Managing Electrical Diagnostics in the Transportation Industry

If you're the guy who runs the shop, reading this might be helpful…

Sullivan Training Systems
Mechanic to Manager Series
Volume 1
Dan Sullivan

www.brighterideas.com

About the Author

Dan Sullivan is a teacher. He earned his A&P license in 1983, and started teaching vehicle electrical systems in 1988. He earned a Bachelor's Degree from Southern Illinois University and a Master's Degree in Education from eastern Illinois University. He's taught at three technical schools and colleges, worked for the NC State Department of Community Colleges as Transportation Systems curriculum coordinator, and operated his own training business since 1996 when he began specializing in the truck and equipment industries.

Dan has authored a 200 page electrical diagnostics shopbook written especially for technicians that is currently in use at a dozen tech schools, and with several major manufacturers, having sold over 6000 copies. He's trained over 4000 technicians since 1996 across the U.S. and Canada.

He is specifically skilled and knowledgeable about electrical theory and practice. The concepts in this short book are the result of all of his efforts over the past decade and a half trying to better understand the peculiar nature of electrical systems, why they fail, and how they should be diagnosed.

More than anything else, Dan hopes that the result of this work will be an increase in shop efficiency, and profitability for fleets, and most importantly, technician skills and confidence.

Introduction

Over the past 30 years I've been involved in technical mechanical work. I started on aircraft, but have since worked on cars, trucks, equipment, trains, boats and mining equipment. It might seem too much experience to claim, but the way I can be competent on so many different vehicles is because I only work on electrical systems.

I don't claim to be an expert on all of the different vehicle systems above, because no one can be. What I specialize in is fundamental electrical knowledge and skills, and in my three decades of learning, and then teaching, I've come to understand that being successful as an electrical diagnostician isn't all that difficult. In fact, one of the things I'm most curious about as I learn more about working on and teaching electrical diagnostics is that the more things change, the more they remain the same.

As I've moved across the country from truck dealers, to equipment dealers, to OEMs, to coal mines and utilities and to one-man operations in small white buildings, I've come to understand that all electrical systems work the same way, regardless of the logo on the side of the vehicle. I know a great deal about some very simple concepts, and knowing them makes any vehicle's electrical system easy to understand

There is only 1 load per circuit, 2 primary rules for reading a schematic, 3 wire faults, 4 basic circuits, and 5 voltmeter readings — why is electricity so hard?

There are a lot of reasons it is, but this document is only focusing on one factor, and it has nothing to do with a tech's skill and knowledge. This paper is directed at the men and women who actually direct the maintenance operations in a shop. What I want to bring out into the open for discussion is simple to appreciate. It's not something many shop supervisors think about, although I think all of you will recognize the environments I'm describing. I've come to believe that the primary reason electricity never seems to get easier is that it's managed incorrectly.

When you analyze the actual job functions a technician experiences, one specific difference between mechanical work and electrical work shows up pretty well. Because the two are very different, they need to be treated differently and hence, managed differently. I'm hoping that as you read you'll begin to understand that there's a lot more involved in being successful electrically in a shop than just reading schematics or meters

I sincerely want all of you to accept what I'm offering here is a new way to think, and not a list of things I'm telling you should do, just because I say so. I'm a teacher, and what I do is explain things in a way that hopefully makes them make sense. The ideas in this book make sense to me and after you read it, hopefully they'll make sense to you.

You're a manager of mechanics, and the world you live and work in has changed a lot in the last 30 years. But unfortunately, the shops you work in really haven't. The same old pressures of ego, pride and fear still exist, and now with electronics and computers staring you in the face at every turn, what used to be simply annoying are now downright destructive.

You have a huge responsibility to manage a very complicated process, and very little real training on how to do it. You're depending mostly upon your mechanical abilities, which can't help you with electrical problems. You need an entirely new way to think, but changing what you've been thinking for years will not be easy. But, I believe, you need to try. If it helps any, the cost of a new way of thinking is $0.

Don't think that this book is a way for me to seem smart. As I said, I'm a teacher. My job is to tell you everything I know, presumably and hopefully to make your life easier. If I do my job right, you'll eventually know everything I know and I won't have a job. You already have talent and intelligence; I can't give you that. All I can do is try to come up with new ideas and better ways to explain things so they're easier to understand.

You'll have to decide how you want to apply what you learn, if you will —

Special note to guys who feel they get it…

As I've reread and edited this document that I'm now calling a whitepaper, I've started to realize that I didn't do a very good job of being specific about who I'm writing this for. When I started, it was all a jumble of thoughts that seemed pretty redundant. In fact, I found places where I'd written practically the exact same thing on two separate pages, almost word for word.

I fixed that, I hope.

But, I also started thinking, after talking to someone about this project, that some of what I've written might sound very sharp and pointedly insensitive to you, which I do not want it to be. I know my personality pretty well by now, and sometimes my passion and enthusiasm will get the better of me. I really want these ideas to be discussed and if possible, used to help improve electrical diagnostics and repair (EDR).

The one thing I'd like to point out is that I wrote this thinking of the supervisors who struggle the most. I didn't write very well to soften the discussion for guys who have a good idea of what I'm suggesting, and who already are using some of the methods I'm trying to introduce.

In particular, I realized that many of you do understand the value of schematics and you do hope that the techs will use them. You might have even specifically told your guys that you feel that way. But I wrote as if you don't and you didn't. Again, that isn't what I wanted to convey.

But there's still a problem of perception, because you might think one way, and your guys understand another way. Very, very many of my students tell me (1) they don't know how to read schematics, (2) they're scared of them, and (3) they'll get in trouble if they use them. If you do think drawings are important, you might be advised to make sure the people who work for you know that and know how to read them.

I hope you'll give me the benefit of the doubt, and assume that I'm doing this to promote good practices and to help you get into a better frame of mind when you're faced with our rapidly changing electrical and electronic systems. I can't assume all of you know everything I'm writing about, I shouldn't assume none of you know any of it, but I should assume all of you know a lot.

You obviously do, and I'm just trying to help fill in the gaps. I hope you enjoy this, and if you don't happen to see the glitches and goofs I'm talking about as you read, there's a chance I successfully edited them out. I will try, but if I fail, I hope you'll be willing to take it with a grain of salt.

Chapter 1
The Real World

Anyone reading this book will be familiar with the non-stop frustrations that go along with trying to diagnose and repair electrical systems in modern vehicles. Now that manufacturers are throwing computers onto vehicles faster than you can spit, the problems we've always experienced are only getting worse. Truth is though, electrical work has always been kind of tough, and most shops have only one or two guys who are considered to be their "good electrical men".

If you stop to think about it, only having one or two electrical guys who get all of the electrical work is not a very good policy. There are a lot of things wrong with this thinking, even though in some cases, it's the best a shop can do.

First, giving all of the electrical jobs to only two guys blocks all the rest of the shop from learning electrical diagnostics. This really isn't fair to them. Their careers depend upon what they know, and what they know depends upon the jobs they get. If they only get axles and brakes then their professional options are severely limited.

Second, if something happens and your good electrical man suddenly doesn't like you and your management style, you suddenly don't have a good electrical man anymore. If this happens then all of the guys who never had the electrical jobs suddenly are faced with becoming good electrical men. In the process, you have to deal with all the time and money losses that happen as your mechanical guys to get up to speed electrically.

Is it reasonable that you depend upon only one or two guys for the electrical work? Maybe. If you deal with severe time pressures and you're not set up to offer electrical training because you have such a small number of techs, then making sure that everyone in the shop is fully equipped to diagnose electrical faults can be nearly impossible.

I do realize that none of this is particularly easy. What are you working against?

- You don't have enough mechanics to let you send everyone to training all the time to keep up with all of the new systems, or there aren't enough annual training hours available for the guys you have.
- Most guys have never had a really good grounding in electrical so just reading schematics and meters can be harder than it needs to be.
- 237[*] manufacturers give us 237 different diagnostic procedures for the same faults. Engineers want us to believe that the computer will know everything, but it never does, and poor basic electrical skills still must be accommodated.

[*] I'm exaggerating a little – sort of…

- The logic trees are never logical enough, and instead of just telling us how the system works and where everything is so we can fix it, details are hidden inside books that are too big, very repetitive and pretty hard to use.
- There are a lot of pressures in the shop that make it harder than it needs to be to do the job correctly — time, ego, self-confidence, fear, embarrassment, and money.
- Tech data is delivered electronically now which makes updates easier, but which means more time at the computer and less time with an impact in your hand — which is hard for everyone to stomach when the clock is ticking. Digital delivery of schematics is a serious problem of an entirely different nature.

Any way you look at it, it ain't easy. This book is being written to give you — the shop manager (supervisor, lead man, team leader, foreman, shift manager…) — an opportunity to look at the process of diagnosing and repairing electrical faults in a different way than you probably do now.

These are the truths and realities that people can talk about logically but are easy to ignore. These are ways to structure your policies and manage the people who work for you that can greatly improve your electrical success rates. These ideas will force you to evaluate what you're doing now so that you can make some changes, and we all know that change is tough.

But, as you know — when the going gets tough, the tough get going, or the schematic…

Let's be really honest. If you're in a position of supervision in a truck shop or equipment shop, you're there mainly because you're supposed to know more than the people who work for you. That's the way it's always been done. The guy in charge knew best what needed to be done and how to do it, and everyone else came to him for advice and help. In the past this worked fine because there were so few systems in use on the vehicles.

Today though, that is NOT how it is. There are so many different manufacturers doing so many different things that it's nearly impossible for one person to be an expert on any one vehicle *system*. It's **more** than impossible for one man to be an expert on an entire vehicle, and crazy to think you can be an expert on every system of every vehicle you could see in a bay.

So, the question is, do you want a shop of specialists or generalists? I think all of you would love to have every bay manned by someone capable of working on any kind of system on any kind of vehicle. If you have a small cadre of electrically specialized guys, it isn't by choice — it's been forced on you. Why?

Because so many people think electricity is hard, when it isn't.

Any tech who isn't a "good electrical man" is probably a "scared-of-electrical man". I'm convinced, and you will likely agree, that the majority of all electrical faults will be found using good, essential and fundamental electrical

skills. Anyone can learn these skills, but confidence and self-assurance are equally as important, and these can only be achieved if the electrical D&R processes are managed properly.

The age of electrification means the age of managing differently. Electrical diagnosis and repair have always been fundamentally different from mechanical work, but no one seems to have noticed. If you try to apply the same mechanical logic and thinking to an electrical problem, I've discovered that you're really pretty much doomed to fail.

I mentioned change a little while ago, and I also mentioned that change is difficult, even if it's for the better. All of the reasons for this difficulty are in your head — ego, habit, inexperience, and fear. It takes courage to change your thinking and move away from what's comfortable. Critics are everywhere, and you have a lot to lose. But in my mind, there's a heck of a lot more to gain by taking a chance adjusting your thinking.

Humans are creatures of habit, so I'm not crazy enough to think that everyone reading this will suddenly shift gears and make changes overnight. I do hope — at least — that you'll think about what this book is trying to say and consider whether you agree with my logic.

If you don't, I'd be really grateful to hear from you so you can tell me why. This isn't about me being right. It's about all of us getting it right.

