but not more.

Tartarewicz: One other thing, before we move to Dayton. That is, I'd like to know a little bit more about what your interests were in physics during the seven years that you spent, what sorts of aspects of physics interested you the most?

Katz: Oh, not nuclear physics. No.

Collins: Not nuclear physics.

Katz: I was interested in experimental vacuum techniques, and making mirrors and steps wedges and things like that.

Tatarewicz: So you did a lot of fabrication and a lot of manipulation of materials.

Katz: Yes.

Tatarewicz: As part of the physics, and so you had some substantial involvement in optics, then.

Katz: Yes. Well, most of the optics I learned, I learned after I went to Wright Field.

Tatarewicz: OK, let's then go to Wright Field. You're in the photo lab, assigned to the--

Katz: Assigned to the photo lab. The chap I worked for told me one day, "There are three things I'm not interested in--cameras, photography and airplanes." Here I was in the airplane photography business and he makes this observation!! This came to a head one day, when the B-19 came to Wright Field. I know you've never heard of the B-19. This was the world's biggest airplane. It had twice the wingspread of a B-17, and four little engines on it, and these engines barely got the thing off the ground. When this airplane flew, you could look south and see it flying, go back and read a book for ten minutes, come back and it wouldn't have moved very far from the place in the sky where it was 10 minutes earlier. It looked like a butterfly flying. The world's biggest airplane, it had tires that were seven feet high, as I recall.

I was down in the basement of the laboratory building. I couldn't go on out to the airfield to see it as everybody else was doing unless my boss gave me permission. So I said, "Clarence, let's go see the B-19." He said, "What's that?" I said "Geez, it's the world biggest damned airplane!" He said, "Well, how big is it?" I said, "It's twice as big as a B-17." And he said, "If I want to see that, I'll stand twice as close to a B-17."

So I had a problem. It's absolutely true. I couldn't make up a story like that.

Tatarewicz: You were on pretty good terms with your boss. You were calling him by his first name. what kind of work were you doing in the photo lab? What were you duties?

Katz: Well, that's interesting. We had this guy George Goddard, I gave you a paper on him, as laboratory boss, and he knew a few physicists and appreciated their work, and he put me in the sensitometry laboratory. The sensitometry laboratory dealt with film. We'd make sure that the film batches we were getting from Eastman Kodak had H & D curves as advertised, and sufficient sensitivity. We had a gigantic sensitometer which was able to

impress on a piece of film an H & D curve, would measure the calibrated light values. I spent quite a bit of time reading those curves, pushing the spot photometer, where you match the density that separates with a known calibrated density and see whether it's higher or lower. It was quite a sensitive instrument.

It was dull work. I got interested in camera shutters, and I worked out a measuring device for camera shutters. It was much better than the device they had, which looked like it came from the 1893 Fair, very primitive. It's described in this book. I'll tell you about this book in a couple of minutes.

Tatarewicz: For the tape: this is Herbert E. Ives, AIRPLANE PHOTOGRAPHY is the title of the book. What is the date of--

Katz: Probably around 1920. There's much to be said about that book, I'll say in a minute or two.

Tatarewicz: OK.

Katz: I got interested in camera shutters, and we set about a program which I can describe to you as a logical program, which isn't the way the program evolved. The description I put on it--after we looked back on it to see what the hell we did--we went to tell the story logically, but it wasn't done logically at all. I worked with a very clever engineer, largely self taught, Billy Mungell by name. We designed and built a very large louvre shutter for a 48 inch F16.3 lens. The louvre shutter consists of a venetian blind arrangement of steel slats which are driven by a spring. My part was an article on camera shutters in the JOSA, which describes the shutters in detail. I did the mathematical theory of the system, while Mungall designed and built the shutter.

I worked out testing methods for shutters. We worked with NDRC, part of the OSRD, Office of Scientific Research and Development, and started some shutter projects. We improved the speed of shutters. We could see airplanes were getting faster and we wanted to take sharp pictures. The only way to take sharp pictures is to get a short exposure time.

Later during the war we cooked up the idea of moving film, which all those things are done now, film moved during the exposure, and came up with the image motion compensating speed. Riding forward in an airplane, everything's going this way, your film's moving in the same direction, because the object is going by in the opposite direction, to compensate for a blur and so on.

So I got into that, and I got into lens testing in the same laboratory. Goddard wanted us physicists to fly. He said, "You're not going to learn anything about the subject if you're just sitting in the laboratory." He's right. So he said to me, "Take pictures. Develop pictures yourself." Everybody got a Speed Graphic, a four x five camera, lots of free film, all the weekends you want. Take pictures, develop them yourself, print them, learn the subject." It was great.

Tatarewicz: So the laboratory, all the film you were testing at your first job within the film lab, this was all for reconnaissance photography?

Katz: Yes.

Tatarewicz: That was the main focus of this laboratory?

Katz: Yes. That was the only focus. There was a mapping section at the lab, to support the Corps of Engineers, and they were concerned with mapping cameras.

Tatarewicz: That was the only focus of the laboratory at Wright. And how did you go from your work on calibrating and testing these batches of film to designing the shutter? How did you pick that up?

Katz: I stopped doing one thing and did something else. There was no transition.

Tatarewicz: There was no transition. Did you get interested in it? Did somebody assign you to another project? Or did you just get interested in mechanisms?

Katz: I got interested in camera shutters. I must have gotten permission to do it, because I was doing it in a kind of bullpen laboratory, with offices off the periphery. It is hard to describe. So I would be testing shutters. In fact, the shutter tester I evolved became the industry standard. Ernie Krause helped me at long distance on that project, because I didn't know much about electronics. We got a Dumont oscilloscope, 175 A I think it was called. We wired a photocell, a light behind the shutter, then clicked the shutter. The photocell plotted the aperture curve, and we put an audio oscillator on the thing and chopped it up in tenths of milliseconds so we could count how many milliseconds it was open. We had enough data so we drew shutter efficiency curves, as it opens. For the focal plane shutters we used a different kind of a tester.

When we were involved, we were soon doing experiments. I don't know how we got into it, we just saw something to be done so we'd pick it up and do it--the system by which we did some things and failed to do others.

Tatarewicz: Had you had in your physics training exposure to electronics at all?

Katz: No.

Tatarewicz: Did you just pick that up?

Katz: I picked up the little I had, which isn't much, by talking to Ernie Krause, and to a guy in our laboratory (Dave Kerns) who was an electronic type working elsewhere. It doesn't make much sense now, but I think it's accurate to report that it didn't make much sense at the time either. That's the way it was.

One day we got the idea that lenses weren't taking sharp pictures. I am talking about lenses used in aerial cameras. We looked into lots of possible reasons why. We wanted to know how sharp the pictures were. We ran resolution tests in the laboratory. We had a three-line target. It works like this. Here's three lines. You have three lines going in the horizontal direction. This is the pitch. That's the width of one line and one space. One line and space was a tenth of a centimeter, and you'd have ten such lines per centimeter. We made targets which had this spacing, and eventually, we went down to spacings that varied by the cube root of 2, variation between spacings, and we went down to the 6th root of 2, to get finer readings. Here we had a pattern consisting of big lines like this, and smaller lines, down to--the most we ever got in the laboratory was about 25 lines per millimeter. We would move the resolution target--the lantern slide with both course and fine three-line targets--in the focal plan of the collimetor and turning on the lamp, we would project the image of the target as if it was at infinity. We then mounted the lens under test on an optical bench and photographed the original target. The lens under test was say 24 inches full length. The collimator was, say, 96 inches full length. The image of the target would be photographed by the 24 inches lens, the resulting image would be 24/96, or 1/4 the size of the target. We would inspect the image and discover for example the target just barely resolved was the pattern which on the target was eight lines/mm. Then we knew that the lens under test resolved 32 lines/mm.

So you look up here, you find which pattern is resolved, you

know what the calibration of that pattern is, and you say the resolution of that lens is 32 lines per millimeter, or whatever. We tested lenses in various angular postions. The reason the historic results can't be used for, these tests can't be used any more, because they were limited by the collimator. We had an old Georz Dogmar Lense. That wasn't very good. We replaced it with a parabaloid reflecting mirror which Baker designed for us, which improved the resolution of the lens under test. After talking about this for a couple of months, I decided to make some aerial tests. I didn't have any targets at this stage, but I did take some big blotting paper, used to dry big prints. It was about so big. I had black sheets and white sheets.

Tatarewicz: It's about one yard square roughly.

Katz: One yard square. I made lines out of that and nailed it to the ground. I got the first picture somewhere in this office. We could never tell where to direct the pilot. We needed a conspicuous spot. Wright Field--runways a mile lone or so in length--and Wright Field had experimented with an accelerated runway. They had the bright idea that they could take an airplane up the hill, how they got there I don't know, and pave a piece of concrete going down the hill, and the airplane would get a flying start.

So this was a noticeable location. It was an eccentric idea, a right angle runway, but we used this little corner here, serves as a good checkpoint to tell a pilot where to fly over. I nailed these things to the ground, literally, and had some pictures which proved what we knew but we didn't have proof of--namely that we could get very good resolution in the air, as long as you take a low altitude picture. You don't want to miss that, with a lot of details, so big it swamps the sharpness, but if you're at high altitude, 30, 40 thousand feet, most of your requirements are, because the details are small--let me see if I've got some pictures here.

Tatarewicz: This accelerated runway which is inclined feeds at right angles into the middle of one of the conventional runways, and this target is placed just in the right angle outside the two runways but where the accelerator runway joins the conventional runway.

Katz: This is a picture that shows, taken at the same time, the same object, two cameras. This camera had moving film. This camera did not. You can see the amount of blurring here, every thing is blurred in this direction, about a quarter of an inch or half an inch.

Tatarewicz: For the tape, this is IVV DCEFA 28 May, '51, comparison test--IMC--

Katz: Image Motion Compensation.

Tatarewicz: Image Motion Compensation versus no Image Motion Compensation, IMV verus no IMC. It's taken by a six inch K-17 camera at 400 feet distance, 255 miles per hour, at 1/50 of a second at f.22, with 4.8 inches per second Image Motion Compensation.

Katz: It's a nice picture and this is a terrible picture.

Tatarewicz: Yes.

Katz: See, the airplane was going 225 miles an hour, that's about 300 feet a second or more, 1/50 second of an exposure means six feet of motion, at 300 feet a second, during the fiftieth of a second the subject has moved. So this looks like a very sharp picture but it's not very sharp in terms of lines per millimeter. Everything is crystal clear. It's big. There's no substitute for getting close to an object.

Collins: So I'm not exactly clear then what purpose the target served that you set by the right angle runway.

Katz: The target served the purpose of being something that you could speculate in terms of lines per millimeter, measured in actual flight in the currency of the laboratory.

Tatarewicz: So how did you determine that the problem was the motion of the aircraft and not something else? Was that because you were flying so low that all the other effects had to be negligible?

Katz: Yes. In the case of that picture I showed you, that was true. In the case of high altitude pictures, there are lots of things in the picture. As a matter of fact, if we'd started out in this subject saying, "Here's an airplane, come and take a picture from it," and turned the problem over to a couple of physicists, they'd prove you couldn't take a picture from the airplane. You know the difficulty you have taking a picture of your kid on the weekend, getting him in focus, getting him to stand still, not blurred, following motion, there's vibration, there's temperature effects, there's index of refraction effects--nothing good happens when you take a camera in an airplane. That's not good. Bad things happen. Vibration can be

just as ornery as image motion compensation, and image motion without compensation.

So we worked on all those things, not systematically, because there was a war on and we had requirements from the field. That always took priority.

Tatarewicz: You mentioned George Goddard earlier in the context of the laboratory. I presume he was director of the laboratory when you got there?

Katz: Yes. He was a major at the time. His second in command was a Major Cabell, who later wound up as deputy director of the CIA, a four-star general. Goddard was a remarkable man. He was very unmilitary, as I've written. He didn't care much about the military except photography and flying and long focal lengths, bigger and higher and faster and lower and darker. He was a photographic nut, or perhaps I should say "enthusiast". He's just what it took.

TAPE 1, SIDE 2

Tatarewicz: You were just describing George Goddard and his style at the laboratory at Wright Field. What kind of an organization was this laboratory and how large?

Katz: I'm not going to be able to help you very much, because I was in the laboratory for 15 years and I should know these numbers, but I don't have them. The laboratory population pulsated. In a state of emergency during the war, it was quite big, probably about 250 people in the laboratory, which had an optics section, it had a photo physics section, which had a few physicists and chemists. It had an installation branch, had an engineering branch, large photography branch--we worked with flash bombs, which were very dangerous. Then when the war ended, the population of the laboratory went down. When Korea happened, it went up again. Now it doesn't exist at all. It's been organized out of existence.

Tatarewicz: You also mentioned that James Baker was there at one time. I was wondering if you could describe the circumstances under which you first met Baker.

Katz: Yes. It turns out I met Baker's wife Elizabeth before I met Baker. I didn't find it out until after I knew him for a couple of years. She was in one of my graduate math classes in Wisconsin, a class in theory of functions of real variables.

Baker was hired by Goddard as a consultant for very low pay. He came from Harvard, took a room above the railroad station in a cheap hotel, came in every day to work designing lenses.

Then, when the war started--this was before we were involved--the war had started in Europe but not in the United States, the United States was not involved--in 1941, he set up the Harvard University Optical Research Laboratory, didn't work at Wright Field any more, he just came every couple of months.

Tatarewicz: Who else did Goddard bring in? Was he always bringing in consultants for special problems and special projects?

