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Electrex Inc.

By Joe Tito
Wiring Harness News

In many ways, Electrex is not unlike other cable and harness assembly manufacturers. Their products, processes, quality standards and even their customer base will sound familiar to those who read the Industry Profiles in each issue. But there is a remarkable difference. You see, Pete Ochs fashioned the business around a model of stewardship, rather than ownership. Randy Johnson, Chief Sales and Marketing Officer for Capital III, the holding company that owns Electrex, sat with me recently

to discuss the history of the business and the unique umbrella under which it exists.

Pete Ochs bought and sold many businesses through the 1980’s. An investment banker, he became somewhat of a turn-around expert; making strategic purchases of businesses, building them up to a profitable status, then selling them. In 1991, Pete was presented with the opportunity to purchase Electrex, a small harness manufacturer owned and operated by a gentleman named Bill Rexroat.

As Randy described, the company was in a small 25’ by 75’ facility with eight employees and about \$800,000 in annual sales. “Up until this time,”



Precision Crimping at Electrex

noted Randy, “Pete had never considered keeping a business long term and building a company culture.” Electrex was the first company Pete chose to develop under a group that eventually became Capital III.

Randy described the vision Pete had at the time as pursuing organizational excellence while serving people, stewarding resources and honoring God above all. If it sounds like a mission statement, that’s because it is for Capital III holdings. Pete believes a business should create more than just economic capital, so he created an organizational model around just

that. We’ll delve more into the other holdings of Capital III later in the article.

As Pete has pulled back from many of the day-to-day activities of Capital III in favor of building Enterprise Stewardship (a consultancy teaching other businesses how to adopt a stewardship model), I didn’t get to speak with him directly. But he described one of the main ways Electrex has lived out these values in a recent podcast. Electrex had risen to about \$3 M in sales by the early

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35 Years of Excellence at Cirris Systems

We all love reading the bootstrap stories about manufacturers in the wire harness industry. It’s important to remember, however, that many suppliers to our industry share the same humble beginnings. That’s why it was such a pleasure to sit down with Joe Klekas, U.S Sales Manager, Sarah Landeen, Marketing Communications, and Ray Jenkins, Software Architect of Cirris Systems, to hear about the company’s history and formula for success.

Back in 1984, Marlin Shelly was working for a well-known printer company. The company was having a problem with the wiring components of their printers. They needed a way to test the circuits, but there was no low-cost solution. He began to tinker in the garage of his Salt Lake City home and developed a simple tester

that his company could use. The unit was a hit, and Marlin began to think about the commercial viability of such a simple circuit tester. What he found was an untapped demand for low-voltage continuity testers. Joe explained, “Everything out there was so expensive and Marlin saw the need for a fast and efficient tester.”

Having proven the validity and usefulness of his creation, along with the market viability, Marlin began construction of the first commercial model, he called the Cirris Signature 1000. Like the prototype he designed for the printer company, it had one position of internal memory, or one internal test program. As Joe explained, “Each series of electronic connections produces a unique signature. The claim to fame of those first units was that they were able to

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REACH Is Getting Some Teeth

By Michael Wurzman and
Heidi M Wittenborn
RSJ Technical

REACH is starting to get some teeth, but that doesn’t mean it has to take a bite out of your bottom line! Until now many companies worldwide including many in the EU have adopted a strategy of ignoring REACH entirely as enforcement actions were focused on large volume consumer products. Today things have changed. The EU amended its Waste Framework Directive to include the implementation of a database to identify substances in all products made in or imported into the EU – the SCIP database ((https://echa.europa.eu/scip-database). SCIP is the acronym for Substances of concern in articles, as such or in complex objects (products).

With the 2015 “Once an article, always an article” (O5A) decision by the European Court of Justice, the interpretation of what is an article under REACH changed. The definition of an article went from the fully-assembled product to each component incorporated into that product. The data for the SCIP database is for

the lowest level article in a product, such as the lead frame inside an IC. A product, such as a wire harness, is a complex object made of multiple articles. Data is needed for each level of components in your product.

All companies within the scope of the REACH regulation are required to submit data to the SCIP database no later than December 31, 2020 for products currently being sold in the EU and those which will be introduced in 2020. From January 5, 2021, new products cannot be introduced into the EU unless the data has been entered into the SCIP database. The reporting requirements apply to products made in the EU and to products imported into the EU.

Right now, at a minimum you must submit data to meet REACH Article 33(1) requirements. Ultimately, you will be required to submit full material declarations (FMDs) for each article to meet the EU’s stated goal of achieving a circular economy. An FMD lists all substances present not just those currently required to be disclosed by REACH or other regulations.

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PUTTING INSIGHTS INTO ACTION

Zero to One: Getting Difficult Projects Started

By Paul Hogendoorn

Often the toughest thing to do is just get started. Stepping into the unknown, or perhaps looking forward into a big, indeterminate and not fully defined project, is easy to avoid doing. As Shawn Casemore, the outgoing

president on the EMC rhetorically asked and answered at this year's Advantage Through Excellence Conference, "How do you eat an elephant? One bite at a time". Another wise expression I have often heard is "Even a journey of 1000 miles begins with a first step". It sounds easy in slogans and sayings, but for many of us, that

first step - or bite - is not.

Let's shorten the journey to 100 miles and break it in to 3 stages: zero to one, one to ten, and ten to one hundred. The idea is that the progress of the journey is logarithmic and not linear and reflects the degree of difficulty at each stage. Whether the journey is starting a new business, attempting to innovate the plant, or building a new sales channel, the 100-mile journey is the same: zero to one is often the hardest stage, but it is the most critical stage.

Why is zero to one so hard? It requires not just a leap of faith, but many steps of faith, and very few people in organizations are actually willing, not to mention able, to take those steps. That's why new companies usually start with one, or at best, just a few people. The rest "don't see it", or only see all the roadblocks or impediments, or don't think its worth it. In an organization, the few who believe and are willing to take that first step have to contend with the many who see only the roadblocks or don't think it's worth it. It's why I call this first stage "launch". Just like launching a rocket, it takes an immense amount of energy to lift the rocket off the pad even a few hundred feet, and the resistance is intense. The re-



Paul Hogendoorn

sistance lessens only slowly as small amounts of momentum are gained, but it takes the commitment and perseverance of the few who believe to continue the motion upward, against the persistent resistance of gravity.

The second stage, from one to ten, happens when the early momentum makes it possible for a slightly larger group to believe. As there is now some growing momentum, there is also less resistance - but there still is a lot of resistance. However, now there is a larger group to help, and some of those that initially only saw problems and impediments can now be recruit-

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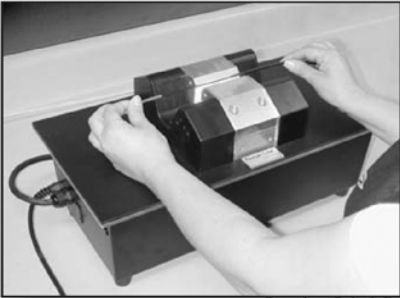
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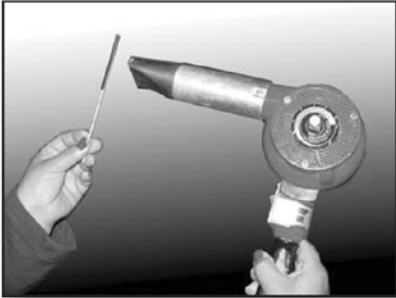
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Zero to One: Getting Difficult Projects Started

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ed to solve them. The key here though is to recruit the folks that want to solve the problem and get to the third stage, and not those that want to make a career of being the expert on solving a particular problem. Vision has to be first, not career. If the wrong people are added at this point, the initiative will stay stuck in this stage and never hit the ten to one hundred, or third stage.

If the vision was right, and the trajectory correct, the rocket will accelerate rapidly on the

momentum gained in the second stage and will almost certainly hit its target, however lofty they may first have seemed. Getting everyone to jump onboard at this point (third stage) will not be a problem, since the objective is in sight and the course is clear. At this point it's a matter of scale and continued propulsion. Since there is far less resistance, the same amount of energy applied can take you a lot further and a lot faster.

Although getting to the third stage is the goal, and getting the right people involved in the critical one to ten stage is often the

difference between success and failure, the zero to one step is where the vision is first formed and where motion is first experienced. One of the lessons I learned as a boater is that the boat can't be steered unless it is in motion. Unless there's water going past the rudder, the course cannot be altered. First motion is key. What happens after that then becomes equally important.

In our Manufacturing companies today, there are a lot of companies contemplating things like "Industry 4.0" and "Smart Factories", thinking

they have to accurately predict and plan their way from zero all the way to one hundred, and not knowing even where to start. To them I'd suggest to simply start with zero to one; find a simple project and an early champion (or better yet, champion it yourself), and take that first step. Then after achieving first motion, be careful who gets recruited to help solve the first problems, choosing people that are focused on the third stage objective over those that are focused solely on solving second stage problems. Choosing wrong at the one to ten stage usually means remaining stuck at that stage, and the critical zero to one momentum is lost.

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Diana Zielonka is a ‘Power Woman’ in the wire harness industry. She is currently employed at Fiat Chrysler’s Technical Center in Auburn Hills, Michigan but her path started many miles South in Honduras.

Although Diana’s father worked as an electronics technician while she was a kid, he did not involve her in any of his task-related activities. However, her dad did enlist support from her brothers with electrical and home improvement activities. Even though he had a mechanical, problem-solving mind, her dad was also the parent that brought her and her two younger brothers to elementary school every day. Her mother, on the other hand, was an accounting manager at a large Honduras bank. She had the prestigious title and was the main breadwinner of their family. From a young age, Diana knew that she wanted to have an esteemed career similar to that of her mother’s.

Because she liked math, Diana was leaning toward Finance as a college major. However, her mother advised her to alternatively consider engineering because Diana was ‘much too curious’ to pursue Finance. Diana then changed course. She con-



Melissa Femia

sidered attending a well-renowned public engineering school, but the school was associated with negative scheduling issues. Instead, she attended the most highly ranked engineering school in the country Universidad Tecnologica de Centroamericana (UNITEC). Even though it was a private college and part of a global university system, Diana cautions that it was not like attending a private college in the United States.

