



Career advice for engineering students

December 2007

Unknown Editor

Why am I the guest speaker?

- ✚ Several reasons...
 - Budget for speaker was \$0
 - Search for speaker began last Thursday
 - Someone in the IEEE volunteered me!
 - And I'm not even an IEEE member!
- ✚ Today I'll give some "career advice" then squeeze in an elevator speech on Microwaves101.com
 - I'll try to keep you off the short bus!



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Soon you'll be out of school, and at work

- ✚ Welcome to the machine!*
- ✚ Now you're into the third quarter...
 - Birth
 - School
 - Work
 - Death**

* Title of 1975 Pink Floyd song

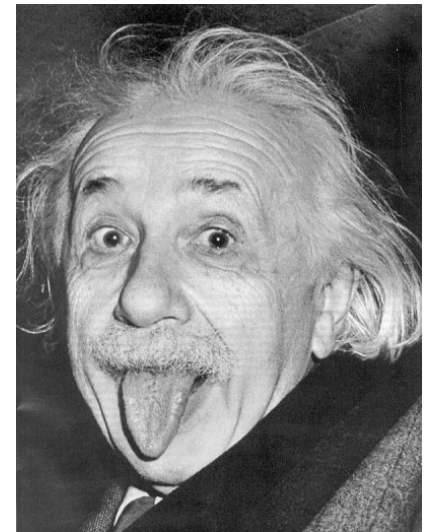
** Title of 1988 song by the Godfathers. Good video of them on Youtube!



Image from Fritz Lang's 1928 silent masterpiece, *Metropolis*

Actually, there is a fifth time period

- ✦ It's called retirement, start planning now
- ✦ As soon as you start a job, begin saving
 - Consider maximizing your 401K contribution
 - Resist temptation to "own" a new car
 - Home equity is not spending money
 - Only a fool carries a balance on a charge card
 - Wait a few years before you have kids!
- ✦ To apply smart thinking to your life, ask yourself:
 - What would Einstein do?
 - Do you really need new rims for the car?
 - A gambling vacation in Las Vegas?
 - Or \$5M when you retire so you don't have to wear Home Depot's orange vest?



Speaking of retirement...

- ✚ Take care of your health, you will need it later
 - Find a hobby that involves physical activity
 - Running, swimming, hiking, dancing are all good
 - Video games and computers are the enemies of fitness!
 - Riding a "quad" is not exercise, ride a bicycle instead
 - Get some sleep, you can do that regularly once you graduate!
- ✚ Your generation has some new challenges
 - National debt (sorry about that....)
 - Hilbert's peak (sorry about that too...)



Big or small company?

- ✦ In big companies opportunities are diverse
 - Big companies are efficient, they can afford mistakes and redundancy
 - Opportunities abound to screw up yet not get fired
 - Alanis Morissette could have added the lyrics, "you screw up, you learn"
- ✦ In small companies, rewards *can* be higher, but risks *will* be higher
 - Founder of Hittite is worth more than \$500,000,000!
 - Expect to work much, much harder, failure can result in pink-slips
 - You may get stuck in one task, i.e be "The Limiter Guy"
 - You may have to water the plants and take out the trash!
- ✦ Consider starting at a big company...
 - Try different jobs, gain breadth of experience
- ✦ Then move to a small company, or start your own company
 - Don't expect a business that is solely run by engineers to make money!
 - Microwaves101 is a good example of how NOT to get rich!

What is big company disease?

- ✚ Not defined on Wikipedia
 - An opportunity for someone?
- ✚ Here's how I define it:
 - *Aspects of a big company, that when transferred to a small company, will cause it to tank*
- ✚ Here's two symptoms of BCD
 - In general, the larger the company, the more profitable.
 - Due to extra money, non-value-added jobs and "initiatives" are created
 - Hot tub retreats with Mayor McCheese don't add to the bottom line
 - Another aspect of BCD comes from mergers:
 - Companies get rid of employees instead of organizations
 - Multiple organizations compete for the same work
 - Collaboration can be reduced

What do we need from you?

- ✚ New people bring new ideas
 - Ideas are never “stupid”, some are just unworkable.
 - *Lack* of ideas is stupid.
 - Bring us 100 ideas and we’ll help weed them down to a few that will change everything!
- ✚ You have an advantage with computers:
 - Many of us that grew up with IBM punch cards are sick of learning new operating systems and “tools”



Jean Auscher's
maritime acoustic
locator, 1960.

