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LEMELSON CENTER FOR THE STUDY OF INVENTION AND INNOVATION

Wayne Alfred Wiitanen

Transcript of an interview
conducted by

Christopher Weaver

at

National Museum of American History
Washington, D.C., USA

on

30 November 2018

with subsequent additions and corrections

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Preferred citation:

Wayne Alfred Wiitanen, "Interview with Wayne Alfred Wiitanen," conducted by Christopher Weaver, November 30, 2018, Video Games Pioneers Oral History Collection, Archives Center, National Museum of American History, Smithsonian Institution, Washington, DC.

Acknowledgement:

The Smithsonian's Lemelson Center for the Study of Invention and Innovation gratefully acknowledges financial support from the Entertainment Software Association and Coastal Bridge Advisors for this oral history project.

Abstract

Wayne Alfred Wiitanen begins the oral history by discussing his early family life, education, and early exposure to science fiction and engineering. He next recounts his time at MIT, working at Datamatic, and his subsequent residential life where he met Martin "Shag" Graetz and Steve "Slug" Russell. Wiitanen discusses the Hingham Institute and his contribution to *Spacewar!* concept. He concludes by recounting his military service, his post-MIT career, and the current status of his present-day family.

About the Interviewer

Christopher Weaver is a Distinguished Research Scholar at the Smithsonian's Lemelson Center for the Study of Invention and Invention, Distinguished Professor of Computational Media at Wesleyan University and Director of Interactive Simulation for MIT's AIM Photonics Academy. He has contributed to over twenty-five books and publications and holds patents in telecommunications, software methods, device security, and 3D graphics. The former Director of Technology Forecasting for ABC and Chief Engineer to the Subcommittee on Communications for the US Congress, he also founded the video game company Bethesda Softworks. Weaver is co-director of the Videogame Pioneers Initiative at the National Museum of American History, recording oral histories and developing new applications for interactive media and public education.

About the Editor

Justin S. Barber provided transcript audit-editing, emendations, and supplementary footnotes to this oral history as part of his broader work into video game history and digital museology.

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Video Game Pioneers Oral History Collection

Interviewee:	Wayne Alfred Wiitanen
Interviewer:	Christopher Weaver
Date:	November 30, 2018
Location:	National Museum of American History, Washington, D.C., USA

Weaver: Good morning. Would you please be kind of enough to tell us your full name, the date, and where we are doing this interview?

Wiitanen: My full name is Wayne Alfred Wiitanen, and we are at the Lemelson Center in Washington, D.C.

Weaver: And the date.

Wiitanen: And the date is the 30th of November 2018.

Weaver: Thank you. Good morning.

Wiitanen: Good morning.

Weaver: For purposes of this oral history, I would like to try and take you through a chronology leading up to *Spacewar!*, so if you don't mind, I want to start very early. Would you please tell us where you were born and your earliest family life?

Wiitanen: I was born in Detroit, Michigan, at least according to my birth certificate, and I spent the first three months of my life in an orphanage. I was adopted by Ruth and Alfred Wiitanen. They had put in a request for a child of Finnish descent. They were unable to have children of their own.

I grew up in Ferndale, Michigan, which is a blue-collar suburb of Detroit. My dad was a principal of a K-7 school and was Director of Special Education for the school district of Ferndale, which was quite unusual in the 1930s and 1940s. Ruth, my mother, was a substitute teacher. She was a native Michiganian. My

dad hailed from Michigan's Upper Peninsula in the Copper Country. He was a fluent speaker of Finnish and English. I speak only English.

Weaver: Thank you. Can you tell me about your earliest recollections of how you became interested in math and science?

Wiitanen: Well, I think it started with a Boy Scout paper drive, or maybe even Cub Scout. It was quite a long time ago. You could sell newspaper, and as long as it was all bundled, you could get, oh, 10 cents for 100 pounds or something like that, and so you could raise money for the Scout troop or the Cub Scout den. I stopped at one house to find out what this particular woman had, and she had a nice big package of newspapers all bundled up and ready to go. She said, "Oh, there's a bunch of magazines out in the garage that you could have." I went and got those, and they were all science fiction magazines. I have to admit, I sequestered those for myself. That had its own repercussions. My mother was rather concerned that science fiction was going to teach you how to blow up the world. Well, that didn't bother me any. I got a start reading science fiction, I think in 1949. I can even tell you what the first one was. I think it was the serialized version of *Seetee Ship* by [Jack] Williamson. Not a particularly great novel, but it's enough to trigger an interest in science.

Weaver: And you also had interest, my understanding, in music as well.

Wiitanen: Well, yes. I always have enjoyed music for all of my lifetime. In grade school, we were given stringed instruments to try out, and I played the violin for one day and my dad couldn't take that. So, we tried piano lessons, and I banged away at the piano for years, to very little effect. I'm not very good. I don't have very good muscular coordination for that sort of thing but loved music. I sang in the vested choir at the high school back in the days when there were actual music programs. My particular high school had a marching band, a full orchestra, two different choirs, a vested choir and a madrigal group.

Weaver: My understanding is that when you were in your science fiction period, you read both the *Lensman* series and the E.E. Smith *Skylark*.

Wiitanen: Yep.

Weaver: What's your memory of that?

Wiitanen: That it was, let's say, fairly reflective of the time in which it was written. E.E. Smith was not particularly a great word craftsman, but he satisfied the first law of melodrama, which is "keep it moving." You can write an awful lot of bad text

and still have a rather dramatic story. Some of the expressions, idioms of the day, were kind of peculiar. For example, when Dorothy was talking to Seaton when they were looking at the newest version of the Skylark of Space, she said, "Oh, Dickie, isn't it kippy?" Whatever that meant.

