QSO Today Episode 344 – Robert Zavrel – W7SX

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Eric, 4Z1UG 0:00
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Eric, 4Z1UG
This episode of QSO Today is sponsored by Icom America, makers of the finest HF, VHF and UHF transceivers and accessories for the radio amateur, reminding you to check out their new IC 705 all band portable transceiver now shipping from your favorite amateur radio dealer. My thanks to Icom America for their continued support of the QSO Today podcast.

Welcome to the QSO Today podcast I'm Eric Guth 4Z1UG your host

Robert (Bob) Zavrel made an outstanding presentation during the expo weekend that ended up on Zoom with a limited audience able to follow him off the expo platform. However, we captured it and put it up in the expo auditorium. Be sure to watch Introduction to Antenna Aperture by Robert Zavrel, W7SX.

When it comes to understanding how antennas really work, then the go to guy is Bob, W7SX, author of the ARRL book, Antenna Physics, an introduction. Through this book, Bob bridges the gap between how to antenna books and calculus based antenna theory books for engineers. Bob has a long resume in radio and electronics is the accidental creator of the Signetics NE602 mixer chip. Bob was my guest in this interview over 200 episodes ago and shares his story in this replay in this QSO Today.

W7SX this is Eric, 4Z1UG. Are you there Bob?

Bob, W7SX 3:58
Yeah, 4Z1UG? W7SX you're five nine here, Eric. Go ahead,

Eric, 4Z1UG 4:05
Bob. Thanks for joining me on the QSO Today podcast. I found a QSL card on-line that said that you took apart your mother's radio at age four. Was this the start of your ham radio and electronics career?

Bob, W7SX 4:17
Yes. It goes back as far as I can remember I've always been very interested in in radio and listening to radio. And yeah, I think it was I was maybe three or four years old and I saw my mother in the kitchen using a butter knife, a regular table knife as a screwdriver. And while she was away, I decided I was playing with the radio or just an old tube table radio. And I use that to pull the screws apart and I managed to get the thing apart. Then it was on. And she came in horrified to see me had taken the radio apart. And I was still plugged in and playing. And she came in and tore the plug out of the wall. And told me not to ever ever play with radio or electricity again. I think at that young age, that was the trigger to make me want to play with electricity and radio,

Eric, 4Z1UG 5:31
You're of a generation where your mother was quite familiar with how dangerous it was. And like every child, you don't take your mother's advice.

Bob, W7SX 5:39
Absolutely. Well, I of course, she did. absolutely the right thing. And of course, not being a particularly conforming young, young person, I put the opposite path. And here I am today, so and you survived. Yeah, I survived. And I don't recall I getting a shock from it, I obviously did not touch the wrong part of the the chassis or underneath the chassis of the radio. So that was, and then we had a Hi Fi set, which was made. This is in the south Chicago in the 50s. And my parents knew a guy that was building them on a pair of 6L6s. And, and I was just completely fascinated by watching those tubes, and how they were producing the music that I grew to love so much. And so there was also a kind of a, an early fascination with vacuum tubes. And nobody in my family had any electronics or engineering experience. So I was kind of left to my own imagination as to how these things work, then it wasn't until later that I that I got into the details of of how vacuum tubes work and started to learn electronics pretty much on my own in the beginning anyway.

Eric, 4Z1UG 7:10
How did it proceed from there as a boy learning electronics? Did you have books or mentors that kind of brought you along?

Bob, W7SX 7:15
Yeah, the Chicago heights library had, I think it was three books on on radio at the time. And one of them was the the Amateur Radio Handbook, or the ARRL book, which I which I had constantly out. I remember when I was in fifth and sixth grade. And then they gave me one Christmas I got a crystal radio set that was very interesting. And there was a guy fellow student in seventh grade who, whose father was an electrical engineer and he knew he knew about transistors. So he introduced me to transistors and very rudimentary circuit theory and what have you. And then one night, I was I think I was about the seventh grade again. I heard on the Hi Fi set, W8MAE who had moved in from Cleveland into into Chicago heights, about three doors down. And he was a he was on AM and it was a beautiful audio quality. And I heard CQ CQ. And so the following day, went over to his house, figured out who it was there was a antenna in the backyard vertical antenna stuck. And so I knocked on the door and I introduced myself and I said that I'm hearing your, your transmissions on on my Hi Fi set. And he said oh well, well, you know, I'll stop transmitting. I said no, no, no, I'm really interested. And so we got to talking, he invited me in and went down in his basement, knew he had an SX 25 and a Viking II. And he was on 40 meters. And so I got to watch somebody operate a ham radio station for the first time. And he was on CW and AM and and I was hooked at that point. That was instant love. And so he was able to mentor me at least through the first stages. And I started to learn the code. I taught myself the Morse code on on the sofa just out of a book and then I got a code practice oscillator and the the code came relatively easy to me. I think it was within a week or so. I was up to the five words a minute. And then Marty W8MAE, the same guy again. He belonged to the tribe column, amateur radio club, who met Hazel Crest, Illinois once a month, and he took me up there. And then I got introduced to a lot of different people. And Barbara Key, K9RPX was kind of a mentor. And he also gave novice licenses on a regular basis. So at that point, I was, I was on my way. And then I met some other teenagers my age that were licensed. And so I made a lot of friends there and, and had a lot of positive reinforcement. So that's what got me going.