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Power Women of the Wire Harness Industry

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ing majors at that time—Information Technology (IT), Industrial Engineering (IE), and Civil Engineering (CE). Diana chose IE with a focus in automation—textiles and quality were the other areas of emphasis. There were about eight females in the program of about 25 total students. She and the other females fit in well and did not perceive any obstacles related to their gender.

Diana was recruited at UNTEC by Empire Electronics, a wire harness manufacturer. She was hired as a Program Engineer with responsibility for release engineering, APQP, and launch activities. She remembers wanting to utilize her automation education, then quickly learned that wire harness assembly has a very manual build method. Still, she was able to use her skills to create better electrical test features and preferred quality designs. She appreciated that Empire was flexible and open to new ideas. While she enjoyed working in different areas of the business, she also indicated that she faced some struggles as a female in the manufacturing environment in a Honduras factory.

After working in Honduras for a year, Empire transferred Diana to their Troy, Michigan headquarter office. In Troy, she was an Advanced Program Engineer, a liaison between the Honduras facility and Empire's



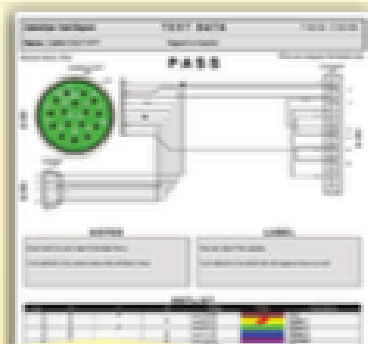
Diana Zielonka

customer base. She held this role for about 5 years. Then, a previous colleague of Diana's advised her that FCA was looking for an English/Spanish bilingual wire harness engineer at their Auburn Hills, Michigan technical center. Diana was hired, and became the NAFTA lead in Supplier Quality at FCA for wire harnessing. This position involved management and distribution of Lessons Learned documentation and USCAR-21 education communication. She was in the

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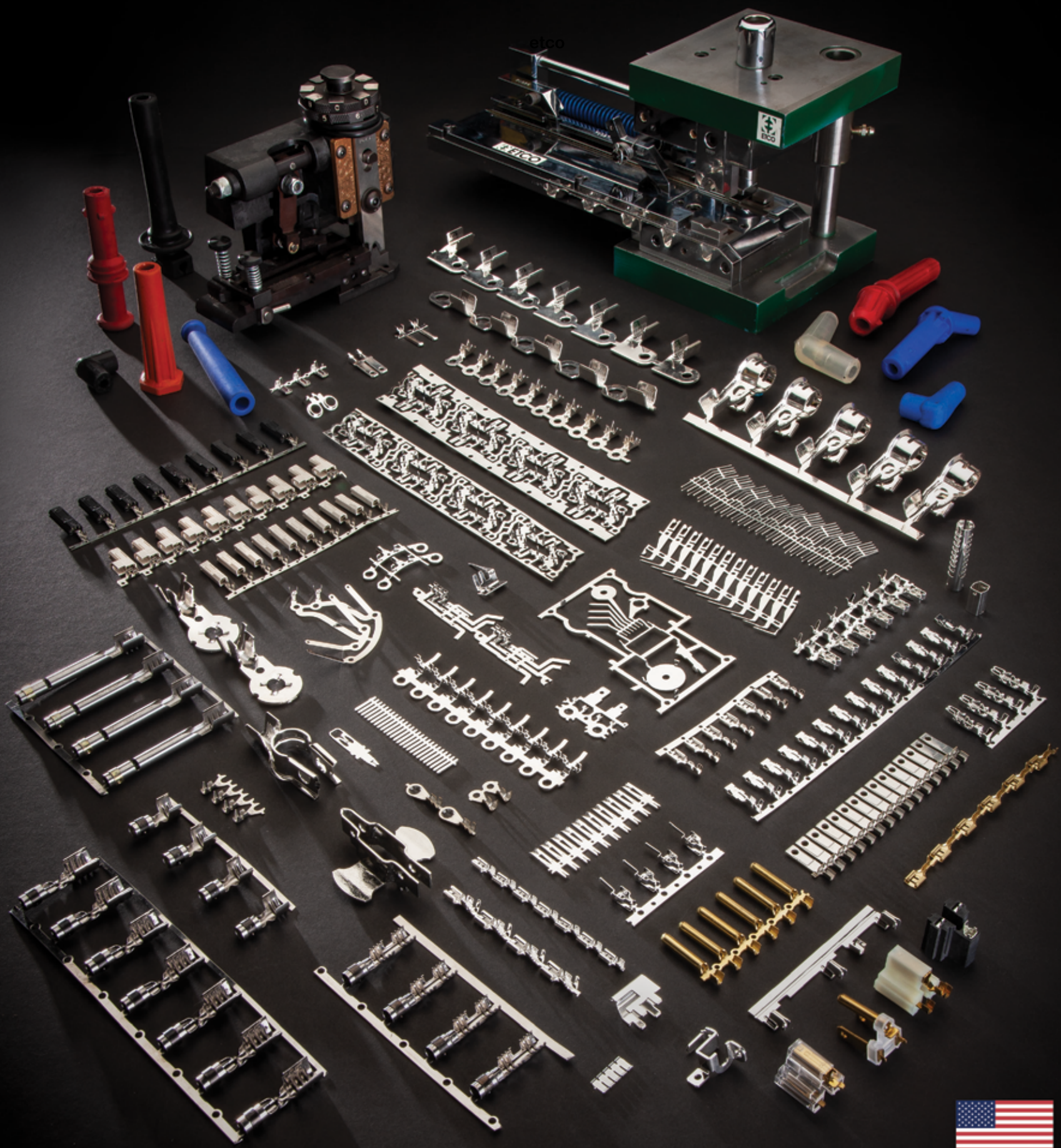
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Power Women of the Wire Harness Industry

Continued from page 10

position for about 1 year, then also took on responsibilities as SQE for electrical and chassis components like the electro-mechanical shifters, power distribution centers and instrument clusters. She held the position from ~2013 through 2016. Subsequently, Diana was promoted to Supervisor of Supplier Quality within the Powertrain team. She remembers being nervous about moving to a role outside of wire harnessing as the role was more mechanical and she was not experienced in engine components or processes. She nonetheless performed well. In 2019, Diana became the Engineering Program Manager of the e-Torque system in the Electrified Powertrain team. With all of the emphasis on emissions reduction and more fuel-efficient vehicles, she expected that hybrid and electric technology would be an exciting area in which to work.

Diana advised that FCA also has an initiative to highlight empowered women in the workforce. She was recently honored to be one of 25 FCA females chosen within North America to be part of the first ever Women's Leadership Experience in 2018. This program focuses on developing and empowering women in the organization utilizing training, coaching and

executive sponsorship. As a graduate of this program, Diana continues supporting the program as a mentor for the next phase of selectees.

As far as Diana's opinion of females in engineering, she believes that engineering is very flexible and engineers are needed in many different industries. One can stay technical or move in to program management or business. She views there to be endless opportunities. As Diana was raised in a country where engineering was uncommon for females, she felt that an engineering degree granted her initial respect that she then solidified with strong job performance. Like her mother, Diana is a power woman, just on the technical side in her case.

Thank you, Diana, for supporting and promoting engineering among females. Your advancement is testament to the opportunities that exist for females in engineering.

If you are interested in sharing the stories but missed the original WHN distribution, the articles are available on the Jana Diversity Solutions website at www.janadiversity.com, or at wiringharnessnews.com.

If you know a female engineer who would make a great candidate to feature in the Power Women series, please direct them to me at melissa.femia@janadiversity.com

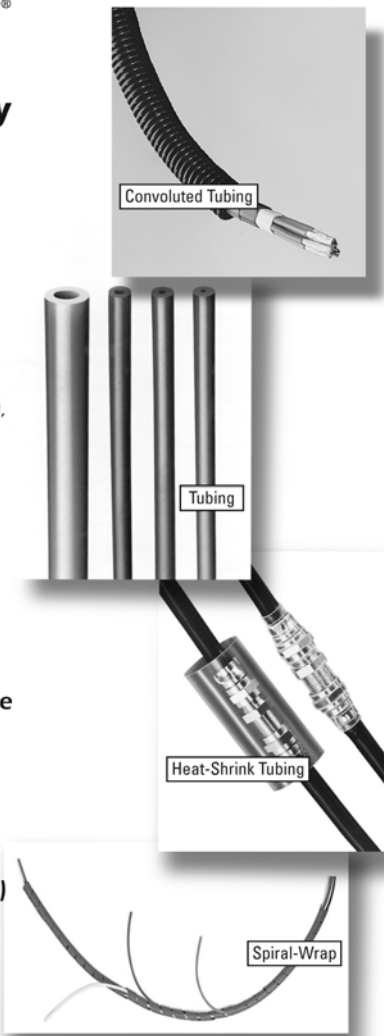
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REACH Is Getting Some Teeth

Continued from page 1

Collecting data for the SCIP database will be challenging for many reasons. First, the database structure is being finalized now. The final structure of the database is expected by the end of the first quarter of 2020. A second issue is the protection of confidential business information.

Discussions for determining what will be legitimate confidential business information in FMDs, and, therefore, allowed to be kept confidential are ongoing. The EU is committed to protecting such information. What we do know is this information is defined as NOT including declarable substances, i.e. those subject to regulation.

To compound the data collection challenge, the EU is committed to significantly increasing the Candidate List (SVHC list) by the end of 2020 through the European Chemical Agency's Community Rolling Action Plan (CoRAP) (<http://bit.ly/2DQKFMt>). CoRAP calls for all currently identified potentially hazardous substances to become Candidate List entries by December 31, 2020.

Given this short time frame and the unknowns surrounding which substances will be added to the SVHC list, you need to start collecting your product substance content data now. The commonly collected certificates of compliance and reporting of current SVHCs only will be insufficient in the future. Furthermore, certificates already collected will be obsolete. While some leeway is expected initially, SVHCs contained will be the minimum information required for initial data entry.