Katz: Baker was unique. As far as I can recall, I may be wrong about this but I don't think so, he was the only consultant we had who was a direct contract employee, in the sense of being hired by Goddard as a consultant. We had lots of work done for us by scientists, after we got into the war. There's the remarkable Volume 16.1, OSRD 16.1, the OSRD series. Did you see that?

Tatarewicz: Yes, we're familiar with that series. But for the purposes of the tape and the interview maybe you should describe what that volume is.

Katz: That volume described work in optics and photography done by the National Research Defense Council, operated in the Office of Scientific Research and Development, OSRD. There were several long chapters by Jim Baker in there on lens testing, lens designing, and building, which is what he did. The book describes the work on anti-vibration mounts done by Jaspar Chandler up at Eastman Kodak Research Labs. Jasper Chandler, some excellent work. It's a very valuable volume.

Let me tell you about this book by H.E. Ives. One day I went over to the library at Wright Field, and I saw a shelf which had this book on it. There were about eight or ten copies of the book. I looked--the card was still in the book--and found that nobody had taken those books out for at least ten years. I took the book out and read it, and I found that every idea I had had been anticipated in this book. Set your scan at a regular time, frequencies. Ives invented or describes moving film magazines, camera mounts--it's a kind of old fashioned looking book, it doesn't seem like anything would be in there.

Tatarewicz: At what point in your tenure at Wright did you come across this book? Early, middle, late?

Katz: Late in the war.

Tatarewicz: Late in the war.

Katz: Yes.

Tatarewicz: Many copies of this book had been sitting on the shelf and had some of these ideas been brought up by people or by you independently, as fresh solutions to problems?

Katz: Sure.

Tatarewicz: While this was sitting on the shelf in the library?

Katz: That's right.

Tatarewicz: This is on page 75 in the chapter called "The Shutter." "In connection with film cameras, another solution which has been suggested is to move the film continuously during the exposure in the direction of the plane's motion," and then a formula is given for the speed of the film that will eliminate distortion.

Katz: That's great.

Tatarewicz: So how at Wright was the Image Motion Compensation problem solved?

Katz: When we say we solved the problem, we didn't solve the problem, ourselves. We had a number of facilities to build things. We made an experimental shutter for a big camera one time. Before making things, we found out the contractors, we then supervised and agitated and complained and finally paid them off. So we had moving film magazines made for us by contractors.

Tatarewicz: Who designed these magazines and designed the specifications--was it you?

Katz: We wrote the specifications. Camera magazines were built by Fairchild Camera, which is no longer in existence. Chicago Aerial Survey, which has been transmuted into another company, Chicago Aerial Industries or something like that. And a couple of other contractors made these things.

Tatarewicz: So you just wrote a specification that the film magazine must be able to move the film at such and such a speed.

Katz: With such and such a precision at such and such a range.

Tatarewicz: It was up to them to invent the mechanisms or whatever was necessary to implement that in a piece of hardware.

Katz: There was one camera we had, a continous strip camera, which was adapted from and inspired by a race horse camera. You often see picture at the end of a horse race.

Tatarewicz: Oh yes.

Katz: That's taken by a strip camera. It's focussed on the focal point at that line, and it photographs what's going through that line, so it paints the horse as the horse runs. The film's moving at the horse speed, all horses don't run at the same speed, so there's a compression and some extension on the part of some horses. But it can tell which horse's nose got across first.

That inspired the aerial strip camera, which was a camera that operated as follows: you have a film magazine here, you move the film past this slit in the focal plane of the camera--the film moves in the line of flight. That camera interested me very much because philosophically, that was an aerial camera. That camera couldn't work in an airplane that was standing still. You take a Leica or a Contax, Nikon, you can take a picture from an airplane when the airplane is standing still. You take a picture when the airplane's moving, you'll find a shutter speed that stops the motion. But the strip camera requires motion of the airplane. It's philosophically an aerial camera. It can't work if there is no motion relative to the ground.

Tatarewicz: I'm kind of curious, do you know who it was that made the connection between the race horse camera and implementing that in an aerial context?

Katz: Yes. Stop that for a minute. . . . . you ought to write down a name, George Lawrence.

Tatarewicz: For the tape--the story of the use of the race track camera is in George W. Goddard, with DeWitt Copp, a book <u>OVERVIEW, A LIFELONG ADVENTURE IN AERIAL PHOTOGRAPHY</u>. And that is Doubleday, 1969.

Katz: I'll show you later some items, on the second shelf on the top at the end, Goddard's archives.

Tatarewicz: Oh yes, Goddard Archives, 1914 to 1980.

Katz: This is a World War II Air Force publication. The other

one is the British Photo Interpeter's magazine.

Tatarewicz: OK, very good. Let me ask you before we do that, you just mentioned this person who took the panoramic views of the San Francisco earthquake from a camera borne by kites and balloons. I was wondering if you could tell that story, and then tell us a little bit about how much digging you did back into history?

Katz: Yes. I was always interested in history as a subject, although I admit now that if I had recognized that what we were doing at the time I was working at Wright Field when I was busy with the subject was, in fact, inventing the reconnaissance, I would have paid more attention to the historical aspects, kept materials; more materials would have been packratted away, and I would have paid more attention to historians. To my eternal regret, I never met Orville Wright. One of the two Wright brothers was still living in Dayton when I lived there. That's like a similar experience here. Up to a few years ago, Kerensky, who led the Russian Revolution, was in residence at Stanford. He died just a few years ago. I could have met him but I didn't. These are regrets.

George Lawrence died before I was able to meet him, in fact, before I ever heard of him. I ran into George Lawrence in the ENCYCLOPEDIA OF PHOTOGRAPHY. His story was so fantastic that many years ago I took off a few days and went to Chicago and looked him up in the Chicago Reference Library. There are quite a number of his photographs, and some of his cameras as well. But nobody was able to write extensively about him because his family controls all his diaries and had no interest in having anybody do it.

As I recall George Lawrence got into photography through the back door. He owned some property in Chicago. One of his tenants was a photographer and one day the guy didn't pay the rent. He absconded, leaving a camera and equipment, so George Lawrence got into photography that way, by default on rent payments.

He liked, like George Goddard, the big stuff. He was commissioned by the Chicago and Altoona Railway to take a picture of a famous train, the Altoona Flyer. He built a camera which took a picture eight feet by four feet, on a glass plate. I remember reading that the glass plates cost $1800/dozen and this was in 1900! This camera was huge, weighing about 1400 pounds!

He took pictures, where he got in the balloon business, he liked to take pictures from heights, and he made and used the

world's biggest tripods. He'd tear around Chicago with his horse and wagon and the wagon would be filled with a tripod, in sections, like a fireman's ladder. He'd climb this damn ladder, get up to 200 feet, as I recall--that sounds high but not that high.

One day he fell off this platform onto some telegraph wires, and bounced. He didn't kill himself, fortunately. He gave up climbing and went in for unmanned kites and balloons. He photographed lots of towns in the Midwest, producing historical pictures of great interest. They looked like the 1890s. He's the guy who invented flash powder, to take pictures at night.

Tatarewicz: So you found out about him in the Chicago Public Library?

Katz: I'll dig it out in a few minutes. I've got a file on him here somewhere.

Tatarewicz: Did you apply any of these or get any ideas through learning about some of these inventors?

Katz: Well, what I learned from George Lawrence is, anything is possible. He invented flash powder, as I said, and one day he was taking a picture of a political convention in Philadelphia or some place. He had the room lined with his flash powder, had 50 pounds of flash powder, took the picture, they couldn't go on with the convention any more, had to clear the hall, all the smoke. They moved the convention to another hall. He got his picture.

Anyway, Goddard and George Lawrence made an interesting pair. I thought Goddard would be fascinated to find out about George Lawrence. He didn't give a damn about him, wasn't interested at all. Because Goddard wasn't doing research, he was operating, he was making cameras to fly lower and faster and higher, and he said, when I told him about these picture that George Lawrence took, how he made the world's biggest damned camera--as a result of that, Goddard laid down the reqirement for a camera with a 240 inch focal length, 30 inch aperture. Baker designed the lens, I think--it was a 20 foot focal length--30 inches in diameter. That camera ought to be in the Smithsonian. It's parked underneath the wing of an airplane out at Wright Field, in the museum they have there. This 240 inch camera took pictures 18 x 36 inches on 18 inchwide film.

Tatarewicz: Were any more of these built? Did it become an operational useful tool?

Katz: No. It was a good idea to build this one camera, because what happened, if we can make this camera work, we can make any smaller camera work. You can compensate for temperature and pressure and hold your film flat, and image motion compensation--all these effects were exaggerated with this big camera. It was shaped like this. As I recall, a figure four, the film out here, the lens here, lens would bounce off mirror up here and come over here, film that way.

That was a picture that carried our budget through for some years--that camera took a picture of a golf ball. You've heard of the golf ball?

Tatarewicz: No--please.

Katz: We actually got a picture of a golf ball from 40,000 feet. Now, to be honest about it, what we took a picture of was a golf ball, but the image size of that golf ball was considerably greater than the calculated image of a golf ball at that height. It bloomed. It lit up like a star. It was on a green background, and green is the low point of sensitivity of aerial film--green shows up dark. So this golf ball was bigger than a golf ball. We knew it was a golf course, we identified that readily. We knew it was not a football field or a basketball court or a soccer field, it was a golf ball on a golf course.

It shows an important point--how you identify stuff on pictures. Context is the main contributor. You see something going down a highway, you know it's not an airplane. You'd bet against it being an airplane. You see an object on an airfield or runway, it's probably an airplane.

Tatarewicz: Now, the photo interpreters were at Wright Field?

Katz: No.

Tatarewicz: They were not? Was there much contact between the people using the things that you were producing and researching, and you?

Katz: During the war there was minimal contact. The major contact was made by me. I designed an aerial photographic slide rule, which is designed to solve the problem, an enormously difficult mathematical problem of answering the question! Given an image size obtained at given altitude, from a camera with a specified focal length--how big is the object? I developed a simple slide rule with decimal points, at a sacrifice of precision--I've got the slide rule here. No, I don't have it

here, I have it at the other end of the house.

Tatarewicz: Photo interpreters, using the products of the cameras, would be doing these calculations by hand.

Katz: Yes. And they weren't very good at that because, during the war photo interpreters lived off the British. The British taught us a lot about photo intepretation. They had a P.I. organization before we did. They had a--Constance Barrington Smith, who's a famous PI, wrote a book called AIR SPY, on photo interpretation, during the war.

We had a school at Harrisburg, Pennsylvania. I visited it once. It wasn't till after the war that we got closer to the photo interpreters--not close enough. I objected to the photo interpreters taking a million dollar camera and a multimillion dollar airplane, taking a roll of film that cost $500 or a thousand dollars, and examining the results with a ten cent magnifying glass. It took me years to discover why that was, why they didn't want better equipment. Because, it turned out--this is a mystery that will be explained for the first time today--the photo interpreter had to sign for his equipment. He didn't want to be responsible for a $100 magnifier. He didn't want any more than a ten cent magnifying glass, because he had to sign for the equipment. I never solved this problem as long as I worked for the government. Does a pilot sign for an airplane? Does a tank driver sign for a tank? Why does the photo interpreter sign for his brief case full of cheap equipment? The Germans used a classier magnifier.

Tatarewicz: Oh yes.

Collins: What motivated George Goddard to push for better equipment? He wasn't apparently motivated by the military to do it.

Katz: No, he wasn't.

Collins: In a direct way, but somehow he was motivated to seek out these improvements and try variations of design to produce striking results.

Katz: What motivated him? I don't know what motivated him. He was a nut of a peculiar variety, I mean that gently, not in the psychiatric sense. Successful physicists become successful at an early age before they develop any other interests in society, in government, in social work. They're monomaniacs. They work on their subject and that's all they work on. Goddard was like that in photography.

Collins: But he wasn't really interested in doing the technical work himself. He was really more of a manager type person, to direct the efforts of others to develop the new equipment, is that right?

Katz: He got the credit for it. I don't mean that meanly. I mean it exactly. He developed this camera. It doesn't mean he built it, or that he designed it.

Collins: His interest seemed to be in directing others to carry out his conceptions. That's the impression you seem to be giving.

Katz: Goddard's the only guy at Wright Field who had an Air Force named after him. Just at the end of this bookcase here, you'll see a plaque of the Goddard Air Force.

Collins: Yes.

Katz: And everybody who ever worked for Goddard is a member of the Goddard Air Force. It's kind of winding down now because people are retiring and, but we like to keep the books.

Tatarewicz: This is a folder that you're looking through that says, from your files, "Goddard Air Force."

Katz: Yes. For example, here's the roster of people that came to George Goddard's 80th birthday party, 1969. He's still alive but not in good shape.

Tatarewicz: What is the Goddard Air Force?

Katz: The Goddard Air Force is just people who were associated with Goddard. Here's a thing we made up for his 80th birthday party. I want to show you this. There's your faithful correspondent to the left.

Tatarewicz: Oh, there you are. Yes.

Katz: The laboratory at Wright Field had camaraderie. But while we were working for him, we forget and argued with him.

Collins: But beyond Wright Field, Goddard was appreciated as a driving force among others interested in aerial photography and developing the technology.

Katz: Definitely, that. Because Goddard felt, rightly so, that

some guys were out to get him, and in that biographical note, I didn't tell the whole story. It's disgraceful--in the middle of World War II he was removed from his job at Wright Field, and sent to be Venereal Disease Control officer in North Carolina for the Army! You didn't expect that, did you?

Collins: That's a good one.

Tatarewicz: How did that happen? Here's a guy who is a critical element of the war effort, performing quite well, to say the least.