That was kind of the problem, but Smith could plot fairly well, and the activity was at a good level. It got you to think about, "Is this really possible?" and, "Yeah, let's find out if we can make that work."

Weaver: Jumping off from science fiction, my understanding is that you did a number of things that earned you science awards, I think during high school. Would you tell us about that?

Wiitanen: Yeah, there were a bunch. I was a good student, a very good student, in fact. I had been president of the Honor Society and all that sort of thing. I was awarded the Bausch & Lomb high school science thing. And I entered the Westinghouse Talent Search. My project was music-related, music- and physics-related. I was interested in the question of can you extract from musical tone played by a particular instrument what the components are that give it its particular timbre. I built an oscilloscope from a Heathkit [device].[1] I had—I think it was a WebCor wire recorder that I borrowed from my dad's school.[2] I had a friend who was a good violinist and another friend who was a French horn player. They would record a nice steady tone for me, and I would record it on the WebCor. Right there we had some signal degradation. And then I could play it back through the oscilloscope multiple times. I would take a piece of photographic paper and hold it up against the face of the oscilloscope and play that particular segment of tone and I would get a nice waveform from it. Then I designed a form for calculating the Fourier transform of this particular waveform, and it was *extremely* tedious work doing it all by hand, so that didn't get very far.

But I did submit the project to the Westinghouse Science Talent Search and ended up being an honorable mention, in spite of not having directly demonstrable results. I think I did very well in respect to the state of Michigan in that particular one, which was rather surprising, since Detroit had the Cass Technical High School. You'd expect some good performance out of them. In my case, I was doing it all by myself. My physics teacher was hopeless, and my

[1] Heathkit is the brand name of kits and other electronic products produced and marketed by the Heath Company.
[2] The Webster Chicago Corporation was a maker of electronic equipment in Chicago, Illinois. Many products were sold under the brand name Webcor.

mathematics teacher, he ended at advanced calculus. No, not advanced calculus; advanced algebra. So, I had to do a lot of this on my own.

Weaver: You talked about Michigan. When it came time to go to college, what did you see initially as your options?

Wiitanen: Oh, well, we spent our summers in upper Michigan, which is Copper Country. It's not copper ore, but it's mass copper. These are just great blobs of metallic copper that can be extracted. When I was growing up during World War II, two of the copper mines were still in production: the Painesdale Mine and the Calumet and Hecla Mine. For a small person who was interested in machinery, they were just absolutely wonderful because they had these huge, huge devices all powered by steam. There was a big boiler house and there were these huge pistons. The huge drum that the skip cable would be wrapped around and a huge indicator to say at what level the skip was. Bell signals telling the drum operator what to do: lower the skip, raise it up. Is it poor rock or is it copper rock?

I spent a fair amount of time there poking around the old mines. My cousin and I used to go up to some of the old earlier abandoned mines, which my dad's father had worked as a carpenter. We'd sit on the poor rock pile and sort through it to get copper specimens. That was very easy. When it came time to decide where you wanted to go to college, my dad was a University of Michigan graduate. The Michigan College of Mines I found very attractive because I liked messing around with the old mines. We used to go exploring the abandoned adits and so on.

I was there on vacation one July prior to that and I was reading some idiot book when one of my dad's friends, college friends, showed up unexpectedly to see him. He looked at what I was reading, and he said, "Well, looks like you're about ready to go to college. Where are you going?"

I said, "Well, I'm thinking about Michigan College of Mines."

And he said, "Well, why don't you think about MIT [Massachusetts Institute of Technology]?"

"What's that?"

Turns out that my dad's friend was Dean of Students at MIT. Talk about coincidence. So, I ended up going there.

Weaver: Did you get a scholarship to do that?

Wiitanen: I had a scholarship for the first year. I was not a good student. I was well out of my element. But, you know, you get started, you make friends. It's a matter of maintaining your friendships and a fair measure of pride. So, I struggled along. By the end of my second year, tuition was going up from $300 a year to $600. Coming from a lower-middle-class family, that's a big change, so it was time to look at work-study, which I did. I had just completed a course in statistics. I go into the work-study office—this would have been 1956 in the spring—saying, "I'm looking for part-time work."

And the person there said, "Well, there is an outfit in Newton Highlands that's looking for someone with a little mathematics background. Why don't you go check them out?"

It was Datamatic Corporation, and they were building a machine, the Datamatic D-1000. You can check it out on the Internet and see how it all worked. It was a decimal machine, had a huge mag tape about three inches wide, very peculiar tape drives. They were looking for someone who could handle some programming. They would teach you to program and do some support and that sort of thing. I took the job not really knowing what it was going to lead to, and so within a few weeks, I was starting to program IBM [International Business Machines] 650 computer. That was essentially the beginning of this computer madness.

That had an odd result in that I was taking numerical analysis the next semester with F.B. Hildebrand. One day he stopped me in the hall, and he said, "I haven't seen you in the calculator lab."

I said, "Well, I don't see there's any point in going to calculator lab. I can write computer programs to do this *much* more easily and more accurately than cranking out numbers on a Marchant calculator."

F.B., he says, "Well, I think you still need to go to calculator lab."

I said, "Well, I don't think I'm going to."

He says, "You'd better." So, he flunked me.

Weaver: I want to go backwards a little bit because I want to talk briefly about your freshman year at MIT. You were in a dorm room. You were put in a dorm room.