To meet SCIP requirements, you will need to provide:

- information that allows the article (product) to be identified;

- the name, concentration range and location of the SVHC in the article; and
- possibly other information on the safe use of the article.

The SCIP database will be accessible to customs and other EU authorities, as well as consumers and your competitors. Authorities will be able to check for the presence of product substance data before allowing a product into the EU or being sold in the EU. This is what will give REACH enforcement real teeth.


What You Need to Do

You need to start now gathering the data you will need to populate the SCIP database for your products. Due to the anticipated expansion of the SVHC list, the most practical solution is to collect FMDs to minimize data recollection efforts. (Data recollection efforts are costly and can be difficult as you exhaust your supply chain's willingness to respond with repeated requests for data.)

Step 1 – Formulate a Plan to Collect and Manage the Data





You will need to collect more data; manage it effectively; analyze it for the information needed to comply with regulatory requirements; and create data submissions for the SCIP database.

Compliance data can be challenging to collect especially for items already in inventory or items purchased as lifetime buys. You are going to have to go back to your suppliers







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on parts you may not have purchased in a while.

You need to

- Understand what data you need
- Determine the mechanism you are going to use to collect the data.

Step 2 – Collect the Data

Collect full material declarations for all materials and components used in your products. Collecting the data includes reviewing incoming data for acceptability which means developing standards of what constitutes acceptable data. Collecting the data may well include educating your supply chain to provide data that meets your acceptability standards. Finally, you must continue to pursue the data until you have acceptable data for every material and component in your product.

A critical part of your data collection efforts will be your communications to your suppliers. You must set the expectation for full FMDs while allowing for less than full declarations to be acceptable for any first attempt by a supplier to provide data. Some suppliers will ignore requests for data in hopes that the issue will go away. Others may refuse to supply data because they are not contractually obligated to do so.

Educating suppliers regarding the data needed and the criticality of providing it will be an ongoing challenge. Do not expect your suppliers to get it perfect the first time around. Also remember that your suppliers may have to reach out to their suppliers and on and on to tier N to obtain the necessary data.

Step 3 –Analyze Your Data

You need to identify which of your component parts and assemblies, if any, contain reportable amounts of SVHCs. The reporting threshold is 0.1% of the substance against the weight of the part. In other words, if a part weighs 10 grams and the amount of the substance present in the part is 0.01 grams, you must report this part as containing an SVHC that meets or exceeds the reporting thresholds. Remember reporting an SVCH includes not only identifying the substance and the amount present but also exactly where the SVHC is in your product.

If you have any questions regarding the SCIP database and the required data collection and management process, contact Michael Wurzman, mwurzman@rsjtechnical.com.

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Capacity Calendar

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View By Order

View By Location

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Mechanical Assembly

Inspection Station 1

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1

6

11

16

21

26

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M & A 101: Lessons learned from decades of deals

A Downside of Debt

By Loren Smith

Because borrowing money to finance various business activities is such a normal

practice, I am often asked about the pros and cons of incurring debt. The best way for me to respond to this question is anecdotally, based on my own years as head of my wire harness company.

To change careers and acquire Monona Wire Corporation, at the time generating less than \$1 million annually, I needed to borrow capital. I chose a medium-size bank for my financing.

Within a few years, I had two credit facilities with the financial institution--a working capital loan and equipment financing--and my growth plan was working. I was making money. But then I got a surprise call from my loan officer.

He informed me that the bank had been sold and, as a result, the bank's credit criteria had been modified. Our small company fell below their size minimum, and all customers who no longer fit the credit criteria were required to pay off their loans. Although all of our loan covenants were in compliance, my attorney advised me to move quickly, as a bank can always find a legal reason to ask for its money.

We didn't have the cash flow to enable us to immediately pay off the debt; nor did I have the personal wherewithal to pay it off. As a consequence, we had to find another lender quickly, which we did, but the time crunch made that process disruptive. Most critically, the tight time frame prevented us from finding an optimal deal or the right financial institution for our needs at the time.

A number of years later, we had long since weathered loan problem #1 when we had a similar experience. Even though we were now generating approximately \$20 million in annual revenue, I got a call from our




Loren Smith CEO
Blue Valley Capital

bank at that time letting me know new management had revised the bank's credit criteria. Though profitable and with all of our loan covenants fully compliant, we nevertheless encountered déjà vu.

Thankfully, I now had the ability to pay everything off within several days, and I then resolved that as long as I owned a harness company I would be debt-free.

Given that bank financing is a necessary part of business, experiences like mine are not that unusual--because changes in the ownership or policies of financial institutions are not unusual. For that reason, I recommend that business owners contemplating borrowing money from a bank make sure they have a solid plan B. You can never be certain you won't need to contend with a call like the two I received.

Loren Smith can be reached at lms@blvcapital.com or www.bluevalleycapital.com



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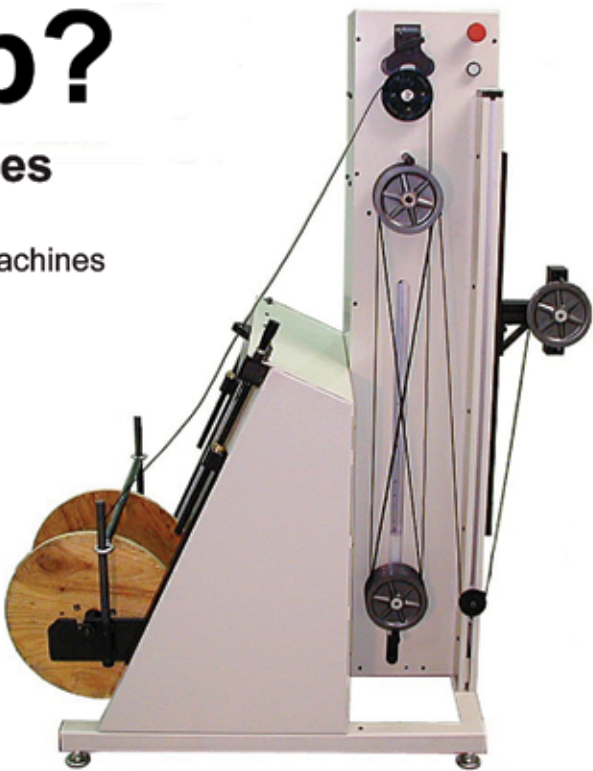




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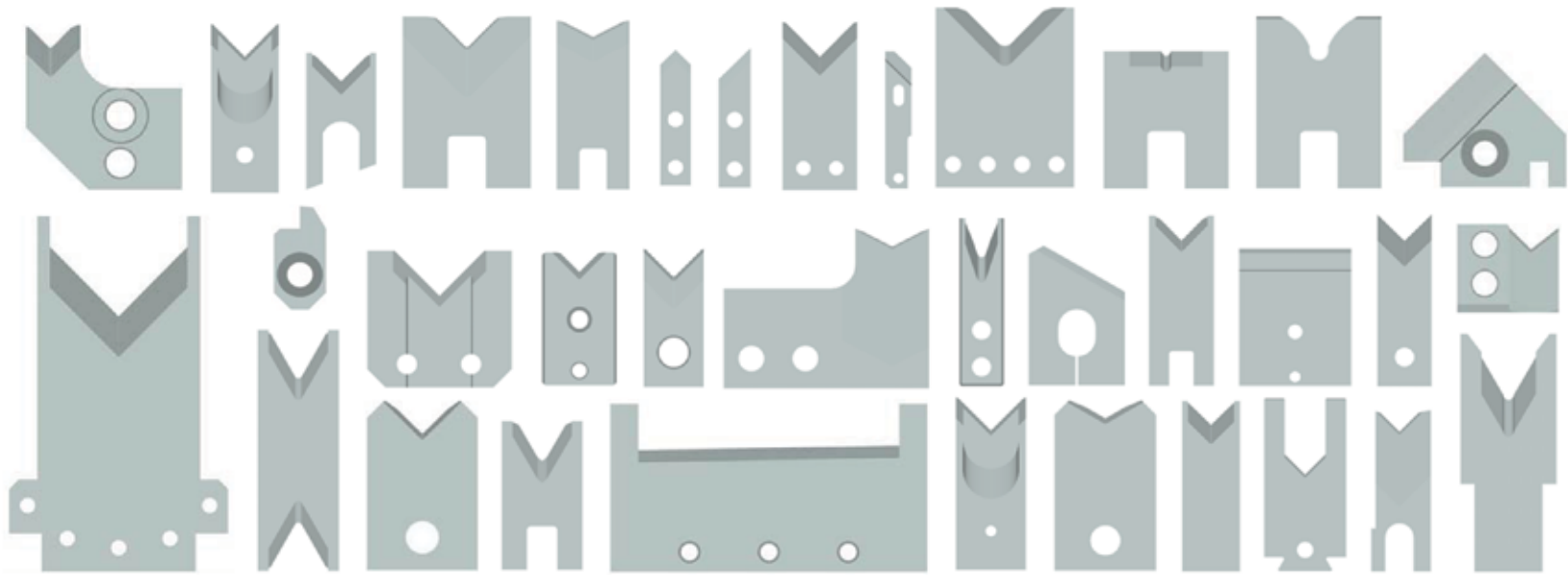
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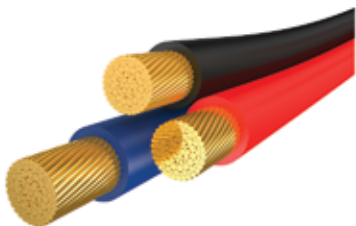
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• Take in a multitude of networking activities, from the newcomer's reception and ribbon cutting ceremony to the ice cream social on the show floor.

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Table 1.2: Temperature Specifications for Copper Conductors	
Bare Copper	100°C
Tinned Copper	150°C
Silver Plated Copper	200°C
Nickel Plated Copper	260°C

Service Temperature
If the application requires high temperatures, a copper conductor with silver plating or nickel plating would be recommended. As shown in Table 1.2, plating can drastically increase the service temperature and prevent oxidation of copper conductors. While nickel is less conductive of electricity than copper, it is the best choice of coating for applications requiring very high and sustained temperatures.