Katz: Well, Hap Arnold was head of the Air Force. This guy's got five stars. His son-in-law was a guy named Minton Kaye, and Minton Kaye was interested in mapping, and thought that Goddard was not working hard enough on mapping. Kaye's name's not mentioned in the book, but he's called "his nemesis." He <u>was</u> Goddard's nemesis, and Kaye was out to get Goddard. So the story goes. There was a lot of that entropy up the Y axis going on in the United States at that time--still goes on.

Collins: Can you explain that a little bit more, please?

Katz: Yes. this is a generalized concept. The phase angle of the work was about 80 degrees. This was Y, imaginary Y axis. This was intramural--some guys in the Air Force that you're fighting, this is the enemy--Germans, Japanese, the vector is up here somewhere, most of it going on the Y axis, up in smoke. [There is a drawn diagram on a separate page with Katz refers to here]

Collins: That's a beautiful way of describing that kind of organizational tension.

Katz: It happens everywhere. There's a rule that goes along with this, Bloggin's Rule. Did you ever hear of that? It's something like Murphy's Law. Bloggins's Rule is, 80 percent of the work is done by 20 percent of the people. Twenty percent of the criminals commit 80 percent of the crime. The 20-80 rule. Applies to everything. Even to beer twenty percent of the people drink 80 percent of the beer.

Tatarewicz: Goddard's group was responsible then for producing maps as well, or was that turned over to another part?

Katz: Corps of Engineers was responsible for mapping. The Air Force is responsible for charts. What's the difference between a chart and a map? A chart has detail of interest to an aviator.

A map is of interest to a guy that's planting his shoes on a trail--the Infantry. Lots of maps look like charts and lots of charts look like maps, but this distinction is clear. The Air Force had an outfit in St. Louis called the Aeronautical Chart and Information Center, ACIC, which has since been consolidated under the Defense Mapping Agency.

Tatarewicz: So the Army Map Service, and the Aeronautical Chart and Information Center--

Katz: Air Force.

Tatarewicz: Air Force, well, actually they were both Army at this time.

Katz: Yes.

Tatarewicz: --different institutions and they're supplying different customers with services.

Katz: The Army always complained that the Air Corps wasn't giving it enough service. This carried on in Vietnam and Korea, we see that. In Korea, we'd see the Army running individual requirements on the Air Force, and the Air Force fighting to meet the requirement, not to argue about the requirements. The requirements were stupid. They demanded photography at large scale, because they didn't have any PIs. Instead of commissioning reserve PIs, they wanted to get photography at large scale, so a general could look at a picture and see something.

Tatarewicz: PI being photo interpreter.

Katz: In Korea, we lost one of the outstanding photographic operators, reconnaissance operators of the last fifty years, a guy named Pop Polifka. I'll give you something about him.

Tatarewicz: OK, this is a letter of 20 September, 1955, to the Honorable Trevor Gardner, Assistant Secretary of the Air Force, R and D, and this is a letter from Amrom Katz to Trevor Gardner.

Katz: That's when I was trying to get an air base named after Pop Polifka.

Tatarewicz: Colonel Karl "Pop" Polifka. If we could make a copy of this sometimes, we can keep this copy and put it in the file.

Katz: Sure. It's about Dick Philbrick, Colonel Philbrick, also.

Tatarewicz: OK, we'll add this to the file.

Katz: I was starting to tell you that the requirements sent down by the Army against the Air Force are usually unreasonable, and in Korea particularly when ordered to operate reconnaissance, the 67th Squadron I think it was called. He told me, before he was killed the following spring, that one day he put on sergeant's coveralls, took his eagles off, put on dark glasses, and said, "I'm going to deliver the film today."

What happened was that the Air Force was sitting in Japan when I was there. I fly in Korea, come back to Japan, process the film in the laboratory--the reason they did that was, they were confined to the Pusan perimeter before we were almost shoved off of Korea ultimately, no place to go. Then we delivered the stuff to the Army, huge bales of pictures and prints, enlargements. So "Sergeant" Polifka delivered it up to the Army. He said, "Where shall I put it?" "Put it over there, under the table." "What's that stuff there?" "That's yesterday's stuff," still unwrapped, and not used. With that said, Pop blew the whistle, he wasn't going to do that any more, didn't care what happened.

Well, before the effects could be taken, he was killed, by doing something he shouldn't have been doing, flying. He was killed in a P-51 and he couldn't get out of it. He was by this time a little older and a little fatter, and his parachute got hung up on a cowling, and the airplane crashed and he was tied with it, crashed with it.

Tatarewicz: At Wright, did the group you were in train pilots?

Katz: No. Nothing like that at all.

Tatarewicz: You were just developing the systems and--

Katz: We had pilots assigned to the military laboratory. There were a couple of lieutenant colonels and lots of majors, a full sprinkling of officers and enlisted men. I had a pilot working for me in the shutter unit. So it's hard to describe--if I had an organization chart, which I do not, I'd go through it and my memory would be refreshed.

But in Korea this happened, in Vietnam it also happened the same way. The Army would lay on requirements, the Air Force would fly it--frequently they flew the same mission two weeks at a time, they couldn't find the prints, so they'd fly it again, get shot down--stupid system.

Tatarewicz: What would you characterize as the most important things to come out of what I'll call Goddard's group at Wright, in World War II?

Katz: Good lenses. Baker lenses were produced. The 40 inch f\ 8.0. The 40 inch f\8.0 was a fantastic lens. I don't want to inquire too deeply into how it was used, because I'd probably eat my heart out and get an ulcer, finding out that it wasn't used very much.

Night photography was developed, wasn't used very much. High speed shutters were developed, weren't used very much. Polifka took two of my cameras with high speed shutters in that were made by, modified the standard K 17 c six inch mattlin camera.

George Mitchell of Mitchell Camera, working for NDRC, out here somewhere in Hollywood, Mitchell Camera Company, took a look at this shutter and immediateley decided the cam that drives that the shutter leaves is too heavy, so he developed a new lightweight cam, and got Sussfield to fire it, who was second. Polifka stopped in the laboratory on the way from New Guinea to Italy and took two of these cameras along with him in his B-4 bags. He wrote me, it's in one of the papers, that it was used in the battle of Monte Casino, I think, where he, Polifka, flew the cameras, one of them on the right side, one on the left side. He flew the mountain, mapping the whole mountain all the way up, showing German gun positions. He'd fly this way and get them with the camera on the right side, he'd fly the other way and get them with the camera on the left side--two cameras. He claimed he got the positions, saved the day, and they were able to take Monte Casino, etcetera. I haven't been able to find this anywhere except in Polifka's letter to me, which I printed, in the Optical Society paper on shutters.

But our finest flower was the atomic bomb tests in '46, when we were called on to take pictures of the atomic explosions at Bikini. That was an operation, I was in charge of, and I took notes. Let me show you the notes.

TAPE 2, SIDE 1

Tatarewicz: We're looking at the Bikini Diary.

Katz: It starts the 13th of September, 1945, and goes through 21 November, 1946.

Tatarewicz: These are five bound approximately folio sized volumes, with clippings, some letters and carbons, and hand-written notes.

Katz: It's the only record of what we did. I kept this diary because I was dealing with a very odd colonel, since deceased. He would make decisions on one day, changing a contrary decision he'd made the previous day, and didn't believe it till I'd show him in the diary.

Tatarewicz: Your group was called upon to document the tests in Bikini.

Katz: Yes, doing scientific photography. The whole thing, I had a fascinating experience with him at the time. One of the major lessons of bureaucracy I learned in this exercise. He said, "I want a plan, what planes you need, what cameras you're going to take, what instruments are needed, what kind of people you're going to need." So I came back in two weeks and gave him a plan involving two C-54 airplanes, and approximately 30 people from Wright Field. All of us were at that time at the height of our physical powers and we were all young and we really knew the camera business. We knew how to take pictures. We knew how to analyze scientific photography. So I said, "We'll do all this, we'll fly the airplanes, we'll run the photo lab, develop the film, calibrate the scientific photography, write reports, we've got enough guys to do that. It will be very elegant. It can be done with a few guys if they're the right guys." So he looked at me very strangely and said, "I don't want an elegant operation, I want a big outfit."

He got that outfit, those two airplanes--we needed only one airplane, but in case one was going to be down for a period--the two instrumented identically. We had spectrophotometers. We had photometers. We did all kinds of things. And he had 950 guys in that outfit.

Tatarewicz: 950? This is just on the documentation?

Katz: In the photographic unit attached to 1.52.

Tatarewicz: Just the photographic unit. I presume there were other people running around.

Katz: 40,000 people in that Bikini test. Almost a thousand in this photographic thing. I knew we could do it with 30. The net result was that, I wrote this up in a book I'll show you, a book on science, RANDOM WALLKS IN SCIENCE, have you ever seen that

book?

Tatarewicz: Oh yes.

Katz: Volume two is called MORE RANDOM WALKS IN SCIENCE, and this is in that book.

Tatarewicz: I didn't realize you had an entry in MORE RANDOM WALKS.

Katz: Yes, this particular story is told, and the 10 or so B-29's, plus the two C-54s. All the work was done by our two C-54s. When you start building a big unit, first you need guys to handle the mail, and guys to keep attendance, guys to keep records on how much gas we were using, and all that. It's crazy. I didn't want a big outfit, we got a big outfit. I fought him every inch of the way.

I was the only guy who took any notes at all. Noboby had any data, when the operation was over, what happened, who did it, who struck John. That was before the ballpoint pen was invented. Mostly written with a fountain pen. My handwriting has since degenerated into an illegible scrawl; I can't take notes anymore. I can't write clearly, and I'd never do a thing like that anymore. I think I'll donate that monument to your institution.

Collins: We would accept.

Tatarewicz: Absolutely.

Katz: Do you collect stuff like that? Where do you put it?

Tatarewicz: Well, that's an interesting subject which gets to be a little bit involved. We will accept papers, as an archive of last resort. We encourage people to prepare their papers and to donate their papers to an institution that has an archive, an institution where their papers would make the most sense, that is, some place they've been associated with, or some place with a permanent archivist where the papers would be well cared for. In cases where somebody wants to give us their papers, and they prefer not to put them in any other institution, we'll accept them. We like to work with people and try to keep all of their professional papers together in a single corpus, because of archival practice, we just don't believe that a collection of papers should be broken up, a little bit here, a little bit there.

Katz: What's the difference between your institution and the

museum at Wright Field, which I've never seen?

Collins: Relationship are cordial. I mean, there's no official relationship, it's simply that we're both government museums.

Katz: Do they have a charter that's different from yours?

Collins: I think their charter is different in the sense that they focus pretty exclusively on military items. Our charter is a little bit broader, and I don't think that they go into the documentation end of it as much as we do. I don't know for a fact, but I don't think they consider that as part of their activity. They're not as well staffed as we are, for one thing.

Katz: You ought to steal that camera from them. Baker told me he saw it out there.

Tatarewicz: It's sitting out in the weather, or is it inside?

Katz: Oh, I guess they have big hangars.

Tatarewicz: Yes, they do have hangars.

Katz: That camera would be useful for astronomical purposes, sky mapping. It has a flat field. Baker designed a flat field system in Volume three of AMATEUR TELESCOPE MAKING.

Tatarewicz: Yes. Yes.

Katz: He has a chapter in AMATEUR TELSCOPE MAKING, takes an ordinary parabaloid, and puts his field flattener on it and field extender, and it takes pictures 8 X 10, and one of them was made for Vanderbilt Observatory. Where is Vanderbilt? I think it's in Nashville, and he went there and looked at it and said, "How come you're using such a small 4 x 5, you could use 5 x 7, 8 x 10?" "We can't afford the film."

A fascinating point--Baker once explained to me, this is early in the game, space game, that the total cost of astronomy in the "free world" per year was about a million dollars, to run astronomy. That's for routine stuff, not the capital equipments. And that's when we were pissing away 20 million at a time on an ordinary launch--while an astronomer at Harvard was eating horse meat, his salary was so low. That was about '54.

Tatarewicz: Baker said that?

Katz: Baker told me that. Yes, a million dollars a year for

astronomy in the free world--that's for astronomers' salaries, running the shop, maintenance of equipment. He probably was wrong by a factor of two but what the hell's that? It was the right number of decimal points.

Collins: Let me back up to the diary for a second. I was curious, you had some clippings in there. You didn't come by those when you were out on the islands, did you?

Katz: I wasn't on the islands the whole time. I was in St. Louis part of the time, at the analysis shop in St. Louis.

One of the best stories that ever happened to me, I'll have to tell you that, and you can throw it away if you like. I was with Walt Levison, he was my deputy, he later became vice president of ITEC Corporation. We didn't have anything to do, except we were setting up when ACIC got started. They had some room and we set up shop there. We'd eat in different restuarants every night. We were writing scientific reports on the growth of the cloud and the shock waves and all this stuff. So one night we went to an Italian restaurant. St. Louis in summer is a hellhole. It makes Washington look good. So we went into this Italian restaurant, sawdust on the floor, red checkered tableclothes, in 1946. We had had a few scotches before we went to the restaurant. I figured the menu looked like the New York Times, so I read spaghetti and one meatball and tomato sauce, so much, spaghetti and meat sauce and two meat balls, so much--so pretty soon my head started swimming, it looked like five equations and five unknowns. I decided to solve for the price of the meat ball. I worked my fifth order determinants with a fountain pen on napkins. Can you imagine that? For two hours! Everybody was looking at us, playing with napkins. And I got minus 10 cents, the price of a meat ball. So I though, oh hell, ridiculous, so I checked the calculation, I got minus ten cents. And then if you looked carefully you'd see how you got screwed out of a meat ball while paying more. So I called the waiter and explained this to him carefully. He got the manager, a big guy, six foot three, wearing a chef's hat--he comes over and says, "What are you boys doing?

"We're working this problem, we've solved, it costs a dime not to get a meat ball, how come?"