Eric, 4Z1UG 10:45
When did you get your first license?

Bob, W7SX 10:47
Well, I passed the novice of fall of 1965. So I was 14 years old when I passed the novice, and I got my license in January of 66, right after my 15th birthday. And so that was I passed up when I was 14, but I actually got the license was a few days into my, my 16th year I was 15 years old. At that point,

Eric, 4Z1UG 11:18
what was your first callsign

Bob, W7SX 11:20
WN9RAT, the Rat. Go ahead.

Eric, 4Z1UG 11:26
That was a great call.

Bob, W7SX 11:27
Well, it was a good CW call, but I didn't the notoriety was a mixed bag. Sometimes it was fun. But if I if I made a mistake on the air, you know, they obviously they'd call me rat operator or lid wrapped or whatever. So especially when I still make mistakes today, but I don't make as big as mistakes as a novice. That was it. It was a double edged sword, so to speak. But I got I got to know I got to be known as the rat. And that was kind of fun, especially for a teenage boy and, and then I got a pass for the general later that year. And of course became WA9RAT. And I held that call. Until I guess it was 76 or 77. They had I hadn't I had passed my extra I think in 71 or 72. I gotten the extra and then they had they open the calls up the two letter calls and and I had moved out to Washington state by that time. And that's when I requested and actually W7SX was my second choice. But I got that call. And I was I've been W7SX ever since and an extra operators ever since then.

Eric, 4Z1UG 12:56
Do you remember your first rig?

Bob, W7SX 12:58
Oh, yes, yes. Well, when I graduated from grammar school, in 65, would have been that June of 65. Before I got my license,

my dad bought me a S120 which from Allied Radio in Chicago. And so that was my first real shortwave receiver that allowed me to do code practicing. But I also was very interested in at the time in DXing on AM broadcast and I had I think about 30 states confirmed at that one point on AM radio. And so the whole idea of QSLing and what have you was very, very appealing to me and couldn't wait to get my ham license. So I'd actually do it now. When I got on the air. My mother got me an HT40 the old Hallicrafters rig and two 80 meter crystals for for Christmas. And the S 120 wasn't quite up to snuff as a ham receiver. So Marty had an extra receiver and an old S20R the old Hallicrafters rig from the from the 30s. And I was able to borrow that receiver. So I had the S20R and an HD40 loaded vertical ground mounted in the yard for transmit and they and just a long wire for receive because I couldn't afford a coaxial relay. And then I'm just a straight key and so as often running at that point,

Eric, 4Z1UG 14:44
I didn't feel to make the first contact.

Bob, W7SX 14:46
Oh my goodness. Yeah, it was transformational experience you might say. And I remember my first QSO was a guy in in eastern Iowa. Well, which was maybe 150 miles from, from Chicago Heights. And I was just delighted that I had actually gotten out that far, so to speak. So that was a, that was the start of it. And then I quickly began now the HD 40 did not have a watt meter or an SWR meter. So I simply peaked for maximum output. So I think the mismatch must have been horrible on the antenna, and running only 30 watts or so in effect, that was a QRP novice station because I really didn't know what I was doing at the time. But that's helped me build up operating skills and the code speed certainly. And that was a tremendous help. And then through through the club by God, I got to know more experienced people. And I got bit by the DX bug very early. And started experimenting with antennas building all kinds of different antennas out of wire and anything I get my hands on that look like an antenna material. And that was that was that I was also very interested in learning radio theory. So that very early on my my focus in ham radio was DXing and theory, especially HF DXing going for DXCC, and trying to get more countries confirmed and getting getting to do the DXCC award, which I got. When I was 16 years old. I had qualified for my DXCC certificate. So that was the early days through high school anyway, there. Go ahead.

Eric, 4Z1UG 16:50
Can I ask you what your rig is today,

Bob, W7SX 16:53
I use a K3. That's my main rig. We're in the process of moving so everything's packed away. And I have I'm sorry to say I have about one ton of radio equipment and parts in storage right now. I had no idea I had that much until I took them took it all apart, but I haven't. I have a K3. And the whole array of, of homebrew mostly homebrew equipment. I have a belt I use the GS 35 V which is a Soviet era Russian tube as the basis for 160 through 10 meter amplifier on belt. And then I also have a base on the same tube a six meter mono band amplifier, I guess about Oh, it's got to be 20, 25 tuners and tuning networks all kinds of remote control equipment noise reduction controllers for phase store receiver arrays. I got one if you if you look on the QRZed page, you can see a lot of stuff.