Speaking of computer skills...

- ✚ A mistake that afflicts many microwave new hires
 - When presented with a problem, they jump in and use computer-aided electro-magnetic analysis, thinking it will give the correct answer quickly...
- ✚ You need to apply fundamental principles of microwaves **before** EM analysis; you can weed out a lot of bad approaches
 - Example: no need to EM a coax structure, everything you need to know can be solved analytically!
 - Don't throw away that #2 Pokemon, Spice Girls or Power Rangers pencil, it still works great!

Presentation skills are needed

- ✦ You will never get anywhere if you don't present your own work.
- ✦ Fear of public speaking is normal
 - You don't need therapy, or a book, or a seminar...
 - You just need practice! And we'll give it to you...

Your parents and teachers lied

- ✚ You are no more *special* than the rest of us
 - Even though you have a closet full of "participant medals"
- ✚ You were raised in an age where self-esteem was rated as more important than results
 - Good effect: you probably don't take any guff
 - Bad effect: you might think all of your work is great and unique. Chances are someone already had your brilliant idea!
- ✚ Competition in the work environment is REAL!



Who not to hang around with

- ✚ There are plenty of people at work who hate their job
 - Rather be somewhere else
 - Never spend an extra minute
 - These people will bring you down

- ✚ There are other people at work that love it
 - Get to know them
 - Nerds rule!

It's five o'clock,
Yabba dabba doo!



What trumps* knowledge?

- ✚ Enthusiasm rules!
- ✚ Don't be afraid to say "I don't know" once a day, but follow up with "but I'll figure it out"

* This archaic term is the video game equivalent of "pwns", often used by older adults who occasionally play non-computer-based games involving small card with numbers and other stuff printed on one side.



We'd rather work with Mikey than Paul Jr. any day... don't be high-maintenance!

Interviewing 101

- ✚ Refrain from talking like an idiot
 - “I’m like, she’s like, OK, I don’t know, you know what I mean?”
 - Yes, we know what you mean.
- ✚ Better to wear a suit than ripped jeans
- ✚ Don’t finger-mine your ear when someone is talking to you!



What to look for in a supervisor

- ✚ Bad boss: *let me tell you my vision for you...*
- ✚ Good boss: *let's talk about what you want to be doing in five years...*

- ✚ No matter what, you should enforce an 80/20 rule for yourself:
 - 80 percent of the time I'll do what the boss needs to be done (even if it sucks)
 - 20% of the time I will find stuff to do on my own by networking with smart co-workers

Defense or commercial job?

- ✚ What would you rather do?
- ✚ Work on a team of 100 engineers trying to reduce the price of a cell phone by fifty cents
 - This job can easily be exported
 - Your work doesn't have to be a secret, it's OK to publish
- ✚ Work on a team of 10 engineers trying to reduce the price of a weapon system by \$1,000,000?
 - Job is protected by U.S. border
 - You have to be a U.S. citizen
 - Publishing can be very difficult, national security is more important than your ego

Miscellaneous...

- ✦ Analyzing data is way different from taking data
 - Presentations and reports should draw conclusions, not anesthetize the audience
- ✦ While we're on the subject, label all of your data as much as possible
 - If you look at it a month later, you won't know what it means
 - Make sure everything is date-stamped
- ✦ Often you will be leveraging from other's work
 - Another word for this is "engineering"
 - Always give credit!
- ✦ If you have an assignment that is over your head, tell your supervisor
 - Many new people think it is better to hide for a couple of weeks to avoid admitting they are stuck, seek help when you need it!

What makes a microwave engineer different?

- ✦ Like the real world, it's predominantly analog!
- ✦ We have to worry about distributed effects
 - An open can easily become a short!
 - A resistor is really an RLC circuit!
- ✦ We think in decibels, VSWRs, and S-parameters
- ✦ We use the Smith Chart
- ✦ We are bi-lingual (inches and millimeters in the same sentence)
- ✦ Need to know materials science and thermodynamics to be successful
- ✦ We use waveguide – the “one conductor” transmission line!
- ✦ We constantly worry about transmission lines: velocity of light, phase and amplitude constants, characteristic impedance, VSWR
- ✦ Skin depth needs to be considered, this is the source of most losses