He looked at us, "You guys from the OPA?" Office of Price Administration. Government inspectors. That happened.

Tatarewicz: Did you have to develop any special equipment for this test, or did you have everything you needed?

Katz: The main thing we developed was a fantastic photometer, because we didn't trust the light curves we were getting from Los Alamos. We didn't know what the exposure time ought to be. So we thought, well, if we get scrubbed on this first test, we will at least have the light data, with photometers. So we made a photometer as follows: We took a 400 foot roll of film, and mounted it, made a slit a few thousands of an inch aperture, nine inches long, and we got, from Eastern Kodak, step wedges.

The wedge was three inches long, we got three of them cascading up this nine inch slit, so this one had three step wedges on, this had two step wedges on, this had one step wedge on. So we had a density reading in film, as I recall, it's in that book somewhere, from zero perfect transmission, to density at nine, which is letting the light come through, and we would catch this phenomenon somewhere along in there.

It turns out that that's exactly the way to make a--and you pull it through at high speed, so we managed to get this film through in five seconds, upped the speed 1 second. We had an aircraft starter motor pushing it and another aircraft starter motor pulling it, and we moved the film at a thousand inches per second. That was a good instrument.

A funny story with that instrument, though. That's the way you make a bang meter. A bang meter is a simple item, it's a Vela satellite for detecting atomic bursts and for measuring yield. For above ground burst, the yield of an atomic bomb, the light curve goes like this--and then fades out slower. And the time to this minimum is a direct measure of the yield. For a Bikini bomb, it was about 19 milliseconds, and that was--we didn't have delicate instrumentation, we had a crude method, we'd hold it up like this, measure with a yardstick. Nothing delicate about our instrumentation. But our instrumentation was the only instrumentation that worked on that test. There was a well known guy, I think it was Jerry Wiesner, who was in charge of timing.

He was sitting down in the basement of a boat--the hold of a ship, I should say--surrounded by padlocks and master timing control, and he had--and all the Navy instrumentation was run through that ship, and they had instrumentation aboard some ships that were unattended and we were supposed to listen to this signal, listen to how fast the six was run. We listened the whole time. It was a continuous tone signal. We knew that the guy dropped the bomb and the signal ceases, and then about 45 seconds later, the bomb was supposed to go off. Dropped 45 seconds or thereabouts. That's a dumb thing, because anything can stop a

signal from going.

So, sure enough, something stopped the signal, and Jerry is down in the hold, no windows, nobody to talk to, and he sees that the signal stopped. So he waits 45 seconds, throws the master control switch, all the instrumentation, high speed cameras, all ran out, about an hour before the test.

Except ours. We didn't trust this crap from the Navy. We didn't trust the signal, so we had manned--we had a guy by every instrument in our airplanes. So we put a switch in series with the instrumentation, and parallel with the instrumentation. So we listen to this go off, we see it's not time yet, we listen on other channels as well--we throw the switch and take it off automatic control. We listened for the real signal, and all our stuff worked. We also had lots of luxury in time, we had five seconds, since we got the speed to 1 second, so we had high speed cameras that would run for 20 seconds. We had all kinds of stuff.

There's something else I think I'll donate to you guys. Here's a photo album from that test. This is the colonel that gave me all that steam.

Collins: What was his name?

Katz: Paul T. Cullen. Here, cameras mounted all over.

Tatarewicz: Oh yes.

Katz: In the door, the high speed cameras. Duncan McDonald was dean of [?] University.

Collins: Did you find that the film that you were using was adequate for this high speed?

Katz: Sure. Good film. Out of compulsion I don't throw out anything. Let's see, you get a spread of the cameras used. The camera used by this, 1.52. Lots of cameras.

Tatarewicz: Quite an array of equipment.

Katz: My God, it's 40 years ago! And of course, that's General Stilwell. Karl Compton. General LeMay. I ought to throw this stuff out. We've invested enough time in this, shouldn't anymore--

Tatarewicz: We're very interested in all of this. We don't keep rigidly to a chronology or that kind of an order. I would like

to talk a little bit about what you learned at the group at Wright because you'd come there not all experienced in photography.

Katz: Right, never flew in an airplane.

Tatarewicz: In the course of, what, ten years, by the end of the war, not even--

Katz: The war went very fast.

Tatarewicz: Yes.

Katz: To the guys involved in the war, it didn't seem to go that fast. But from our perspective looking back, it went by very fast. I joined the lab in 1940, the fall of 1940, and the war over in 1945. We kept on learning and doing things.

Tatarewicz: See, you had learned mechanisms, optics, electronics--

Katz: A little of all that stuff. I'd gotten interested--when I saw that bomb go off in Bikini, I said, these things aren't very practical. I came back from Bikini, I started lecturing for the Emergency Committee of Atomic Scientists, Einstein's committee. I gave lectures on Operation Crossroads and the atomic bomb. I had some good film, which I've still got somewhere around here, and I got interested in world government, so I joined the World Federalists. My interest broadened, and quite a few of the other people involved in the recon business joined that same organizatation, and were interested in the same sort of world affairs problems, and I soon saw that reconnaissance techniques useful in war would be useful in peacetime work.

There's something very neutral about a camera. You take a picture over a Minuteman field in the Dakotas, for example--you look at the picture, you can't tell if the picture was taken because of your military interests or because somebody's interested in the wheat. The same camera takes pictures of wheat and missiles, missile sites. You can't say that of any other techniques used in war. Bomb making and bomb sights aren't very useful in peacetime. Guns aren't very useful in peacetime. But photography carries on 100 percent of the way.

Tatarewicz: Had you ever thought during your wartime work, before the Bikini tests, had you ever considered the peaceful applications?

Katz: Let's say, I didn't during the war, I didn't stop to think about that until I was at Bikini.

Collins: That's clear, because a lot of your clippings seem to be ones that took the critical view of the test.

Katz: They were?

Collins: I was just browsing through it very quickly.

Katz: I haven't looked at it for years. I took whatever was relevant to what we were talking about, put it in the book to make it interesting.

Collins: This is a kind of a period where you began to rethink some of these issues.

Katz: Yes. It was an amazing sight. Now everybody sees pictures of the atomic bomb. But (R.V.) Jones points out, it would be a good idea if people would get a look at the atomic bomb again. It's a very interesting point.

Tatarewicz: This is a SAGE publication for the Center for Strategic and International Studies. This is a paper, the Washington paper is No. 88, "Future Conflict and New Technology," by R.V. Jones.

Katz: I marked this section... "Another aspect of mental attitude that needs to be considered is that the leaders and officers of the major powers have now and for many years been conditioned to think, for example, of a 20 kiloton bomb as small." That's true, everybody thinks a 20 kiloton bomb is a small weapon. People talk about megatons. Yet few have had direct experience of even what a few tons of explosives can do. On a personal note, I'd been conditioned for a least six months before the first V-1 fell on London to expect its warhead to be of one ton weight, and I dispassionately estimated the damage it would do. I was about 150 yards away from the bomb that hit the guards' chapel. It brought home to me the difference between detached talk and practical experience. Those who have not even had experience of World War II could be in danger of becoming too detached in dicussing nuclear warfare. Although some degree of detachment in decision making is absolutely necessary, the danger is that nuclear bombardment could be ordered by men who have become so acclimatized to talking of nuclear warfare that they have become desensitized regarding its consequences. The suggestion that those who might have to order such an bombardment should every once in a few years witness a trial nuclear explosion, has much

to commend it." Bright idea.

Tatarewicz: Did your thinking about the social implications of all of this, did that happen suddenly or did it gradually grow?

Katz: No, I was always interested in world affairs. I took a minor at the university in labor economics, from a famous labor economist at Wisconsin, Selig Perlman. I always had these broader interests. But I didn't have anything to focus them on.

Then in '46 or so I read a paper by somebody talking about atomic energy controls, and surveying vast territories. A natural for photography. I quoted that in one of my papers. That reference. And then the problem of inspection came up, and all this was very natural work in that field.

Tatarewicz: All the while you continued to work at Wright.

Katz: Till '54.

Tatarewicz: Until '54. How did the lab at Wright and your work change after the war? During the demobilization?

Katz: I made one proposal that didn't get anywhere at all, unfortunately, I think--whether we shut the laboratory down, not allowing anybody to come in with proposals or buy anything, and find out what the hell happened during the war.

What worked, what didn't work, what's needed, and we didn't do that, because the budgets started coming in, and you get caught in budgets, and you're required to spend your whole budget. If you don't spend your whole budget, you won't get as much next year. So we brought equipment, modified equipment, just incremental stages, no new radical ideas.

But Goddard was always interested in higher, faster, slower, darker, bigger, smaller--the extremes. He went in for balloon photography, experimented with that, experimented with V-2s.

Tatarewicz: Now, you hadn't done any balloon photography during the war? You'd concentrated exclusively on aircraft?

Katz: Exclusively on aircraft. Why we were going to take balloon pictures was so we could say we'd gotten the highest picture ever taken. Nothing more than that in Goddard's mind, I'm sure. Now, we discovered all kinds of interesting things with balloons, and RAND came to my attention that way. I had some guys from RAND come out one day and ask me, Bill Kellogg and Stan

Greenfield--Bill Kellogg is now director of the Atmospheric Laboratory out at Colorado Springs, or Boulder, rather, I forgot the exact name.

Tatarewicz: NCAR--National Center for Atmospheric Research, I think that's where Kellogg is now.

Katz: Yes. He came out to Wright Field and asked me if we'd ever thought of taking pictures from balloons. I said, "Sure, want to see some?"

I took some beautiful 9 x 18, we'd lofted the camera and went to 100,000 feet, gorgeous picture, tremendous area coverage, large scale. We were up high, 24 inch, 36 inch camera, and knocked his eyes out. We didn't know at the time, they were thinking about recommending to the Air Force to use this for transiting the Soviet Union.

Collins: This is about what date, then?

Katz: I don't recall the date offhand. If it was of any real interest, I can discover the date, because I've got all my diaries.

Collins: I was just wondering whether it was before or after the first atomic test.

Katz: Oh, it was well after. That I'm sure of. Kellogg didn't come to RAND until about 1948, I think. But I've got here all our trip diaries. This is Korea. These are Vietnam.

Collins: Marvelous. At some point we really should talk about the disposition of your papers in some detail. I think you've got a lot of important things here that should go someplace, if you're willing to part with them and see them in some sort of repository.

Katz: I feel good about finding a place to put them where they can be of some use. I know my writing is horrible. It's a monument to--

Tatarewicz: A lot of scholars are going to be interested in those over the years, in those papers. They're extremely valuable.

Katz: I've got about ten boxes of slides. Interested in them?

Collins: Yes, we do collect that kind of material as well, and

with the--

Katz: I don't have any idea of what your filing space is like. Do you stack everything?

Tatarewicz: We have rooms, we have buildings, we have places all over the country. Basically, what we would have to do is set up a small project, perhaps with somebody from the aeronautics department, at our museum, in which we would go through your papers and determine how much material there is, and make some suggestions as to where it might go. Certainly the Smithsonian photo collections, the photo archives of the Smithsonian is one possibility for all those slides, because from some of the things that you've showed us here, the slides and the prints and a lot of that material is of very large historic importance, and we do have some control of storage.

OK, continuing with the interview now after a brief pause. We can get back at another time to talk more about the balloons and about your work with the V-2s, but you started to talk about RAND, as an institution.

Katz: RAND as an institution was able to work on ideas that were not yet profitable. When I came to RAND in 1954, I found that RAND led the United States and other institutions in industry and so forth, in calculation of the theoretical specific impulses of rocket fuel. You might inquire, how could an outfit the size of RAND do that? Because this was not yet a profitable idea, they were able to put together a team of four people and do this.

As soon as it became profitable for industry to do so they could outweigh RAND, out-compute, out-man, and so RAND left that field and didn't help its competence in that after that period.

So they worked on what I call, not yet profitable ideas. This was certainly true of space, in the forties and fifties. When RAND came to my attention for the first time, we were visited by several distinguished RAND people--as I recall, Frank Collbohm, Hans Speier, and a few others who came to Wright Field to give a lecture on RAND. It was novel and exciting, and this as I recall was in '48. I've got the little lecture transcribed in my notes somewhere, could get it out if necessary.

I next ran into RAND when Kellogg and Greenfield came out to inquire into whether we knew anything about balloon photography. We had just been doing some of that, not motivated by anything except the desire to get higher and see what we could do from very high altitudes in interpretation. They were pleasantly sur-

prised to find out that we were off the drawing board and actually doing some.

This led to the balloon project, on which you have exhibits in your gallery. It was highly classified at one time. The camera developed for the balloon project was a natural outgrowth of some work we'd been doing at RAND. Mert Davies had been looking at space stabilized cameras, and designed one for use with a satellite. What were you asking me?

Tatarewicz: About how you first got to RAND and your initial awareness of Greenfield and Kellogg's interest in balloons, and in photography from balloons, and the camera system that you had developed under Goddard for that.

Katz: Later, or perhaps even earlier, I'm not sure, we were visited by a team from RAND working on a reconnaissance satellite, and we had just spent a few years trying to take pictures of railroad ties from 40,000 feet, which was something that Goddard assured Stuart Symington, then Secretary of the Air Force, that he could do. We did this under pretty carefully controlled conditions--freshly laid ballast on the tracks, freshly laid ties, high contrast, a lens in perfect focus, operated by the best photographer we had, and we did that.

Then Symington said, "I'd like that done over St. Louis," which is his area. That meant we didn't have any influence with the track laying people there, and we spent about a year doing that, and we accomplished that. So when we heard the news briefings, we were doubtful after doing the railroad tie photos 28 lines per millimeter is what we calculated the resolution was.