Eric, 4Z1UG 18:06
And now this message from Icom America. I can already feel spring in the air and the great outdoors is calling. Get outside under the stars with one of Icom's ultimate SDR transceivers stay connected while off the grid. The Icom IC 705 is the perfect transceiver for hams who enjoy both a great indoors and outdoors. It's the perfect QRP companion with base station features and functionality at the tip of your fingers in a portable package covering HF, six meters, two meters and 70 centimeters and is weighing in at just under two pounds. These features include a 4.3 inch touchscreen with live band scope and waterfall. Five watts with the BP 272 battery pack or 10 watts with an external 13.8 DC power supply. single sideband CW, AM, FM as well as full D-Star functions, and micro USB connector Bluetooth wireless LAN and an SD card slot. Integrated GPS with antenna and GPS logger. The HM 243 speaker microphone is standard equipment. The basic accessory for the IC 705 is the optional backpack the LC 192 with a special compartment for your IC 705 and room for accessories for SOTA activations, or a day social distancing in the park. Visit the IC 705 web-page to view accessories and free software available for download. If you lean to the VHF and above region, then you can create your own band opening with the Icom IC 9700. This transceiver radio brings direct sampling to the UHF VHF weak signal world. This all mode transceiver is loaded with innovative features that are sure to keep you busy. These features include a 4.3 inch touchscreen color TFT LCD with real time high speed speed spectrum scope and waterfall display, smooth satellite operation with 99 satellite channels, dual watch operation and full duplex operation in satellite mode. I believe it is the most exciting VHF and above transceiver on the market today. And finally, the Icom IC 7300 is the most advanced HF transceiver in its price class and ideal for the new ham or the experienced ham looking for an upgrade. The Icom IC 7300s High Performance innovative HF

transceiver with a compact design that will far exceed your expectations. This innovative HF transceiver digitizes RF before various receiver stages to reduce the generated inherent noise in different IF stages. The IC 7300 is the radio that changed the way entry level HF is designed. And I own one and I think it's brilliant. Its features include RF direct sampling, 15 discreet bandpass filters, large 4.3 inch color touchscreen, real time spectrum scope, and an SD memory card slot. The real HF phone starts at Icom, be sure to buy one of these fine Icom transceivers at your favorite ham radio dealer. And when you do it, tell them that you heard about it here at QSO Today. And now back to our QSO.

Eric, 4Z1UG
How did ham radio play a part then in the choices that you made for your education and career?

Bob, W7SX 21:25
Well, they were extremely instrumental. I think I always had a knack or a interest in, in science and engineering. Largely due to my father's encouragement in that area. He was a biologist and an author. But by my interest was in physics and and electronics event in particular radio, so I brought that interest in that experience, to the university. And but my first degree was actually in geography, which was a little a little odd. And I was also interested in maps, and of course, DXing, like it or not, and start instills a keen interest in geography. And so I got going in that. And it wasn't until years later, several years later that I went back to school, and got my second bachelor's degree, this time in physics, and I grew maps for about a year with the degree in geography, and of course cartography is part of that. And I decided that I didn't, I really didn't want to draw maps. And at that point, I had a pretty good solid knowledge of basic electrical and electronic theory. So I got a vendor was $1.50 cent guide for the first class radio telephone license, which I passed fairly easily. And went to work in radio broadcasting, which I did for several years. And then a job came open at the University of Oregon, for the classical radio station, the public station, after being in commercial radio for quite a while. And part of the deal, you're on the staff of the university and cost for staff members back in the day, it was $12. I remember that $12 a credit to go to school. And I could take off from work. I had to work, of course, the eight hours a day, but I could put holes in that eight hours a day and walk a few buildings over to the physics department. And that's how I got my, my second degree, and that I graduated with the physics degree in 83. And the height of the recession, and of course, we're living in Eugene, Oregon at that point, and Scylla comics down in Silicon Valley, hired me as an applications engineer, and we had our firstborn in 83. So that was a big, big year very eventful, eventful year moved to California and began work with in fact, it was the the main guy there that was that hired me I didn't report to him but he was a senior engineer at Ed Oxner, KB6QJ. He was sort of known as Mr. FET. He had written several textbooks on field effect transistors. Also was instrumental in the early work of building fat ring mixers, these were active jFET. mixers. And I was assigned to the DMOS, analog switches, the SP5000 series. After reading Ed's work and being mentored at a professional level by Ed, I thought that it might be, might be interesting to take an SD 5000, which was actually four of these analog switches, configure configure them on a ring and create a commentating rather than active mixer out of a similar to a diode ring. So we did that. And there was a guy, other ham there was...

Bob, W7SX 25:51
...Van Brollini, he was NS6N and he did the layout of the the IC. And where it became what was the 8901. And that was in 1984. And it's still available today, it's still perhaps the strongest mixer, you have for those familiar with intercept point. And as an input intercept point about plus 35 dBm and requires maybe 1/10 of the LO power that a diode ring does and it's still used, in fact the my K3 and a lot of the more advanced transceivers today use that configuration for the front ends to make very, very high dynamic range show HF front ends, kind of running away with this conference. Then after I was there, while another ham, Rudy Severns. N6LF was hired as the applications manager. So I reported to him for a while. And he was doing the power FETs. And I also got my hands into RF power FETs and built at the time, I think I held the world's record for power output from a pair of transistors that was about 360 watts at two meters from a pair of DVD 150Ts and then Silicon Products sold their RF power line to Macom. And that was the foundation of the Macom FET line. That was back in the 70s. And there was a they were gradually defocusing from RF and into into power applications. So I left and I went to a Signetics down the road in Silicon Valley and I became the first RF Applications Engineer for Signetics, which Philips had just bought out. And that started a whole new chapter in my RF. My RF career so to speak, the NE602 was was one of the devices that I was in charge of as an applications engineer. And now that the device is still available after what 30 some odd years

Eric, 4Z1UG 28:23
On the cover of the last month QST I think the July 2016 QST is a homebrew receiver that has an NE602 chip on it.