Typical Conductor Materials

Table 1.3 examines some of the more typical conductor materials with their pros and cons.

2. STRANDED VS. SOLID CONDUCTORS

There are two options for the construction of your cable's conductors: stranded and solid. Stranded means multiple smaller conductors are twisted together to make a larger

conductor. A solid conductor refers to a single, solid wire. Each construction has benefits and drawbacks—so again, the conditions of your application should be considered when making this selection.

Stranded Conductors

Stranded conductors consist of multiple thinner conductor wires combined to act as a larger conductor with a higher gauge. Multiple conductor stranding options are available, depending on your needs (see Table 2.1 Page 23).
The primary benefit of stranding is flexibility—the construction of stranded conductors makes them less rigid and stiff than their solid counterparts. As a rule, higher conductor flexibility can be achieved by increasing the number of strands, and decreasing the strands' diameter.

Continued on page 23

Table 1.3: Most Typical Conductor Materials	
Alloys (Brass, Bronze, Steel, etc.)	
Multi/Cable can manufacture conductors in countless different alloys, including high strength alloys, thermocouple alloys, and resistance wires. Depending on the needs of your specific application, an alloy can offer benefits that outweigh a small loss in conductivity.	
Bare Copper	
PROS: • Low cost • High conductivity	CONS: • Is susceptible to corrosion & oxidation
Tinned Copper	
PROS: • Excellent solderability • Added strength provides a longer lifespan • Added protection from corrosion allows for use in a wider range of environmental	CONS: • More expensive than bare copper
Silver Plated Copper	
PROS: • Better conductivity than bare copper • Excellent solderability • Higher service temperature than tin plated copper	CONS: • High cost
Nickel Plated Copper	
PROS: • Higher service temperature than silver plated copper	CONS: • Poor solderability
Gold	
PROS: • Good conductivity • Resists corrosion	CONS: • High cost

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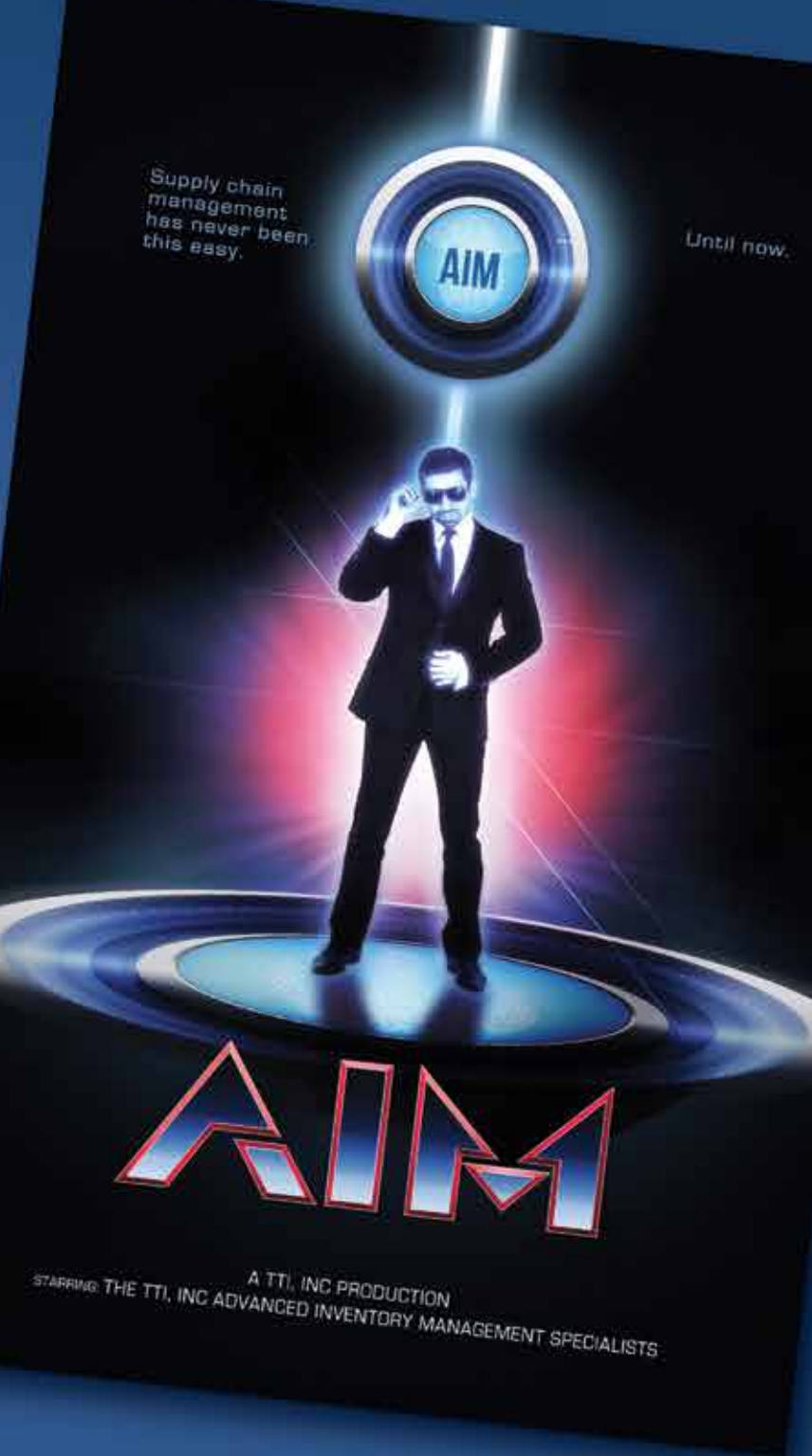
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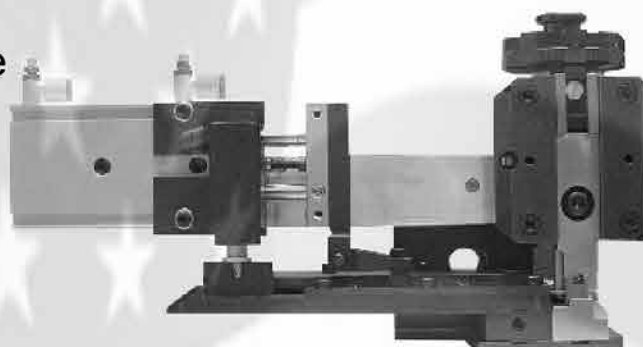


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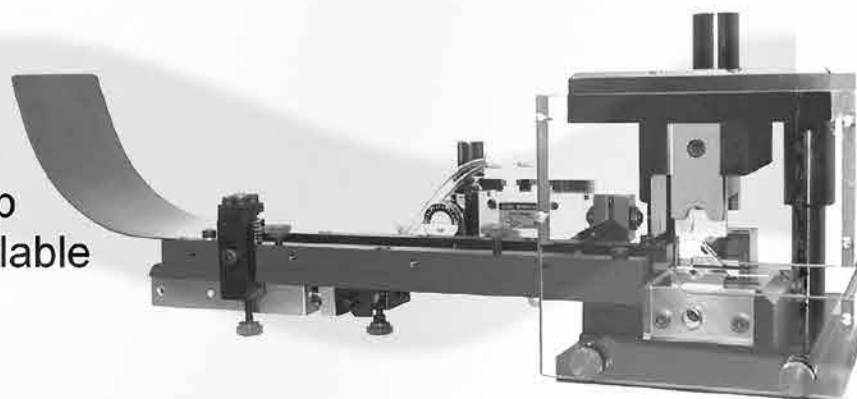


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Choosing a Conductor for Your Cable - A Practical Guide

Continued from page 21

Table 2.1: Stranded Construction Options		
Multi/Cable can manufacture conductors in countless different alloys, including high strength alloys, thermocouple alloys, and resistance wires. Depending on the needs of your specific application, an alloy can offer benefits that outweigh a small loss in conductivity.		
Construction Type	Description	Advantages
Bunched Stranding	Wires of the same diameter are twisted in the same direction without regard to the geometric arrangement of individual strands.	<ul style="list-style-type: none">• Greater flexibility• Lowest cost
True Concentric	A central wire is surrounded by one or more helically laid wires with lay direction reversed and the length of lay increased for each successive layer.	<ul style="list-style-type: none">• Increased mechanical strength• Increased crush resistance
Unilay	Same as true concentric, except that lay direction and length of lay are the same for each successive layer. Normal direction is LHL.	<ul style="list-style-type: none">• Has the smallest diameter and lowest weight of helically laid core constructions
Rope Stranding	Made up of cabled groups. Generally used for 8 AWG or larger.	<ul style="list-style-type: none">• Increased flexibility

While stranded conductors are typically more expensive than solid conductors, they also offer easier installation and longer lifespan (in typical applications), so in the long term they may be a more cost-effective choice.

Stranded Conductor Applications -

Flexible stranded conductors are a good choice for applications such as circuit boards, where a wire may need to twist and bend intricately. Stranded is also a good choice where the conductor will be subject to re-

petitive motion or to vibration (such as in robotics), as they can endure these factors better than a solid conductor.

Solid Conductors

As the name suggests, a solid conductor consists of a single metallic core. This is usually much thicker than the individual wires found in stranded conductors.