Wiitanen: Yeah, I was in Berkman House, which was a converted hotel. I was on the third floor and my longtime friend "Shag" Graetz was on the fourth floor. It was typical dorm living, study mostly. [Laughs.] Your freshman year, you were required to take commons meals. It was a sure bet whenever they had chicken croquets, we'd all have diarrhea. But that's where I met Shag[3]. It was freshman year. We were both interested in music and the out-of-doors, so he and I were both members of the MIT Outing Club. We did a lot of hiking together, some rock climbing and so on. We hit it off, and we've been friends for now sixty-five years without any interruption.

Weaver: When you were at Datamatic and learning programming, you clearly took to the programming part.

Wiitanen: Yep.

Weaver: Tell me a little bit more about what you previously called "the computer madness".

Wiitanen: Once you discover, or once I discovered, that you could actually get interesting results and do interesting things with computers, a lot of schoolwork became kind of irrelevant. I can remember one of the projects that I bootlegged—and I bootlegged quite a number of them—was a calculation of the dynamics of the stretching of nylon rope. Now, why would I be interested in that? Because we did a lot of rock climbing. In some climbs, the leader is not being belayed from above, and so if the leader falls off, you need to catch them. With nylon rope, you've got two dynamics that you have to deal with. One of them is just the slippage of the rope. You're going to try to slow that down around your buttocks where the rope goes if you're the guy below. The other dynamic is, once you begin to put tension on that rope, it's going to stretch. So, we were interested in knowing the dynamics of stretchy nylon rope.

Well, my friend Jim Burkane was class of 1956 and he was a physicist. Jim is probably the brightest person I have *ever* known. He should have won a Nobel Prize, but the experimentalists got it instead. Jim did the calculations, all the physics on it, and I cranked out the numbers. I don't remember what the conclusion was, but that was the sort of interesting thing you could do.

Another case was that I had a friend who was very much interested in steam engines, and so we generated some steam tables for him. This was on an IBM 650 at Datamatic before they got a 704. He worked for Raytheon. He was a

[3] Martin Graetz

radar engineer. He would come in every evening and run his radar simulations. You got to see a whole bunch of different kinds of things that you could do with computers. That's a real inspiration just seeing how other things work.

Weaver: In 1956, I believe, you got a job at MIT. Would you tell us about that?

Wiitanen: The 1956 job was at Datamatic. Following that, I worked for the Office of Statistical Services at MIT. I didn't have quite so long a bicycle trip. I used to bike to work in Newton Highlands, which was about 11 miles, to work two days a week, Tuesday and Thursday from whenever I got there until midnight. That got kind of tedious after a while, so I managed to get a job with the Office of Statistical Services. I think the main thing that I was involved in there was doing auto- and cross-correlations of bonds. Some guys from the Sloan School of Management wanted to know, you know, do these things correlate over time or don't they. So, there was a lot of calculation on that arrangement.

I had a falling-out with the director of the lab, which put an end to that job. I was behind in my schedule for the bond calculations, the auto- and cross-correlations. I went in on a Saturday to see if I could catch it up, and there's Frank Rizou, who was the director of the lab, cranking out numbers on the 650. He was a little nervous about that, so he accused me of coming in to bootleg time. I told him I was coming in to finish up my work on this particular program. He said, "No, you're coming in to bootleg time." I took my key and threw it at him and disappeared.

But I worked for Bill Thurston there. He was really good. He ended up being part of the management team when MIT got the 704.

Weaver: Well, go backwards for just a minute. You've used the term "bootleg" twice now. Can you go back to your first reference to it? Because you talked about a number or bootleg projects, so I just want to be sure I understand what the term defines in terms of what you're saying. Are we talking about unsanctioned work that you used when the machine was available off time?

Wiitanen: Bootlegging time essentially is using time when the computer is available, but you're not paying for it. The machine is idle, you've got something to do, so you run it. If the machine's not idle, well, you're not doing it. So, it's a form of white-collar theft.

Weaver: Or education.

Wiitanen: Yeah. [Laughs.]

Weaver: If I'm reading the numbers correctly, 1957 would have been your graduation, in spring.

Wiitanen: Yeah. I did not graduate. I'm two courses short and a thesis. I was going to write a thesis on Tarski's decision method for elementary algebra and geometry, but I had no access to computing stuff at this point. Not any access to hardware, so that didn't materialize. I needed to take physical optics and real variables, I think, in order to graduate. Well, that really didn't bother me, because I was doing all kinds of interesting things with computers, and so why worry about it.

Weaver: In the summer of 1957, what did you do?

Wiitanen: I got a job with the MIT meteorology department and the Numerical Weather Prediction project with Jule Charney and Norm Phillips. This was the same time that "Doc" Bullitt was discovering the butterfly. The Numerical Weather Prediction project, I believe, was doing barotropic modeling of the atmosphere. My job was to use what was called the Hafworg logic facility of the IBM 704. Now, this was a special add-on you could get so that you could do arithmetic on 18-bit sections of a single 36-bit word. This was ideal for mapping because you've got the x-y coordinates in one word. You've got a considerable saving of space, core space, with these things, and the idea was then to essentially create predictive weather maps. Well, a lot of programming went into this, and the weather prediction would run overnight, eight hours or so, on the IBM 704 to produce a fifteen-minute projection. But, you know, it was kind of proof of concept, early steps in actual numerical weather prediction.

Weaver: So, after the summer, in the fall of 1957, I believe you moved.

Wiitanen: Yep. Shag and I moved to—he moved in and I moved in. I was living in one men's cooperative before that that was a bunch of MIT Outing clubbers on Highland Avenue in Cambridge, but most of my roommates were class of 1956 and left, and the 1957 class—let's see, we had two floors—and it was time to leave. I joined another men's cooperative. In those days, you had men's cooperatives. You did not have mixed cooperatives. It's kind of funny now, if two guys go out to look for an apartment these days, the landlord kind of looks askance. If a guy and a woman goes out, that's fine. It used to be *exactly* the opposite in the 1950s.