Bob, W7SX 28:32
Yes, well, the NE602 it was actually a mistake because the 602 and the 604 were supposed to be one IC and it was to take the the first IF of an analog cell phone. This was before digital cell phones by the way. And the IF was 35 megahertz and the

602 would convert from 35 down to 455 kilohertz for the IF and the 604 was then the limiter and the and also the demodulator. For FM analog FM, well, the designer could not get the monolithic form to work properly. So he broke it into two chips, the NE602 which was the mixer oscillator, and the NE604 which was the oscillator so if he had not made that mistake, the NE602 would have never come into existence. And I don't think we ever sold most of I my memory is a little vague here but I do recall that of the NE602 and the 612, which was a derivative, it's a same basic thing, a different testing criteria for it. But about only about 10% of the ones we made actually ended up in cell phones, they it became a such a ubiquitous device, that it ended up in all kinds of different applications. And it's, it's still available today. So let's, it's actually that that device was actually a result of a mistake, an accident, an accident. That's right, that's right, and an accident,

Eric, 4Z1UG 30:41
Good product for Signetics.

Bob, W7SX 30:43
Oh, it was a very good product for Signetics. And it gave a lot of the, the sales pitch, the RF semiconductors were not selling that much in terms of revenue, but they were, they were proprietary parts. And so the sales people understood that if you could design those parts in, then it would be much easier to get the real volume, which are the digital integrated circuits at the time of 4000 series CMOS and what have you into their design, and that's where the real money was. So I was very popular with the sales-force, unfortunately, I had to spend a lot of time on my road a lot of time in Europe, and in the Far East, traveling all over the world, and showing people how to how to use RF integrated circuits because it was relatively new at the time. So we were replacing discrete transistor designs with these with these new ICs. And in one case, there was actually one case where we actually replaced the vacuum tube with some of the new ICs which was pretty, pretty novel. And through that, you know, there you go, you go all over the world and, and so many of the, of the engineers that the RF engineers you talk to are also hams. So I was able to meet a lot of very large number of very technically savvy amateurs or people that started in amateur radio and, and ended up in an RF engineering, either they were inactive, but a lot of them were this day still are very active in ham radio, and they all have very similar stories, I'm sure to mine and we could we could sit there and talk about how they got into ham radio exactly what what we're doing in this conversation and compare notes for people my age that grew up in Japan or France or Germany or the UK or wherever. And that was that was that was pretty nice. I made a lot of lifelong friends on those business trips. And of course, so reading their their material over the years, Peter Hart G3SJX was also working for Philips at the time I was and he does all of the fact he I think he's come out with a book or two evaluating ham rigs. He's very, very good at it. Thomas Mollier VL7AV was at Siemens in Munich and spent a lot of time talking with him and and why don't you go back and you end up...later I met Peter Chadwick G3RZP who was later president of the RSGB. I worked with him at Plessy. And then it's really fun. Later, you know, years go by and then you hear him on the air and you work them again. And that's a lot of a lot of fun to recall the old days and find out what they're doing now, etc, and maintaining those relationships. So for my part, it's very, very difficult to separate my amateur radio career as it were from my professional career. So it's when you say how did one lead to the other it it was, so untwist and and tangled together what woven together that it's hard to separate the two especially on People that people that I know and respected in the field certainly.

Eric, 4Z1UG 35:06
Well, I think that's a great history. And there's some very interesting things along the way. Obviously, if you're a home brewer, then you've kind of run into these parts along the way. And it's nice to hear the background story. In your QRZed page, you say you made the DXCC honor roll with only wire antennas supported by trees. And I think I know why that's an important statement. But can you explain why you made it and what antennas you use that were held up by the trees?

Bob, W7SX 35:33
Yes. So back in my broadcasting days, of course, I had to contend with a lot of large towers, particularly for FM I never had to climb an AM tower but I did climb some FM towers and I did not like towers. It in terms of... they're kind of scary, they're expensive, and I don't think they're very nice looking in a residential area. I'd rather use and unfortunately, in Oregon and Washington, Western Oregon, Washington we have the whole landscape is filled with antenna masts called Douglas fir trees, which even the second growth trees are 140 to 160 feet high. So they're straight trunk, then if you can get a wire up there, you have a tremendous mast. And so hanging wires up there, and mostly, I started with dipoles and extended Zepps. And there were, I published a lot of the antennas in QEX and QST, for extended Zepps, and and some trap arrangements that I worked out. And then when we bought this place, 12 years ago, in Elmira, Oregon, I had three acres at the top of a ridge with some with some high trees. And I was able to design what I call a mini curtain for 160 meters and so that you don't have to use it just wires hanging in a tree. And so the cost and the effort and the the impact on the gardens and vineyards and what have you on the rest of the lot were minimum, but they perform very very well. And so 40 meters ended up being as being my, my favorite band, and all of the contacts I've had 40 meters were with with wires. And I think it's 332 countries confirm now on 40 as well as 158 or something like that on 160 and 230 or 40 I can't remember what it is on 80