Chapter 2
Electrical and Mechanical Diagnostics and Repair (D&R) are different

This is a concept I've only recently come to understand and start teaching, though I usually teach only the techs and not the managers. I can do all I can to get the guys up to speed on all of the important electrical skills, but if the shop environment the tech returns to isn't managed according to the processes I teach, a lot of what the guys learns will be lost.

If the shop runs according to the typical line of thinking — namely that mechanical work is mechanical work, period — then a lot of opportunities will be lost. I've heard some pretty harsh stories about guys trying to use the methods I've taught and having a supervisor in their face telling them they're stupid for doing it that way.

Never mind that the guys used the new methods the week before and watched them work. Never mind that the manager probably hasn't had anywhere near the electrical training that the tech has. The reality is that old habits die hard, and if a supervisor feels the urge to be pushy, over time the tech will abandon the training and go back to doing it the "wrong" way, just to make the supervisor happy.

The rhetorical questions then become, (1) why did you pay me to teach him in the first place, and (2) why would browbeating the tech be more satisfying than using his new skills to increase the shop's efficiency?

Supervisors often manage the electrical process in the same way a mechanical failure is managed, and the two are completely different. If the process is managed poorly, then the outcome can never be as efficient as it could be. In most cases the process is flawed from the very beginning, simply because your expectations as manager are wrong.

I won't be polite here and say "misguided" because I want you to get a little torqued off that I'm telling you you're wrong. I want you to really think about this. I want to you to be really critical and try to prove **me** wrong. This really needs to be discussed, talked about, thought about and worked over.

◊◊◊

You probably never gave it a lot of thought, but take a second and consider that mechanical D&R are completely the opposite of electrical D&R — *time-wise*.

When a vehicle is sitting with a mechanical problem, you can be pretty sure of a couple of things. First, the actual *diagnostic* time is pretty short. It doesn't really take a lot of time to identify the nature of most mechanical failures, and if you can't actually observe the knocking or screeching part inside an engine block or pump body, you still know what needs to be done to get into it to see the problem.

I hear the same complaint in class every week — “You can’t work on electrical because you can’t ‘see’ it.” You need to key on the word “see”. I agree that you can’t see the electrons moving in the wire. But, you’ve never seen air in a brake line, or oil in an oil passage in a crankshaft, or oil in a hydraulic system either, and you work on them without thinking about it.

Is it that you can’t “see” electricity, or that you can’t “see” the actual **electrical fault** the same way you can see a flat tire? That’s what I think it is. I think techs are so used to being able to look for and find the *mechanical* failure immediately that when they’re faced with an *electrical* problem, they try to use the mechanical way thinking and it can’t work.

Mechanical faults are usually obvious, while electrical faults are hidden. The fix isn’t as plain as the nose on the tech’s face, and the inability to instantly see the problem and order a part is very hard to deal with. Why? Because it means you have to start diagnosing, and since we don’t really teach and manage correctly, the diagnostic process scares the living crap out of almost everyone.

All of you are completely okay with a mechanical repair that takes a half-day or more. It doesn’t bother you to call a customer or dispatcher and tell them “your hydraulic pump failed and sent trash all through the system, so we have to disconnect all the lines, flush out the system, change the pump and replace all the filters. We’re waiting on the pump but we’ll get on the lines now. It’s already 3:00 o’clock, so we should have it ready to go by lunch tomorrow”.

You’re confident in your decision and action, you and the dispatcher can visualize the process and agree on the times, and the tech knows exactly what the problem is and how to fix it. You can predict costs, schedules and success. Everyone is happy.

The diagnosis was quick. It didn’t take a lot of effort, it didn’t really stress you or your ego, and because it’s something you’ve seen before you’re completely confident in the outcome.

But think now about an electrical failure on a new vehicle you’ve never seen before. Can you reasonably expect the *diagnosis* to only take minutes?

Is it fair to expect even a skilled tech to walk up and make a quick and accurate decision about what to do and how to do it to get the truck running? I’ll answer that for you. No, it’s not, because that’s not how it works. The process for a hydraulic pump and a multiplexed electrical system are not the same, and if you try to manage them the same you’ll fail.

An electrical fault is usually insanely simple in nature, and therefore will take less than 5-10 minutes to repair. But it can take hours to get to it. This is normal and defensible.

Most of the time when the real problem is located it ends up being a small thing like a cut wire, a corroded connector, a bent pin, a rusty ground or a blown fuse. You know this is true. You know from experience that the electrical *diagnostic* process takes hours, but the actual *repair* times are short. This is

something any group of supervisors would agree upon — and you should agree it's *normal*.

How does this affect your management of the process? Simple. Stop *worrying* if the electrical diagnostic time runs into hours — as we said above this is *normal*. It's *normal* for a broken axle to be identified in 2 minutes (including plan of action) and finished in 3 or 4 hours. It's *normal* for you to accept the mechanical times.

But, it's *not normal* for you to expect an electrical problem to be found in minutes and fixed in minutes. That's not how it works. We want the diagnosis to be short, and it can be shortened over time, but it will *never* be as short as the mechanical diagnosis.

We can discuss these realities logically, but we don't apply them to the process very well. Some of you do, many of you don't. If you think about it, it really doesn't make a lot of sense for you to be happy that a mechanical fault takes 8 hours or more, but not be completely happy that a very confusing electrical problem is solved in the same 8 hours.

Eight hours is 8 hours — who cares if it's a wire problem or a cracked frame needing to be welded? More curiously, when did we start thinking there's a difference? This is a very harmful way of thinking because of how it affects the eventual outcome of an electrical problem.

No self-respecting mechanic would ever consider using anything other than a standard part for the repair. No one would use a piece of rebar in place of an axle. No one would use sheet metal screws to fix a cracked frame, and no one would use vegetable oil for hydraulic fluid. This would NEVER happen.

But, how many times have you seen Radio Shack switches, wrong-sized parts store wire, butt splices and Scotchblocks® in a harness, all tied together with electrical tape? I've even seen wire nuts tying together power wires for an auxiliary brake pump on a truck. I can name as many of these examples as you need me to to make my point, but I really don't need to go any further because I know, that you know, that this is true.

In other words, you'll never allow anyone to make a grab-ass repair to a MECHANICAL system, using parts that aren't right or methods that would result in a failure or injury. BUT, if the problem is ELECTRICAL you, and the guys who work for you, don't seem to hesitate to rip a harness apart and use badly-installed non-standard parts with minimal understanding of the system, just to get a vehicle running.

The only explanation for this is that you're more than likely expecting the EDR process to be the same as the MDR process.

You can be angry with me for raising the issue, but you know I'm right. You know full well that if a problem is mechanical the work will take time, and you're willing to let the guys work to the end, making sure they have all of the materials they need to get the work done.

But, the guys don't often get the time they need to get an electrical job done right, including doing a great diagnostic and a quality repair. I've heard guys tell me that, "the manufacturer wiring was wrong, so I just wired in a jumper". What the guy was really saying was, "I have no idea how this system works, and I don't have the confidence and courage to take the time I need to figure out what's going on, so I'll just run a wire and get it going…".

This is fine when you're Mr. Scott and you need Warp Speed to escape an exploding star. This is NOT what you do when you need to keep very expensive and very complicated trucks and equipment running for the amortized life of the fleet. If this is the normal way that your shop works then you need to seriously consider how this method will work for you in the next 10 years.

Give this a lot of thought. Ask yourself if you're one of the supervisors who work mechanical problems and repairs without blinking or thinking, but struggles with electrical ones. If you are, I can promise you that rethinking the way you approach electrical D&R will make it far easier to stop making "get it running" decisions and start getting more things fixed.

Electrical D&R and mechanical D&R are different, and if you're willing to let this be a guiding principle in your management style, I can assure you things can improve.

Chapter 3
DIAGNOSE Circuits, REPAIR Wires

You might have noticed that I haven't used the term "troubleshooting" yet. I won't be using it at all, because I've decided that the term doesn't really have a meaning. I've learned that since most guys use the mechanical model for their electrical thinking, they lump ALL of the different actions into one process they call "troubleshooting", and I'm convinced this is part of the problem.

I know it might seem odd to take time to define diagnostics and repair, but most people don't think of them as different. If you don't make a distinction, the temptation is to skip back and forth between meter reading, changing parts, poking holes in wires, swapping out good parts, making phone calls and reading the schematic and the system operational materials (last).

There's no organization if you call everything you do "troubleshooting". And moving hither and yon and to and fro from phone to the parts counter can't work. How do you keep track of the steps you've already taken? How do you really know where you are and where you left off? Did you reconnect that connector you shouldn't have disconnected, and did that change the reading that you're now acting on?

All of these actions are based on the desire to find what's wrong and to fix it, because that's the way the mechanical model works. But in MDR most of the work happens knowing exactly what's wrong. In EDR, all of the work happens so you can *figure out* what's wrong. The world is flip-flopped and it's not comfortable.

If you don't really know how the system works how can you fix it? If a tech doesn't take his time and try to fully understand the system as he works (because he's being pushed to get the truck or dozer out using a mechanical mindset), how can he ever learn how the system works? Here's a fact that you need to appreciate and take into account if you want your guys to get better.

You do NOT learn from the electrical repair; you ONLY learn from the diagnosis…

Think about what we said earlier about the times associated with the D&R processes. The electrical repair is done in minutes, and what can a guy learn about the system by just cleaning a connector and plugging it back in? Nothing. He *should* be learning and remembering for next time that most repairs are pretty simple. But that fact doesn't usually register because he's so worked up worrying about how long the diagnostic process is taking.

The only way a tech can ever learn about the electrical system is to work *with* it, not on it. Working "with it" means figuring out what it does so he can understand what it's doing, so he can understand why it's not doing what it should be.

If we go back to the discussion about electrical and mechanical D&R, we see another difference — namely that in a mechanical world the tech's OJT is based upon eyeballing the machine as he disassembles and reassembles it with tools.

Mechanical learning is hands-on and completely un-pressured. A tech sees, he thinks, he does, and he succeeds. When confused by electrical work, the burning desire to use tools can easily outweigh the logic of sitting and reading in a quiet place, redrawing the schematic and thinking.

If the tech doesn't understand the electrical system and the diagnostic process isn't supportive, the OJT you hope will happen won't. OJT based on myth and mystery is essentially useless.

Here are two examples I'd like you to think about. In my advanced class 6 students build 15 circuits that make up a complex system. We then put one fault in one of the 15 circuits and start diagnosing. The students spend about 16 hours in total looking for and fixing between 25-30 faults, one at a time.

When we conclude the class the students are stunned to realize that each of the actual faults took less than one minute to fix, while the balance of the time was spent finding the fault. In other words, in 16 hours of "electrical work", 15-1/2 hours were spent thinking and looking, and less than half-an-hour was spent repairing.

The second example is more of a question for you. If a student returns from a class and tells you that he now has the ability to reduce the average electrical "troubleshooting" time from 8 hours to four hours, wouldn't that be exciting? But, how would you feel if you asked him how that could be accomplished and he responded with, "I sit on my butt and read for 3-1/2 hours…"?

In the long run you save 4 hours and increase productivity by 100% — BUT — *would you let him do that*?