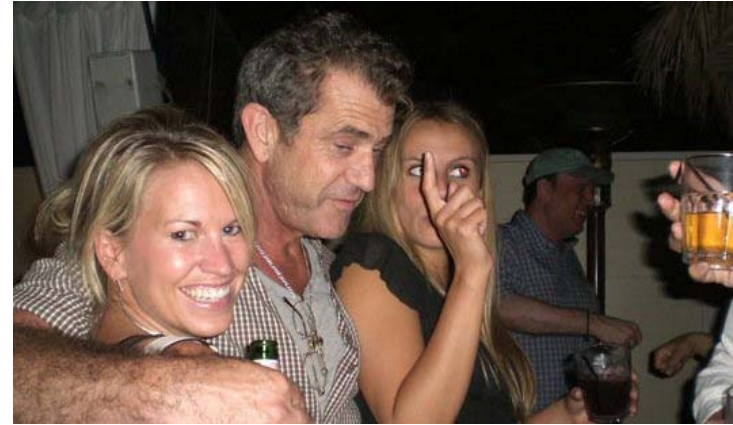
What's the future hold for microwave engineers?

- ✦ Semiconductors: GaN and SiGe replace GaAs
 - GaN does the heavy lifting
 - GaN power density is almost ridiculous!
 - Silicon provides the "army of ants"*
 - Corollary of Moore's Law: anything that CAN be made of silicon SHOULD be made of silicon
- ✦ Drive toward high frequency:
 - You get to reinvent everything that worked at X-band, now at millimeterwave
- ✦ Low-cost phased arrays will pop up everywhere
 - Your kids will get to watch the dish network while you drive!
- ✦ Low-cost "soft" boards replace expensive hybrid microcircuits

* Army of ants comment attributed to Ali Hajimiri of Cal Tech

Microwave career killers

- ✘ Past examples include aluminum silicon carbide packages, IMPATT diodes
- ✘ Microwave MEMS are an example of a technology that just might have been oversold a teensy bit
 - Zero-dB loss switch
 - Cheap as dirt
- ✘ But the limitations weren't mentioned at first...
 - Slow switching speed
 - Low power handling
 - Hot switching = destruction
 - Self actuation due to RF
 - Performance isn't guaranteed over temperature
- ✘ Progress has been made due to cheap chip-scale packages that seal out contaminants
- ✘ Like Bush's Iraq policy, DARPA doesn't give up easily so expect more programs like MIP*

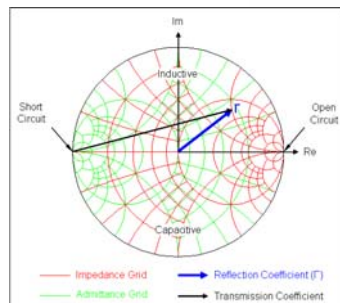
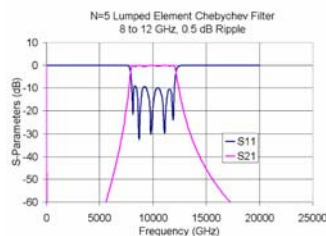
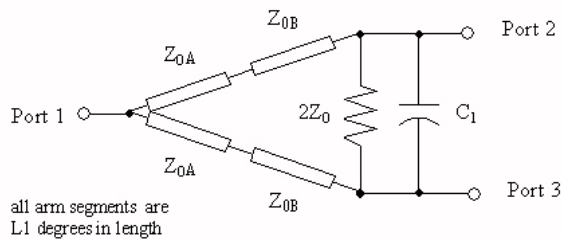


*MEMS Improvement Program

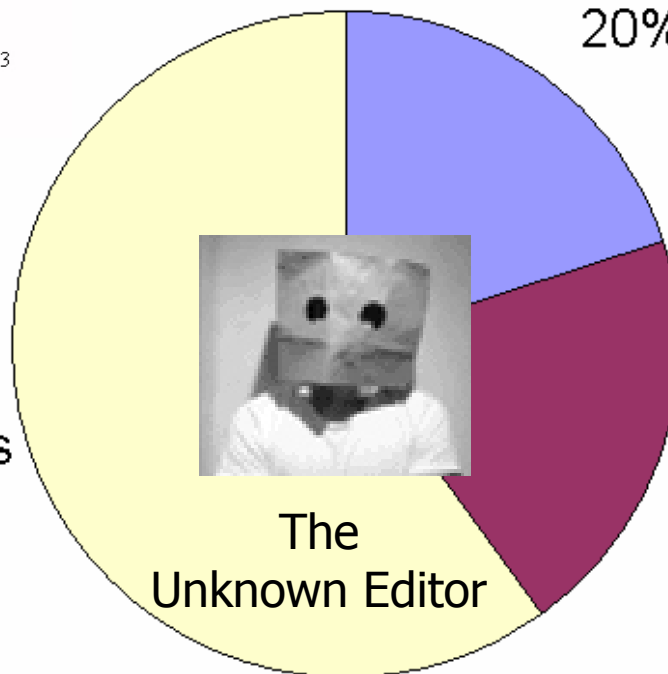
What is Microwaves101.com?