meters. So these antennas work quite well so just on 40 meters alone I got very close to the honor roll DXCC and then what the getting some of the rarer countries only on 20 or the higher bands. I also did those with with wires up in the air so I only need two countries for mixed. I need North Korea and Prose having just worked the French expedition down to Wanda Nova a few months ago. So my last goal for DXCC that is the number one on a roll but then then you can they've got it set up so that you can keep setting new challenges for yourself of this DXCC challenge and getting more and more countries on each or entities I guess they're called now on the on each of the bands. And then I got bit by the six meter bug a few years ago and I had to put something up for that and the my interest in antennas... I went from the the semiconductor part of radio, radios got to be less and less interesting to me as the level of integration increased. And now you break apart a cell phone And there's maybe two or three chips in there. And that's it. So there's not a whole lot you can do with these ICs from a hobby standpoint because they're so...

Bob, W7SX 40:14
...so specific to an application. On the synthesizer side, though there's quite a bit that can be done with phase lock loops and DDS and, and I did a lot of work with a startup company back in the late 80s, called Digital RF solutions out of Silicon Valley. And DDS was a new technology at the time. And I was involved with getting designers in the military and commercial applications and wrote the first paper for using DDS as a as a replacement for reactance modulators and FM broadcasting, so I actually regressed and went back to my broadcasting roots. And that improved the linearity tremendously of FM analog transmission. And then also wrote a paper about using DDS for HDTV, which was kind of a natural follow on and, and then later, I wrote kind of a whimsical article in a ham radio magazine. And I was tomorrow's receivers, what the next 25 years holds. And that I put down the first block diagram. It was just kind of an off the cuff article that I didn't take serious. And, and the block diagram became the basis of what is called Software Defined radios to the SDR. Now there's a guy John Mattola that actually wrote the first serious paper about SDR. I put down a block diagram and laid out some of the basics in terms of what to expect, but John, I think he did it on his own. And was there were a lot more serious about using that. And of course, that technology's taken off tremendously. But the the DDS, of course, is a prominent component or subsystem in SDRs, since it's the software defined waveform that you generate. And basically any modulation waveform in principle can be done in software with a with an SDR if you have the AM FM and PM ports available to you. So that was a big part of what I was doing in the later 80s. And then, of course, go back to the ham roots. I wrote a couple articles about using DDS for a VFO and what have you. And, and then later, I ended up at Plessy, which is a British company, and spent a lot of time in the UK. And we actually designed the first wireless LAN for Apple for Apple talk, which was a blazing 360 kilo-bits per second, if I recall, it was a frequency hopper. And that was in the early 90s. And then I got a call from IBM one day and went off to North Carolina for three and a half years and Research Triangle Park working with silicon germanium, which opened a whole new area into into semiconductors, and both in terms of data conversion for software defined radio and, but also for a wide variety of applications. And when I ended up these were all director level jobs and I ended up back at Bell in Colorado Springs and they had just purchased a company in Germany that was producing silicon germanium, so I headed up that effort in 2000 the year 2000. I struck out on my own as a consultant And I did that for about 10 years with all kinds of different projects. And then I got a job opening four years ago from Trimble Navigation in Corvallis where I am today. And...

Bob, W7SX 45:16
I'm almost completely involved with antenna development now. And, and that's for the past, I'd say 10 years, I became much more enamored with antennas and interested and that's what I'm, that's what I'm doing today. And designing a lot of different configurations for a lot of these new industrial applications for you know, wearables and all that sort of thing. But primarily involved in antennas. Again, since the the radio part, they're all little modules that you could put on a circuit board, and you're done, you know, but the antenna is still a and of course, the software interface, which is another whole *nother bailiwick*, but the antennas still a lot of room for innovation, and figuring out how to optimize it. So. So I think, yeah, everywhere in my career, which started in the early 70s, up to this point, I'm still working, has involved RF and is dovetail very well into into the the amateur radio side, I should probably mention, or like to mention, the book Antenna Physics, an introduction, which was released by the ARRL in January. And going back to Antenna development, there were cheap, there seem to be two types of books on antenna theory in particular, one are the introductory books like the ARRL antenna book and, and there are many, many other books for more how to and they give you just enough theory, so that you can understand what some of the basics. And on the other end were graduate level textbooks like John Kraus, W8JK, silent key now. But his his antenna book is still my Bible, at the advanced level, and Johnson and Jasic and Ollinas, some other there are many others. But these are all very advanced textbooks. And you really need to have a pretty good mastery of calculus. And not only calculus, not just understand it, but be able to function in it. And it took me quite a while to be able to master most of what crowd said was trying to say. And I realized that there's a huge gap between these introductory books, and, and these wonderful masterpieces by these great engineers. But there's nothing in between. and that much of what is in those more advanced textbooks and hidden in those very complex equations of vector calculus and differential equations and integrals to calculate patterns and radiation resistance and what have you are really fairly simple to understand from a

conceptual standpoint. And that's what's being that's what I attempted to do in this book is to bring some of these more esoteric concepts and try to express them in relatively simple terms. So I, there's there's calculus in the book, but I try with each of the calculus equations to break them down and saying what, what they're actually saying. And my, my hypothesis here is that in order to understand these basic concepts, you don't have to be able to solve a calculus problem. But it's of tremendous use, if you understand what they're saying, and what these equations the terms these equations are relating to, and something about real English. Describe what calculus is, both both differential and integral calculus. And so that's that's kind of the intent of the book. And so far, I've gotten some pretty good...