Not if you're managing him with the mechanical model. But, if you manage an electrical problem the way I believe it should be managed, you would let him sit and read. Four hours is four hours, and if the guy is learning how the system works instead floundering, wouldn't 3 hours of reading eventually be 2 hours, then 1 hour, then in some cases, none?

This is the electrical OJT you CANNOT accomplish thinking mechanically.

The instantaneous gratification the mechanical process provides tends to encourage the tech to try and duplicate that feeling electrically. The problem is that very few immediate electrical predictions for ego purposes will ever be right.

There's another ego aspect of this that needs to be considered. Electrical diagnosis and repair is not very manly. There's a big difference between rebuilding an engine and crimping a wire, and not a lot of guys can accept EDR as equally as important as MDR and that each has a different type of success associated with it.

If the tech has a need to feel proud of his mechanical ability, spending hours of frustration looking for what will end up being water in a connector is not going to be very satisfying. This is a learned thing, and if you can get a guy over the hurdle of worry by giving him the chance to succeed, he'll never want to pull a transmission again.

Remember though, learning and improvement *cannot* and *will not* occur if the diagnostic process is flawed. The process will be flawed **every time** if you put pressure on the tech to rush to an answer. You understand that the actual repair will be simple and inexpensive — why is it so urgent to have the electrical system repaired faster than a mechanical failure?

The reality is that this sense or urgency is unnatural, unwritten and unproductive. No one will ever claim to be able to look at a vehicle with an electrical problem from 10 feet and know what's wrong. No one should realistically expect them to be able to. No one understands why this happens.

◊◊◊

In summary, diagnosis is the time we take to figure out what's broken, and the repair is the time you take to fix it. The two are different, especially with respect to the time each takes to accomplish. If electrical work orders are going to become less frustrating and more profitable, understanding the difference will help.

Chapter 4
"What's wrong and how long?" Questions without answers…

It makes perfect sense that when all of the pressures have built up after a very long diagnostic period, the urge to do *something* is enormous. As a manager, your job is to make sure the job gets done, and when there's nothing else you can do than ask a question, you're going to ask. This is more likely if you need to respond to a production manager or a paying customer.

If the problem is electrical, the only two questions that normally get asked are "what's wrong" and "how long"? While you might think that there's nothing wrong with asking these questions, you'd be mistaken.

Believe it or not, there are no honest answers to these questions.

Think about it this way, based on what we discussed earlier. If the diagnostic process is going to take hours — which is normal — then you should accept that and not put pressure on the tech to have an answer when you already know he won't. You also know that the tech won't know what's wrong until the *end* of the diagnosis.

Even if you don't have the ability to know what the exact location will be of the exact problem, you do have the experience and ability to give the tech a pep talk and remind him that in the end, it's <u>not</u> going to be something huge and involve thousands of dollars of parts. You should remind him that when he finds the actual fault he'll likely find a small spot of corrosion on a ground terminal that will amazingly make everything start working when it's clean.

I don't mean to suggest that you should never ask a tech how things are going. You should. It's your duty to keep everything moving ahead and keep track of the schedule so you can do maintenance planning.

But, repeatedly asking for an update can't do anything other than create problems. I can promise you that in my classes, the one thing EVERY tech can relate to and will tell you torques him off more than anything else, is having to deal with constant questions about the fault and the time. I understand the frustration these guys are feeling.

Put yourself in his position and ask yourself if it would feel good to be asked questions that will always have to be answered, "I don't know." That's the only honest answer he can ever give you. He won't be able to tell you what is "was" until he finds it and he fixes it, since it's probably going to be a 5-minute repair. Why come tell you what he found, and then go BACK to fix it. He's just going to find it and fix it, and then tell you it's done.

And if you think about it, if you know there won't be an answer before the diagnostic is through, *you're asking him to lie*. Maybe not intentionally, but that's how it plays out. He either has to painfully say "I don't know", or give you an answer you know can't be true. If you've never thought about it this way, you should.

Let's back up a second and kind of review our thinking up to this point. You, as the supervisor, feel pressure to keep everything moving ahead and to stay up on how things are progressing. Historically the shop manager has been the guy who knows more than everyone else turning wrenches.

The guy who's trying to find a rusty wire in a haystack feels pressure to find it really fast, and you feel the pressure to be able to help him (which you can't, really) and to make the customer — either internal or external — happy.

Every instance of interruption causes the logical diagnostic thought processes get all goofed up. He's on the track of something, testing or measuring something, and he gets a call or a visit. If he has to stop and give you answers to questions that you know there are no answers to, he can't *keep* on track.

He also gets a boost to work faster after each visit, which is bad. Rather than simply working through to the end using a logical and controlled process, the stress can build up and the tech can start throwing darts thinking you're really mad, but you aren't saying it.

The tech worries because he doesn't know what's really broken, what you and the other guys in the shop are thinking, and what's going to happen if he doesn't get this thing going. You're worried it's taking too long, what this will do to your reputation, and what the customer is thinking. The customer is wondering what the heck is taking so long, what this delay means to his business, and in the end, wondering why he's paying $783.76 for two Deutche connector pins, a new silicone o-ring seal, and 6-1/2 hours of labor.

The weird thing is this. In the mechanical world you *can* answer the questions "what's wrong?" and "how long?" but, you never even have to ask the them. Why is this? Because of what we said earlier. You and everyone standing next to the vehicle instantly know exactly what's wrong and can estimate the time it will take to fix it.

This is why you don't hesitate to ask during an electrical fault. The questions never cause problems in the mechanical job, so why not ask them in an electrical fault? Because they hurt, not help.

This is the reality that nearly every shop in the country experiences, and there are a lot reasons we should do something to fix it. I'm convinced that the simplest way to do this is to reset our understanding of the process. If we can understand the difference between the diagnostic process and the repair process and structure our thinking and management decisions, I believe things can run more smoothly.

◊◊◊

In response to the question I know you're asking yourself, namely, "what SHOULD I ask", the answer is simple. Ask, "What's *right*". If you keep identifying the segments of the systems and circuits that are functioning correctly (since they all only do one thing) you eventually have to end up at the one segment that isn't working.

It seems odd, but asking what's right is far more effective in keeping the tech on track. It helps avoid overlap of effort, it gives him a chance to rethink some of his actions and decisions, and most importantly, ***it keeps you in the loop without creating tension.***

Systems and circuits can fail in several specific ways in thousands of locations, and the problems can show up all over the place. If you keep with the notion that only one tiny portion of one circuit in one system has failed (say, 0.1% of the systems), then ALL of the other systems are working (the other 99.9%). This means very simply that your target will be a tiny problem and everything else will be working normally.

This is particularly helpful when there are shifts involved. Too often the later shifts repeat the work of the earlier shift, "…because I don't trust who worked before me." If you're involved and can state with total confidence that certain systems and circuits are off-limits to the diagnostic, then there'll be far less wasted effort and redundant work. As manager you should be able to have as much insight as the techs, and asking the "what's right?" question often is a good way to achieve it.

Chapter 5
Why do we get embarrassed? Ego, ego, ego…..

You can't manage the electrical D&R process without considering the psychology of the techs you work with. This is what I meant when I suggested that the shops haven't changed much in 30 years. Nearly every tech I've ever taught has admitted that he's never been as confident and as successful as he wants to be while working on electrical faults.

No one ever experiences these problems with mechanical jobs, other than someone doing something for the first time, and that's just lack of experience. The mechanical fault is usually pretty easy to identify, the fix is equally as obvious and easy to teach, and it's usually localized to one small area in the vehicle. Not so with electrical, as we've said already.

So, we know that very few techs look forward to electrical faults and they will often do all they can to avoid them. This is bad for them and bad for you. They hate being wrong, they hate feeling stupid and they hate being ribbed by others in the shop. Their entire ego and identity are wrapped up in knowing the answer. It's what defines them.

That's why they hate electrical work. Everything about it makes them uncomfortable, takes them outside their comfort level, makes them vulnerable to criticism, and forces them to think or say "I don't know" more in one day than they normally would in a month. In short, the jobs just really stink. But, I'm convinced that much of this will go away if we rethink the process.

◊◊◊

When a tech is working on a **big** machine with **big** parts and a **big** price tag, using **big** tools out of a **big** toolbox, it's logical (to them) that whatever is keeping this vehicle out of action *has* to be a **big** problem.

Nope…

What is most destructive about this thinking is what it does to the tech's response. First, he feels really stupid and embarrassed that it took him the time it did to get find and replace a bent pin in a connector. Secondly, he has to explain his 'failure" and somehow do it without making you — the supervisor — angry. And lastly, he needs to come to grips with a pretty odd electrical situation that never seems to register or sink in, namely — "how can something that small break something this big".

He has to accept the uncomfortable reality that this huge, very expensive vehicle that has been out of action for too long, was likely shut down by a single ground wire that was a little too corroded. This is really a huge ego slam. This guy not only has to deal with all of the pressures we've explained in order to get to the end of the diagnostic process, NOW has to deal with the reality that ALL of his efforts led to a rusty 25¢ butt splice.

It's NOT an easy thing to deal with, having to accept that hours and hours of effort on a huge vehicle that's been broken for hours and hours is now running because you spit on a ground and twisted it a little. You've had this discussion in the office, and you're never comfortable with it.

What I'm really talking about I'm talking about is that "how in the heck are we going to bill this guy nearly $1000 for a full day and a half of digging and tell him that in the end, all we did was clean a ground?" problem.

There are two things going on here you need to address. The first, and most obvious, is the customer problem. The second, and seldom considered problem, is the tech feeling stupid and embarrassed. This is a different problem than the customer one, but in my opinion, I believe it's far more dangerous.

This feeling of inadequacy doesn't increase confidence and make it easy to learn from the process. Rather than acknowledging what happened and learn from it, the tech will most likely consider it a failure and will try to forget the experience. How can this be an effective OJT program?

If you think about it, we don't typically have a pep rally after an electrical job, to discuss the lessons learned and to make sure guys don't get down on themselves feeling like failures. But, we should.

How will this guy approach the next electrical problem? Happily and eagerly, looking forward to the opportunity to increase his skill? No, not usually. He usually cringes and tries to avoid it. You know this is true. You've had to deal with this for years. Why else would you understand one of the first things we discussed — having only one or two "good electrical men".

◊◊◊

I think I have a very simple solution to a lot of this. We really do know from experience that the eventual outcome will be something simple, and when we eventually find it, the tech is more likely to feel stupid than proud. Since we do know this.

Start out the process by stating — very firmly — that when the end is reached, the answer will be simple. Just reverse the thinking.

In other words, as the tech walks out the door heading to the bay or to the service truck, your last words should be, "…oh yeah, by the way — don't forget that the real problem IS going to be really simple, so don't get all worked up thinking it's huge. You'll need time to sort it out, and if you need help with the manuals, let me know. I'm pretty sure that you'll find a wire problem that's not going to take a lot of time to repair, so don't start thinking parts will solve it. I'll give you about 4 hours of diagnostics before I bug you, but I'd like to know how things are going by then. Don't forget to make sure you have as good an understanding of the system as possible before you start."