While this option is less widely used, and offers less flexibility, solid conductors are more rugged and

Continued on page 25




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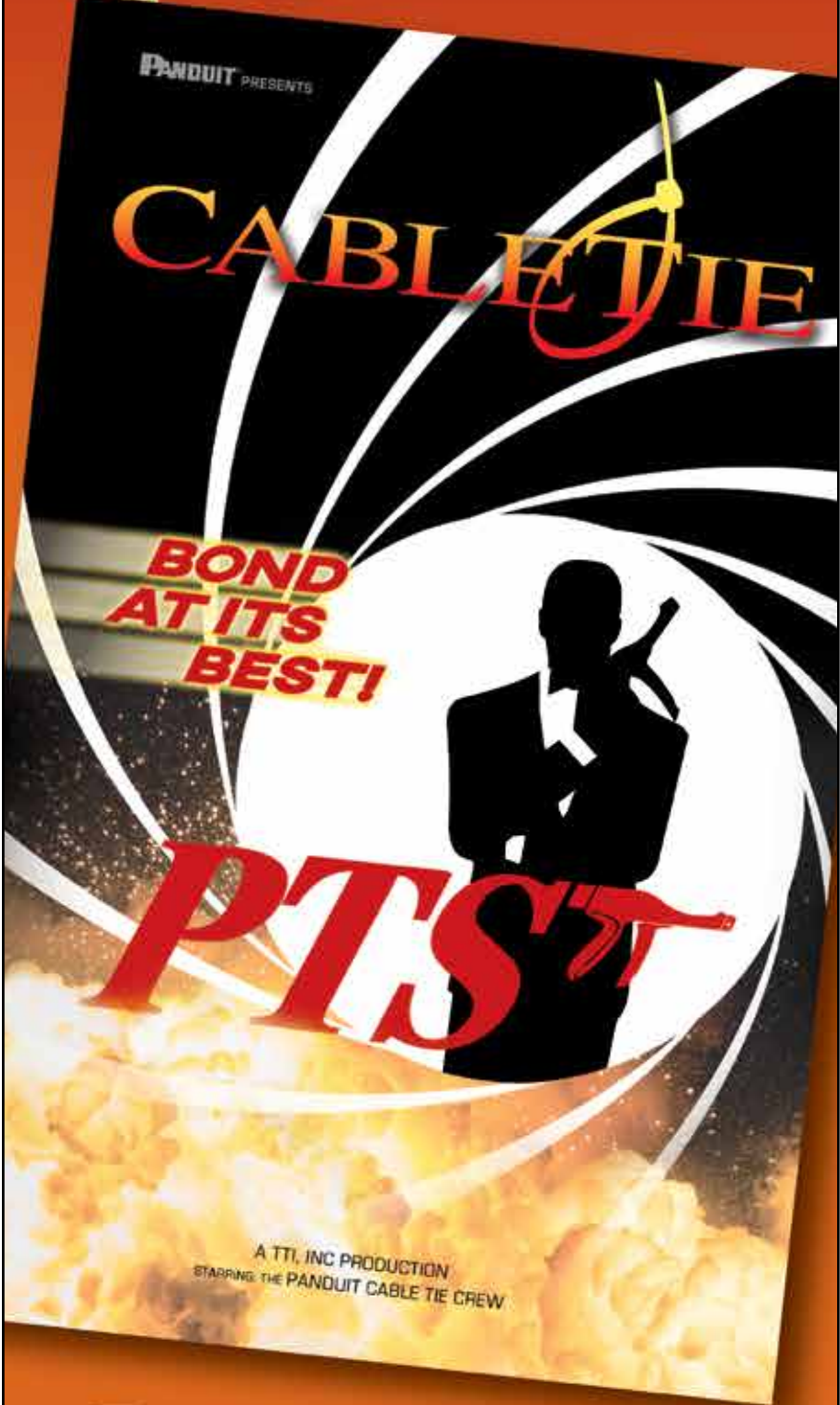
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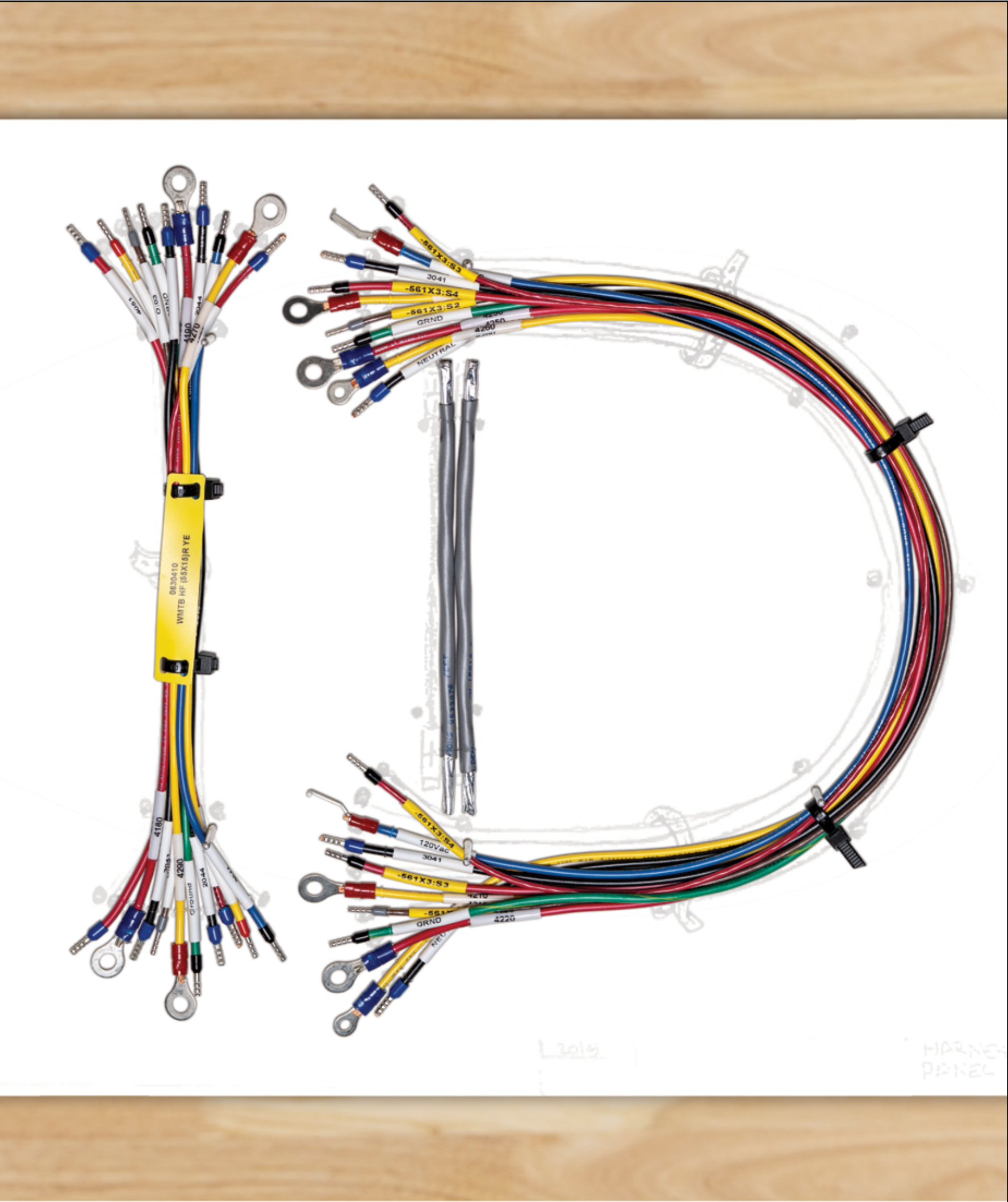
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Choosing a Conductor for Your Cable - A Practical Guide

Continued from page 23 _____ transformer) utilize solid conductors.

durable than their stranded counterparts. And thanks to their simple construction, solid conductors also offer the benefit of lower cost.

Because a solid conductor lacks the spaces between multiple wires, its diameter can be more compact than a stranded conductor, without a decrease in carrying load. This lack of empty spaces also makes solid conductors better at preventing electronic interference.

However, it is important to remember this rigidity can also be an obstacle in many applications. If used in an environment where the cable is subject to frequent motion, a solid conductor will become worn more quickly. Thus, a cable that was initially lower cost will turn out to be less cost-effective. This factor may be disregarded in applications intended to have a shorter lifespan.

Solid Conductor Applications - Because of their inherent durability, solid conductors are frequently used in applications where harsh conditions may be present—especially if the conductor will be exposed to adverse weather. When corrosion is possible, a solid construction can offer better performance and a longer lifespan. Both blasting wire (which connects a detonator to an explosive device) and direct burial wire (e.g., used to connect homes to a power

3. HOW MANY CONDUCTORS DO I NEED?

Once you have determined the exact conductor type needed for your application, your next question will be, how many conductors do I need?

Depending on the requirements of your application, your cable can have one or more conductors – even hundreds of them. The typical range is 2-100, but the number will ultimately be determined by the needs of your application – how many circuits it contains that need to be connected, and whether spare wires are desirable.


4. CONDUCTOR SIZES

The size of the conductor wires should be selected based on the necessary power load of your application, as well as any physical requirements your application has.

Refer to the Stranded Conductor Data (Table 5.1) and Solid Conductor Data (Table 5.2) tables for information on sizing and power to find the AWG size that meets your needs.

About AWG - In the United States, wire sizes are measured with the American Wire Gauge (AWG). AWG is a standardized stepped wire gauging system for the diameters of round, solid, nonferrous, electrically conduc-


Continued on page 27



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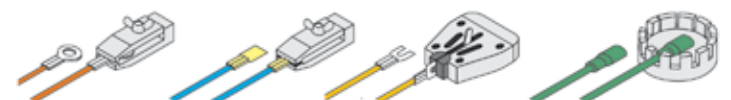
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Choosing a Conductor for Your Cable - A Practical Guide

Continued from page 25

tive wire. Higher numbers indicate cables with smaller diameters.