Bob, W7SX 50:15
...pretty good feedback, not all our 100%, I'd say maybe 80 90% of the feedback has been very positive. You can't please everybody. And I understand that, of course, there have there been some typos and a few mistakes in the first edition, which I'm working with the league to correct them for future printings. And we've already corrected some of them the second printing, which is the current currently available, copy now. So that's been my major project lately. And also trying to, I'm hoping to be able to use some much more advanced tools. Rather than that being you use what is called 3D tools to apply those to some perpetual problems like ground mounted verticals that use compromised ground systems. Volumes published on empirical measurements, which is great, but the dream has kind of put together a unified theory and in terms of the multiple variables and number of radials, how many radials, what the ground resistance says, what, etc, etc. and take those, those critical terms and put them into a single equation so that you can actually do some prediction in terms of efficiency, which is the whole point of trying to get ground systems to work. So maybe I'm getting too technical here and going off on a tangent. I don't know, Eric, you might want to correct me or you want to move on to something else here. I could talk for days about this work.

Eric, 4Z1UG 52:05
Let me take a quick break to tell you about my favorite amateur radio audio podcast. And that's the ham radio workbench podcast with George KJ6VU, Jeremy KF7IJZ, and then now includes Michael Walker VA3MW, where they pursue topics Technology and Projects on their ham radio workbenches. Every two weeks, the group documents their projects and make circuit boards available to their listeners. They have interesting guests and go in deep, Jeremy may complain about the overall length of the podcast. But friends, let me tell you that I could listen to it all day. And that's good. Even if you are a seasoned ham radio builder, or just getting started, be sure to join George, Jeremy and Mike now, for the ham radio workbench podcast on every podcast player, use the link on this week's show notes page by clicking on the image. And now back to our QSO Today.

Eric, 4Z1UG
I would think that for most ham radio operators, your greatest contribution, probably with antenna physics and introduction, and I'll put a link to it on the show notes page is where it could lead to maybe some calculating tools that allows people to input the variables of their environment to help them create the right kind of antenna for the goal that they want to achieve. Did you think that's a possibility?

Bob, W7SX 53:26
I'm not sure that you can do that as a result of the book. I think what the book does, from a practical standpoint is give the reader a deeper insight into how antennas actually work. I make the point in the the preface to the book that an engineer and the engineering sciences are only as good as the natural sciences upon which they're based. So, for example, it was a mathematician Maxwell and not a physicist, Heinrich Hertz. And then an engineer called Marconi. I mean, there's a lot it's a very simplified version of the the evolution of radio technology, but that Marconi couldn't have done what he did without the work of Maxwell and Hertz. So the idea is that the better the more you know, and the more you understand the basics, physics behind what you're doing, will make you a better engineer. And understand, like where does path for how do you calculate path loss, then the relationship between aperture and gain, which is absolutely critical for any use in radio. The Handbook will give you the formula for let's say path loss between point A and point B with X amount of gain, you know, free space, free space link and, and wavelength, etc, etc. But it in no way gives you why you're doing this or what that equation says. And so it answers a lot of a lot of questions and a lot of and being amateurs we're not professionals. And so there's a lot of misconceptions out there and you hear a lot of things on the air, which are just just completely wrong or half truths or what have you. And having been having to mentor and and explain antennas for many years to non technical management or younger engineers

in a mentoring environment. And also, through amateur radio, of course, you find that you're repeating the same concepts over and over again. So that's what I tend to stress in the book is the things that are not intuitive are things that you cannot figure out on your own. I was very heavily involved in woodworking for years and I had collected many books on woodworking but most of the books on woodworking explained everything that you could do deduce empirically, or just through experience, so it became hard to find things that to answer questions which are not intuitive. I finally found a book, again, a guy named Peter Corn some years ago, and he goes into all the details because he runs a woodworking school. And he explains all the stuff that is not intuitive. And that was very, very important. So that one little paperback book was worth a whole shelf full of other books. And so that was kind of an inspiration. And also the book by Cornell Drentia on Receiver Design (and Technology **ISBN-13:** 978-1596933095). I wrote the introduction to that book, he asked me to do some editing for him, and which I did. And I really liked this narrative style, where he goes from one point to the other, and everything kind of flows. And I was really impressed by that. And of course, I had many conversations with Wes Hayward W7ZOI in his second book on experimental methods, and radio design. So these were inspirations that they were very, very diligent about getting things right in the book, and communicating relatively complex concepts, clearly. So both of these guys are, I call them good friends. And they were also a tremendous inspiration on doing everything I could to make this book as good as possible. So I guess I'm still being mentored by, by by people. So I still have Elmers out there.