The time of greatest learning will happen when the genuine problem is discovered to be the small thing we knew it would be. Instead of feeling embarrassed, you should take some (billable) time to help the tech review the

real indications and figure out how they fit the fault. This is YOUR time to shine by reinforcing what your superior experience told you knew it would be.

The easiest way to summarize this section is to tell you about the “old guy” at the county fleet I was teaching at in a “small Texas town”. I’d finished the class and had a few hours to kill before heading to the airport, so I was hanging around the shop area just soaking up the atmosphere.

From the side, this “old guy” came up and asked me if I “was that electrical guy everyone’s so fired up about?” I assumed yes, so I said yes. Turns out he needed help on a service truck that had lighting problems on the left side, so we went out and proceeded to work through this problem.

The short version of the story is that when they’d rewired the 7-way connector for the cable trailer they’d miswired it and I ended up helping them solder the leads and getting the connector squared away. But, after the rewire, the truck lights wouldn’t work. According to my new friend the schematic wasn’t available (although I found out later it was in the shop library) so I followed him and ended up on my back on gravel in south Texas in 99º heat, in full sunlight, in the rain. No, seriously — full sunlight and a downpour.

The service truck was an International, and having limited experience on them up to then I started dragging my way back to the front under the chassis looking at wire numbers. The wire nearest the light fixture was 56G, and the next one closer to the fuse was 56F. When I saw this I said some choice words then went to the fuse panel and found, yep, wire 56. The wire numbering logic was sound, and finding the fuse was pretty simple because this “old guy” already had the fuse panel (and the dash) ripped out.

When I looked closer I saw that the fuse was blown — probably caused by one of the last rewires and all the scraping around at the connector. I showed it to him, and I swear on my father’s grave his response was, “do you like hamburgers?”

After a brief period of confusion I looked at my watch and said, “yes, I do”. At that, he motioned me over and into his pickup, and without a lot of thought we wheeled out of the yard heading somewhere. After some tense minutes looking at the gun rack and wondering what was going on, we pulled into a little hamburger joint, and went inside. He still hadn’t said anything since he asked me about liking hamburgers, and he just kind of nodded to the counter.

After I ordered he paid and we sat down at a well-worn white Formica table with wobbly chairs. We both just sat there for a little while until he broke the silence and said, *“don’t tell ‘em it were a fuse, ‘cause I told ‘em it was something a lot worse.”*

I looked at him with a lot of compassion and said, “sure, no problem. Good hamburger…”

True story, and it goes a long way to explain, at least to me, why the ego problems that we face occur. This poor guy was so worried that I was going to

run into the shop and start squawking about how stupid he was that all he could think of to do was get me the heck out of there so I couldn't tell tales.

How incredibly sad… In the end, I spent an hour at the hamburger joint teaching him whatever I could to help him out. There have been very few times since then that were more instructive to me as a teacher, and more satisfying to me as a friend. This guy was all alone, deathly afraid of failure, and unable to get support from the people he felt closest to.

Is this your shop? Do you have old guys? Do you allow what seems like good-natured ribbing to create tension and make electrical success that much more difficult? If it is, go get a hamburger and figure out how to make the changes I can assure you need to be made.

◊◊◊

There's no doubt that confidence is a very crucial factor in being successful, which, if you think about it, is why no one ever fails mechanically. But in the electrical world, lack of confidence is rampant because so few techs have had a chance to succeed. It's a vicious triangle — to succeed you must attempt; to attempt you must have courage; but to have courage you need to succeed.

You play a key role in developing your techs, and to develop their electrical skills a lot can be accomplished by changing the way you view the process. The best way to create a "good electrical man" *is to never let him fail*.

You can do that.

Chapter 6
Statistically Speaking

I've been hammering away doing all I can to emphasize that the actual fault keeping your truck, grader, tugboat or airplane idle is going to be something embarrassingly simple. We've already discussed this, but not quite this way.

The vehicle was running up to the second before it quit, so what could have happened in that short of time to cause the shut down? We don't have the luxury of looking under the chassis to see a puddle of oil, hear an air leak, or see evidence of an explosion or shrapnel. Electricity seldom makes it *that* easy.

But, if you understand the nature of the faults we deal with, you don't need those blatant signs of failure to help you out. Think first to the wealth of your experience and ask yourself what usually ends up being the problem. What you've seen over the years and what the manufacturers will tell you will likely be the same.

80-85% of all electrical faults end up being in some part of the wiring, or in wiring related components — connectors, terminals, grounds, etc. Why? Because the wiring is the most fragile part of the system, and it's the part of the system that gets beat up more by the weather, the environment and the mechanic.

The question is, why don't we learn from this, and go out to the vehicle KNOWING this will probably be the way it works out? If you spend the three days and then find the small problem, you feel stupid as a result. But what if you START knowing that the result will be something silly and simple? If you do, when you find it, you're a genius…

And, if you begin with this assumption and the outcome matches that assumption, what better way is there to boost confidence?

Think about it this way. According to these statistics, if you walk up to the vehicle and say, "it's going to be something small and insignificant in a wire", you'll be right 8 out of 10 times. That's batting .800. What's more, if you start with this idea in mind and make this reality clear to the shop, your guys will be more likely to look for what will be the right target and will find it faster.

Instead of wanting to change lots of expensive parts up front, they'll instead be able to focus on what's probably going to really be the problem and start looking for the real fault. This changes the entire D&R process by keeping it logical and on track, rather than skipping around from here to there hoping to find something.

What happens when a guy is handed an electrical problem? The first thing he wants to do — usually without a single test — is PREDICT the actual fault. If you ever see 3 guys standing next to a machine and one of them says, "maybe", the second says, "probably" and the third guy says "last time it was this", they

have no idea how the systems works and might as well go get a donut for all the good they'll do.

Tell your guys to stop trying to predict the fault, and if they offer one, don't accept it, unless the prediction is that it's going to be a wire. Any other prediction is almost never right, it always involves the ego in a negative way, and it gets the process started on the wrong foot.

◊◊◊

There are only three faults that can occur in a single wire — open, short-to-ground and high-resistance (corrosion). If these are the only things that can happen to a wire, why is it be so hard to find them? It isn't…

We don't start out understanding it has to be one of these faults. Lacking a real understanding of the system allows our imaginations go crazy creating some wild and ridiculous and massively complicated fault that we think explains the massive failure we're experiencing.

Remember what we said earlier? Our ego needs the problem to be big because we don't know the answer. So instead of saying "I don't know" we try to convince ourselves we DO know by insisting that it was aliens from Area 51 that flew over the electrical system and did something weird, so "I need to rewire the whole thing because the manufacturer didn't have it right anyway…"

Really……?

It was working yesterday. What could've happened since then to make the thing quit? Easy. The corroded wire that wasn't corroded enough yesterday is now corroded enough so it either opened, or shorted-to-ground, or just is dirty. That's it. The most likely place for the WIRE to fail is at the end. The wire is copper, and the connector or terminal is NOT copper. This is what is known as "dissimilar metal corrosion".

Put two different metals together in water and air, you're going to get corrosion. The corrosion can cause the wires to work poorly, break or get crossed, especially in a connector. The ends are where the greatest stress is, and where the tech is involved more, making mechanic-induced failure more likely.

One other thing, the oxide film that forms on a piece of copper or aluminum that kills your vehicle is VERY thin — 0.001" or less. This is very, very small, and as we've said already, the actual fault will <u>be</u> something pretty small. You need to remind your guys to look for ANYTHING that looks bad, even small amounts of dirt and film. Their eyes are calibrated for the tons of crud they find on the chassis of trucks and equipment, or in the bilge of a tugboat, *not* for the insignificant film of oxide on a connector pin.

You need to draw on your experience and teach and remind them that small things matter, and in some cases, a vehicle can be put back into service just by opening and closing a connector 5 times.

And, if you're seriously worried about diagnostic times, you need to think about sharp, pointed tools — ironically — as a mechanic. If the corrosion is as thin as it is, and a mechanic is inclined to push hard to "get a good connection", did it ever occur to you that the pointed tool will penetrate right past the oxide and the reading will be incorrect? You'll miss the problem and go skipping on to the next step…

If the diagnostic process has been dragging on for a while, and the pressure is built up pretty good, when the guy finally(?) finds the problem — the green wire and terminal — he's probably going to be so stressed from "taking so long to find it" that he's going to be in a big hurry to get the thing out the door.

This means he probably likely won't be prioritizing stopping, taking a breath, and spending another half-hour making the REPAIR correctly. Instead, he's likely to clean the connection with a wire brush and call it good.

If the corrosion was there and now isn't, then the size and capacity of the wire has been reduced because the oxide ate the wire away. Not only that, if it's where is can be seen, it's also going to be where is CAN'T be seen. There's a huge problem here that goes back to the ego discussion.

Green corrosion is copper oxide — CuO_2. It doesn't form ON wires — it used to BE wire. ANY green corrosion on any component is grounds for replacement. If your tech comes back and reports that he got it fixed and everything is hunky dory, you need to know for sure he didn't just try to clean off the green stuff and call it good.

◊◊◊

Getting back to statistics, if you have an entire fleet of MileMuncher 3000 tractors, or dozens of DirtSlinger 99 excavators, and you've had these things since, like, forever, you're probably going to have a pretty good idea of how they work. You're also going to know where many of the more common problems crop up most of the time.

If a certain fault happens to a certain kind of vehicle, and the indication is the same as you've see a thousand times before, it would be absurd NOT to go to the exact place you probably know it will be and check there first. That's both logical and a good, solid diagnostic practice. I would never tell you not to do that.

What I'm talking about are the 4 out of 10 times when that isn't the problem. You have your tech check all of the obvious places you've seen in the past and none of them are the answer, so what do you do next? That's when you have to start thinking about a logical D&R process.

Fuses and circuit breakers and grounds are good examples. These are the areas where faults are very likely to happen, and again, *it doesn't take a huge fault to shut down a huge machine*. These are easy to check, and there's a pretty

good chance your uncle Ernie with 8 fingers told you to *always* check the fuses and grounds first.

Uncle Ernie was pretty smart. But uncle Ernie also probably worked on vehicles that had a starter, some lights and a horn. It's still important to check the simple stuff first, but it's also critical to have a firm understanding of what EDR really is if the fuses and grounds aren't failed.

We need to at least discuss electronics here, because so many of the systems we work on are operated by computers fed by sensors. In the early days of electronics everyone worked on them pretty much the same way as they did anything else. Let's yank out the box and see if that's the problem by tossing in another one.

Again, in the early days, that wasn't necessarily a bad thing because computers back then were more or less standard. The fact that computers weren't as reliable as they are now made the swap out more reasonable, and it was likely you might have another one available, even if you had to pull one off of another vehicle.

According to the manufacturers, since wiring/wiring-related components are the problem about 80% of the time, what are the other percentages? Components, such as bulbs, relays, switches, etc, fail about 20% of the time. This already adds up to 100%, which means that electronic failures are pretty rare – statistically. These boxes and sensors now fail less than 1% of the time.

Do boxes fail? Yes, they do. Can you just swap them out with another one in minutes to rule out the box? Yes, but not as easily as before, because boxes now are often different between models and serial numbers. This means the box is not as effective a diagnostic tool as people want it to be.