- ✦ A microwave website, idea started in June 2000.
 - Our on-line encyclopedia predates Wikipedia!
- ✦ An on-line microwaves textbook has advantages over a hardcover:
 - Easy to update, never obsolete.
 - Audience participation drives and improves content
- ✦ Mixture of technical content, humor and history, like no other resource.
 - Slang dictionary, Microwave Mortuary, Hall of Fame, Rules of Thumb...
 - Tons of useful downloads, an interactive forum, on-line calculators
- ✦ Owned and copyrighted by P-N Designs of Tucson Arizona. P-N stands for "paper napkin", where the best ideas often take shape.
- ✦ Free for everyone to use, with no hassles of "joining", remembering passwords, or solicitations for personal information.
- ✦ We are changing the industry!
 - Example: MMIC suppliers now post downloadable S-parameters of their parts, after we kept complaining!

Microwaves101 is a mixture of content...



Microwaves
60%



Free downloads include..

- ✂ S-parameter Utilities Excel file that uses S-parameters that you load to generate plots of VSWR, group delay, Rollett's stability factor, Smith Charts, and tons more!
- ✂ Various lumped filter calculators
- ✂ Excel file for calculating N-section impedance transformers, including Chebyshev and Butterworth.
- ✂ Several Excel files that search for mixer spurious products.
- ✂ An Excel file for cascade analysis of gain, noise figure and P1dB.
- ✂ RF sheet-resistance Excel spreadsheet (translates skin depth into something you can use!)
- ✂ Spreadsheets for analyzing coax and waveguide, with features even Agilent's \$100,000 Advanced Design System can't match.
- ✂ Graphics downloads such as Smith Charts.
- ✂ Posters on connector care, and "Fite Microwave Stupidity"
 - Hang them all over your lab!
- ✂ Got something to contribute? Join the party!

Want to make a hundred bucks?

- ✦ Microwaves101 will pay you for solving this problem:
 - We hate calculus!
- ✦ A certain coax is built of four different metals, we want a closed form equation for the metal loss
 - The center conductor is hollow metal pipe (material M1 wrapped around air) of outer diameter d , radial thickness t_1
 - The center conductor is plated with metal M2 of thickness t_2
 - The coax dielectric fill has is irrelevant to the metal loss
 - The outer conductor is plated inside with metal M3 of thickness t_3
 - The outer conductor itself is metal M4, inside diameter D , thickness t_4
- ✦ Solve for R' (resistance/meter) versus frequency in terms of dimensions and metal properties m and r
 - If you're interested, send a note to [UE@microwaves101!](mailto:UE@microwaves101.com)
 - Offer is retracted if you are the second submitter...

Microwaves Hall of Fame

- ✚ History is a great hobby, watching the History Channel sure beats watching “reality TV” or consumption-based decorating shows.
- ✚ Microwave Hall of Fame candidates must have made at least one truly great contribution to microwave engineering.
 - List starts with Napier – inventor of logarithms!
 - Ends with Herb Kroemer, inventor of the HBT.
 - Faraday, Maxwell, Hertz Lange, Wilkinson, and many others are in between
- ✚ Nominate your favorite nerd!

Some microwave trivia... Believe it or Not!

- ✂ Oliver Heaviside was the guy who actually reduced Maxwell's 20 equations into four. Like director Ed Wood, he used to paint his toe nails!
- ✂ The original transatlantic transmission system (Marconi) did not have the benefit of an amplifier on the receiver.
- ✂ Philip Smith's paper on the Smith Chart was originally rejected by the IEEE!
 - So was the first description of COMPACT software by Les Besser.
- ✂ Why are the waveguide letter band so strange?
 - To confuse the enemy during World War II! In microwaves, the alphabet goes: L,S,C,X,K,Q,V,W,D
- ✂ Actress Hedy Lamarr invented spread-spectrum transmission!
- ✂ Edwin Armstrong invented the feedback amplifier, FM transmission and the superhet receiver, but committed suicide by leaping from a building!