Eric, 4Z1UG 58:32
What antenna systems would you recommend for the ham, who wants to work DX, but finds himself in a city lot with a small number of young trees? Well,

Bob, W7SX 58:42
I think that's, that's an eternal question. And of course, the main thing is, with limited space, there's a couple rules of thumb that need to be kept in mind. The first is polarization. And we're, really you have the choice of horizontal or vertical polarization. And most hams understand the difference between between those two, vertical polarization will offer lower angles of radiation, which is what you want for DX. But then, you have this issue of the ground. And, and if you're in a small space, there's there's several facts that you run up against that are physics and not engineering. One of courses radiation resistance, where you're talking about efficiency when you're talking about a ground system and when your ground loss which ends up being an equivalent resistance value becomes an appreciable part of the radiation resistance, then you can, it boils down to a simple equation to figure out what your efficiencies going to be. So you want to get, if you're limited by height, and you want to get on low bands, you know, rule of thumb, I think a horizontal antenna needs to be three eighths to a half a wavelength up to have any real hope of becoming reasonably effective DXer. So if you can't get up, and 160 meters, that becomes a, you know, 250 feet. So for 80 meters that's, you know,.. I've run dipoles at 100 feet, but with sloping ground, so there's all kinds of other variables that come into into play there as well. But if you can't get up, let's say 60, 70 feet on 80 meters, you're really going to be limited with a with a vertical antenna. And the vertical antenna is all about radiation resistance. And radiation resistance is all about how you distribute the current over the length of the antenna.

Eric, 4Z1UG 1:01:36
So in the front of every QST, the antenna manufacturers are touting these all band vertical antennas that don't require ground radials. What did those antennas do? Are they resistors, at the end of the coax, or...

Bob, W7SX 1:01:52
I'm not sure exactly what they're doing, I think what they're probably doing is feeding them somewhere in the center. Therefore you have and I go into into detail in the book about this issue as well. And that has to do what your what the current is near the ground, if you can have a high current node at ground level, where you're not actually grounding the antenna. Then if your resistance is constant, like a resistor, the ground is a resistor. And you know that if you have a given resistance and you drop a higher voltage across it, you're not going to get as much as I^2R loss. Whereas a ground mounted vertical, where you're, let's say a quarter the typical quarter wave vertical, you're feeding in a current maximum at the base. And therefore you're going to be taking a maximum amount of loss due to that. So if you can put up a three eighths way vertical or halfway vertical, for example, and feed it at the base, halfway vertical will be a voltage maximum and you need very, very little radial system. It's like a Bobtail curtain if you have the the ARRL Antenna Handbook, you can you can see that and it's fed at a at a voltage maximum and doesn't require as much my mini curtains relied upon the same thing. radials

are a real pain if you're in a residential environment. And that's why hams want to avoid them. And as soon as I get some land, they lay down all of this, all this all these radials as well as they're really not necessary, if you know how to distribute the current on the antenna. Now, if you have as having said that, if you're again limited to less than a quarter wave, or an eighth of a wave antenna or smaller, then you're going to you're going to have some other problems relating to radiation resistance. So I don't care what kind of loading they're using. If you have a 20 foot vertical operating at 160 meters, that radiation resistance is going to be a fraction of an Ohm. Now you may not need a radial system under but you're going to be hard pressed to get any kind of efficiency even out of an antenna like that because of the low radiation resistance. So I don't know what these manufacturers are doing. I have not looked at them carefully. But physics is a definite limitation. It's like in acoustics if you have a speaker system, a really good efficiency of bass for bass frequency has to be bigger. Because the physics says you got to grab more air in order to move it at those lower frequencies. Same thing is true. I mean, it's kind of a not exactly a strong comparison. But I'm using a comparison because it relates size to efficiency versus frequency. And the same is true with antennas. It's all a function of how long the antenna is as a function of wavelength. And how, how you're able to distribute the current on that on that conductor. And Krauss is the only one who reduces that in an indirect way I had to take Krauss' equation, but you can you can go directly in Krauss, rearrange some terms, and come up and get a very, very accurate calculation of the radiation resistance of a vertical antenna as a function of wavelength and how the current is distributed. And then there are I also go into ways of redistributing the current, particularly when you get up to a quarter wave, for example, a quarter wave vertical as a radiation resistance about 36 ohms. And...

Bob, W7SX 1:06:29
...if you if you talk loaded, so that the current maximum is not no longer at the base, but halfway up, it rises to about 70 ohms That's a doubling of radiation resistance in a pure, so just by just by doing proper top loading, you can get as much efficiency gain as, as you can by maybe increasing from four radials to 60 radials, for example. So it's, if you do both, you're going to be even further ahead. So the question is, it's all about the overall efficiency of the system. And and if you understand the, the terms, and the coefficients, which dictate that efficiency, then you will be in much better shape to look at your situation and be able to come up with something that that looks looks better. The larger the vertical structure you can put up the better no matter what it is. So that's the most important,

Eric, 4Z1UG 1:07:51
Given your years of experience in ham radio, what most excites you now in the hobby?