Current-Carrying Capacity

Can your conductor(s) safely carry the necessary current? Of course, higher voltages mean higher temperatures, but there's more to consider. Don't overlook these factors, which can contribute to overheating:

- Ambient Temperature: Is your cable for an indoor or outdoor application? What do you anticipate the temperature and/or weather conditions typically being? Will adequate ventilation be available along the conductor's entire length?
- Construction Type and Diameter: When multiple (stranded) con-

Continued on page 28

Table 5.1: Stranded Conductor Data					
Size (AWG)	Stranding	Nominal O.D. of Strand (in.)	Nominal O.D. (in.)	For copper conductors only:	
				Nominal Weight* (Lbs/Mft)	Nominal OHMS* (Resistance Per Mft)
32	7/40	0.0031	0.0094	0.203	159.0
32	19/44	0.0020	0.0099	0.230	142.0
30	7/38	0.0040	0.0120	0.339	95.40
30	19/42	0.0025	0.0120	0.359	90.80
28	7/36	0.0050	0.0150	0.529	61.00
28	19/40	0.0031	0.0160	0.553	59.10
26	7/34	0.0063	0.0190	0.841	38.50
26	19/38	0.0040	0.0200	0.920	35.50
24	7/32	0.0080	0.0240	1.356	23.30
24	19/36	0.0050	0.0240	1.430	22.70
22	7/30	0.0100	0.0300	2.120	15.30
22	19/34	0.0063	0.0310	2.280	14.30
20	7/28	0.0126	0.0380	3.150	9.600
20	10/30	0.0100	0.0410	3.090	10.168
20	19/32	0.0080	0.0400	3.680	8.900
20	26/34	0.0063	0.0370	3.120	10.05
18	7/26	0.0159	0.0480	5.360	6.040
18	16/30	0.0100	0.0520	4.940	6.740
18	19/0092	0.0092	0.0450	4.900	6.323
18	41/34	0.0063	0.0470	4.920	6.600
16	7/24	0.0201	0.0600	8.560	3.670
16	19/0117	0.0117	0.0560	8.020	4.152
16	19/29	0.0113	0.0570	7.350	4.480
16	26/30	0.0100	0.0660	8.030	4.000
16	65/34	0.0063	0.0600	7.810	4.020
14	7/0242	0.0242	0.0726	12.76	2.480
14	7/22	0.0253	0.0760	13.56	2.310
14	19/27	0.0142	0.0710	11.59	2.700
14	41/30	0.0100	0.0700	12.70	2.476
14	105/34	0.0063	0.0740	12.40	2.660
12	7/20	0.0320	0.0960	21.69	2.490
12	19/25	0.0179	0.0900	18.43	1.450
12	19/0185	0.0185	0.0925	20.15	1.770
12	65/30	0.0100	0.0910	19.66	1.564
12	165/34	0.0063	0.0950	19.82	1.680
10	7/0385	0.0385	0.1160	32.06	1.580
10	19/0234	0.0234	0.1170	32.06	1.000
10	105/30	0.0100	0.1140	31.76	1.000
8	7/0486	0.0486	0.1460	50.10	0.980
8	19/0295	0.0295	0.1440	50.00	0.650
8	133/29	0.0113	0.1670	54.00	0.640
6	7/0612	0.0612	0.1840	81.10	0.410
6	19/0372	0.0372	0.1860	81.10	0.400
6	133/27	0.0142	0.2100	84.10	0.410



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Choosing a Conductor for Your Cable - A Practical Guide

Continued from page 27 _____

ductors are cabled together in any construction type, more heat will be produced.

- Insulation: You'll need to think ahead here about what insulation material is best to use – choose one that is rated to handle the anticipated temperatures, at minimum.

Table 5.2: Solid Conductor Data			
Guage (AWG)	Nominal O.D. of Strand (in.)	For copper conductors only:	
		Nominal Weight* (Lbs/ Mft)	Nominal OHMS* (Resistance Per Mft)
32	0.0031	0.203	159.0
32	0.0020	0.230	142.0
30	0.0040	0.339	95.40
30	0.0025	0.359	90.80
28	0.0050	0.529	61.00

*Values are approximate and can vary depending on plating material and thickness

Voltage Loss


Voltage loss does not typically need to be considered unless your wire run will be quite long (25' or more). In these situations, voltage loss can be minimized by appropriately selecting your conductor:

- Materials with better conductivity (e.g., copper) will lose less voltage than those with lower conductivity (e.g., aluminum)
- Shorter wires will lose less voltage than longer wires (when comparing cables of the same AWG). For short runs (under 25'), drops in voltage are considered negligible.

- Thicker wires will lose less voltage than thinner wires (when comparing cables of the same length).


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And a recap of the additional great benefits included in membership

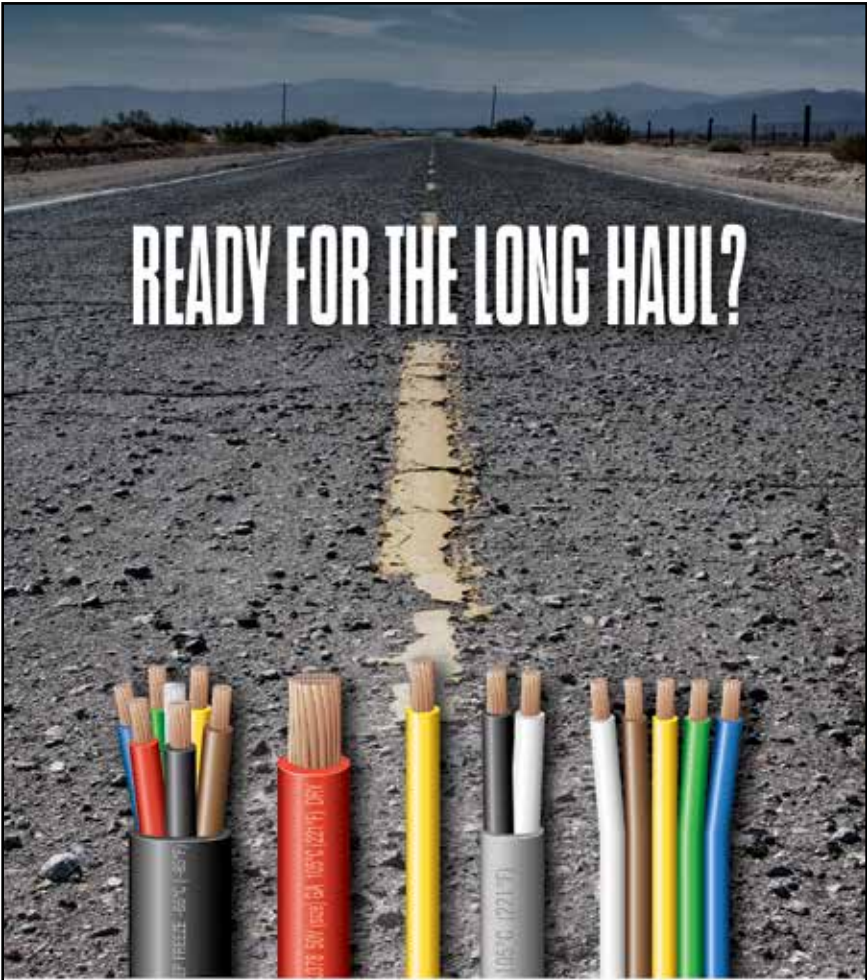
By Christine Siebert

A little background on the WHMA organization first. The Wiring Harness Manufacturer's Association® (WHMA) was established in 1993 to serve and dedicate their resources to the global cable and wire harness industry. WHMA is the ONLY trade association exclusively representing the cable and wire harness manufacturing industry including manufacturers, their suppliers and customers. The Wiring Harness Manufacturer's Association is dedicated to providing our members the technical support, access to leading edge technology, benchmarking and the ability to network with the leaders in wire processing equipment, services and manufacturing.

WHMA's goal is to "LEAD", "EDUCATE" and "CONNECT" their members to resources that make them industry leaders. WHMA leads by providing members knowledge exchanges of best practices through participation at events, peer networking and sharing valuable information on-line. Educating the industry with the only industry-consensus standard for the Requirements and Acceptance of Cable and Wire Harness Assemblies, IPC/WHMA-A-A620. WHMA connects their members and promotes the value of building relationships throughout the year. The WHMA membership is currently comprised of over 200 manufacturing companies and over 55 supplier organizations.

With these goals of the organization, there are many benefits for Wire and Cable companies to become a WHMA member, but one new exciting benefit was just announced! WHMA and IPC members now have exclusive access to health plans you typically only find with larger manufacturing companies. These are top-quality health plans with flexible