Some mnemonic tricks

- ✚ How do you remember E-plane from H-plane in waveguide?
 - Bending in the H-plane is the “hard” way, bending in the E-plane is the “easy way”

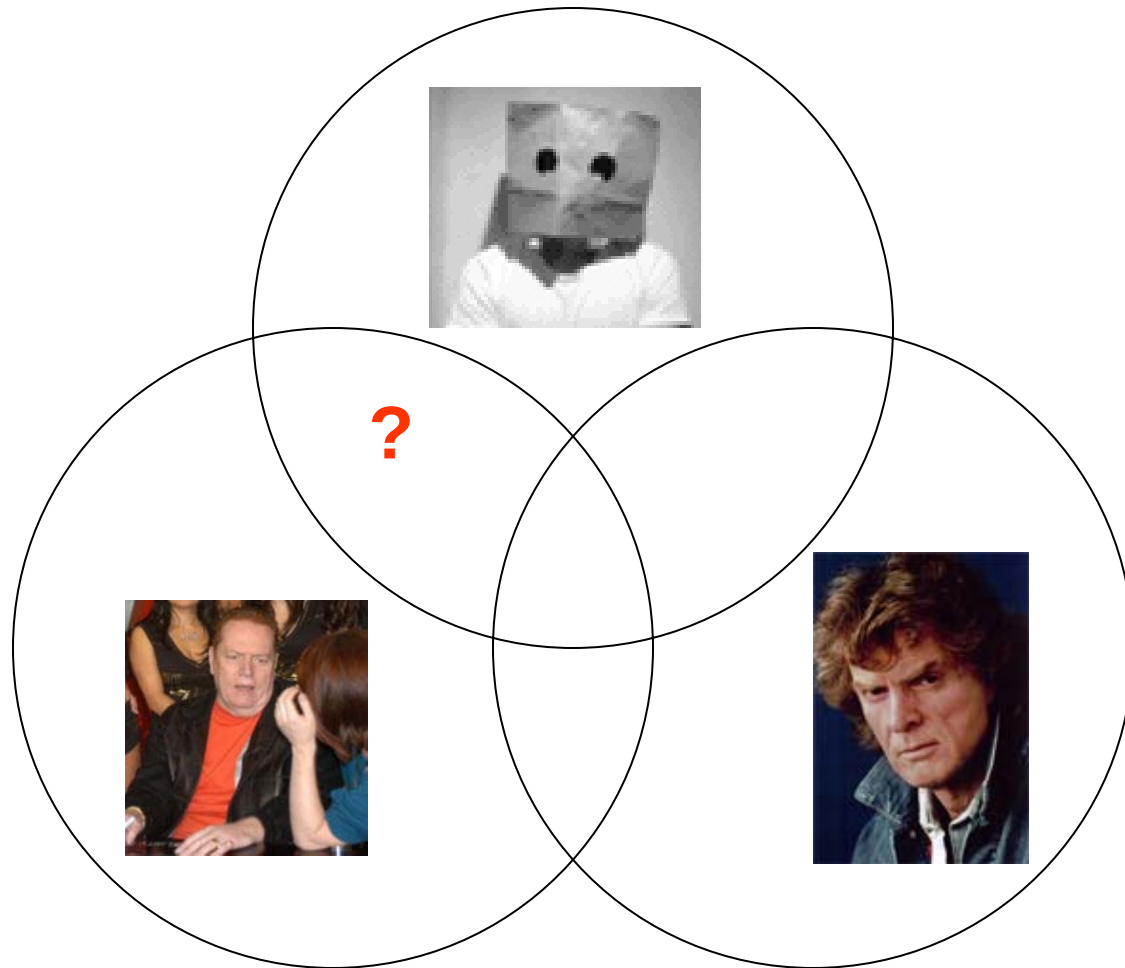
H-plane bend



E-plane bend

- ✚ How do you remember Ku band, K band and Ka-band?
 - Ku is “under” K-band, Ka is “above” K-band

What does the Unknown Editor have in common with pornographer Larry Flynt but not with syndicated radio talk show host Don Imus?



He can't be fired!

- ✚ If you see something you don't like on Microwaves101, tell us and we'll try to fix it
- ✚ Otherwise, try RfCafe.com or one of the many microwave trade rag web sites!
- ✚ Thanks and have a great career!