I moved into a men's cooperative called Old Joe Clark's. Old Joe Clark's was a men's cooperative that started in the 1930s and was in operation—it used to rent different buildings. Finally, a bunch of the alumni got together enough capital that they bought a three-story house in Cambridge on Fayette Street, and you

paid $25 and bought a share in the corporation. Then you could have a room and all of the facilities of the house, which was a kitchen, dining room, parlor, freezer room, that sort of thing. Shag also moved in at the same time. I had a room up on the third floor. It was quite an interesting adventure in the place. Lots of the alums would come in and have dinner with the current residents on a Friday and then they would all go folk dancing. Old Joe's also had a square dance band. Shag was the piano banger and I sort of clanked away on a banjo. We had a couple guitar players and a violinist and a caller, so we could go out to various school things and put on a whole square dance, line dance, folk dance show. That was kind of fun.

What else about Old Joe's? Old Joe's is now dissolved. I cashed in my share that I paid $25 for, for $1,600, so that was a good investment.

Weaver: Can you tell me when your first meeting was with Slug [Stephen Russell]?

Wiitanen: Not precisely, but it had to be after McCarthy left Dartmouth and came to MIT. I have no idea when he kind of entered our life, but he certainly did.

Weaver: When you left the MIT meteorology department, why? In other words, in spring of 1958, why did you leave?

Wiitanen: Ah. Because I got a letter from my draft board saying that "Unless you are in a defense industry, we're going to draft you." And curiously enough, Shag did, too, got one from his draft board. We consulted with one another. Well, therein we decided to join the reserves. That was in May. We then both went to Dix for basic training. He was in one of the platoons and I was in another. And then we were both sent to Fort Sill for artillery survey training, and we were both in the same company there.

Fort Sill was kind of an interesting thing. I had an old Volkswagen at that time. It was made out of cast iron, I think, and, boy, it was durable, but slow. We drove from Cambridge to Lawton in that old Volkswagen. Going through Oklahoma, one of the big signs you keep seeing is "Watermelons. Twelve, your choice, for a dollar." Watermelon was big, yeah.

Fort Sill was a very interesting place. They had artillery range for eight-inch guns, so they shot over long distances. There was a lot of accuracy that's required by surveying, so it's a nice technical military occupational specialty, what's called an MOS. That's mostly what happened. We were done at the end of, oh, six months after May. What's that? That'd be December, roughly. We then took up separate quarters. I found an apartment on Beacon Hill, on Pinckney Street,

and Shag found himself an apartment in Cambridge. But we did, prior to that, leave Old Joe Clark's and had the Hingham Institute. We had a place on Hingham Street.

Weaver: In 1958, I believe you got a job working for Doug Ross. Would you talk about that?

Wiitanen: Oh, yes. In the Electronic Systems Laboratory, Doug Ross, who was the *enfant terrible* of the time, was working on an automatic tool program, the very first CNC kind of machine. The machine was a Bridgeport mill in which all of the controls had been retrofitted to stepping motors. Doug Ross' team was to devise a means of going from a description of a part to the actual G-codes that were required to do the milling. One of my roommates, Jerry Wenker, was involved in the project. He had the peculiar job of looking at all the various op codes for the 704—I think it was probably a 709 by then—to see what kind of real numbers they approximated so that if you were really in a pinch for certain values, you could reference an already existing operation code. Kind of a strange business. I don't remember what I did for the project, but programming of some sort.

Weaver: After the Electronics Laboratory, do you remember what your next job was?

Wiitanen: Yep. The Littauer Statistical Laboratory with Al Beaton, one of the best persons I ever worked for. He had a Ph.D. in educational statistics. They were looking for somebody that would essentially maintain their system for them. That consisted of knowing how the 704 operated and how the software worked and that sort of thing. I was what in those days was called a systems programmer for the Littauer Statistical Laboratory, and my office was the pantry of an old house in Cambridge.

Working with Al was really good fun. He and I were going to propose to the National Science Foundation [NSF] that they fund a compiler for statistical work. At that time, I had learned about Backus Normal Form, ways of expressing computer languages. We designed a full statistical language, made a proposal to the NSF, and someone that was involved in the foundation came and talked to us about it. He said, "We're not going to fund this."

And Al said, "Why not?"

He said, "You're not asking for enough money. We don't think you can do it with the budget you asked for."

That was the end of that project. And today we have R, which is an open-source, very nice statistical programming language. It's based on C, but the syntax is a little odd.

Weaver: Talk a little bit more about when you moved into Hingham.

Wiitanen: Hingham Street, ah, yes. Well, it was inexpensive. It was a pretty rundown building. We were on the second and third floors of that. Another mutual friend of ours, Dave Freeman, who was another MIT Outing Club guy, he was a guitar player, had a wonderful tenor voice, had rented the ground floor. This was kind of MIT bums. The house layout was pretty straightforward. There was a front room where I had put up my bookcases. I'm a bibliophile. And in the back of that was the kitchen, and then there was a stairwell that went up. There was a bathroom upstairs with a shower and a tub and two bedrooms. We cooked a lot of our meals together, and Slug began to show up, so the three of us would often have shared meals together there. That's probably what I remember about the place.

Weaver: Did you help Shag get a job?