Even though you know this, and there are a lot of OEM safeguards in place to prevent unnecessary replacement of ECMs, there is a component of the MDR effect here. When the tech is confused and he can't change the box, the imagination kicks in and we get ego-driven mechanical actions that aren't all that logical.

You have to balance your experience with electronics and your vehicles, with the true nature of what the most reasonable failures are. Techs will always feel the urge to swap boxes though because the MDR model makes it easy to justify.

I can't tell you how many times I've watched someone START by taking out their screw gun and ripping out the dash or a panel where the switch for the system is because they didn't want to trace wires. Anything is better than that.

Equally important is realizing that when you prove the box is NOT the problem, we have to snap out of the mechanical way of thinking and get back to the reality that the real problem will inevitably be the small fault we've already talked about. You still need to keep this in mind as you plan the diagnostic, hopefully before you start throwing parts.

The essence of this concept is that as the manager, your primary job is to make the jobs of your techs easier and more efficient by guiding the process, NOT by knowing the answer up front. Your experience *mechanically* might be adequate to instantly tell a guy exactly what tools are needed in what order to work on a mechanical system, but I doubt you have that ability *electrically*. No one does, so ego is not a real factor, only a perceived one. If *no one* can do it, why would anyone be embarrassed that they can't.

Electrically, your time and effort are better spent working to help your tech see the logic of the problem and the most likely places to look. You need to be willing to accept that knowing what you do know is good enough. Knowing that it will likely be a wire is not a weak position. It's a very strong position, and applying this knowledge confidently will make your life a lot happier.

If anyone complains about this thinking you need to take heart in knowing that you'll be doing exactly what the manufacturers want you to do. I've looked at a LOT of different manuals, schematics and flowcharts, and they all have one thing in common, no matter what logo is on the vehicle.

EVERY manufacturer wants the tech to confirm the integrity and operation of the wiring in the associated circuits BEFORE ever changing a part or starting to disassemble the entire system. They know that wires are the problem most of the time, and even though they do a pretty bad job of writing the logic tree, if you look carefully you'll see that that's what they're saying.

They don't always use a logical process to find the logical problem, but you're smart enough to take what they give you and actually make it work.

Chapter 7
Part Numbers for Problems?

I realize that there's a lot of overlap and a lot of repetition in this information, and that's because there aren't that many concepts that we're dealing with and they aren't all that complicated. The problem isn't the complexity of the suggestions I'm making, it's the difficulty in making a conscious decision to change your habits and possibly adopt some of these suggestions.

Depending upon what your experience is and how you're reading this, you may read something one way in one chapter and another way in another. Some people are wide open to criticisms and comments about improvements, while others aren't. Since I don't which one you are, or how many of you there are that are reading this, I have to cover every base.

Let's start here with another new way to express a reality. The 80% rule of wire failure means that in EDR <u>the problems very seldom have part numbers</u>.

Guys can relate to this explanation because in their experience the mechanical D&R process almost always includes a new part or parts. That's what makes it a mechanical job — taking something apart to get at the broken thing so you can put a new thing in and then put it back together.

Unfortunately in the electrical world, this isn't the case most of the time. Most of the time, as has been said, the actual repair involves cleaning something or tightening something or reconnecting something. If there is a part number, it's usually not really a part number because it'll be a piece of wire or a terminal of some kind, or in some cases, a harness or a sensor.

I realize there's no way to be 100% accurate in these predictions, and your actual experience may vary, like your mileage. However, the numbers do hold up pretty well, and keeping them in mind helps. The part numbers I'm talking about though are the big-ticket items — fuel pumps, ECMs, motors, starters and alternators.

There's a special note about batteries, starters and alternators here. My joke about starter voltage drop testing is that there have been a whole lot of "$600 cable cleanings with free starters thrown in". Starters and alternators are the electrical components that: (1) are the biggest and heaviest, (2) have big bolts, (3) are reasonably easy to get to, and (4) have part numbers.

Because of these factors, they're very quickly removed and replaced on a hunch (or because changing parts is a bad diagnostic method), often without any proof they've failed. This is a huge mistake, and if you apply the 80% wiring principle again and use correct testing procedures for these components and systems, you'll be changing out a lot fewer starters and alternators. But, the need to be "working" can make doing all that testing hard to prioritize, since the MDR experience teaches them they should just be able to *know* the answer.

It's important to resist the very strong urge to revert back to a mechanical way of thinking when the going gets tough. When the diagnostic process stalls, the sense of failure and embarrassment can creep in and make it very easy to want to swap something out just to see what happens. More often than not, the new part will be left on the vehicle because the process of getting it removed and back into the parts system is pretty tough.

As a side note, I've met some fleets that have so many of a particular vehicle that they keep a stock of standard parts billed out to the shop that are there just for the purpose of "replacing with a known good part". One fleet painted all of them a very ugly green color so they wouldn't stay on the vehicle, and if they did, they'd be swapped out at the next opportunity because they showed up so well on the machine.

Anyway, the idea is that there have been a lot of unnecessary parts changes in the name of an electrical "repair" that were really part of a failed *diagnostic*. I hear the phrase, "well, he was gonna be needing a new one of those pretty soon anyway, so it won't really matter…" If you're in a fleet and this happens a lot, it does matter, because it's very expensive, and it really goofs up PMs and life-limited parts exchanges. It's not all that easy to keep track of either.

If you have a particular vehicle that has a very high rate of exchange on a sensor or motor, there's a very good chance that the wiring has failed, possibly intermittently, and the part swaps were not very well thought out. We all know how much guys hate "tracing wires" so the problem is understandable, but it's still a problem.

◊◊◊

Owner/operators of trucks, equipment fleets and other companies that have to send their stock out for repair put a very blatant pressure on shops that everyone is aware of. These are the guys who stand at the window, at the door, or by your shoulder waiting, that you have to deal with when you hand them a bill for 6 hours of diagnostic labor and 10 minutes of repair labor.

They're never happy about this and tossing a few parts onto the truck, oddly, can make the cost seem more reasonable them. Seeing shiny new parts and paint and grease scraped off of the bolts somehow makes a big bill seem more acceptable, because, in my mind, they suffer from the same misconception that everyone else does.

To them, a lot of labor hours suggest a lot of *sweat-producing* labor, which means impacts, wrenches and busted knuckles. If a customer doesn't see stuff happening he gets agitated; if he sees books and schematics, even today, he can get angry. They're no more in tune with the realities of EDR than many supervisors and techs are, and they're never fun people to deal with.

Jack Richards was one of my mentors in the first shop I ever worked in, and he's the guy who told me that you can't *make* a hacksaw cut straight, but you can *let* it cut straight. Seems gravity can be your friend when cutting bar stock.

He also told me that, “a customer will remember a bad job, far longer than a big bill.” I’ve come to understand this and have applied it to my work ever since.

I appreciate that it’s incredibly stressful to tell a customer or boss that the actual work portion of the electrical job was *only* 10 minutes after a three-hour search. But, I still don’t understand this. Why would adding $500.00 of parts on top of the $250.00 labor be a good thing? Wouldn’t the people paying the bill be happier to discover that they *didn’t* need parts?

It’s really amazing, but seeing that new part seems to make a difference, and that does seem to fit the “bad job, big bill” theory. If that new pump is installed along with cleaning the connections on the old wires, the extra $250.00 is not a problem, I guess. Seeing that shiny something seems to satisfy the psychological sensitivities of the customer. He can actually SEE what he’s paying for, even if he’s paying more.

Even if the parts weren’t needed, the truck is running. If the wire cleaning was the real fix, and the new part wasn’t required, the “good job – big bill” principle applies. The extra cost of the new parts is acceptable because he has more confidence in the new components, the problem is gone, and the bill is taken in stride.

I don’t know if I’ll ever really understand why this might happen, though no one can deny that it does.

◊◊◊

I’ve started to be a little offended that we don’t seem to be very capable of explaining and defending what we do electrically, and not be so afraid of a long diagnostic time. There is the reality that a horribly failed diagnostic has to be offset because it took way too long. But, doing it as a habit is a problem, and that problem can be improved through training and good management.

I do appreciate that there’s a profit angle here because parts are a revenue stream, but only if we’re talking about a commercial shop. A fleet shop (or shops) would seem to want to *reduce* expenses, and keeping in mind that electrical problems very seldom have part numbers is a good way to help reduce parts costs.

As I said earlier, I can’t know about each of your personalities. Some of you will obviously be better able to defend the diagnostic process, while others of you might not be. My hope is that, for those of you who aren’t as confident in defending the argument, reading this might make it easier. When you think about it, if you’re able to continuously reduce the diagnostic times by managing the process better, this problem eventually will go a away.

Chapter 8
Blue wires and toggle switches…

I've taught for every conceivable type of facility since July 26, 1996 — the date of my first class as an independent. This happened to be a CAT dealer, and the nine students were mostly lift truck guys with one equipment tech tossed in. It was pretty scary for me, since I knew that all of my grand plans for self-employment were riding on that week.

On the first day of class I started by going over some basic materials, but I very quickly jumped into the hands-on and handed out ice cube relays to each guy to look over and discuss. Because these guys had been working for a while I didn't think twice about just assuming they had a pretty good idea of what relays were and how they worked.

The question, "what is this?", asked by a guy named David (and followed by about 7 other guys asking the same thing) made it pretty clear pretty fast that I shouldn't have made that assumption. I was stunned — literally — and the only thing I could think to do was to call a break and go outside and rewrite the entire class in 20 minutes.

How could these guys, who worked on ELECTRIC forklifts, not know what a relay was? The relay is the most basic and common electrical device in use and every electric lift truck in the world has at least a dozen of them that operate EVERY system. Somehow, these guys were getting these trucks fixed without really knowing how they worked.

This experience and many others since have taught me some important lessons.

First, if we mechanics were as dumb as many of our high school guidance counselors thought we were, nothing would run. We obviously are pretty smart guys who get some pretty complicated vehicles running on a pretty slim body of knowledge, so it doesn't make sense that so many techs are scared of electrical work.

Secondly, if you're the guys who are supposed to be teaching the techs from the deep well of experience you have, why haven't you taught them what a relay is? Asked another way, why do I have a job teaching them what a relay is?

The answer is as obvious as it is embarrassing. You may not know either.

It can't an easy thing to accept, but your electrical knowledge possibly isn't as thorough as you wish it could be. I fully understand this problem because you have to deal with the same problems as the techs do. You feel the same pressure as everyone does to get the job done fast. You've been a part of this process both as a tech and then as a manager.

I promise you this isn't meant to be a harsh criticism. It's meant to be an opportunity to hear me say something that you could very likely feel, or felt. After

25 years of teaching, I understand this reality. I appreciate that your incomplete knowledge of electrical systems isn't something you want advertised. It's a secret.

But the only way you'll ever learn and improve is by slowing down and using the diagnostic process for all it's worth.

You're the primary reason your techs feel the time crunch. Trust me. I've heard it from almost all of the 4000+ guys I've taught in the past 15 years. I know there are a lot of shop supervisors who know not to pressure the diagnostic, and if you're one of them, good. But, even if you try to manage the process according to these concepts, there's a good chance that your techs still feel pressure.

If you aren't the source, then the only other possibility is the techs themselves and the shop environment they work in. However it happens, most techs DO feel pushed and pressured when working an electrical D&R. Regardless of why it happens, if it does, you really need to work at making it stop.