Tatarewicz: 28?

Katz: 28 lines per millimeter.

Tatarewicz: --lines per millimeter, you did this with balloons?

Katz: No, this was with the standard B-17 airplane.

Tatarewicz: A B-17.

Katz: And a 40 inch f.5 Baker lens, a K-22 camera. We flew, of course, not down the track but across the tracks, so any blurring of the ties would not be from ? motion. The ties were this way, you did the best thing you could do to get that picture. The point is that we relized how damned difficult it is to get a sharp picture from altitude. So along come some theoretical

physicists now telling us what they can do from x hundred miles, calculating the theoretical lens quality and all that stuff, and I said, "Bullshit."

Tatarewicz: That is, the physicists from RAND had calculated what the theoretical resolution should be from a hypothetical satellite orbit.

Katz: And they also felt that having calculated that, that was all that was required to achieve it. Whereas between calculations and achievement are vibrations and accelerations and motions and disturbances and everything that happens is not good. Nothing good happens to a camera you put in an airplane or a satellite.

TAPE 2, SIDE 2

Katz: This is .. September 27 to December 31st.

Tatarewicz: September 27 to December 31, 1948. That's the notebook, right?

Katz: Frank Collbohm, president of RAND, Ed Paxon--lecturer on theory of planning, tactical planning, strategic planning--he was deep in [John] von Neumann and [Oskar] Morgenstern--all this was very novel to us at Wright Field, to see this stuff.

Tatarewicz: I'm a little confused. Was this your first contact with RAND, then, not the later thing with Kellogg and Greenfield?

Katz: This was the first contact with RAND. As I recall now, because I'd never heard of RAND before, and I was selected to go to a briefing, and when Kellogg and Greenfield came, I didn't have to ask what RAND is anymore. So I knew about RAND.

Tatarewicz: OK, so this was a briefing they came to give the whole group at Wright.

Katz: At Wright Field, yes. They showed the application of game theory, duels between a bomber and a fighter. This had nothing to do with satellites or photography. It was a general briefing on RAND. There was Paxon, Charlie Hitch, Hans Speier.

Some time after that, perhaps about '52, '51, they came out to brief about the satellite, the work on that. And talk about the theoretical calculation, and I described in detail how we had just come off of this difficult photographic experiment to pro-

duce pictures showing the railroad ties from 40 thousand feet or 30 thousand feet. So these guys were telling what they could do from 300 miles. I said, I was determined to prove they were crazy, so to do this I took my Leica camera, my own camera. I had two lenses which Dave Goldstein, president of Elgeet Camera in Rochester, mounted on a Leica for me. Dave Goldstein had been making lenses for movie cameras, and the two lenses he gave me were 7 1/2 mm focal length and 15mm focal length. It's no trick putting a lens like that on a camera, the trick is for the camera to have enough clearance for the focal plane shutter and all that stuff, so these were reverse telephoto lenses, they had a long back focus. This was a long lens, how to clear the machinery of the Leica, mounted on a face plate, and he did that and gave them to me. Believe it or not, I've still got them somewhere in my closets, the lenses.

I took these lenses myself up to 30,000 feet in a B-17, and took pictures with them, designed to prove that matching scale proposed for a satellite, you'd see nothing, and I was quite surprised to see something. They were not great picture, mind you, because I deliberately wanted to make them lousy pictures, looked like television pictures--which brings up another matter.

The original thinking on reconnaissance satellites was paced by the ICBM program, both negatively and positively. Originally when RAND started its satellite program, they realized they were going to have to design and cause to be built a rocket specifically for that satellite. There were no spare rockets lying around, there were none in production of the requisite size and throw weight.

The reason there were no rockets in production, no rocket program, was that nobody had solved the re-entry problem. Re-entry, by the way, is precisely the wrong word to use. When this rocket comes in through the atmosphere, it enters the atmosphere, it doesn't re-enter the atmosphere. It starts out in the atmosphere, goes up, and enters again.

That problem had not been solved. Therefore the satellite that was--if it was going to work, it had to stay in orbit a long time, and transmit electronically, by television techniques. Therefore, following from that, is that when I took those pictures I mentioned a while ago, I used coarse grained film, hot developer, trying to simulate television in a way. I've still got these pictures somewhere, if you guys are really interested, if your files will take them.

Tatarewicz: At some time, yes, we would be.

Katz: I know where they are, they're right in that drawer right there.

Anyway, so the constraints on the satellite program were the following. No re-entry, long life on orbit, because rockets would be so damn expensive, there wasn't a plethora of rockets.

What we failed to notice was that in 1954, [Bernard] "Benny" Schriever, then Brigadier General Schriever, later to become four star General Schriever, came out here and started the Western Development District, WDD, which later became, what the hell did it become? I don't know what it became--one of the more obvious names for what they're doing.

The Manhattan District, another nondescript name. OK, whatever the name is, it's changed its name a number of times. I'm not sure what the current name is, I regret to say.

It was failed to be noticed by everybody except RAND, in 1954. When Schriever came out here to set up his empire, his goal was to overthrow the assumption that re-entry was not soluble. First, if you're going to get ICBMs to work, they have to come back through--to recover was going to be a practical thing. So RAND focussed on recovery at that point, changed its mind.

Tatarewicz: RAND didn't worry about re-entry, assuming that that was going to be solved?

Katz: Carl Gazley at RAND was the pioneer in solving the re-entry problem, by ablation. I think occasionally, he has not gotten full credit for this, but that's probably part of the RAND syndrome as well. RAND was never set up for people to get the credit for the things that they did. A lot of people don't give Gazley credit.

But fortunately, in this business, as I've pointed out many times, many places, there's enough credit to go around for lots of people, without taking away from anybody else.

So RAND turned its attention, in '54, the year I joined RAND, to re-entry, recovery, and so forth.

Tatarewicz: What prompted you to join RAND?

Katz: One day I was visited by a couple of guys from RAND, Phil Bahrman and Alec Wylly, talked about one thing and another, and I

told them, "Next time you see me, you'll have to see me in Washington."

They said, "How come?"

"I'm leaving here. I'm going to Washington, work in intelligence."

"What don't you come out to RAND?"

"Nobody's ever asked me."

So he said, "We're asking you." That's the sum of the conversation--that's the whole length of the conversation we had. I went out to RAND, looked it over, liked it, and signed up. That's the result from 15 year blues I get. Fifteen year blues is a disease which I get, every 15 years. I've got to change jobs. I was at Wright Field for about 15 year. I started noticing the last couple of months at Wright Field, I'd wake up in the morning and have no desire to go to work. I was pretty sure I had a desire to leave Wright Field. My time was up. I'd done my work. I wanted to go on to something higher and finer. I was 39 years old at that time and I realized, if you hit 40 in same place, the temptation to stay there is going to be overwhelming. Or inertia, roots.

So I went out to RAND, and maintained all my contacts with Wright Field, the reconnaissance community, and was able because of RAND to have access and style and perspectives and charters to move on to broader things I could never do at Wright Field.

My problem was, everyone at Wright Field was in the civil service--I conquered the civil serice system. Up to the time that I conquered the civil service system, a few years before I left, it was required that in order to get a promotion, you had to have more people working for you. You're familiar with this, I'm sure. It's universal in government, our government.

So I decided to see how job descriptions are evaluated, and I found the guy who did the job descriptions looked in a book. He doesn't know anything about what you do technically, he's looking at words, so I had trouble following the words he's looking for. So I got from the public library, or you could get from the Library of Congress, a handbook used by these job evaluators, which is highly classified. It's not classified security wise, it's classified, you can't get your hands on it, and it's very effective.

So I soon found out what words were used, and we wrote a job description which gave me a promotion, and got rid of everybody I had working for me at the time. Nobody working for me. I never had anybody working for me since then, either. Of course the Smithsonian is above all that sort of thing! Or below it.

Tatarewicz: We may have to stop the tape for the interviewers.

Katz: About RAND--

Tatarewicz: So you came to Santa Monica for the expressed purpose of working on this?

Katz: No. I came for the expressed purpose of continuing my interests, whatever they turned out to be. I didn't have any assignment. It was going to be reconnaissance clearly, for a while anyway.

Collins: What division were you in when you came to RAND?

Katz: I have no idea. There's an answer to the question, but I don't know what it is. Some kind of engineering division, except they hadn't organized the engineering division then.

Collins: I know, for example, that when Mert Davies came he was in the missile section. I wondered whether you perhaps also were in some section.

Katz: I was in that section for awhile. I don't think I knew what I was doing. That's the point. RAND had a contract with the Air Force, most remarkable thing ever written--you heard about that, one sentence.

Tatarewicz: It's the one-liner, yes.

Katz: It said substantially, translation: "Work hard, do good, and if you find something of interest to the Air Force, let us know." That's remarkable.

I'll tell you a story that not many people know, which describes RAND also. Jules Moch who was minister for disarmament in France for many years, came to UCLA one day, and three of us from RAND went out there, had lunch with him. There was Herman Kahn, Bob Buchheim, and myself, and Moch, his english was not perfect, but he said in "Que'esque ce RAND? "What is this RAND?

So Herman started explaining explaining to him about what we do, things we work on, atomic bombs, nuclear war, divisions, the

casualties, the fact that--all this stuff--he couldn't understand one damn thing Kahn said. Bob Buchheim explained in a very orderly fashion, as if he were giving a corporate briefing to the president of RAND, the advisory council, the divisions, work on projects, writing reports, papers, go to meetings. Moch wasn't happy with that either. I said, "I'll try it. It's like this, Mr. Moch. Here's the Soviet Union, here's the United States, certain problems have come up between the Soviet Union and United States. We work on those problems." He said, "Je comprend." That's all he wanted to know. I said it perfectly.

Tatarewicz: That brings up an interesting situation, in the sense that we talked earlier about after the Bikini test, your growing interest in social concerns and in applying your technology to the solution of problems of government and to the peaceful solution of problems of government and so forth. Did you ever find any conflict with that in being in an environment in which people were also producing a strategy?

Katz: Not a bit. The main aim of the strategy was how to not get in a war. I was all for that, still am. There's no such thing as strategy for how you fight this war, in my judgement.

I'm turning now to a notebook that's highly classified. "Ideas, Notes and Fragments." I put all kinds of things in there such as this.

Tatarewicz: Well, since it's classified, I'd better not say.

Katz: It's classified "Interesting." No I won't start reading quotations from here. Because it would take the rest of the evening to go through that.

Tatarewicz: Anyhow, you had no conflict with that?

Katz: Not at all. One of the papers I gave you today was "On Peaceful Uses, Transfer Between Two Cultures, Civilian Sector" and so forth, and I have a paper I'm going to give you which was "Doing Food Reconnaissance."

Tatarewicz: Oh yes.

Katz: Did I give you that paper?

Tatarewicz: No, you mentioned that there was a paper on the subject among your writings.

Katz: I'll dig that out shortly. "Disaster Relief,"--I proposed

using reconnaissance for disaster relief, and broadened the concept greatly. It turns out that the first thing you want to know when there's natural disaster like a mud slide, Peru, or Chile, where they had that mud slide a few years ago, is what roads are open, what facilities are open, and they can't communicate because wires are down, their radios are shot, the place is overrun. Here we have exactly what's required for it, reconnaissance. The camera is neutral. It can take a picture of a disaster or a bomb attack. Then I proposed also that we use U-2s for that, because they can go anywhere in a hurry, and maybe the SI-71s. That fell afoul of budget requirements. I thought it would be a good exercise for the Air Force to do that. Take a C-130, you can fill that full of reconnaissance, take a squadron, developing tanks, everything it takes to make pictures, for war or for peace. Sometime later we'll go into that.

Tatarewicz: Yes, I'd like to.

Collins: You were beginning to think about these ideas say in the late fifties?

Katz: Early fifties. Late forties. It turns out, a lot of the early work in the Arms Control and Disarmament Agency was formed in 1961. I think. '61, yes. Before that time, Colonel Leghorn was active in disarmament negotiations, agencies in Washington, and he got an interest in world government, which I spurred him on, and that happened in the following way.

He gave a lecture at Topeka, a lecture which I reprinted in Selected Readings In Aerial Reconnaissance. Topeka had a big symposium, with the RAF, Royal Canadian Air Force and US Air Force, on reconnaissance. I reprinted four or five of the papers given there, seminar papers, including one paper by Leghorn in '46, well before this, in which he talked about requirements for overflight, requirements for strategic reconnaissances and orgainized it fairly well. That is in this.

Tatarewicz: In Selected Readings in Aerial Reconnaissance.

Katz: So anyway he gave another speech at Topeka, which I thought was a jingoistic, saber rattling speech. As I said, one night we were talking about world government. That speech that I assessed in those terms is in that paper, too, and I can't find what the hell made me think it was saber rattling; maybe my standards have changed since then.

But anyway Leghorn, Dick Philbrick, another colonel, that I wrote about in that paper I gave you about Polifka, and Walt

Levison all got interested in World Federalism, world government, and were led from this interest into a natural interest in applications of reconnaissance. Several of those people testified before Senator Humphrey's committees on disarmanent, well before the Arms Control Agency was formed.

So this is a natural growth out of your professional activity. Your further professional activity is broader. There's no way that Wright Field could ever have gotten interested in that officially. No way. Not that it's illegal, but there's no path that would lead them to it, to work on it or know about it.

Tatarewicz: Did there seem to be a path like that or a potential path like that at RAND?

Katz: There did indeed. I was invited by Leghorn, when he was no longer in the Air Force, to attend a meeting at Gould House in 1956. I've still got the notes from that meeting here, which talked about these matters in broad detail, broad spectrum and some detail, but mostly broad. From there I got led into Strategy for Peace conferences. There was never any problem in going to these conferences from RAND. No problem whatsoever.