Wiitanen: Oh, yeah. And Slug. Slug was kind of tired of working for McCarthy. Let me back up to Shag instead. Shag was looking for work. The Littauer Statistical Laboratory was looking for someone to run the printer and the card reader, so I got him that job. And a little bit later, they were also looking for someone to do some programming, statistical things, and Slug was available, so I got him that job.

He was pretty much involved with, I think, the Mosteller business. Frederick Mosteller is a statistician at Harvard who wanted to find out who the authors of the unknown *Federalist Papers* were. His hypothesis was that there are probably linguistic indicators, words that are unique to the authors. And, yes, he found one word: "whilst." That's a little iffy at that level, but it was quite interesting. Every word was keypunched onto a card, so the whole *Federalist Paper* set was keypunched with the word and what paper it came from.

One of the big efforts was to sort that. What do you do when you've got boxes and boxes and boxes, and it runs through a card reader? Well, you do what's called a multiphase sort. You copy all these onto a tape and then you section the tape. You take the first hundred and you sort those, and you take the next hundred and you sort those and then you do big merges on them. Every now and then, the multiphase sort program would fail, and you would print out the

results. And that's the only time you knew it failed, is when you printed out the results. Some of the words would come out just absolutely garbled, but some of them were pretty funny. I think Shag collected a whole bunch of them, words that came out like "circumciticivil" and—oh, I've forgotten some of the others, but they were pretty funny. Shag and Slug and I worked together at Littauer for some time.

We had an assistant director of the lab. When I first went to work, it was C. Harvey Wilson, very interesting fellow, but he went on to other things and Peter Wegner took over as the assistant director. I'm afraid we didn't have a lot of respect for Peter, and so we would scribble all kinds of crap on the blackboard and then go out to lunch. And if you came back a little earlier, there would be Peter copying down what you had written on the blackboard, so that was kind of a fun game to play with him. Those were good years.

At that time, I was one of the few fortunate people that actually had a listing of Fortran 1. I could go in there and poke around and see how IBM did things. You would be appalled at the arithmetic, the algebraic parser in that thing. Everything was ad hoc. There was not a uniform way of doing it like the Bauer-Samelson method that was developed with two stacks and that sort of thing, which made a big, big difference in how you think about parsing code or parsing algebraic statements.

Weaver: I want to, just for the record, establish—tell me the story of the Hingham Institute, please.

Wiitanen: [Laughs.] The Hingham Institute. Well, MIT is called "The Institute" by the students, and sometimes worse names like "The Institute for Destitute Prostitutes." And so, for tongue-in-cheek, we decided we would call this dingy apartment our Hingham Institute. It was pretty much a joke, an "in" joke. Slug, who was now part of our social group, and Shag and I became the directors of the Hingham Institute. The only thing that ever really came out of that was our get-together to invent *Spacewar!*.

Weaver: Why don't you expand on that.

Wiitanen: Oh. How can I expand on that? We were having tea one day. It must have been early summer or perhaps mid-summer of '61, and we knew that a PDP-1 computer was coming to the Minsky Lab. We knew that it was going to have a CRT display, big tube. We had not seen it, but you begin to wonder what you can do with this new shiny toy, which is sort of typical for geeky people to want

to exercise it. Being science fiction fans and having read all of the same things together, we think, "Well, maybe something that involves spaceships, maybe something that involves battles, and let's do it with real physics if we can." That's fundamentally the ideas that were put forward, so, "Let's make a game called... something." I don't know who suggested *Spacewar!*, but there it was.

The fundamental ideas were to include physics, manipulable objects that would be spaceships, and battle things like torpedoes and real physics. I don't think we initially thought about a big massive central star. I think that evolved out of subsequent discussions, as did hyperspace and the fact that it would be somewhat unreliable, actually evolved out of later discussions and refinements. Whether it would ever be implemented or not was another issue. We had no idea how the PDP-1 would be managed and whether this would actually be doable, but it looked like it'd be fun, so we planned to do something of that sort. And I say "we" because I also planned to help in that thing. Then suddenly I get a letter from the U.S. government saying that "You are recalled to active duty," and there goes my opportunity to write code.

Weaver: Would you say in terms of the thought process or the suggestion of the game of *Spacewar!* that it was shared or was one of you more the proponent than another and the others then took it up?

Wiitanen: I think, if you read Shag's [Martin Graetz] history, that I suggested it, that I essentially planted those seeds and then we all jumped on it and pushed it along.

Weaver: So, did you, in fact, plant it?

Wiitanen: I guess. It seems really likely, that the rest of the course of my life so far seems to be a lot of seed planting.

Weaver: When you were then recalled to active duty—I'm just stating this; you tell me in your own words, but did you ever do any programming on *Spacewar!*?

Wiitanen: On *Spacewar!*? Not one line. Not one line. I'm kind of an accessory before the fact on this thing. All the other guys had the fun of implementing it. I have kind of the, let's say, idea that you don't really own something until you have implemented it. In a sense, I don't own *Spacewar!* at all. I have no implementation in it. That's kind of like you don't really own calculus until you do the problems.

Weaver: Then again, if you designed calculus, you might own a portion of it.

Wiitanen: Oh, yes. Yes, you have that joy, anyway.

Weaver: Do you consider that you do have that joy?

Wiitanen: Oh, absolutely. Yeah. As far as I'm concerned, it doesn't need to be known.

Weaver: Well, it will be now.

Wiitanen: Yes, unfortunately. [Laughs.]

Weaver: Do you have any feelings or recollections about, at the time, did you have any perception of what this could be on a larger scale?

Wiitanen: Absolutely not. This was something that we wanted to play with a new machine, find out how it worked, how much can you do with it. "We've got the CRT. Let's work with the CRT, see what we can do with that." At least to my understanding, there's no thought about distant future on this thing. "Let's just see if we can get this running. It should be fun."