Where am I going with this? You now know I understand where you sit because I've worked with hundreds of managers and supervisors in the 15 years I've been at this. The "what's wrong" question discussed earlier can be a way for you to stay involved so you can plan and learn. You might not see this as pressure but it is, and I can assure you it still isn't a good question to ask.

My advice to you, when it comes to the electrical work you face, is to step back and take a more hands-OFF role. Don't feel the need to know the answer before you start — do a better job of helping the tech get to the answer, AND do a good job keeping guys unstressed, and making sure that once the fault is identified, the tech takes the time to fix what's really broken.

You have an ego too, and in cases like this it seldom does you any good. I know mine doesn't.

◊◊◊

The title of this chapter is based upon my experience with a lot of smaller shops, often manned by as few as 2 or 3 techs, responsible for pretty large fleets. This is common in counties and municipalities, and I know I'm going to make some people a little angry, but a lot of these fleets use way too much blue wire with toggle switches to, "get it runnin'…".

As you know, "getting it running" is NOT the same thing as "getting it fixed", and all too often the pressure to "get it running" overwhelms the shop, the tech and the supervisor. So instead of finding the real problem in the harness and fixing it, the roll of 14AWG primary wire comes out, and a new hole gets drilled in the dash for a new toggle switch. Yikes.

For those of you who think I'm being a jerk, consider this. If you're working on a 2010 county dump truck with a couple of computers on it, you can't simply

rewire the dump bed hydraulics with a parts store light switch, or one you yanked out of the wreck in the back, and bypass the computer.

No, you can't. Why? Because it's wrong. But, is it done? Yep…

Are you going to tell me that you don't have the ability to find a break or short or corroded connector in 8 feet of wire? Are you going to tell me that you can't find the harness and do a good visual inspection to locate and repair the actual fault when there are only three? Are you going to tell me that you've hired a mechanic who can't locate an obvious failure of a wire after a 30-minute search?

No, you're not. But you might tell me that it's too much trouble and your tech might tell me I "don't have time to spend tracing out all the wires looking for something when I know all I need to do it cut out the harness wire and splice in a switch".

What?

It can't make sense to potentially unwire the factory harness and bypass heaven only knows how many systems and subsystems and safeties because it takes less time to butt splice in a new blue wire, than is it does to carefully inspect the harnesses and connectors (80% rule) to find the actual fault?

It can't be logical to lose whatever system integrity you had in the new truck and setting it up for more failures in the long run. It would be senseless to wipe out the truck's technical data so that when Bob quits and Bobby gets hired he won't have a clue how Bob's rewire works – you'd never suggest that this is a good idea.

You'll likely be one of the supervisors who'll jump up and tell me I'm out of line, and that you'd never do that to anything in **your** fleet. Okay. I'm glad you are. But, I've seen enough blue wire and toggle switches to know that it occurs, so someone out there is letting it happen. If it ain't you, who is it?

The point of this illustration is simple. Your guys ARE smart enough to find a fault in an 8-foot piece of wire, and when it matters, they should. The flaw here is that once becomes twice, twice becomes three times, and three times becomes habit.

The problem isn't necessarily with the new wire and toggle switch; it's more that so many guys consider this solution to be *normal* and *accepted*. Instead of going through a logical diagnostic process and find the real problem, LOTS of guys consider primary wire to be the ONLY way to repair an electrical system because they prioritize *fast* instead of *right*.

I'm not a complete idiot, so I do understand that in some cases a new blue wire is the best answer. Trailers are a good example. They're not all that complicated and they get the tar beat out of them. Wires just seem to disintegrate so putting a new one in is what's called for. But, what about that

new 2010 truck? Is a new blue wire what's called for if it only has 1000 miles on it? I'd argue no.

If you encourage this, I encourage you to stop.

If you don't, you'll have guys who will be VERY unwilling to learn anything new at all, and who'll never really ever understand that you can't rip out wires and randomly splice in new wires because that's what Uncle Ernie did. They'll age out much faster and end up leaving the trade because of the fear and embarrassment they'll start feeling when the 21-year old kids start getting all of the electrical work and go home clean instead of dirty.

It's no surprise that the guys who laugh loudest at the blue wire joke are the oldest.

I had a supervisor call me once and ask me if I'd spend a little extra time in class with an "older fella" who was pretty nervous and needed a little extra help. I of course said yes, and started thinking about the next week to get ready for him. Monday morning rolled around and he wasn't there. But there *were* twelve people, which meant someone was there in his place. I asked if everything was okay and his replacement's response was, "he quit Friday."

What?

I asked for more detail, and it turns out that this tech, older, highly experienced and *highly valued*, was being sent to my class to help him come up to speed on fundamental electrical skills. They wanted him to progress so he could keep up and they could keep him. Turns out things got pretty heated in the foreman's office when they called him in to prep him for class.

In the end, he stormed out screaming that he was a "front-end, air brake, and chassis man, and there ain't no way in heck you're making me take no danged electrical class." He packed up his box, loaded it on his truck, collected his final check and threw up gravel high-tailing it out of the yard.

True story. Extreme, but true. I never found out how old he was or if things ever settled down and he went back, but I was pretty dumbstruck by the experience. Does electrical work really scare that many people? Apparently yes.

There's a possibility that you're one of them.

And, if a lot of guys are scared of electrical, then I can assure you they're going to do all they can to make it go fast, to minimize embarrassment and ego problems. If that means gauging their success on how many vehicles they "get running", it means a lot of wire out there is blue.

Guys will ALWAYS use the time crunch as their rationale for choosing blue.

How do you play into this? Simple. You own the fleet, essentially, so anything that happens in a bay or the field is on you. Are you willing to accept a new hole in the dash because of the time pressures that push on you to get the fleet moving?

I have to assume it's not stated company policy that it's desirable to destroy the electrical system of a brand new piece of equipment because having it "now" is more important than preserving its electrical integrity

It's one thing to look at a wire that's destroyed and splice a new segment into a portion of it. It's another thing to care only about getting the motor turning or the bed dumping and bypassing complete systems without really knowing how the system works. Is this really how we want our fleets to be repaired? I can't believe it is.

We need to stop allowing forces that don't fully understand the problem to push us to take dangerous actions, and in some industries these ARE dangerous actions. Accept that no one has the right to ask you and your guys to magically lay hands on a vehicle and see the fault in seconds. It can't happen, and if you manage as if it can happen, should happen, and you will get in trouble if it doesn't happen, *you're managing wrong*.

The reality will always be that the electrical diagnostic process will take hours, and the repair will take minutes. No amount of blue wire will ever change that, and as the machinery we work on gets more complicated, blue wire will become that much more destructive.

If you feel your job is to "get it running", then you might not think this means anything to you. But, if you believe your job is to diagnose and repair your fleet's electrical faults, then you need to lock up the wire rack and have a conversation with your guys.

It's time we all get a little better understanding of time.

◊◊◊

Special Note: I just finished proof reading and editing this chapter – again - and after doing my best, I still think it was a little intense. It's not supposed to be pushy or bossy, but I did want it to be passionate. When I look at a vehicle electrical system and see its simplicity, but I have to look past a rat's nest of non-standard wiring to see it, I get angry.

I'm angry that my job is now harder than it needs to be. I'm angry that someone was so thoughtless as to throw in as many as 20 wires that bypass systems that can hurt people and increase downtime. But mostly I'm angry that the environments we work in make it so hard for average guys to improve their electrical skills.

What is most odd is that in order for the "blue wire" repair to work, the tech has to understand that all the wires does is get voltage somewhere. If he knows this, why would he be reluctant to get into the harness or system and find the small and easily corrected fault?

It can only be that the *time* needed to get to the fault adds to an already long diagnostic time, and the tech assumes he can't afford the extra 30 minutes

or hour to do the job right. I go back to the reality that this would never be acceptable in a mechanical situation.

This is a very important chapter. So many of the elements I'm trying to explain (and understand better) are involved here and it's the section where everything is starting come together. Hopefully, if you've read to this point, you're seeing where I'm going and are enjoying the ride.

Chapter 9
Maintenance vs. Production

Life in the shop would be a lot easier if all we did was work on the fleet and it never moved. It would always be there and we'd never have to worry about it being torn up by drivers and operators. But, what's the point of having a fleet? Using it, of course, and when the operations people turn the key and leave the yard, we know for sure that it won't be coming back the same as it was when it left.

That's the problem. Maintenance people want to work on the stuff, and those "other guys who drive it" but don't really understand how it works and what we do *want to destroy it (at least that's our take on it)*. This is true in every place I've ever taught. In some places the problem isn't as big of a deal, but in other places it can become downright fatal.

Who wins this fight, and why is it a fight in the first place? Does Production have the say as to when the vehicles roll, or does Maintenance? If something is broken, is it more important to get it back onto the line using whatever means we can, or to take our time to make sure the stock is as close to perfect as possible before we park it on the berm?

In some places this can be a tough question to answer, but in my world the answer is simple. Once it crosses the rails of my shop it's mine, and my professional responsibility is to fix the machine. It's not my job to "get it running" so it can go out and get torn up even more with a few badly installed band-aids holding it together.

I obviously am not making any Production person who might be reading this happy, but after nearly 30 years in maintenance, including working on aircraft, I can tell you without hesitation that fleets fall apart far too quickly. It's NOT because we don't work on them, but because we get too many phone calls telling us that, "all that matters is that it's running because we're behind quota and we need it NOW. Just do what you need to to get it back to us, and you can fix it the next time it's back in for something else."

Yeah. Right.

We all know we'll never ever get it back and have enough time to do what we should have done in the first place, because as soon as we get it back someone from Production will call again and tell us they need it NOW.

Has no one ever thought to tell Production that if they'd just leave us alone and let us get the stupid thing right then maybe it wouldn't be failing as often? "Oh, and by the way, maybe if you spent your time teaching your drivers and operators not to tear the stuff up, your in-service times would be greater, and we wouldn't be spending OUR time coming out to band-aid stupid little things that could have been prevented if someone had just operated the equipment correctly."

I've heard these arguments more times than I can count, but again, why does this happen? Easy — everyone thinks that Production *makes* money, and Maintenance *costs* money. Well, I suppose that's one way to look at it, if you're horribly short sighted. I mean, really, can that way of thinking actually be allowed to exist in a company that beats machinery up to move and sell rock?

What drives this frustrating and pointless conflict? Part of it is turfism, or the tendency for people think that what *they* do is more important than what *everyone else* does. Many people seem to believe that the world will come to a crashing halt if they fail, but that everyone else can give up their money, their priorities and their responsibilities without flinching. This is both normal, and hugely destructive.

The operation is a partnership. Production moves things, and Maintenance makes it possible. So, logically, both have a priority, and both need to be able to do their jobs without being harassed and constantly hounded by people who don't understand what the other guys do.

Is this really a maintenance manager problem? Yes, even if you don't feel like you have the courage or force of will to take on the Production guys. Your job is to make sure everyone knows what your job is, and your job is to REPAIR vehicles, not get them running. There's a huge difference, as we've already discussed, and this is where the rubber meets the road.