Continued on page 31

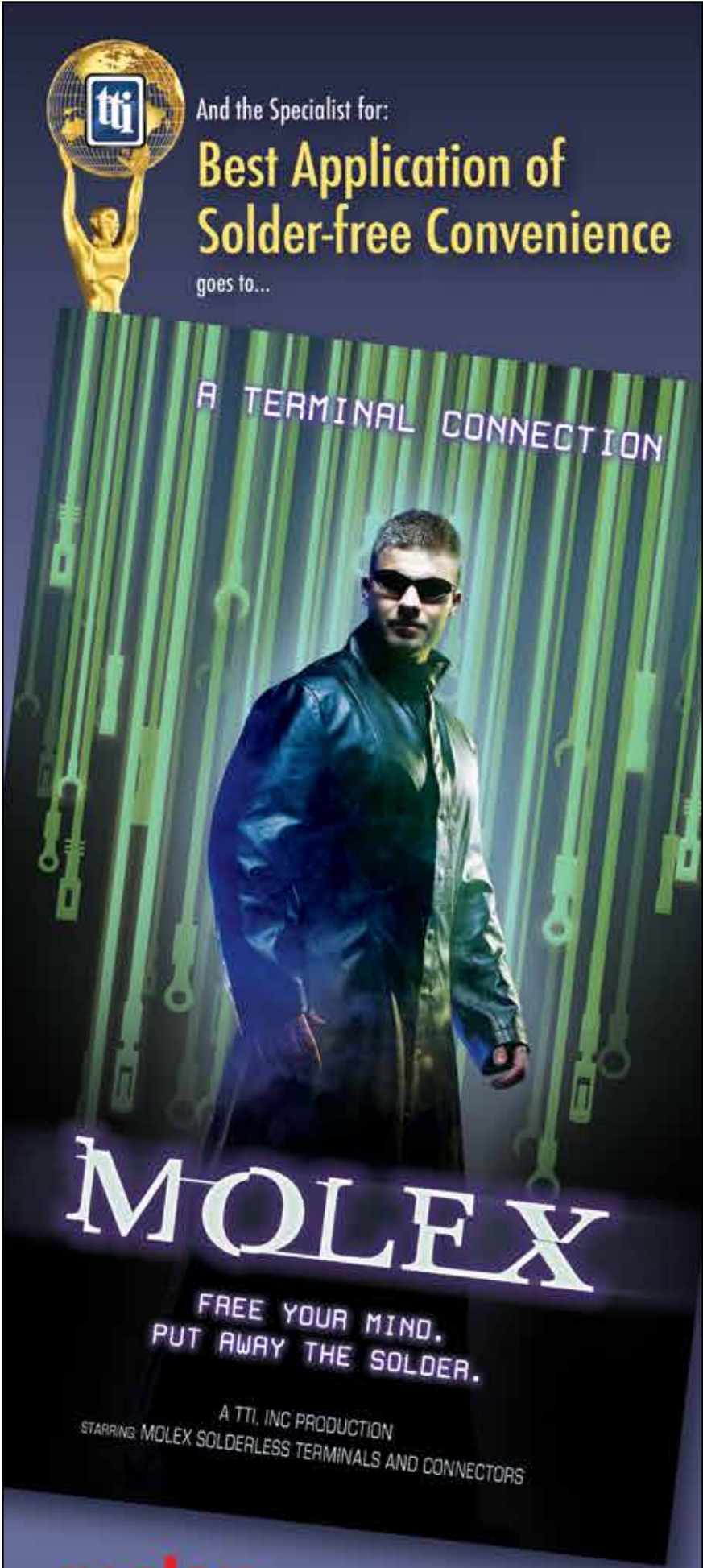


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Continued from page 29


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without degradation. The one major problem with EPDM compounds is that they are extremely poor in applications where oil is present. EPDM is not to be used in applications where hydrocarbons, such as kerosene, gasoline and hydrogenated solvents, are present.

EPDM insulation and jackets are compounded with fillers such as carbon black and calcium carbonate and with plasticizers such as paraffinic oils, and have useful rubbery properties only when crosslinked. Cross-linking typically is performed via continuous vulcanization (CV) with sulfur, but is also accomplished with peroxides (for better heat resistance) or with phenolic resins. High-energy electron beam radiation (irradiated or E-Beam) is used for producing high-quality EPDM wire and cable products.

EPDM has good low-temperature properties, with elastic properties to temperatures as low as -40°C. As the demand for UV-resistant wire and cable increased, so did the use of EPDM for both hook-up wire and electrical cables. EPDM offers great flexibility,

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durability and is resistant to moisture. It also performs well in high temperatures and in high-voltage applications. Typically, EPDM wire and cable is used for high-temperature applications (125° to 150°C), such as appliances. Another use of EPDM compounds is in the manufacturing of medium-voltage test leads. EPDM insulated products can be used as appliance wire and as lead wire for motors, ballasts, transformers, coils or solenoids, where high temperature and/or high voltage is required. Common standards include UL 3284, UL 3374; CSA 1254 from sizes 18 AWG to 4/0.

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Wire Solutions for a Connected World

To Be Precise.



Wiring Harness News Pilots a Spanish Language Newspaper

Wiring Harness News (WHN) recently partnered with M-Expo and WHMA to produce a Spanish language newspaper. The publication was delivered specifically to harness manufacturers in the all-important Juárez market, as well as distributed at the M-Expo Wire Processing Show held in Juárez last October.

The publication featured information on process improvement, equipment maintenance, testing/quality control, software, and other editorial pertinent to the industry. Like the main publication, it also featured

new products and services in these fields. “We are trying to create a more global footprint,” explained Joe Tito, Editor for WHN. “We now have the electronic version that is available free anywhere in the world, but only in English. The concentration of harness producers in Mexico, especially Juárez, makes a Spanish language version the next logical step in increasing that footprint.”

The opportunity for the pilot publication was presented to WHN in mid-August by Gustavo Farrell, President of Cesar-Scott, who also

promotes the M-Expo. Timing was an issue as it was determined the best way to distribute was as an insert in El Mexicano, a general manufacturing publication for the Juárez market. “We had 20 days to put this thing together,” Joe recalled, “and that included getting advertisers on board with Spanish language ads translating current articles.” He went on to indicate the latter would not have been possible without the efforts of Gustavo in finding a translator capable of handling technical material.

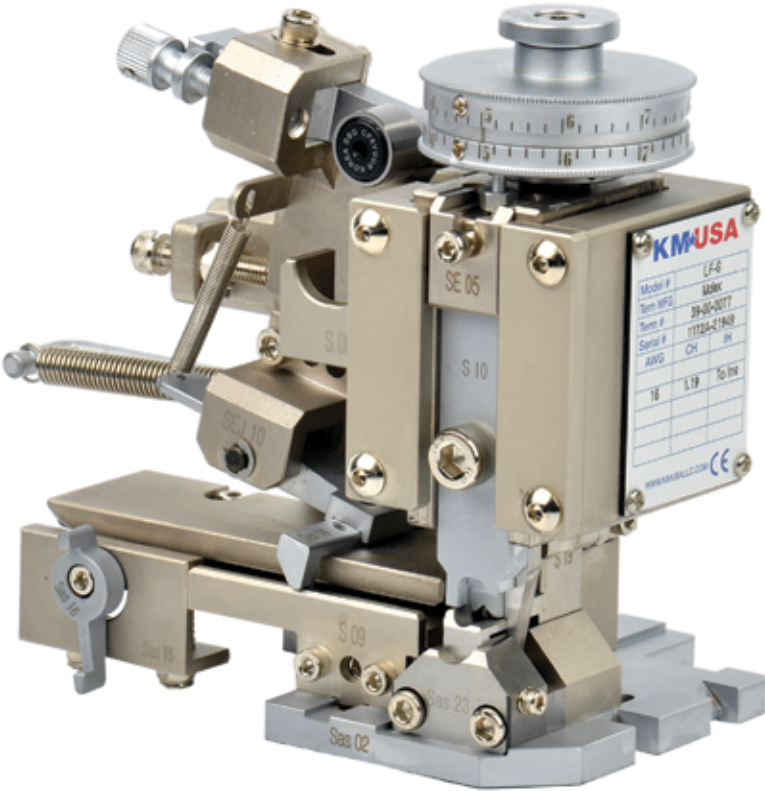
“Most of the advertisers in the pilot publication will be familiar to readers of our main newspaper,” said Jim Brown, Sales Manager for WHN, “but we also intend to reach out to businesses like tool and die makers, who support the Juárez market on a more local basis.”

Special thanks are also due to Ingrid Flores, Marketing Manager of Cesar-Scott, and Christine Siebert, Owner of Siebert Consulting Group, for their efforts. Plans are already underway for what will likely become a quarterly Spanish language version of WHN.

If you are interested in placing an ad or supplying editorial, please contact Jim Brown or Joe Tito respectively. (See contact info on page 3) You can view the entire publication by following this link: <https://joom.ag/Tjve>



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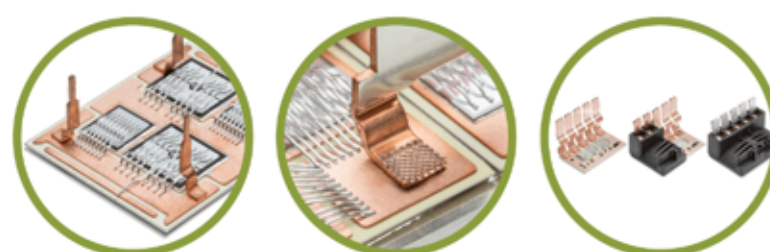
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Few investments beat those which enrich us personally and professionally. A few years ago, WHMA embarked on a journey to vastly upgrade the offering at their annual conferences. WHMA conferences of recent years have been unparalleled opportunities to learn, grow, share, and discover new approaches to many aspects of the wire harness business. The WHMA organization, now under the management of IPC, has stepped up the game even more for 2020. The event will be held on February 18-20, 2020 at the JW Marriott Las Vegas Resort & Spa.

This year's conference keynote presenter will be B. Gentry Lee with his presentation titled "A Passion for Space Exploration". Buchholz is chief engineer for the Solar System

Exploration Directorate at the Jet Propulsion Laboratory (JPL) and successful science fiction writer. During his keynote presentation, Lee will talk about the highlights of his exploration career and touch on the role of wires and harnesses on the most memorable spacecraft. Other presentations and topics to be covered at the conference:

- "Wire Harness Industry Economics – Managing in an Uncertain Economy" presented by Taylor St. Germain
- "Space Challenges from Wire Harness" presented by Robert WM. Cooke
- "Megatrends of CASE (Connected, Autonomous, Shared and Electrification)"

New this year, WHMA is holding a Technical Education Workshop - The Evolution of IPC's Cable & Wire Harness Documents: IPC-D-620, IPC/WHMA-A-620 and IPC-HDBK-62 presented by Robert Cooke. This presentation will be a detailed, but often light-hearted and realistic, discussion on how the IPC's cable and harness assembly documents were created.

We Will Be There!
Stop by our booth at the Conference and let us know what topics you would like us to discuss in future issues of Wiring Harness News. We are always looking for companies to highlight in our Industry Profile feature seen in every issue. Drop your card off and let us know if you are interested in having your business showcased in an upcoming issue.

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NEWS PLUGS

CAMI Research and Doyle Manufacturing Release ZIF Light Director™ Fixtures for Guided Connector Assembly

CAMI Research Inc. (Acton, MA) and Doyle Manufacturing Inc. (Bristol, IN) have joined forces to create Zero Insertion Force (ZIF) Light Director fixtures providing CableEye® users with increased options for light-guided assembly of connectors.

CAMI and Doyle developed this fixture solution under a recently announced partnership.

CAMI manufactures CableEye, a highly versatile, expandable and upgradable, diagnostic and Pass/Fail check Cable and Harness Test System that's PC-based. It's used for assembly, prototyping, production, and QC of standard or custom wire cables and harnesses in countless applications such as Transportation, Energy, Medical Devices, Defense, Scientific R&D, Telecom, and more. The first CableEye tester was sold twenty-six years ago, and systems are now installed in thousands of locations around the world.

