



# **Electrical Engineering 101**

Third Edition



# **Electrical Engineering 101**

Everything You Should Have  
Learned in School... but  
Probably Didn't

Third Edition

**Darren Ashby**



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# Preface

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## THE FIRST WORD

In my day job I have been lucky enough to work with one of the greatest corporate success stories in the technical field ever. For a sparky tech nut just going to the Google™ campus was a bit like traipsing to mecca. I remember my first tour there, and getting a “free lunch.” Our corporate contact made a comment. He said, “They’ve created some kind of engineers’ paradise over here.” I kind of wondered about that comment. Over the last couple of years I have pondered it quite a bit. I learned a lot more about what this paradise was in subsequent dealings with the king of search. They had the free food and all these other perks but the thing that stood out most to me from the first time I heard it was 20% time. A quick Google search will tell you the details of 20% time. The principle is simple: You are given 20% of your time to work on a pet project. The project is your choice. The only caveat is that if you come up with something cool Google gets to use it to make more money. In talking to contacts there I found out that time is sacrosanct; your management cannot demand you give up that time for your main goals. You can volunteer it if you want to but it is up to you. In general planning, however, you and your boss plan four days a week on your main assigned tasks and one day every week is yours.

## Build Intrepreneurs

I learned a new term recently that I think is very relevant in corporate growth and success, *intrepreneur*. The intrepreneur is the baby brother to the entrepreneur. This is the guy who has that big idea and wants to change the world; he has the mentality to do so but doesn’t have the resources. Resources, in fact, is the only way in which they differ. The entrepreneur finds a way to resource his idea, but whether due to motivation or circumstance, the intrepreneur can’t quite get over that issue. Often times these are the shooting stars in your organization. The trick is to enable these guys to make things happen. Give them the resources and turn them loose. The 20% time mentioned above is a great way of finding these individuals. The successful intrepreneur will gather others and use their 20% time to make something cool. What engineer do you know that wouldn’t consider that paradise?

## Engineers = Success

Why are engineers so important to America’s success? Here is an interesting fact or two: Google hires 50% engineers and 50% everyone else. Twice as many start-up businesses are from new MIT grads than from Harvard Business School graduates (and the schools are practically right next to each other). I haven’t

met an engineer who doesn't like to make cool things; it is in their mindset; it is in their nature; great engineers usually make pretty good money relative to the average Joe in America, simply because their skill set is so valued. Thing is, they aren't always the top-paid people, even though their contributions are often much more critical to success than that of all the management above them. I think this is because they get so much satisfaction out of making stuff that, as long as they feel like they are making ends meet, things are good. This type of person is a huge asset to the American economy. Greed doesn't drive them, invention does, and invention leads to an improved economy more than anything else. Invention of new technology improves the standard of living for everyone. It is the only thing that does.

Google went from nothing to the top in 11 years; they themselves credit this to hiring great engineers and cutting them loose to change the world. We need more of this. We humans have a built-in engineering gene; we love to build and make stuff. Every kid plays with blocks, creates things, and imagines things. So why aren't there more engineers? Is it really that hard to become one? Should it be? I hope that somebody out there reads this book and thinks, "Screw all those guys who think I'm not smart enough—I'm gonna change the world anyway!"

## **OVERVIEW**

### **For Engineers**

Granted, there are many good teachers out there and you might have gotten the basics, but time and too many "status reports" have dulled the finish on your basic knowledge set. If you are like me, you have found a few really good books that you often pull off the shelf in times of need. They usually have a well-written, easy-to-understand explanation of the particular topic you need to apply. I hope this will be one of those books for you.

You might also be a fish out of water, an ME thrown into the world of electrical engineering, who would really like a basic understanding to work with the EEs around you. If you get a really good understanding of these principles, I guarantee you will surprise at least some of the "sparkies" (as I like to call them) with your intuitive insights into the problems at hand.

### **For Students**

I don't mean to knock the collegiate educational system, but it seems to me that too often we can pass a class in school with the "assimilate and regurgitate" method. You know what I mean: Go to class, soak up all the things the teacher wants you to know, take the test, say the right things at the right time, and leave the class without an ounce of applicable knowledge. I think many students are forced into this mode when teachers do not take the time to lay the groundwork for the subject they are covering. Students are so hard-pressed to simply keep up that they do not feel the light bulb go on over their heads or say,

“A-ha, now I get it!” The reality is, if you leave the class with a fundamental understanding of the topic and you know that topic by heart, you will be eminently more successful at applying that basic knowledge than anything from the end of the syllabus for that class.

### **For Managers**

The job of the engineering manager<sup>1</sup> really should have more to it than is depicted by the pointy-haired boss you see in *Dilbert* cartoons. One thing many managers do not know about engineers is that they welcome truly insightful takes on whatever they might be working on. Please notice I said “truly insightful;” you can’t just spout off some acronym you heard in the lunchroom and expect engineers to pay attention. However, if you understand these basics, I am sure there will be times when you will be able to point your engineers in the right direction. You will be happy to keep the project moving forward, and they will gain a new respect for their boss. (They might even put away their pointy-haired doll!)

### **For Teachers**

Please don’t get me wrong, I don’t mean to say that all teachers are bad; in fact, most of my teachers (barring one or two) were really good instructors. However, sometimes I think the system is flawed. Given pressures from the dean to cover X, Y, and Z topics, sometimes the more fundamental X and Y are sacrificed just to get to topic Z.

I did get a chance to teach a semester at my own alma mater. Some of these chapters are directly from that class. My hope for teachers is to give you another tool that you can use to flip the switch on the “a-ha” light bulbs over your students’ heads.

### **For Everyone**

At the end of each topic discussed in this book are bullet points I like to call *Thumb Rules*. They are what they seem: those “rule-of-thumb” concepts that really good engineers seem to just know. These concepts are what always led them to the right conclusions and solutions to problems. If you get bored with a section, make sure to hit the Thumb Rules anyway. There you will get the distilled core concepts that you really should know.

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<sup>1</sup> Suggested alternate title for this book from reader Travis Hayes: *EE for Dummies and Those They Manage*. I liked it, but I figured the pointy-haired types wouldn’t get it.



# About the Author

Darren Coy Ashby is a self-described “techno geek with pointy hair.” He considers himself a jack-of-all-trades, master of none. He figures his common sense came from his dad and his book sense from his mother. Raised on a farm and graduated from Utah State University seemingly ages ago, Darren has more than 20 years of experience in the real world as a technician, an engineer, and a manager. He has worked in diverse areas of compliance, production, testing, and his personal favorite, research and development.

Darren jumped at a chance some years back to teach a couple of semesters at his alma mater. For about two years, he wrote regularly for the online magazine Chipcenter.com. He is currently the director of electronics R&D at a billion-dollar consumer products company. His passions are boats, snowmobiles, motorcycles, and pretty much anything with a motor. When not at his day job, he spends most of his time with his family and a promising R&D consulting/manufacturing firm he started a couple of years ago.

Darren lives with his beautiful wife, four strapping boys, and cute little daughter next to the mountains in Richmond, Utah. He believes pyromania goes hand in hand with becoming a great engineer and has dedicated a Facebook™ page to that topic. You can email him with comments, complaints, and general ruminations at [dashby@radd.com](mailto:dashby@radd.com); if all you want are tidbits of wisdom you can follow him on Twitter™ under sparkyguru.