Weaver: One or two more questions. Well, the first thing is, is there anything that you can think of that we have not asked relative to *Spacewar!*, whether the story is anecdotal or not, that you think materially aided, challenged, changed, influenced to try and improve understanding sort of the fabric, the times, and how it came to be?

Wiitanen: I think Slug has pretty much covered the ideas involved. One thing I do remember rather clearly is that when I got out of the Army in the mid-summer, late summer of '62, Shag took me down to the lab to show me what they'd done with *Spacewar!*. It was pretty impressive. I tried it and really got nailed, of course, because I had some experts to play against me. Then Shag confided in me. He says, "Oh, boy. Dan *really* has cursed us for gravity." That I remember clearly. I'm not a game player. I'd rather build it than play it. But other than that, I have very little in the way of recollections of contributing anything particular to the game itself.

Weaver: And just to sort of finish up, when you then were called to active duty and had to go away, briefly, what did that entail? In other words, when you left, what did you do?

Wiitanen: What did I do? I went to Fort Bragg. Then through a series of rather interesting circumstances, I ended up doing temporary duty at the Walter Reed Institute of Research in Bethesda. The reason this happened is when I was—I had a job after

the Littauer Statistical Laboratory for an outfit called Computime, which then got bought up by another outfit called CEIR. While I was working for Computime, one of the clients was Phil Stone of Harvard University, who was doing some kind of programming for psychological statistics or something of that sort. When I told him that I would be leaving for the Army, he was somewhat upset because he was counting on me to help him with the programs, but he said, "Well, I've got some friends at the Walter Reed Army Institute of Research, and I'll see if we can get orders cut for you to be there."

That didn't work, so I spent some time at Bragg. At the Christmas break, I actually went up to Washington, up here, to stay with the Zahnisers. The Zahnisers had been friends of my now-wife's family for a long time. Howard was the executive director of The Wilderness Society, and he was the man that shepherded the Wilderness Bill through Congress. The Zahnisers and I became very close friends.

Went back to Bragg, and we had field maneuvers on one occasion Coming back from the maneuvers—well, I might back up and say an artillery unit has guns, so you have a gun emplacement. They have targets, so you have a target and you've got to locate targets. And to connect the two areas, you have what's called a connection survey. I was doing the connection survey. I was involved in that group.

Anyway, we had done this particular mission and the gun batteries had blasted their targets as appropriate. It was pretty late in the evening. We had a meal and it got dark, and so they packed up all the Deuce and a Halfs with people and equipment. We were going back to the cantonment area. We're going down these dirt tracks in the dark of night with cat eyes on the Deuce and a Halfs. The driver could see the road right in front of him, but not much else. The lieutenant who was leading the convoy with a Jeep was throwing cherry bombs up into the air and letting them go off just for a little bit of excitement. Well, he threw a bomb up in the area and here comes from the other direction a Jeep with its cat eyes. The cherry bomb lands beside the Jeep and goes off. The Jeep comes to a screeching halt, turns around, comes up to the first Deuce and a Half, and the passenger yells at the driver, "You stop this convoy!"

And the driver says, "Sorry, sir. I'm just the driver."

"Well, I'm General Conway." Conway was in charge of Fort Bragg.

And the driver said, "Sorry, sir. I'm just the driver."

He went up and yelled at the lieutenant to stop the convoy, and the poor lieutenant got some hot water over that.

I had an opportunity following that to go up to Washington for a three-day weekend, and I went to visit these people at the Walter Reed Army Institute of Research that was the experimental psychology group. John Armington was the head of that group at the time, so I told him my story. He said, "Oh, let's go and talk to David Rioch," who was yet higher up in the thing than John Armington was.

We went and talked to Rioch and I told him the story. He laughed and he said, "George Conway and I have been good friends for twenty-five years."

He gets on the phone, calls up Fort Bragg, says, "This is David Rioch. I want to talk to George Conway. Hello, George. I hear you had some fun with a cherry bomb." You could hear the splutter over the telephone. Then Rioch says, "You've got some excess baggage I want this week."

I got back to Bragg Sunday evening and I had orders cut to leave Monday morning for Walter Reed Institute of Research.

I spent—it was a really wonderful assignment, because I was teaching one hour each day, five days a week. When the research group was having their lunch, I was teaching the programming techniques. And if I wanted to come down and go to one of these museums or anything, I'd put on my monkey suit and get in free.

But the upshot of that was that I got a *really*—I had lots of opportunity to sit in their library and read journals. [I] found that physiology and neurophysiology are very, very interesting subjects. When I got out, I decided that, well, you know, here's a real opportunity to apply computer techniques to a field where there aren't any. I went to Harvard night school and built up my biological background. [I] managed to get into graduate school and earned a Ph.D. in biology with a specialty in neurobiology, particularly of insect vision. Now, the ironic bit of that is that my first two papers with Francisco Varela had to do with the optics of the bee's eye. Here I was from MIT days one optics course short [of graduating].

Anyway, my thesis advisor was Torsten Wiesel at Harvard Medical School. Wiesel went on to get a Nobel Prize in 1983 for the work he and David Hubel had done with cats and monkeys.

Having done that, I got a job at the University of Oregon as an assistant professor in the biology department with a joint appointment in computer science. I managed a couple years later to get a *substantial* teaching grant to develop an area called systems physiology. The idea there was to take techniques from mathematics and techniques from computer science and apply them to interesting problems in biology. For me, that was a project of developing teaching methods. My particular interests were in signal processing, applying that to neurophysiological problems and simulation techniques, which applied to a broader spectrum of problems in biology.