Of course things have no doubt changed by now. The whole country is on a work order scheme. They charge you every time you turn around. That's true everywhere, in RAND as well as elsewhere.

Tatarewicz: At the time, it was just this one line statement of work from the Air Force.

Katz: Right.

Tatarewicz: And it was very open.

Katz: An example of this was, how I happened to get involved with Vietnam. In early 1964, Frank Collbohm the president of RAND, came in and sat down and said, "Can I have a cup of coffee with you, Amrom?"

I said, "Sure." It was interesting that the president of RAND was called Frank at that time, but the guy who brought the coffee was addressed as Mr. Wilson. So we started talking a little, in the following vein.

He said, "It looks like, thermonuclear war, there's not going to be any, and we're in good shape on that subject, and these two

statements are related. On the other hand, wars of national liberation, so called, like what's going on in Vietnam, we're not in good shape, relatively, and there will be more business like that in the future. And those two sentences are related."

I said, "Gee, Frank, what are you going to do about that?"

He said, "I'm looking for three senior, imaginative people to go over to Southeast Asia and take a look."

"Where are you going to find them.".

He said, "I'm looking for two more."

By "senior and imaginative," he meant three old guys who didn't know anything about the subject. So I went home and I told my son, who was then about 16 and living here, "Here, take the last two years issues of The Reporter magazine and the New Leader magazine. Go through them, anything that has to do with Vietnam, Southeast Asia, wars of national liberation, make a note of that item, I'm in a big hurry."

So he did, and I did, and I refreshed myself. It was painful. It was actually very painful getting into a subject like that. It's like I'm running the 100-yard dash, and where are my running shoes? Which way's north? And so on.

Then I got over to Vietnam, spent three months in the Far East, Southeast Asia, and came back with all kinds of recommendations. Some of which were taken, some were not, some really critical I supppose--we were foredoomed there. I came back and wrote up a list of 54 chapter titles for a book. The first one was, "How Come We're the Redcoats?" It takes off from there; it gets better.

Tatarewicz: I'd like to talk about that a little bit later, but I'd like to return to RAND and your first couple of years there. You came there with no particular project to work on.

Katz: No project at all.

Tatarewicz: No project at all to work on, so how did you spend your first weeks and months?

Katz: Well, the first couple of weeks, talking to lots of people, to find out what the hell was going on, and see where I could do something useful. I thought of a project with Mert Davies, on technical intelligence techniques which I'm not free

to talk about, which would have worked fine had it been tried. So that gave me the opportunity to get to Washington again and to Wright Field, and do various things.

We had a project where we were going to photograph the burnout of a rocket from Holliman Air Force Base (north of El Paso), photograph it from Lowell Observatory, with the big 24 inch telescope.

Tatarewicz: This is about the time that Clyde Tombaugh--

Katz: Tombaugh had been there for about 30 years before that.

Tatarewicz: Oh yes, but he was doing some theodolite work, he had been doing theodolite work of V-2s, theodolite tracking, and I think that in about '55, Tombaugh was carrying out a search for near earth satellite--

Katz: --that's right--

Tatarewicz: From Lowell, with a specially designed camera. It was an outgrowth of his missile tracking work.

Katz: The missile tracking work was all done with a camera called the C-2 as I recall; it was at the base. We were trying to see what you could do from several hundred miles away. So we calculated where burnout would happen with respect to the horizon. Too damned much atmosphere--the phenomena were too close to the horizon, and we couldn't get any contrast. We calculated where to point the telescope, we put a camera magazine on the back of the telescope--and we had a lot of fun. It was great sport.

Collins: What was considered the potential use for that kind of thing?

Katz: This was of interest to the intelligence people. They might get burnout of a rocket. Not ours, of course. I don't remember right what the hell they were going to do with various information. By that time we were putting in the big radars in Turkey, and later, they'd void the requirement for this. It was not an expensive experiment, as experiments go. Very interesting.

One of the unanticipated results of that was that the director of the Lowell Observatory got a job at RAND.

Tatarewicz: So that's how--

Katz: --Wilson--

Tatarewicz: That's how A.G. Wilson got to RAND.

Katz: That's right.

Tatarewicz: I always wondered how he got from Lowell to RAND.

Katz: That's it. At night we'd sit around talking, they'd be talking, and asked what RAND was about, I told them what RAND was about, it sounded very interesting. It was.

There's a book on sociology from the air.

Tatarewicz: Our World From The Air, is this title.

Katz: Just look at the topics--fascinating.

Tatarewicz: Very interesting, the way they've put the section headings. Who is the publisher of that?

Katz: Gotkin. Or he's the editor. Some references are given in the paper.

Tatarewicz: It's in the Selected Readings.

Katz: No, in the Retrospective paper. Here's the last--'53.

Tatarewicz: That's a Readers Union Edition. What other sorts of projects did you work on with Mert Davies?

Katz: Worked on a satellite project, told you about. I guess. And arms control projects. Mert went to Washington about 1958, for three years, working in intelligence, and I worked on, what did I work on? I have to look at my papers to tell you. I got interested in Vietnam, 1964. Went to Pugwash meetings. You've heard of Pugwash?

Tatarewicz: Perhaps you could explain what that is.

Katz: Pugwash is this town in Nova Scotia which is the birth-place of Cyrus Eaton. He sponsored it, paid for it, conferences of scientists, from the Soviet Union and the United States and lots of other countries as well, to talk about disarmanent and so forth. I was flattered to be invited to the 1960 meeting, in Moscow. I attended several other meetings as well, in England, Vermont, Sweden, but I have not been invited again. I guess I'm

regarded as too much of a hawk.

It's hard to describe all my activities during that period because I'd have to look at my index.

Tatarewicz: Yes. Besides optical design, and work on optical systems, is that your publication?

Katz: A paper on disarmament. African disarmament.

Tatarewicz: African?

Katz: Or a conference in Ghana, I'd forgotten about.

Collins: What time period was that?

Katz: That was '62.

Collins: Did you ever get disheartened about the prospects for disarmament, since it was something you were intimately involved in and wanted to see the technology that you had worked out for so long help move that process along, yet clearly not much was happening in that regard? How did you feel about that?

Katz: I felt pretty good, because I realized that it did not depend on my achieving these particular goals to have peace in the world. We got peace in the world. More or less.

In 1946, the scientists were hollering, atomic scientists were hollering loudest of all--those who were hollering were hollering, either end of the world or instant world government. Neither our worst fears nor our best expectations were realized. We trod the usual grey path down the middle. There's not a single atomic scientist who was hollering the end of the world in '46, '47, '48 if there wasn't immediate control of atomic energy--not one of them believed we could go 40 years without a world war. I mean, we've done that, quite successfully. Whether you call it deterrence or not I don't know. I don't know about deterrence. Deterrence is something that, while it's going on, you can't prove it's going on. When it's over, you know it's over.

I'm trying to compile a military dictionary, which has these terms in it. I've just written a paper, for Verbatim Magazine, you know Verbatim?

Collins: Yes.

Katz: You do? It's a quarterly, great publication. There are more new cuss words in there. And I defined this term, as well as limited war, what a limited war is, what's your impression?

Collins: Recently it's a limited exchange of nuclear weapons. That's the kind of connotations that comes to mind.

Katz: Exchange of nuclear weapons?

Collins: But in a restrained, somehow restricted fashion.

Katz: My definition of limited war is very simple: it's a war that's somewhere else.

Collins: That's a good one.

Katz: That's all there is to it. But at the place where it is, nobody is persuaded it's a limited war. If you use atomic weapons instead of ordinary weapons and so forth. Nobody believes it's a limited war.

Collins: What you're saying is, it sound like, the concepts for understanding the absence of war over this period are really kind of elusive and difficult to pin down.

Katz: That's right.

Collins: So how does your interest in photo reconnaissance come into play then? It seems to be an equally vague factor. Previously you've indicated that you thought it was a pretty key element in all this.

Katz: It is a key element, if we're going to have any arms control at all. We're dealing with a very secret country over there.

Collins: Right.

Katz: When they say their phone book is classified, they don't mean it has yellow pages. They mean it's secret. The Moscow phone book is about the size of the phone book for Xenia, Ohio. 116,000 people have got a phone bookthat's thicker than the one from Moscow. You have no idea, you can't get telephone numbers. It's just a ludicrous idea.

There's this marvelous story about Moscow. We went to Moscow in December 1960. We'd heard that the rooms were probably bugged, and I was an expert at debugging a room. We made a cur-

sory look, under the pillow, the faucet, the toilet seat, couldn't find the bug.

The next year there was an electronic convention in Moscow, and--this is a great story--two guys from TRW went, whatever TRW was in those days--and they said, "The hell with this crap, we're not going to be bamboozled by being bugged,"--they took some pocket sets of instruments along, hardware tools and instruments, miniature electronic instruments, in their pockets, and they took their room apart. They literally took the room apart when they got there looking for bugging. They couldn't find a bug in two hours. They thought, these guys (the Soviets) are really terrific. So they finally took the rug off the hooks, had a rug against the wall, rolled the rug back in the room, saw a couple of wires going out--they cut them and sat up all night telling nasty stories about Khrushchev.

The next morning they walked down, in the Moscow hotels, you may not know, you take the elevator up and you walk down, no matter how high it is. The elevator is only used for going up.

The manager's waiting, he says, "What room are you guys in?"

They said, "We're in room 546."

He said, "Thank goodness, last night the chandelier fell down in 446, could have killed someone."

Anyway, we're dealing with a country in which everything is secret, except what we can see from the air or hear occasionally, and we just don't know very much about those guys, except they're big and they're mean and they're ugly, they don't wish us well. I don't know if they're ready to start a war or not. We have to keep on looking. Without photos, we'd never get anywhere close to where we are now. It would be a state of complete mysticism Mystery about them.

Collins: So the thing that the photos have done in essence keeps us, how shall I say--

Katz: Agitated.

Collins: Not just agitated but gives us some measure of comfort about where they stand.

Katz: You realize, it's only through their cooperation we're taking pictures at all. They can hide anything they want to. How do we know the missiles are in the silos? I've been talking

like this for a long time. Take a picture of a silo, how do you know there's anything in there? Well, you argue, they wouldn't build those expensive silos and accompanying buildings if they weren't going to put anything in the silo. Certainly not. You attempt to say--is that what you use for determining it? You don't determine that fact. You deduce that fact, if it's a fact at all. Now we realize, they don't even need silos to fire a missiles. Why it took so long to realize that, I don't know, because that's the way we fire Polaris missiles, from submarines. Throw them out, don't light them while they're in the tube, when they clear the water, they light. They're thrown out.

Russians have figured out a technique for reloading. They realize they can use their silos more than once. Or at least they want us to think so. Or, they don't need the silo at all. We launch missiles from a shipping container, have some hooks on it to hold it erect, have a jeep with the fire controls on, push a button and away it goes.

Tatarewicz: So when it's more difficult to tell where missiles are, how does reconnaissance help keep things stable?

Katz: It shows you how far you know what you don't know, and you know you have to go from there somehow. I don't know how to solve that problem. I think about it frequently. We get awful smug about the Russians. They're big crude galoots, new country, don't know much.

I was sitting in Moscow, 1960, December '60, at a Pugwash meeting, writing a letter, during a dull spot in the meeting. I tried to make one of their stamps stick. Their stamps didn't stick. I realized, I had to go back to the hotel, to the floor, get a paste pot from the chief clerk who worked on the floor--like back in grade school days, a paste pot with a little brush wired to the bottle with a short chain--paste it on that way.

At the moment I was trying to make that stamp stick, the secretary of the Academy of Sciences came in and announced they just put up a five ton satellite full of mice, chickens, birds or canaries, I don't remember what they had in there.

Now, in this country we cannot understand how they cannot make stamps stick, and yet put up a rocket. My explanation of it is like this. You have a full spectrum from that light bulb up there. It is continuous, that's the United States, a continuous spectrum, everything works. The Russians are like the spectrum of a fluorescent tube--dark spaces, light spots--what they want to do, they do well. Now, you can't see why the hell they don't

fix the stamps--because you can't say that the guys that would be occupied making glue for stamps are busy making rockets. I don't believe that. They just didn't get around to that yet.

TAPE 3, SIDE 1

Katz: The point of photo-interpretation that most scientists miss is a very simple one. You've got to know what you're looking at before you can interpret it. You can't figure anything out from a picture by itself.

Suppose I buy a World War II surplus aerial camera. I fly it over Dayton, Ohio at 5000 feet and I get a picture with this on it. (This sketch is actual size). [See Katz's insert,(D), showing a truncated triangle]. I go and give this picture to an interpreter from the Royal New Zealand Air Force. For the purposes of illustration we'll say he's never been out of New Zealand. I say, "Jock, what's this?"

And he will say, "I don't know what the hell it is."

I'll say, "Well, let me explain it to you. It's an outdoor movie theatre. When the lights go out and the sun sets, and you're not able to be there with your camera, because the sun has set, the lights go out, the sand box fills with playing kids, hot dogs are sold here, and the screen projects here, cars come in, and when the movie's over it all disappears and it looks like it looks in this picture--dead.

He says, "I got it." Now he'll be able to recognize it with 1/10,000th the amount of information. In the picture itself you've probably got half a million bits of information, at least 100,000 or so.

So he could never figure that out, because he's out of phase with this problem. He goes there at high noon, and at high noon the thing can't work. It's required for it to be dark for it to work.

Now, we've got all kinds of gadgets like that in the Soviet Union, not outdoor movie theaters but other things which don't match our cycle observation and so forth.

Collins: Cultural differences in styles of building and styles of ground planning and layout, and things like that.