It's not a difficult thing to explain that if a vehicle is purchased with an expectation that it will operate productively for a certain period of years, it can ONLY do so if it's PROPERLY maintained. Band-aids do NOT constitute proper maintenance. Band-aids are Maintenance's way of saying that Production is more important, and I wonder about that.

◊◊◊

I've been working with tradesman a long time, and I'm convinced that there are parallels between this turf problem and the problems we see in electrical D&R. Techs have not typically had the greatest educational experience; almost all have gotten out of high school, some have gotten to college, and some of those have graduated.

A great many techs have a built-in inferiority complex that starts with the way the world views what we do, and is reinforced by the way the world treats us when they *find out* what we do. This is why many guys feel they aren't entitled to be electrically smart and to "get it right". In their eyes everyone else might deserve to get it, but not them.

In the fight against production, this sense of inferiority makes it hard to defend our position, and it's even worse because none of us have been trained to argue successfully without feeling that the argument will result in our being reprimanded, or worse, fired.

I know of times it's happened. Good guys with terrific minds and a real appreciation for how things should work have the bad luck of being right about what was going to happen. They then get punished when it happens. Some of you might not find it easy to let the guys who work for you help you by being more right than you. Remember it's not about *being* right; it's about *getting it* right.

If we go back to the very harmful and rather childish arguments that often arise between the Production guys and the Maintenance guys, we have more to consider here than just feeling superior. In a lot of industries, improperly maintained equipment and vehicles can hurt people. Mining, rental equipment, construction, cranes, trucking, marine, lift trucks — you name it. If short cuts and ill-conceived patches consisting of blue wire and toggle switches are the norm, then not only will the machine fail, it can kill someone when it does.

In many of the industries I've worked with I've seen how this really plays out. Vehicle number 713 is in the shop and it's torn apart. Production calls and suddenly "HAS TO HAVE 713 NOW". So, the best that can be done is done, and the rest is put on the to-do list. The guys hustle and crews are pulled off of other work to get 713 out the door. Then, when 713 gets to the ready area and the Production supervisor is informed, he says, "thanks, but we worked around it and ended up using 717."

I've actually been at the desk when this occurred (vehicle numbers are changed). I didn't work there and **I** was madder than a heck. Why does this happen, and how can it? How can a company run by intelligent people, managing intelligent people working on time- and safety-critical systems allow such childish, costly and dangerous relationships and attitudes to develop?

Seriously, how?

Sure, we gotta haul rock, but not in a vehicle with soft brakes or a slipping electronic transmission. We don't want to move freight in trucks with improperly installed steer tires, and I can't recommend going to sea with a malfunctioning bilge pump or navigation system. Where is the argument here? How can we not see both the horribly inefficient and possibly deadly logic?

I wonder if you told the Production manager that rather than installing new brakes on a truck, you simply bolted plywood to the old brake pads. He'd be horrified and think you're nuts. But, if you told him you threw a bigger fuse and a few jumper wires in to "get it runnin'", he'd likely have no problem with that decision. Explain that one to me. As an electrician I find this immensely insulting.

It's a common problem and apparently difficult one to fix, since I see it everywhere and never seem to see it improve. Higher management undoubtedly needs to be involved, and someone needs to establish some pretty firm and unbreakable procedures to make sure, "if it ain't broke, don't fix it, and if it ain't fixed, don't operate it."

Chapter 10
The Schematic is your Friend!

The schematic is odd, because it's easily one of the most useful tools you can have at your side when you diagnose electrical problems, but it's one of the most misunderstood tools out there. Before we get into this, I need to make one point, similar to another I made earlier about the relay.

I can say with great confidence that very few techs have ever come to my class knowing how to read a schematic. I'd go so far as to say that none of them could, but I try to avoid "never" and "always". As I mentioned before, you haven't taught everyone all there is to know about a relay because you may not know.

The same is true of schematics. If you subscribe to the "manager knows more than the average tech and teaches them" theory, then if you knew, they'd know. They don't, so I have to assume you don't. One of your responsibilities as manager, as I see it, is to have all of the tools necessary for the job on hand, and the schematic qualifies as one of them.

I've written and rewritten this chapter a couple of times, because the argument I'm hoping to make is very important, but kind of vague. Over the past 15 years I've seen thousands of techs cringe and recoil when I put a schematic in front of them in class. The response is real, it's from the gut, and it's obvious — they hate schematics.

They laugh nervously, they make jokes, they clear their throats, or they'll literally push themselves away from the table. But, and I can say this with true conviction — they NEVER start reading the schematic. Schematic reading is the one aspect of electrical D&R that virtually all techs hate and will fail at, and we know how much they hate failure.

Here's everything I can think of that people have told me is a reason not to use the schematic:

1. It's wrong (they are at times)
2. I don't have time to look for it
3. We don't have it
4. No one updated it
5. I can't use it, I'll get in trouble
6. I'll be laughed at
7. I try, but fail, then quit
8. It never matches what I'm looking at on the truck
9. It takes too much time
10. If a customer sees me with a drawing he'll freak

11. I can't get them on my service truck
12. I can't read them on a laptop (which is actually true)
13. It's easier to pull wires and change parts
14. I don't know the symbols because they're all different (true)

If there's one thing I'll write in this document that I feel the most passionate about, the most assertive on, and the most certain of, it's that schematic reading is easily the single most important skill a tech can have. AND, once a guy learns to read a drawing correctly ALL of these complaints immediately end, and the confidence level skyrockets.

It's not hard to read a schematic, but there are rules for reading to follow and you need a basic appreciation for what a *circuit* really is and what it's doing in order to make the most of it. You also have to realize that reading the schematic is something you do APART from everything else you're doing. As said before, people toss everything, including the schematic, into a big pot and call it troubleshooting. This is not a good idea.

Common mistakes people make when trying to read a schematic are, (1) reading from positive to negative, (2) worrying about current direction, (3) not understanding that there's only one load per circuit, (4) not redrawing the circuit as a straight line from the factory print, (5) trying to use the drawing as you diagnose, instead of using it to plan the diagnosis up front, and (6) not having a good understanding of what basic components are, and the symbols don't make sense.

◊◊◊

I was helping a truck dealership on a project several years ago, when the shop supervisor asked me to help a young kid working on a radiator cooling fan problem. I agreed and went out to the bay and asked what I could do. He'd had the engine hooked up to the laptop since 7:30 a.m., and it was then just before noon. In fact, I caught him as he was leaving for lunch.

I asked for an update, and he told me the complaint was that the cooling fan would not shut off. My first question was, "where's the schematic". His response? "I don't have it". I repeated my question, "where's the schematic?", and he gave me many different answers, ranging from, "can't get it", "we don't have it", "it's out of date", and more and more.

Finally, the truth surfaced, and it turned out that the shop supervisor was the only person who had a computer connected to the internet who could access the online data, and getting it from him was a pain in the butt. In this case, he couldn't even try to use the schematic because his boss wouldn't give it to him.

I forced the issue, and found the correct drawing exactly where the online source said it would be. I looked it over, and I redrew the system showing him

the ECM, the solenoid and the relay, and explained how the simple system worked. When he saw my redraw, his eyes lit up and he said, very energetically "I KNOW WHERE THAT RELAY IS".

I followed his gallop back to the bay, and I held the flashlight while he rolled a wiring harness over that was buried under the dash. After only a few seconds of looking, he glanced up at me and said, "I'll be doggoned".

He rolled the relay base over and showed me where one of the terminals for the coil had pulled out from the connector. It had been installed backwards at the factory so the terminal never locked in. He snapped it back in place, started the engine and 5 seconds later, exactly as the schematic indicated it should, the fan shut off.

The ECM turned the relay on to turn the fan solenoid off, so the fan turns on – a simple system, and a simple solution.

He'd been trying to solve the problem for over 5 hours, without knowing how the system worked. After he saw the system schematic the truck was fixed in less time than it took me to write this, including getting the drawing number from the shop supervisor, redrawing the system, running to the truck and turning on a flashlight.

The schematic is a wonderful way to see what the system is supposed to do, which makes it far easier to understand why it isn't doing it. If you happen to be one of the supervisors who doesn't encourage use of the schematic, you really should take the time to overcome whatever prejudice or bad experiences you may have had in the past.

Electrical OJT is based largely on myth and mystery — the schematic can change that pretty quickly.

◊◊◊

During editing of this chapter I deleted an entire page because I was making something simple too complicated. I firmly believe that if reading a schematic was something you and your guys simply did without thinking about it, the problem of badly drawn, incorrect, and confusing schematics would simply go away.

But if you're not in the habit of using the schematic every time you need it, then you won't complain to the OEMs and they'll keep using your silence as an excuse to keep up the not-often-very-good-work. TMC won't establish an RP for schematic drawing, and the problems will only get worse as manufacturers look for EVERY possible reason to cut back on expenses.

They'll either assume there isn't a problem (there is), or they don't need to worry about the problem because you don't use the drawings anyway. This is a vicious pattern that can only have one end. It ain't going to get any easier if no one says anything. Your inability — whatever its cause — to use a schematic

instantly and effectively is a problem that needs to be resolved, and everyone needs to be involved.

Chapter 11
Communication & Confidence Disconnect

It would be very easy to summarize everything we've discussed up to this point as a failure to communicate. Perhaps not a total failure, but at least a failure to communicate effectively. As manager of the EDR process, I see it as your responsibility to make sure that the communication that takes place in the shop is effective.

You might need to play referee at times when someone starts to "communicate" to someone else about his radio being too loud in the shop, but this isn't the communication I'm talking about.

"Communication" contains the word "common", meaning shared, and in real communication, what's shared is an understanding of the message that's being conveyed. It technically isn't communication if you said one thing and the tech heard another. It also isn't communication if you say something to a guy, but you leave without knowing for certain that he heard and understood you.

If the transmission needs to be pulled, it doesn't take a lot of detailed discussion to get it pulled. You and the tech both understand what needs to be done and how to do it, and there really isn't a lot of discussion about anything else. Most of the communication is non-verbal.

It's a bad thing to communicate to him — either verbally or non-verbally — that he's taking too long, and that people are getting tense about the job being finished. It's one thing to manage the diagnostic process — it's another thing to simply keep asking if he's found the problem yet. The fact that that he's not in your office telling you it's fixed should be all the non-verbal communication you need to know he hasn't.

As we've discussed earlier it helps to create a positive environment that makes it easer for the tech to take the time he needs to get to the end of the diagnostic process. But there's another aspect of this that needs to be discussed. You need to make sure that you and the guys working for you are very, very specific when you talk about what's being done during an electrical diagnosis.

If you're going to talk about the electrical system or how the diagnosis is going, you need to make sure that you ask specific questions, give specific answers, and use specific terms to explain what you mean. Slang terms are very harmful, and can cause wrong turns that will derail an D&R project.

The best example I can use is the mix-up using the terms "voltage", "amps", "current", "juice", "fire", "spark", and "power". These terms are universally used interchangeably and this can be very confusing — IF you care about being precise in the diagnostic. If you aren't concerned about anything more than "getting it running", then this might not matter.

The manufacturers use the correct terms of “voltage (volts)” and “amperage (amps)” to mean exactly what they’re supposed to mean. Voltage is pressure and amperage is flow, and the two are different. In a detailed and effective diagnostic you can have one and not the other, but if you mix up the terms, the answer can be missed.