Well, what happens when you are in a publish-or-perish environment and there are no journals? Well, the dean was a one-trick pony. My department voted "We want him." The Vice President for Academic Affairs say, "We want him." I was promoted to associate professor without tenure. They didn't like being on soft money. But even more, the downside, I was Acting Director of University Computing, and that was *way* beyond any interest I could possibly have. It was the worst job imaginable. I'm *not* a management person. I like to do things.

Anyway, it was clear that my time at Oregon was coming to an end, so I sent out a whole bunch of letters to, I think, almost two dozen different institutions who were looking for someone with my kind of background. Not specifically, but close. I never got any replies, not one. But I did come across an ad in the *IEEE Spectrum* from the General Motors Research Labs looking for somebody in the machine vision project that had my kinds of qualifications, so I sent off a letter.

Two days later, I get a telephone call saying, "Get on the plane and come out for an interview," which I did. I spent sixteen years at General Motors Research Labs, which was very much like being in a university without committee meetings. The downside was no students. I loved working with students.

That was an interesting place. I developed there probably the first industrial-strength image processing system. It ran on a VAX and used a Ramtek display. I demonstrated that particular one to the manufacturing development people, because they had gotten an actual request from the union to develop something to replace their workers on the line. This was where you put an inner liner in the door. The empty steel door comes down and then you put this inner liner in, and there are a whole bunch of T-screws that you have to turn. These guys do this and every eleven seconds, there's a new one coming through. You can imagine how swollen the wrists and arms get. The union actually asked GM to look into finding a way to do this with a robot. The difficulty, of course, is locating

the holes, and the image processing program did that very neatly. And we could demonstrate it and they all got very excited about it, and it never materialized.

But anyway, one of my colleagues at that time was Dick Young, who I knew from Oregon days. He was in the psychology department. I got him a job at GMR. I showed the system to Dick, and he took me aside and he says, "You need to take a sabbatical from GM and develop this system for a commercial project." This was years and years and years before Photoshop. But that was a fun project.

I did another interactive project, which was a factory-floor control program. We were asked to look at how we can schedule various kinds of machines on the floor. If this machine is down, we have this one that does multiple service, and how do you synchronize all these things. I'd built a Petri net system that consisted of nodes and lines, connections and bars. The nice part about it is if you clicked on one of the nodes, it would bring up a little box and tell you about what that node was supposed to do. Or if you clicked on the bar, it brought up a little information box and told you what it was expecting to see, what its current status was. You would run this thing and you'd get a fairly good idea of how things might work on the shop floor. Again, never went to fruition. Why? Politics, pure and simple.

Another project that we were looking at, I was doing a lot of independent research in the lab on neural networks. I was particularly interested in what are the physiological parameters that can now be incorporated into programming, how much do you need, how much do you not need. My department head was a little concerned, since he didn't know anything about physiology, but John Hopfield happened to be on GM's advisory committee for the Research Labs. George Dodd, who was my department head, arranged for him to come and talk to me about what I was doing. We had a really nice chat for an hour or more, and his final report was that, "Well, it's harmless, but it's never going to amount to anything." And it wasn't much after that that Hopfield became a big name in neural network theory, which was kind of amusing.

One of the results of being interested in neural nets at that point was actually trying to build some for useful applications. One of the applications we were asked to look at was bell housings. There was a plant in St. Catharines, Ontario, that did bell housings for differentials. They had to test all of the bell housings for flaws. The way it was done is the bell housing came out of casting and allowed to cool a bit and this guy would hit it with a hammer and listen to the ring. If it didn't ring properly, then it was recycled. If the ring was proper, you do it so. The proposal was, well, let's just record these things, and we can build a neural

network that will essentially discriminate and tell us when we've got a good bell housing and when we don't. Well, that never went to fruition either. They just hired another guy and trained him to listen to the bell housings.

Another one that never went to fruition because of a political scam was when we were asked to develop a network or system that would help with the electroplating operation. When a car body is manufactured, the raw steel is all put together in raw steel, but you can't paint raw steel. They turn the thing upside-down and they dip it in a mysterious mixture of stuff, proprietary as all get-out. Then they take it out and it's all white and that's then dried. It goes through a heater and dries it off, and then you can paint that. But the mixture changes, obviously, as you plate out more and more vehicles. We were asked is there a nice way to monitor this arrangement. Yeah, we can manage to do that. However, at a joint meeting with the plating group, the electroplating group, the electrochemistry group, and the computer science group, the other three decided that they were going to have a squabble over who had jurisdiction. That was the end of that project.

I think we had one with the medical group, because they were interested in neurological damages to organisms when you have car crashes. But I think that department got dissolved.

When I reached the age of sixty, my department head said, "Well, you're old enough now for early retirement."

You know, I enjoyed my work at GM, and I was having fun with the various projects I was doing, so I wasn't particularly ready to do that, but he was rather insistent that it was time to take early retirement. I talked to my wife about it and we thought, well, yeah, we can probably make it work. GM was willing to do some extra support because I had kids that were still underage and so on. I retired in September of, let's see, 1995. October of 1995, my entire department was dissolved, and all my colleagues were laid off. George knew what was going to happen, which is why he was so insistent that I get the hell out of there. I then moved out here, moved out to western Colorado, where my wife and I have a small farm. It's been nice living out in the sticks.

Weaver: Wayne, let me ask you to go back for a minute based upon some of your educational background. If you were able to talk to someone who was at the age of being influenced in areas of creativity, innovation, invention, what would you say to them? Knowing what you do now, what would you recommend they do?