Katz: Sure. They don't have to show us anything if they don't

want to show it to us.

They ship missiles in container tubes. We don't see the missiles, we see these tubes. We don't know if there's a missile in there or not. They may have stored it in a building. This is a booklet on verification. I'll let you read that and come back with some questions.

Tatarewicz: How well developed was this awareness of the need for the interpreter to bring a whole wealth of knowledge to the interpretation? How well developed was this, say, when you were at Wright?

Katz: It was pretty well developed during World War II. Interpreters are remarkable people. British practice used women for interpreters quite a bit. I knew one of them slightly, Jack Halliday's wife. She was an expert on world shipping, and she knew every ship in the world, just about, every freighter in the world, where it was coming from, where it was going, everthing. Just from looking at pictures continuously and specializing in that one subject.

I hope I don't have the story wrong, but this is as I recall it. There were about 20,000 ships that she knew about. Now, you've got to realize, there's all kinds of contextual information, as I mentioned earlier, when you say that. A ship is one day in the Atlantic, the next day, in the Pacific there is one just like it, you know it's not the same ship, because you can't make that jump that fast. So context and staying with the subject day after day, making note of changes, helps. It's hard to camouflage a ship completely. It's easy to hide a submarine. Just go down and duck under.

Tatarewicz: Now, your area and your job both at Wright and then later at RAND, really didn't have to do with what photo interpreters did with the materials that you helped supply. I mean, your goal was fairly simple.

Katz: Yes.

Tatarewicz: Greater resolution.

Katz: Right.

Tatarewicz: Better ability to perform under various kinds of possible conditions, vibrations, altitude, varying atmospheric conditions and so forth.

Katz: That was the career, yes. That's correct.

Tatarewicz: Wouldn't you say?

Katz: Yes, that's fair. I mentioned Korea, which was interesting. I had some time on my hands there. I didn't know what I was there for. I was called for by [General Douglas] MacArthur. At least the telegram said MacArthur, but then, as we realized afterwards, every telegram that came out of the Far East was signed MacArthur, even a request for toilet paper. So, I went and I was involved with the Inchon Landing. It was a problem which we solved, I solved. But I spent some time with the interpreters of the 8th TAC Recee Squadron, which was situated on Itazuke Air Force Base near the town of Fukaoka.

And I spent some time with them, and not one of those guys wanted to be there. All four were on the way home. They were drafted. One guy was on a ship leaving the Philippines, he went down and hid in the boiler room so they couldn't find him, because he knew he was going to be called back to Korea, which he just left, when the war started, that is.

They were four photo interpreters. I actually started with dumb questions like this: "How long does it take to interpret a picture?" I think that's a straightforward question. You'd have to be a dummy and worse, and they were right, because they said, "See this room?" It was, the room was maybe twice or three times the size of the room we're in the right now. Pictures come in a door at one end, go out a door at the other end. "We have no storage facilities. We have to interpret anything that comes in. If twice as much comes in, we interpret it twice as fast. So we take the number of airplanes that support the operation, 18, roughly, 18 or 20 airplanes, let's say, four cameras per airplane, 80 cameras, each one carrying on the average 300 feet of film. That's 400 pictures roughly, so you put this all together, you've got the number of pictures, by flights, you get a number per day, divide by the number of hours and you get the number per hour and so forth." So the speed was determined by the volume, which is crazy. But that's how it was.

Tatarewicz: At the same time, I imagine you could spend an infinite amount of time on one picture.

Katz: That's right, if you calculate the information in a picture, oh, perhaps 100 million bits of information on a normal high quality 10 x 10 picture or so, and then if you divide by the maximum information rate possible, which is 23 bits per second. There's a guy named Questor at the University of Illinois who did

experiments back in the fifties, experiments with high speed typing, high speed music reading, and he got back, the maximum information rate is 23 bits per second, some number like that. You take 23 bits per second, divide it into 100 million bits, and you find that you can't interpret a picture in your lifetime.

But that's the wrong answer also. Clearly what you're doing is something else altogether. You're not dividing one number by the other number, when you're looking at pictures. You do Gestalt analysis somehow.

Tatarewicz: And you also have a purpose.

Katz: Yes.

Tatarewicz: You always have a purpose in looking at these things. And the same picture 20 years later, with a different purpose, can yield new information.

Katz: That's interesting. Every time a scientific body convenes to study problems of photo interpretation, or analysis of photography, they always come up with the same invention, the blink comparator. They take a picture one day, take a picture the next day, put them in series or one on top of the other. The picture changes manifest themselves--it's great for finding stars that weren't there the day before, but lousy with doing this, because you never get the same lighting on the two pictures, never the same altitude, by the time you fuss around, you've lost the game.

Tatarewicz: Of all the work that you did at Wright, through World War II, what particular invention or innovation or gadget did you find most challenging?

Katz: That's a question, I've never thought about that. Perhaps the advent of high resolution, which comes up and leads to a very interesting point. I maintain that we went from World War II resolution of 10 lines per millimeter on the average, to an easy 100 lines per millimeter these days, with special cameras and special handling and so on, 100 lines per millimeter or higher. The moral is that we old timers ought to get the hell off the stage; we're so impressed with that accomplishment, we can't believe we could do much better. Whereas some of these kids coming in today, they think par is 100 lines per millimeter. We think 10 lines is par. So they start with the present achievements as a given, they're ready to make improvements. Whereas we who struggled to get up to that level, are just going to sit there for awhile and enjoy 100 lines per millimeter. A hundred

line per millimeter is quite a fantastic sharp picture, by the way.

Tatarewicz: Did Goddard appreciate the technical challenges?

Katz: Yes. Let me say a few words about Goddard. He's in a rest home now, doesn't know who his friends are, doesn't know anything anymore--he's about 96 years old now.[1] I've stayed in close touch with him all this time. Before that, we arranged for him to be caught up on the latest developments in reconnaissance. He said, after that one day, it was the best day of his life. He wanted to see what happened before he shuffled off this mortal coil, as the expression goes. I thought it only right that he be brought up to speed, to see what happened, what his kids did for him, and what happened. He appreciated that.

Tatarewicz: Was he more impressed at the time that you were working for him? Was he more impressed by results or did he appreciate more what went into producing the results? Sometimes an enormous amount of effort is necessary for a tiny result, and sometimes a great result comes out of almost--

Katz: Your remarks remind me of interesting experience. The strip camera was used by Goddard for lectures. We documented the aerial destruction in Europe and Japan, with the strip camera, and the way it was done, it took side obliques--here's the airplane flying, this way--here's the camera coming out the side--that's the angle covered by the slit. There's this, two rolls of film, one takeup, one receiving--

(See insert F, referred to on page 54)

The trouble is that this camera works fine when it's pointed straight down, and all the images are perceived at the same speed through the aperture. You take a side oblique, the scale is different from front to back, and small scale stuff goes at slower speed that the larger scale stuff. When it's projected in stereo (we did see this in stereo,) you get curved images, and it looks like you're looking at a crazy thing that looks like this.

So he offered a reward. He went around the country hollering, he'd give a $25,000 contract to anybody who could figure out how to solve this. I solved it, and all I got out of it was a steak dinner. Because I realized that if you point a camera off the side, it uses the slit, let's say, going off the side--the

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[1]George Goddard died in 1988. He was 98 years old.

image is going to sail through there like mad, and be stretched, at the foreground, and stretched at the top, which is the top, upside down, and compressed at the bottom, and you want straight images, straight lines. So I proposed that we take the camera, cant the slit over at an angle like this, for a top camera, and another one, taking stereo (canted) the other way, so that the strip sails through there, the image is going like this, or it's going like this, at high speed. So, you capture, you get a straight line, you capture the straight line, a fundamental requirement for good imagery.

The trouble is, nobody knows what happened to all that film. Marvelous documentation, showed this destruction up close, color, big, made the slides from nine inch film--it all seems to have disappeared. Nobody stole it, it's just the organization, such that dissolves that. I don't know what happened to all the slides we used to have in the photo lab, and pictures, negatives, all gone. Somebody came in with a broom and swept it out.

Tatarewicz: That brings up one thing that we did want to discuss with you, and that is, the kinds of materials that you still have. You showed us some slides that you have, and a large variety of large format photographs such as the one that we discussed, earlier today.

Katz: Yes.

Tatarewicz: I was wondering if you could just sort of describe what sorts of photographic materials you have.

Katz: I'd be happy to do that. I'd be happy to donate that stuff to you fellows, if you give me assurance that it won't be thrown out when it gets to Washington.

Tatarewicz: Not a chance. We want to get a description of this so that we can discuss it with our colleagues and let them know what's potentially available, and make sure that there's a place for it, which I'm sure there is.

Katz: I've got some pictures of Inchon beaches, I'll describe what that was. On September 1, 1950, I was called in to go down and talk to the Navy about a problem they had with invading Inchon, scheduled for about the 15th, and the problem was very straightforward. Inchon has got huge tides, 27, 30 feet tides, and if your landing craft is up against the wall, and the tide goes out, it's stuck there in the mud, and they can take pot shots at it like crazy. So it's a real bad thing to do, be stuck in the mud. When the tide went out at Inchon, it went out for

about two or three miles. So they wanted to know how long, how high the walls are at various stages of the tide, what kind of ladders they'd need. I solved the problem very nicely, assisted by Colonel Philbrick and Don Graves, the latter a co-worker from the lab. I wrote a paper about that, which if I can find it I'll send you a copy, and we solved the problem. We asked the Navy to measure the walls after the invasion, and let us know how good we did, and they gave measurements X. Then we had an Air Force colonel, Oscar Johnson from our lab who was assigned over there, had him measure the walls in certain places. He got a Y, and our measurements were right in between these two spot measurements, which is pretty damned good.

We delivered the pictures to the Navy, and the Marines--these pictures were taken by airplanes flying right into the wall as it were. The wall was here, Red Beach and then Blue Beach somewhere else, and when the Marines saw the pictures, they said it was just what they needed for landing craft, because it gives them a kind of sequence as they come in to the wall, where they are and where they're going. That worked fine.

I've got those pictures, the originals, right here, and they're originals, prints. Somebody's got the original negatives, these are original prints off the negatives. I've got lots of pictures of various events, like the Tet Offensive in Vietnam, to show what was going on, several pictures.

The pictures I showed you earlier came out of a big envelope, 9 x 18s, are examples of 100 inch focal length photography from high altitude, examples of image motion compensation, with and without image motion compensation, selected prints taken by Baker's lenses, and all that. I've got several sets of that, stashed up on top of the chest there.

Collins: That's very important.

Tatarewicz: Yes, and what we would want to do is, at some point, when we put these into the collection, to have you describe, we'll assign numbers to them, have you describe each and every one, so that there is information about them, about what it is and what it relates to--so that they'll make sense to somebody a hundred years fron now, or whenever. So you have slides and then there are these prints and negatives.

Katz: I don't have negatives.

Tatarewicz: You don't have negatives, just prints.

Katz: Right.

Tatarewicz: Prints and slides.

Katz: Prints and slides.

Tatarewicz: OK. As far as your papers go, what kinds of papers have you saved? We've seen that you have notebooks. Have you retained your correspondence over the years?

Katz: Yes. I've been throwing it out lately, because I'm choked on correspondence. In the far corner of that book case, the lower left hand corner, there's some stuff taken from before World War II and through the war, and--

Collins: We would encourage you to sort of think twice about throwing out correspondence. That's usually very valuable historical documentation.

Katz: I had to throw it out, but I carried it packratting around the country for years now. It comes to the point where I'm just choking with it. Every one of these cabinet drawers is full. This drawer is a book I'm trying to write, on bureaucratic humor.

Tatarewicz: We need it! We need that desperately. We can leave you self-adressed postage paid labels, that if you feel you really must get rid of correspondence, if you're going to throw it out, if you wouldn't mind packing it in a box, these labels are postage paid, it will come right to us, and we can hold it for the archives.

Katz: Good.

Tatarewicz: Because, as we were saying earlier, what we like to do is to try to keep an individual's papers together if possible. I realize that there's a lot of materials that you continue to use, but whatever materials that you no longer need, we would be happy to take, and you can of course have access to them whenever you want. If you need to look something up--

Katz: --You find it easier to find a file?

Tatarewicz: If you need a file or need a folder, something like that--we do this all the time with various people.

Katz: I'll be going through most of this stuff in the next few months, and if I come across an item you're interested in I'll put it aside, get a stack of them and mail them out. Very high

resolution is extremely interesting, how we got it that way. All the effort up to that point was--we were just at a plateau, we reached, we gasped, we got 20 lines per millimeter, 30 lines per millimeter, something like that, and that's the best we're ever going to do, because look where we were in World War II, 10 lines. This is it.

Then in the spring of '54, Jim Baker was by that time chairman of the intelligence panel of the Scientific Advisory Board. He and I made a trip to Europe together to look at the problems, and when we did, we came back thoroughly impressed with the lousy light conditions in Europe--the fog, the haze, the low contrast.

He started experimenting in his basement. He had a huge house at the time with a 40 foot by 70 foot basement. Every day somewhere in that house a bulb was burning out. A light bulb every day. His house was 40 x 70 by three stories up, one story down. That's big. Not as big as Buckingham Palace, but big.[2] He had a marvelous lab in the basement, and he ran experiments like this.

He had a target here, which consisted of all kinds of screwball target shapes, ships and airplanes and letters, jumbled, various orientations, on a big sheet that, as I recall now, was at least three feet square, maybe even bigger. On the other end of the basement he had his lens he was testing. He introduced light into this by putting a split piece of glass right there, and throwing light at it on top of the screen, reducing the contrast. He's looking this way through the whole apparatus, and he found that with a certain film, Contrast Pan (Eastman's film), he could take pictures and see these objects clearly when you couldn't see them visually at all. He'd sit back here with the eyeball looking through this piece of plain glass, and the contrast is so reduced that it's below the visual threshold, just a percent or something like that. So then he discovered he could take pictures of it anyway.

