

Introduction of Oldenburger Award Recipient

Remarks delivered by Dr. Robert H. Cannon, Jr. the Twentieth Annual Oldenburger Award Luncheon, December 15, 1987, in Boston, Massachusetts to the Dynamics and Control Division of the American Society of Mechanical Engineers (ASME).

Introduction of Dr. Cannon by Dr. Devendra P. Garg, Chairman of the Honors Committee.

I'm just very privileged to be able to be here this noon and take part in the Festivities involved with the award of the Rufus Oldenburger Medal to Walter Evans. Getting to do this gives me the opportunity to do several things: to thank Evans for all of us who find the method he invented so helpful to us in designing feedback control systems, to thank him very personally for teaching me so much about engineering and making it so much fun, and to give you some glimpses into what a delightful guy he is.

Significance of Evans' Root-Locus Method

Evans invented the root-locus method in the 1940's and first published it in 1948. At North American Aviation's Aerophysics Laboratory where Evans worked, it had already become the primary method for designing automatic pilots for high performance aircraft for the X10 pilotless missile, which was at the time the first operational supersonic aircraft -- piloted or unpiloted.

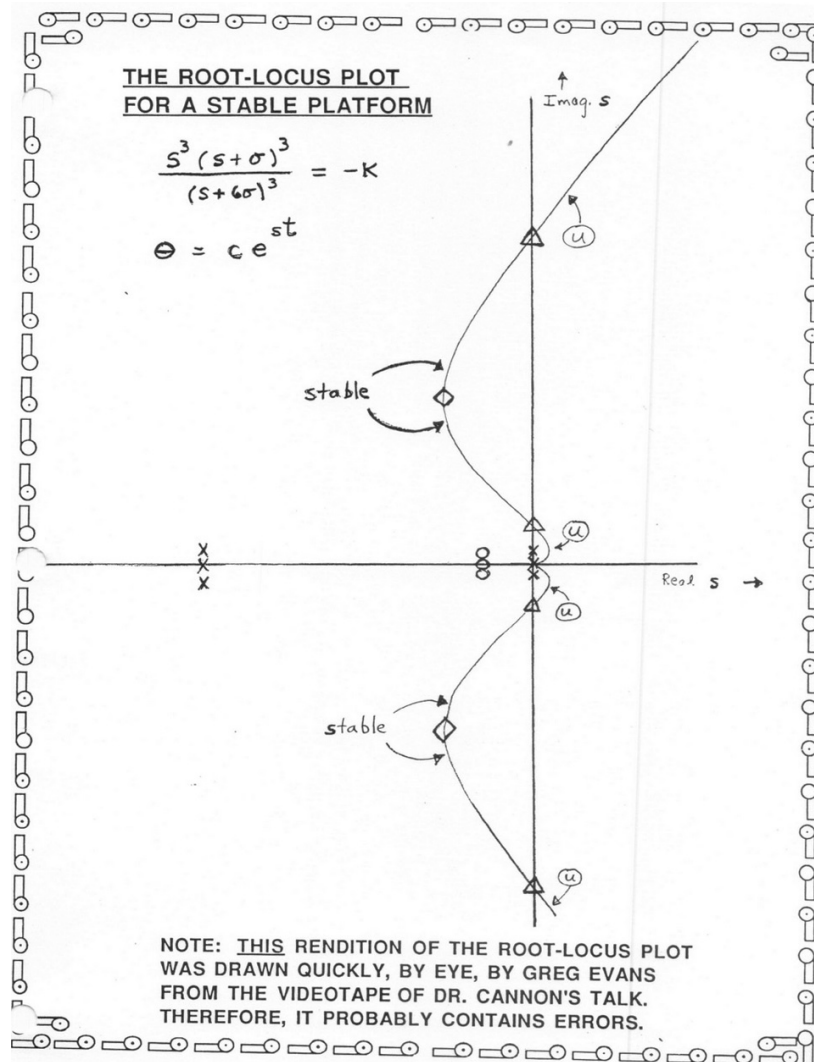
The root-locus approach quickly became widely known and used and took its place as the central context for the

preliminary study and design of feedback control systems. There are several reasons for that. The roots of a dynamic system's characteristic equation reveal directly and quantitatively the natural behavior it will have at what frequencies it will vibrate and how quickly the vibrations will damp out. By plotting the locus of these roots, as Evans' method does, versus the design parameter being chosen (control strength, for example) one sees precisely which values give good behavior and which will not—make the system unstable, for example.

It's of course true that the same information is available indirectly from other earlier approaches (from the frequency response plots of Nyquist and Bode, for example) and we make continual use of such methods also, both theoretically and especially experimentally. But it's the quick, direct display of behavior characteristics and the powerful, immediate dynamic insight this provides, that gives Evans' method its central role.

A Stable Platform's Root-Locus Plot

Moreover, root loci can be sketched quite accurately in seconds, by eye, using clever sketching rules that Evans developed, and I sketched one on the way up in the elevator to show how fast this can be done. Walt will recognize this. It's the root-locus for the control of a stable platform. It's a little Christmassy, of course, and that's intentional.



What you have is a characteristic equation at the top of the figure and what the characteristic equation has to do with is that the roots of that equation are the values "s" which will tell one how the system will behave.