What would you say to them to try and get them interested in better self-educating toward the inventive and the innovative?

Wiitanen: I would recommend a couple of things. First is, read widely. Lots of different sources and find something that really attracts your interest. Then do some concentrated reading in that particular area, because you'll begin to get all kinds of other ideas that people have already had. The second thing that one could recommend is have a very good vocabulary, because one of the things we do is we associate words and those create ideas. Be very observant of things around you that could lead to changes.

I'll give you an example. I do a lot of cooking at home. I cook Indian meals, Chinese, Southeast Asian, that sort of thing, and a lot of them call for garlic. Some of the garlic is minced up and put in. Some of it is grated or run through a press. Well, I've got two garlic presses and I put the garlic cloves in, you squeeze the handle and about a third of it comes back up and the rest goes through the holes. Well, I look at that and I say, well, that's wasteful. What can we do to keep it from backing up? Well, you invent the high-tech garlic press. What do you do? What sorts of things keep backflow away? Well, an obvious one is in the automobile; the pistons have rings. Hmm, garlic press has something that looks like a piston, so why not design a garlic press where the piston has a little ring on it, and it fits a very nicely milled cylinder. Now you have a new kind of garlic press, not cheap. It wouldn't have a huge commercial market, but it'd be pretty damn high-class, and you wouldn't get all that blowback.

Just by observing things that are around you, you can see how they might be extended, get new ideas, put different things together mentally and see what happens with them. A lot of it's how you foster the idea of curiosity, how something works. And don't *ever* stop learning.

Weaver: Thank you. Do you hold any resentment, looking back, in terms of your military requirements, from what it demanded of you at a time when you could have done other things, some of which, for instance, might have been with *Spacewar!*, with some of your friends? Do you hold any resentment, or do you look at it a different way?

Wiitanen: It depends on the time. When I was there, I was bored until I got up to Walter Reed. I resent being bored, but I taught my crew how to play Bridge. That was a game. However, in retrospect, at least in my life, there have been doors that open and doors that close. If you've got a bunch of doors that are closing on

you, you're probably not quite on the right track. You change your attitude, you change what you're going to do, and, all of a sudden, other doors start opening. Yes, the military service was a transition point for me. It transitioned me away from a life of being a programmer into a life of being an educator and seed planter. These things happen, I believe, personally, for reasons. Sometimes you don't like the reasons, but they happen. So, accept it, see what you can do with it.

Weaver: Thank you. When did you get married? And can you tell us just briefly about your children and what they do?

Wiitanen: Well, let's see. Monica and I have been living together for forty-eight years now. She moved in with me in 1971 in Cambridge—it must have been 1970, my last year of graduate school. We got married in 1973 in Fairplay, Colorado. We had just climbed a 14,000-foot mountain, and down by lunchtime. We got married by a slightly drunk judge in the oldest operating courthouse in Colorado.

We have three children living. We lost one. The eldest, my daughter Amy, is a design director for Zelouf fabrics in New York City. As the title says, she designs fabrics. She's an artist in that thing. She was trained in Florence, Italy. She's fluent in Italian, which leads to some pretty amusing stories, actually. She goes to China—in fact, she's in China right now, because she makes sure that they're making the fabrics the way they've been designed. She does all the color separations and things. She's one step down from the president of the company. She's been pretty successful. She was homeschooled up to fifth grade and then went to a Waldorf school and then to the community high school in Ann Arbor. She is a fine violinist. Her violin teacher was a violist in the Detroit Symphony. He said, "Amy, I can teach you to be a professional musician but I'm not going to. Be a consummate amateur. Everybody'll want to play with you." So, number one daughter is doing all right.

Number two daughter actually lives in Paonia now. She went to Mesa State school, Mesa State College in Grand Junction. Kit was all homeschooled, all grades. [She] got a GED [General Education Diploma] and went to Mesa State. She was in the honors program, classics and theatre, then went on to another school. Columbia, I think it was called, in Chicago, in theatre and film, where she wanted to be a documentary maker. She did a session in New Zealand as what they call a cicada wrangler. When they did outdoor shooting, her job was to go around with a big stick and beat all the bugs out of the trees. She worked for a little while in the TV industry and disliked it. She and her now-husband came back to Paonia, worked with my wife, learning baking. They went to work

in Fort Collins for a while. Now they're back in Paonia, where they have purchased a craft brewery and are running the Paonia United Brewery. They have a professional brewer there and they make, apparently, very good beer. They went over to the Crested Butte Beer Festival and won two first prizes on two of their beers, so they're doing all right in that respect.

My son is a machinist. He works in Everett, Washington, for a machine company that does subcontracting for Boeing. He's currently operating a two-million-dollar CNC [computer numeric controlled] milling machine. He shows me pictures of what the darn thing does. They take out 4,000-pound billets of aluminum, put them into the machine, he gets the thing all lined up, makes sure the program's right, and they then mill a single part out of this big 4,000-pound piece of aluminum, collect all of the scrap and reuse that. It's pretty interesting work for him. He works Friday, Saturday, Sunday, three twelve-hour shifts. The other days, he goes to school at the Everett Community College, where he's learning CADD [Computer Aided Design and Drafting] work and welding, blueprint reading, composite materials, a whole bunch of things. He's a builder. He likes to use his hands. He was also homeschooled. When he was younger, he was really into chain mail. He made an entire chain mail shirt ring by ring, thousands and thousands and thousands of them. He cut the rings and then he put them into the shirt. He has enormous patience. We expect to see him at Christmastime. That'll be good fun. So, that's where they are.

Weaver: Excellent. Thank you very much.

[End of interview]