Bob, W7SX 1:07:58
I think low band antennas, I've got so many different ideas. And I've done models on so many different arrays, that now I have to, I'm going to have to get some land and build some of these things where I think that it's possible to have much simpler mechanical structures and get comparable amounts of gain. And, and then also proving them and getting the thrill of working. Let's say Europe or Central Asia, especially from the Pacific Northwest, on low bands is always a challenge. Every every part of the world has as a difficult part of the world to work. And for us up here, it's on the low bands, it's through the Aurora zone. And that goes right through, you have to go through the Aurora zone from everything from Spain north. And it's very distinct from it, we can work the Azores, and that sort of thing very easily, typically. But just, you know, five, 600 miles north you get up into France or the UK and it becomes very, very difficult. And that's why the Europeans are always asking for W sixes and W sevens. And of course the East Coast has a similar challenge going the other way into Japan and an East Asia and what have you so we all have our challenging areas. Europe of course as the Pacific there's always been a challenge for them.

Eric, 4Z1UG 1:09:38
And when you're speaking the low bands, you're now speaking of 160 80 and 40.

Bob, W7SX 1:09:43
Right? Yes, particularly 160 and 80, 40 meters, if you can get up 50 or 60 feet with with a reasonable wire antenna, you know keep in mind an extended double Zepp which is about 84 feet long. On 40 meters is about three dB. In other words, it's about three DB greater gain than a dipole. Before way, full size dipole. A two element Yagi for 40 meters is a full size 40 meter, it's about five dB. So a two element Yagi at the same height is only going to give you two DB over an extended double Zepp with just the wire fed with some open wire line. And if you can put up several rows to more or less cover the compass, you have the equivalent of a of a two element Yagi. Like in my case, I had four, four antennas hanging from wires hanging from trees. And I had full compass coverage. And in most directions, I was maybe two DB three DB down from a full size two element yagi, which has to be on a 100 foot tower. I'll take the two DB K.

Eric, 4Z1UG 1:11:10
And you're using relays at the top of the feed line to switch the antennas for the direction that you want.

Bob, W7SX 1:11:16
I bring the feed lines down through open wire line. And then I switch relays at the bottom at the bottom to choose which antenna feeding. And then if you short the open wire line at the base, now you have a top load of vertical. And you can use that for 160 or 80.

Eric, 4Z1UG 1:11:36
But then you need a ground plane for that antenna, don't you,

Bob, W7SX
It depends on how you feed it and how long it is. Now, but without going into. So if if the current is distributed on the antenna properly, you can end up with a voltage maximum at the base, which means you only need a you know one or two foot ground plane and maybe a few wires going off radially you know maybe of 5, 10 feet, something like that. And you're fine. If you're feeding at a voltage maximum, the in the antenna book, they actually give you a a parallel c circuit diagram on how to feed a voltage fed antenna. So capacitor and inductor and away you go.

Eric, 4Z1UG 1:12:29
You put that outside at the bottom of your antenna, or do you have that actually in the shack with you

Bob, W7SX 1:12:33
No, because now you're feeding your base feeding a vertical. So the feed point has to be there. If you're feeding it as a horizontal antenna, you can bring that feed line back into the house if it's safe. And then have your antenna tuner right by your rig. If your feeding is vertical, you're best to feed good old fashioned coaxial line out to the base, and then have a tuner there. So I would switch that in and out for the vertical. And then for 80 and 40 meters where I'm using it as a dipole, I would just simply bring the open wire-line back into the shack and to tune it there. I just think about that. You can tune in anywhere, and you don't care what the VSWR is on the on the the open wire line, even very high VSWRs result and very little additional loss. So that's another reason to use open wire-line. And it's it's a lot lighter than coax as well and cheaper. So all of those things go into the equation. But the idea of shorting the line at the base and feeding it as a vertical is is very attractive.

Eric, 4Z1UG 1:13:53
What advice would you give to new or returning hams to the hobby,

Bob, W7SX 1:13:56
I would go back to our mandate as a radio service that the FCC mandates and there are several things that for the existence of amateur radio. And I think that can be a good guide, providing emergency communications but also the social part of it is important. Now QST is saying to promote and encourage the scientific and technical development of radio. Back to your question, Eric, I think, you know, read what it's supposed to be. Ask yourself, why are you doing this and pursue it, you know, pursue your goal. And as you get there and you and remember the help that you've gotten from people and reciprocate when when you're in a similar situation later on. It's a fantastic wonderful, very diverse hobby, all kinds of different, different interests and directions. You can go and pursue them And enjoy it and give back.

Eric, 4Z1UG 1:15:03
Well, thanks so much for joining me, Bob 73

Bob, W7SX
73. Eric, thank you very much for the invitation. I appreciate it.

Eric, 4Z1UG 1:15:11
That concludes this episode of QSO Today, I hope that you enjoyed this QSO with Bob, please be sure to check out the show notes that include links and information about the topics that we discussed. Go To www.qsotoday.com and put in W7SX in the search box at the top of the page. My thanks to Icom America for its support of the QSO Today podcast, please show your support of Icom America by clicking on their banner in the show notes pages. You may notice that some of the episodes are transcribed into written text. If you'd like to sponsor this or any other episode into written text, please contact me. Support the QSO Today podcast by first joining the QSO Today email list by pressing the subscribe buttons on the show notes pages. I will not spam you or share your email address with anyone become a listener sponsor monthly or annually by clicking on the sponsor buttons on the show notes pages or use my Amazon link before shopping at Amazon. Amazon gives me a small commission on your purchases while at the same time protecting your privacy. I'm grateful for

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Transcribed by W3TTT