The single-minded quest for speed in repair makes it hard to pause and make sure you both know what the heck you’re talking about sometimes.

You also need to be particularly careful how you give directions and how you ask questions. If you don’t ask questions that are designed to give you a specific answer, then you won’t get much useful information. It could mean you don’t know enough about the system yet to ask a meaningful question.

Telling someone to “go out to the A/C clutch and see what you got”, is not a very good instruction. The answer, “I got a clutch” is correct, but meaningless. If you’re trying to see if the pulley has failed you would more effectively say, “go out and visually inspect the pulley for any signs of failure, including the springs, the pulley and the belt, and the mounting brackets in case it’s slipped”. This is a good instruction. Of course, it’s also mechanical so you might think the detail is pointless

In electrical diagnostics, you have no choice but to be specific, but having a weak electrical vocabulary or being too quick makes it difficult. Instead of saying “go check the connector”, you should say, “go out to connector 50, and check for 24V on socket 11. Make sure the wire can carry a load”. I KNOW you can tell stories of how a bad series of questions and answers, at some point in your career, caused a long delay and a bunch of wasted time and effort.

The problem comes back to the incorrect assumption that we have to rush the diagnosis when in truth we don’t. We’re far better off taking time to ask detailed questions and working with correct answers than letting an unmanaged diagnostic problem drag on and on because of a missed or misunderstood instruction. Speed is not the primary concern. Haste makes waste.

◊◊◊

In an advanced class several years ago I had a situation develop that was very, very educational for me, and hopefully for the students. The problem was a 6-inch single strand of wire crumpled up and stuffed into a connector between the two halves. This caused all sorts of weird indications, making the vehicle seem haunted — which, by the way, is **also** going to be caused by something simple.

The group came back into the classroom and started the diagnosis. To my amazement and thrill (as a teacher) they decided — confidently, in less than 10 minutes — that the only possible fault had to be the connector I had put the fault in. They’d gone right to it after some very logical thinking, and I was already trying to decide what to do next when something very odd happened.

One of the three guys said to another, “go check the connector”, and the guy closest to it popped it open and looked right at the spot where I’d stuffed in the wire strand. My original amazement at them finding it became a second amazement that this guy with the connector in his hand looked up and said, “nope, it’s okay”. He then closed the connector up, and the trio went back to work.

I was stunned. He was looking right at it. How could he miss it? How could a shiny piece of 6-inch wire in a one square inch connector be that easy to miss? I really wasn’t sure what to do, so I just watched. It took another hour for them to make another good decision, and it was an interesting 60 minutes.

They were very confused, very frustrated and it took a while, but they finally came back to the (correct) decision that the ONLY answer had to be the connector they first thought was the problem. So, they looked at the connector again, but this time two things were different.

This time the instruction was, “go open connector 23 and see if there’s anything inside that could be causing a short”, instead of, “go check that connector”. There’s a difference. The specific instruction gave the inspector something to look for, based upon a logical thought process. The first general instruction was correct, but it wasn’t direct. The second was more direct, and it gave the tech looking at the connector a target.

It’s one thing to ask someone to go look <u>at</u> something — it’s another to ask someone to go look <u>for</u> something.

The second thing that happened was that a different guy than the first did the second inspection. I’ve learned that it helps to have a second pair of eyes look for something because the first guy might be prejudiced from the first look. His ego might make it harder for him to acknowledge that he originally made a mistake.

Here’s how I figure it, and I base this on a LOT of time spent watching guys work. I think that because electrical work is so scary and full of opportunities to fail, people will be very quick to question themselves. If their first thought doesn’t result in an obviously visible fault (think mechanical diagnosis) and the tech doesn’t immediately see the answer, he’ll doubt himself. Instead of thinking he got it right but just doesn’t see it, he’ll assume he was wrong (since failure is usually the only option).

This doubt is deadly. This doubt is the primary reason that a good decision becomes a bad decision. I’ve seen this happen. If the fault doesn’t jump out and bite him, the first thought is NOT that “I had a good idea but I just don’t see it yet,” but instead, “I don’t see it right away so I must be wrong, so I’ll go look somewhere else.”

This is what happened in the class. Because the original correct decision didn’t reveal the fault immediately, instead of thinking that the tech just didn’t see it, the group assumed they had to be *wrong*. They weren’t. But, their lack of

self-assurance and confidence in their decision made it very easy to run off to some other part of the system and start looking somewhere else for something that wasn't there.

The answer was exactly where they thought it was, but because they were working with a mechanical mindset, they let themselves get flustered and in a fit of doubt, they screwed up.

The real lesson here is threefold. First, if the tech REALLY thinks he's right about something, he should NOT leave that area until he's absolutely, 100% convinced he's right or wrong. Either outcome is good, because if you're right you're done. If you're wrong, you're that much closer to being done by knowing one more area that's working right!

Second, it's very helpful to have more than one person do the looking. If you're convinced the answer *should* be there and one person doesn't find it, another tech might. And, just because you don't see it right away doesn't mean it's not there. Look really hard and really long. Don't go running off to some other area without really, really, really knowing you're right or wrong.

And third, since most faults are insanely simple and small, it's very easy for a tech to be looking right at the fault but think, "it CAN'T be *this*". Yes it can.

◊◊◊

When you're trying to find an electrical fault there are a great many things that make it hard to succeed. One significant obstacle is the tech's lack of confidence. I believe one of your jobs as manager is to do all you can to understand this and help him overcome this problem. If you do, I can pretty much guarantee you that the other problems will be a lot easier to solve, and both of you will learn far more effectively.

◊◊◊

Your job is to have more faith in them than they have in themselves. Never let them fail.

Chapter 12
Summary and Some Management Concepts to Consider

These concepts are pretty easy to understand, even if they may not be all that comfortable, and even if I might not have expressed them all that well. But, the experiences I've had over the past three decades a make it clear to me that electrical D&R and mechanical D&R are different, and that very few people understand this and manage properly.

I feel strongly that someone needs to speak out for techs who can't speak for themselves, and this is a very strong and brightly-painted plank in my soapbox.

There's no chance that everyone will agree with what I've written, but I do hope that everyone will appreciate that I'm trying to help and will give these ideas some thought. I've seen the process fail and I've seen the process succeed. Failures are usually due to a lack of understanding of how the electrical system works, while successes are due to a willingness on everyone's part to take time and think before acting.

I'll say this, as a way to make the point. I'm convinced that if you see a mechanical tool in a mechanic's hand while working on an electrical system fault, there's a very big chance that he doesn't know what he's doing. If 80% of all faults are in wires, as they are, then taking something apart will not usually be the right answer – at least not early on in the process.

I should point out that all of this information and all of these ideas are based upon the assumption that anyone doing electrical D&R wants to do it right, with skill and confidence, and is only interested in getting the machine fixed. This might be a pretty lofty assumption, because as we all know, there are a lot of pressures working against us. I do understand that everyone's reality is different, so no one will likely be able to simply stop and reverse course to adopt anything I've suggested.

But if we don't discuss it, it won't ever get better, and in my opinion, there's a lot of room for improvement.

◊◊◊

If you have ideas or comments about this book or this process works, or your experience, feel free to contact me. I'd like to think this might eventually grow into something more meaningful by adding your input. As I said several times already, this isn't about me being right — it's about all of us getting it right.

Summary Concepts and Bullet Points

1. Electrical and mechanical problems are fundamentally different in nature, so their processes of D&R are different.

2. Be more supportive of techs who need time to find the actual fault, and make sure you protect them from any outside influences in the shop while they work.

3. Make sure a top priority is to have all of the necessary documents and data available and encourage their use so the tech can be thorough.

4. Don't be critical of slow diagnostic times, and avoid any actions that seem to be rushing a solution. You can't know the actual problem until you get to the end — you can't short-circuit the diagnostics.

5. Diagnosis is the process we go through to find the fault, and the repair is what we do to fix it. These two processes are different, and if we combine them together and call them "troubleshooting" the outcome is less effective.

6. Electrical diagnosis can take a long time, and the repair is usually really, really simple. Your experience and position as supervisor should allow you to make the process go more smoothly by applying this knowledge and helping the tech understand so he isn't stressed more than necessary.

7. There really isn't much need for the supervisor to "know" what the problem is before it's found. There IS a need for you to be aware of how the diagnostic process is proceeding so you can help the tech get to the end.

8. You know from experience that the actual fault will be something very easy to repair, but because of that it means the fault will be pretty hard to find. You should always start the diagnosis by reminding the tech of this reality to reduce stress. If he knows that <u>you</u> already appreciate how the process will proceed, why would he ever feel bad about taking the time he needs to get the job done?

9. If you do ask questions about fault and time you have to understand that any answers you might get **will** be wrong. Techs hate saying they "don't know". If you keep asking questions that make them keep thinking "I don't know" but saying something else, you're actually putting them in a position where they're essentially lying outright. This can never be good.

10. Remember that in an electrical situation you need to let your contribution to the process be the experience you have managing, not knowing the immediate answer. You need to be willing to give up some of the control of the actual diagnostic and repair in exchange for being the guy who knows how the process works. You stay in control, but you're controlling the process, not the placement of parts.

11. Your job should include being willing to defend the actions of your techs, and to be willing to explain to a customer why the labor bill might be high even though no parts were installed. Understand that seeing new parts can make a customer happy, but it can never be satisfying for you. I'm pretty sure you'd rather find the actual problem after a well-managed diagnostic process so you can feel confident and better-educated than before you

started. This may not be comfortable, but if no one ever does it, learning can't occur and the situation will never improve.

12. "Troubleshooting" is an awkward term that doesn't describe the reality of the process. Trying to manage electrical work without being able to differentiate all of the steps will lead to confusion and no real learning.
13. The only part of the work that can actually teach is the diagnostic process. Don't waste this time worrying about how fast the vehicle will be done. Worry about how much the tech learns so the next time will be easier.
14. Remember that the actual repair will take seconds compared to the diagnosis, and this is normal. You have no real right to expect the electrical work order to take any less time than a mechanical work order. Four hours is 4 hours.
15. The customer is paying for the diagnostics, and it's your job to defend the tech's actions. No one has a right to expect to only pay you 25¢ for the new butt splice or connector pin, but not the $400.00 of labor after a five-hour hunt to find the problem.

Conclusion

I sincerely believe that if we accept and agree that electrical D&R and mechanical D&R are fundamentally different, then a lot of things will change for the better. Accepting these differences cost nothing, and with an investment of $0, ANY improvement is a substantial ROI.

If fear is slowing you down or stopping you from making changes you know would help, I understand. But I also know you that the trucks, equipment, boats, cars, aircraft and trains that move and shape this nation do so because you make it happen.

You've already shown that you can you can get the job done — you shouldn't feel like you have anything else to prove. You just need to believe in the powers you've already proven you have. If you use them to change the way the transportation industry techs you work with think and feel about the way we work in electrical systems, you'll have used your powers for good.

Thank you to everyone who's helped me work these ideas through and get them down on paper. Whatever skills and knowledge I offer you are the result of having had a lot of great teachers in my past. I hope I'm doing them proud.