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[2]At this time I lived in a government-built housing project, where with my wife and three kids, we had a house of 800 square feet. No garage or basement, no attic. A tough situation for a pack rat.

The only reason he experimented with that film, it was the wrong film to experiment with, he misread the speed of the film, and the speed of the film was actually much lower than he read. He was off by a factor of 10. He would have never tried that film if he'd known how slow it was! But he tried the film, and the next question was, getting the film faster at high contrast, and that started the whole ball of wax.

Tatarewicz: So we wanted to ask you, you mentioned your work with V-2s, a little while earlier, and we were wondering if you could expand on that.

Katz: We installed a camera on a V-2, Viking came a little later. I forget what the purpose of that thing was. It may have been simply to get pictures from a higher altitude than we could get--it was pretty good, and that's the first picture in my paper on satellites. And an amazing thing is demonstrated in this picture.

Tatarewicz: This is the Astronautics Series.

Katz: Yes.

Tatarewicz: And on page two is the first article, the Viking Rocket picture.

Katz: Here's El Paso. You have a hell of a time making out El Paso there, but that's El Paso. Here's the rail line, you see that line? Going north to Almagordo. An amazing thing happens. Avert your eyes for a moment while I do something.

Tatarewicz: OK.

Katz: All right, where's the railroad?

Tatarewicz: I can't see it.

Katz: See it now?

Tatarewicz: It's right there.

Katz: Yes. It shows that calculations on what you can see, what you can resolve, are not valid when you do objects other than the kind you make our tests on. Long lines are always resolved, because you pick up information all up that line, and when you're denied the information, with this card, it disappears. Obviously it doesn't disappear, it's just as much there now as it was before.

Tatarewicz: The ability to see the so-called canals on Mars is one of the instances in which people invoked that explanation, that very faint long lines, even though below the theoretical limit of resolution, were nonetheless visible.

Katz: Yes. You can always see telephone lines on pictures that don't have resolution anywhere approaching that.

Tatarewicz: So you never did put cameras on V-2s, you were not brought in on the V-2?

Katz: No.

Tatarewicz: But you were asked to put a camera on the Viking?

Katz: Yes, we put a camera on them, a K-25, which was the motorized version of the 4 x 5 hand held camera that the Air Force had. On all its airplanes it had a hand held camera, if you see anything, you take a picture of it--take it up and take a picture, crank the handle--this is a motorized version.

Tatarewicz: Who asked you to put the camera on the Viking?

Katz: I don't know whether we originally suggested it ourselves or not. All kinds of ways to make a suggestion, you start a paper, it goes up and out, and goes somewhere, and somebody says OK, and, more likely somebody will say, not OK. That's much more likely.

Tatarewicz: Was there ever any thought to use rockets operationally to carry out high altitude photography? Would there have been anything to gain?

Katz: Nothing.

Tatarewicz: Above the use of an airplane or a balloon?

Katz: When you stop to think about it, where are you going to launch this rocket? It goes straight up. It has to come down some place. Where? Not in Europe, it's too crowded. We thought the resolution wasn't good enough. It wasn't until we got this panoramic camera in a balloon that we saw the era of high resolution dawn on us. That's that flat camera that you've got, in the balloon exhibit.

Tatarewicz: In the gallery there.

Collins: There are all kinds of photographs there that were taken by NRL with the V-2. You didn't really see it fitting into your interests, because they really weren't working towards that goal of high resolution. They were really more just trying to attempt to see what would happen, as I understand it.

Katz: I was at Wright Field. I didn't know anything about NRL.

Collins: You didn't have much interaction with colleagues there?

Katz: No. In the first place, the Navy was always difficult to work with. The Navy's autonomous. It's a country unto itself. The Air Force and the Army get along, more or less, but the Navy doesn't do business with anybody. Like Eastman Kodak. You exchange ambassadors.

Tatarewicz: Did they have your counterparts working along similar lines?

Katz: In the Navy?

Tatarewicz: In the Navy.

Katz: Not to my knowledge. I don't think they did.

Tatarewicz: How did the get their photography, their charts?

Katz: Their charts were made by the Naval Hydrographic Office. Photography was taken by the Air Force. It's a very confusing subject. At one time I had it straight, just for a fleeting moment. That's a long time ago. A chart is a map made for the Air Force. A map is a chart made for the Army.

Tatarewicz: Yes. And what did the Navy use?

Katz: They used hydrographic charts, looked like Air Force charts.

Tatarewicz: But they didn't have a parallel effort, to the best of your knowledge, going on along the same lines?

Katz: No.

Tatarewicz: I wanted also to talk a little bit about the period before you joined RAND and after the war. Beside the balloon panoramic camera and the high resolution work in balloons, what other kinds of things did you work on?

Katz: Well, in '52, Colonel Dick Leghorn was called back into service at the time of Korea, on duty in '52 in Washington. He had an effort called the Development Planning Objective, where I met some RAND guys, Andy Marshall and Burt Klein. He was looking at the survey of future reconnaissance, and to some extent intelligence, and this activity went on for months. It followed the work of the Beacon Hill Committee. Have you heard of that?

Tatarewicz: What was the Beacon Hill Committee?

Katz: It was a group of scientists studying reconnaissance. It included guys like Ed Land, Purcell, Harvard physicist, Jim Baker. The leader was named Carl Overhage; I think he was from Eastman. There were others, and they looked at this field of reconnaissance carefully, the field of lens design, image formation, and studied long and hard. After that project, in the summer of '52, there was started a Development Planning Objective activity which looked hard at reconnaissance activities; it was a progressive force in the Air Force, looking at the future of the subject. It's important to note that this activity didn't produce a report for several years. It cycled through several chiefs of the office after Leghorn, a Colonel Smiley and a Colonel Johnson had it for awhile, one or two others, but the activity of getting all these disparate guys together--I'd say desperate, I mean disparate--and talking about problems of intelligence, overflight, all that, to set the stage for the U-2. The U-2 didn't come out of no place--it came out of a systematic writing down of requirements. You read Leghorn's papers in that little book on reading reconnaissance, you'll see how the subject developed.

I have an extensive file of correspondence with Leghorn here. Here's his solution to the strategy muddle. You have a letter from Leghorn dated February 22, 1949. To Dr. Compton, Karl Compton. "This note is to thank you for the opportunity you gave me last week to discuss with you informally views on the need to guard the application of more American technology to intelligence problems in the military establishment, through some group or committee specifically organized for that purpose." That's a difficult sentence.

"I mentioned this to Allan Dulles in New York after our discussion. I think it is appropriate to mention the opinion he expressed to the effect that the most important problem of intelligence today is to get American scientific technology more into the picture."

Collins: That's a classic statement.

Katz: Yes, that's a mechanical statement. But '49 is a little early. We weren't looking at excitement in '49.

Tatarewicz: So you worked with the Beacon Hill Committee?

Katz: I worked with the Beacon Hill Committee, worked with Leghorn's DPO, in Washington, for awhile.

Tatarewicz: Was this a kind of assessment of where surveillance stood, or where the overall round of intelligence stood, and how all technologies could be used to systematically benefit gathering intelligence?

Katz: It was focussed on imaging intelligence, very specific. The U-2 came out of that. Not specifically--we didn't design the airplane.

Tatarewicz: But it was a requirement for some platform from which to gather such imaging intelligence.

Katz: That's important, because my impression is that SAC was quite happy with the status quo. They didn't need any new photo intelligence. Because they were moving around in a logical circle, with bombers. So you knew where your cities were, they thought. So cities became targets. If he was targeting and industrial plant, he didn't know where the hell it was. Military base--they didn't know where those were. It's easy to find--

So, they didn't say, "We're in trouble, we have a deficiency in our plans, we'd like to have different plans, or target limited--we'll go around in a circle."

Tatarewicz: So they said, "We will go after the cities, make the cities the targets."

Katz: Right.

Tatarewicz: "And since we can find the cities, we don't need any."

Katz: There's a paper I wrote for RAND, which you don't have a copy of, "The History of Side Looking Radar for Reconnaissance Purposes." Side looking radar was invented by Dick Philbrick, a colonel. He used a strip camera. He argued, if you make an antenna work like a slit in a strip in a strip camera, flying along. And so he took the APQ-7, it was called the Eagle--I don't know how I remember this stuff. I don't know or remember

what I told you yesterday--but the APQ-7 was called the Eagle, and it was about a 12 foot antenna, which put out a pulse this way, and that was like the slit in the strip camera. It just defined its own narrow beam. You move along, images on film, transferred to film, and moving film, strip camera film, magazine, and you've got a reconnaissance gadget.

Now, nobody was interested in that. Three main components in the Air Force were uninterested in this, were hostile to it. SAC, and of course intelligence, and the radar lab at Wright Field. That's crazy, it's like my boss telling me, the three things he's not interested in are photography, airplanes and cameras.

The reason intelligence wasn't interested in this, why, they knew, they had interpreters, and the interpreters didn't know about this radar. The radiation lab at Wright Field didn't want this thing because they did't invent it. They weren't working for the photo lab. So we changed it into a reconnaissance lab. Office of photo limitation.

The radar lab didn't want it, intelligence, SAC--SAC didn't want their maps or charts being made by a radar, other than the ones they were going to use for bombing, which is crazy.

Tatarewicz: They didn't their charts being made by radar, other than the ones they were using, the type that was going to be in their planes?

Katz: Yes.

Tatarewicz: For the bombing.

Katz: These attitudes were so damned dumb, you can't even attack them! Those were some severe handicaps.

TAPE 3, SIDE 2

Katz: I'll give you Philbrick's address. You can contact him, because he did really quite a bit there, on the subject of side looking radar. He took this thing on in '49, '50 or some time in there. I've got his whole lecture and pictures, somewhere here. Where, I don't know. I could dig it up.

Philbrick disarmed those at USAF-RAF symposium in Eugene. It was received enthusiastically. I had him send me the apparatus. They came out and invented something called Blue Shadow, I think.

Blue Shadow. Then the American Air Force went over and looked at it, the British, why the hell can't we do that? Somebody found it good and adapted it.

The radar today is not this brute force radar, it's doppler radar, where the image has a certain effect, two or three times as long as this, by sending out a pulse to an antenna here, and an antenna over here, sending another pulse, and you can measure the time between the pulses, have a whole bunch of pulses getting to an artifiicial antenna.

It's called SLAR, Side Looking Aircraft Radar. You get much better results with this.

Tatarewicz: What came out of the Defense Planning Objective were requirements for new types of platforms, among other things, and also requirements for new types of tools to use on those platforms.

Katz: Yes.

Tatarewicz: Was this a change, compared to the period say before and during World War II, where for the most part, when you were at Wright, were you just given the platforms, say--here's the plane that you've got to work with?

Katz: Some dumb thing like that.

Tatarewicz: Design a tool to fit with this. Were you ever able to make recommendations?

Katz: We recommended that they buy an airplane from Republic called the F-R 12, I think, and that airplane was the first high speed passenger airplane. That's what Republic built it for, for passenger use. They got swamped by Douglas.

We took that airplane and flew it one day nonstop. It was a perfect day, good weather forecast, I was the project engineer. The photographer, flew with three Metrogon wide angle cameras in the airplane, each would cover 76 degrees, and you had an overlap, so it covered the horizon and then some. We had a picture nonstop from San Diego to New York--clear all the way. That's the damnedest thing. You could lay those pictures out, they were about 200 feet. That set of pictures was exhibited at the UN, when Eisenhower made his Open Skies proposal, and exhibited elsewhere, but they've disappeared. I had them for years. I gave it to Itek or somebody. Couldn't store the stuff.

Tatarewicz: So the idea of your recommending the need for a platform was not altogether new.

Katz: Here's a rare item.

Tatarewicz: Volume, Reconnaissance Aircraft and Aerial Photographic Equipment, 1915 to 1945. And this comes from the Historical Office at Wright Field.

Katz: It was secret, it's declassified.

Tatarewicz: It's about a 200-page long volume. Typescript. Chapter eight on the subject we were just talking about, the development of aircraft designed especially for photographic reconnaissance missions, Hughes F-11 and Republic F-12.

Katz: I wonder if you can get this thing from Wright Field.

Tatarewicz: Originally 11 October, 1946. Declassified, 3 June, 1954.

Katz: It's dull reading.

Tatarewicz: The 1950's--and especially the move to the new platforms like the U-2 is a whole other chapter. Do you think this is a convenient place to--

Collins: I think we might--with a last comment, perhaps--I was wondering what Goddard's reactions were to your picking up and moving on to RAND? How did he feel about your move?

Katz: I've got my letter of resignation in the files here. I was going to do the same sort of work, only better, higher level.

Goddard never believed anybody should stop working for him. I used to go the Society of Photographics meetings in Washington. I was looking for Goddard's hat. He'd get in the Shoreham Hotel, always losing his damned hat. He'd say, "Katz, help me find my hat."

So I go looking for his hat, I found ten other guys looking for his hat. He was a character.

As I say, he's in a nursing home now, can't communicate with him. It's a shame. I got a couple of World War I cameras from him. I don't know what the hell to do with that stuff.

Tatarewicz: Oh, artifacts?

Katz: Yes.

Tatarewicz: At some point, if you can put together a list of what you have, I'm sure the curators in the Aeronautics Department that handle aircraft reconnaissance artifacts would be very happy to know about this. About thse artifacts. Any artifacts, I can place with the appropriate person, to put them in the collection.