The roots of this are what go here to tell you what the motion will be like. And so, by plotting those roots as a function in this case of the parameter "k", one can see for certain values near zero (marked "u"), the system will be unstable. Later on, for a fairly wide variety of choices of "k" it will be stable. But then as "k" gets too high (up in the upper right hand corner) it goes unstable again. What we've plotted of course is the real part. If we plot it on a plane, the real part of "s" is horizontal and the imaginary part of "s" is vertical. And the object of the game is to stay in the left half plane. The green control logic was, in fact, designed by Evans to provide stability to this rather challenging plant. Enough of technology.

On S-Plane and Crunchy Spirule Uses

For getting things precise where it's critical to do so, Evans invented the Spirule, with which one can get almost three significant figure accuracy, again in seconds. And the two triangles and the diamond were done that way using a Spirule, which, of course, we all carry in our pockets.

Thus, it is that even today, with great computing power all around us, we typically think about a new control system design in terms of the locus of its roots, which we can sketch in seconds. Then we let our computers work out the details and plot them for us.

To make the point about the connection between root-locus and frequency response methods on the Spirule, which is primarily for plotting these loci, there are also special scales for plotting Bode plots very quickly and very precisely. There are some other scales for multiplying things. many uses. One day I was walking by Walt's office and I heard a voice yell out, "Hey Bob! Got a new use for the Spirule!" and I looked in the door and was spreading peanut butter on his sandwich with it.

Evans' Mental Agility Won Admiration

Working with Walt was enormously stimulating and full of surprises. No period in my life did I learn real engineering more rapidly, or more deeply, or with more enjoyment. Walt shared his small office with two of us, Bill Mullins and mr. Bill was also one terrific engineer who made complex machines that worked, and that was one great office for a young, green fresh-out-of school-guy to be in.

It was in those days that Evans led the development and construction of the stable inertial platforms for the guidance systems for among others the X10 missile, the Minuteman ICBM, and two submarines called Nautilus and the Skate, which used those systems to navigate for the first time under the polar icecap -- without any external reference.

For each system Evans saw the myriad new technical problems coming, and in problem after problem his agile

mind made giant leaps over the details to the key to the good answer. A problem for us mortals was that, in his beguiling modesty, he just naturally assumed everybody else's mind worked as fast as he did. Typically, after he'd left the office, Bill Mullins and I would sit there and we would scratch our heads and after about an hour we'd be able to figure out what it was he'd just told us in five minutes.

Evans' Seven Subject Stanford Seminar

Years later I invited Walt to come up and give a seminar at Stanford. So, he wrote me a letter back and listed seven topics. So, I wrote him back and I said, "They're all good topics, but either 2 or 5 would be particularly interesting to this group of people." Walt wrote back and he said, "You don't understand, I'm going to talk about all seven." . . . which he did... which blew us all away.

Evans' Physical Agility Won Arguments

Walt always loved a technical argument. . . and he loved to win. I can still hear him as he points to a genius pad totally covered with scratches saying, "There's no chance for any error here!" For the center of discussion in our office would be a huge pad of blank paper called a genius pad in the center of the conference table, which was between our three desks, and there was also a fourth chair in the doorway for guests. One day Walt and a guest were going at it hot and heavy both talking at once, both furiously writing equations on the genius pad. Suddenly Walt reached over and broke the other guy's pencil. . . . And then he said, "Now! As I was saying."

On another occasion, when a good argument was going on in the next office, I saw Walt fidgeting. He listened and he stood it as long as he could. Finally, he climbed up on his desk and went right over the partition and joined the argument.

Evans' Often Invoked Goddard's First Law

Evans was a wry observer of the political scene. When I'd first arrived there, and had been there about a week, he said "Now let me explain something to you. You'll find that it will be perfectly clear that if only two of our managers here would leave, everything would straighten right out. The interesting part is that for each of us it's a different two managers."

When pestered by the ever-present program manager's need for projections of what's going to happen in a program or, worse yet, reports on what has happened, Walt would always quote an axiom which he calls Goddard's First Law:

P.C.B.P.A.R.O.A.T.E.O.B.M.

Bill Goddard was a co-worker in the early days. This is his answer to the project manager: "Progress Can Be Planned and Reported Only at The Expense of Being Made." We've all felt that one.

In those days we all worked for a fine manager named Fred Eyestone. When my wife one day bore us another son and I chose to name him Fred, Evans' response was... "Good move".

At Least I Tried, Walt

When, after a lot of years, my book about dynamics finally got to the galley stage, I sent a copy of the chapter on Evans' method to Walt, asking for his comments. Having changed the name from "root-locus" to "Evans' Method" and having introduced "Evans' Form" and the "Evans Function", I thought I might get a rise out of him. What I got back was a letter saying, "I feel like a father who's just been asked for his daughter's hand in marriage. So much has already gone on it's not going to make any difference what I say."

Conclusion

Above all, Walt Evans was ever devoted to his four children, Randy, Greg, Nancy, and Gary, and to his wonderful wife, Arline, who has been his super-supportive and brilliant companion throughout his life and career. Arline, Greg, and Gary, as you know, are here with Walt today.

One last story. One day we were discussing a technical point, and it was getting kind of exciting, and Walt's voice was getting higher and higher as he began to see where it was taking us. Suddenly the phone rang. Walt picked up the phone. He said (using a very high-pitched voice), "Evans! Oh! Hi Arline!"... pause... (at very low pitch), "Evans!"

We're so glad that you guys are all here today. When I look at the list of very, very distinguished recipients of the Oldenburger Medal, I'm just so proud that I know so many of them and that the last one at this point is my very good friend, Walt Evans.