Doyle is a custom machine shop specializing in pogo pin (spring pin) test plugs, production connectors, and continuity

testing fixtures. The products can be found on assembly lines and test stations across USA, Canada, and Mexico. Doyle has been serving the industry since 1989.

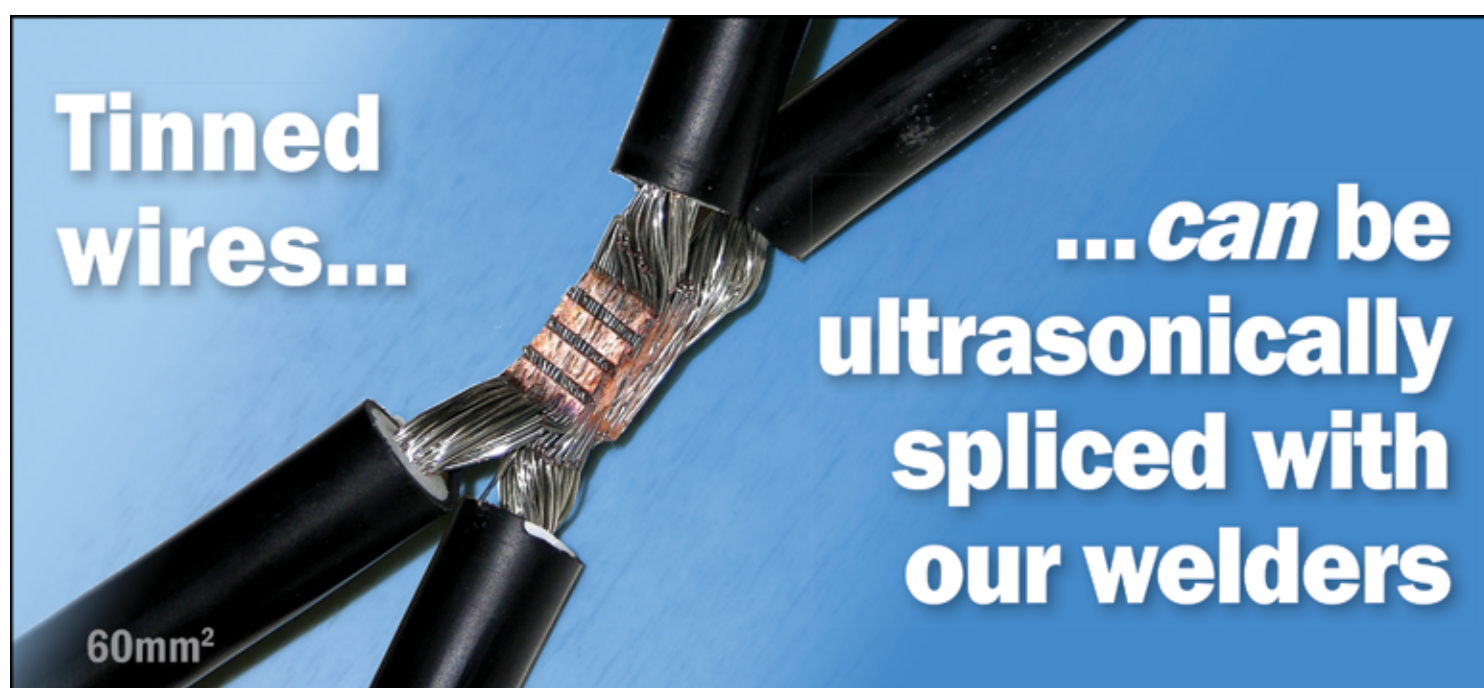
The Application

CAMI's Light Director™ system is a CableEye accessory that provides a computer-guided technique for assembling connectors used in aerospace, medical, and other high-reliability applications. This system uses LED-lit fibers to individually illuminate target cavities in the connector being assembled. When the technician enters the wire code printed on unconnected wires, or touches a wire connected at the other end, the

CableEye software turns on the appropriate fiber, thereby causing a bright, flashing light to project from inside the target cavity guiding the technician to the proper insertion point. Correct insertion is confirmed by the elimination of light from that location, whereas insertion into an incorrect location leaves the flashing light visible.

Using synthetic speech, Light Director can read the pin number to the technician, further reinforcing the target location. Speech can be activated in English, Spanish, French, German, Chinese, Japanese, Korean, Polish or Turkish when a matching generic voice font has been downloaded. Speech recognition is also available as an option permitting the technician to speak wire codes to the system, thus eliminating the need for a keyboard or monitor.

Normally, technicians crimp pins on wires in advance of assembly to the connector. Wires may be identified during the assembly process by numeric code, bar code, color code, or if no codes are present, by electrical detection using a wrist-strap if the far end of the cable has already been assembled and can be electrically connected to the system. Field testing has shown that the Light Director greatly increases accuracy and assembly rate over manual methods while nearly eliminating errors. Because the Light Director greatly reduces the perceptual challenge of manually locating pin cavities in a complex connector,



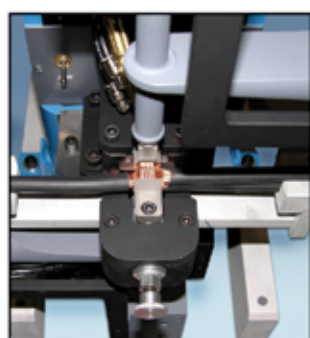
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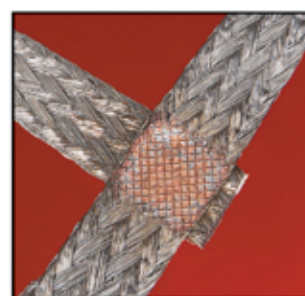
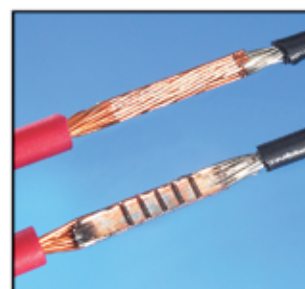
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Continued on page 57



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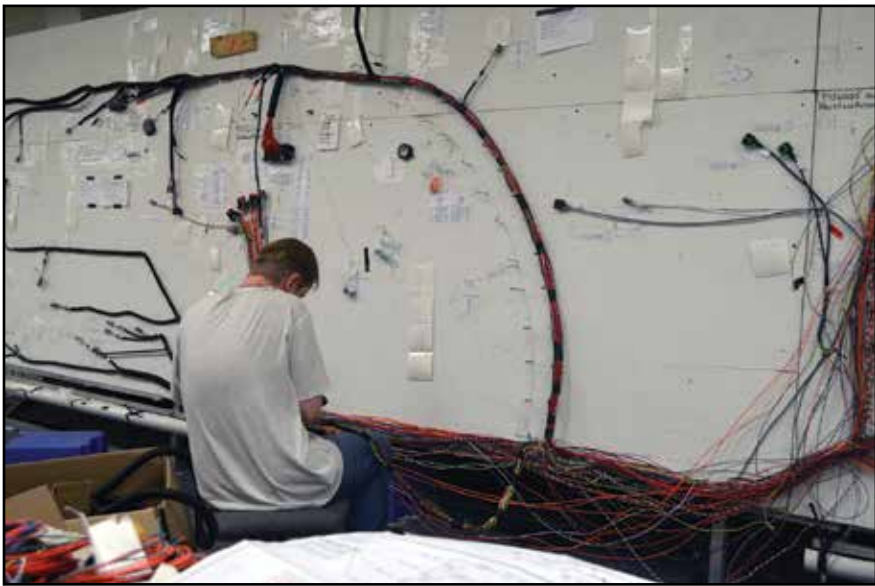
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Electrex Inc. Continued from page 1

2000s. Following a brief setback after 9/11, the company began to flourish once again. “We had a rapidly growing manufacturing company in the small town of Hutchinson Kansas, and we happened to have a maximum and medium security prison there.” Pete recalled. “We could not hire enough entry-level manufacturing people, and so we resorted to hiring work release inmates.” These were folks who were nearing their release date and would be bussed to Electrex during the day, then returned at night.

It worked out great for a few months and Pete approached the warden to attempt to bring in more workers. “He said, ‘Well unfortunately I don’t have any, but if you can figure out a way to move your business behind the walls of my prison, I’ve got 1,200 guys ready to go.’”

The timing couldn’t have been better for the warden as well. Most prisons have areas of industry where inmates typically work. It’s usually work for the state like making license plates, furniture and fixtures for other prisons, and other items not typically found in the business marketplace.



Production inside the Hutchinson Correctional Facility

Kansas was shutting down the operation at the Hutchinson prison, so the warden had 20,000 sq. ft. of manufacturing space. “Within 30 days, we moved a portion of the business inside the walls of a maximum-security prison,” Pete recalled.

In most prison work programs, inmates make a meager wage that may go toward use in the commissary. But that’s not the case with inmates employed at the Electrex prison facility. “We pay the market wage for manufacturing,” Randy instructed, “and it’s set by the state of Kansas.”

It creates a win for the prison system, the taxpayer, and the inmate, as 25% of the wage goes towards room and board. Another portion goes towards a victim’s fund, and to pay fines and restitution for the things that landed them in prison. But a large portion is placed in a savings account for their eventual release from prison. “It’s one of the biggest causes for individuals going back to prison,”

Randy lamented. Most inmates exiting the prison systems in the U.S. do so with no means to buy groceries or find a place to live. “These critical savings allow them the resources to start a new life, and now with marketable job skills.”

It’s not just work that Electrex/Capital III brings to the prison system; it’s also a spiritual endeavor. “We developed a Spiritual Life Center in the facility that is nearly completed, Randy cited. “It serves as what most people think of as a church. It’s non-denominational and open to all religions, with a lot of transformational things going on there.”

Electrex has also started “TUMI” - a seminary level, 3-year program - graduating individuals within the prison to serve as mental health triage support. “There’s 2,500 guys in that facility,” Randy noted “and few resources

Continued on page 44

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A person wearing a white lab coat and white gloves is working on a wiring harness assembly. The person's hand is holding a red connector with multiple wires. The background is a blurred industrial setting.

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Electrex Inc.

Continued from page 42

to address mental health issues.”After a long day working, seminar graduates visit with fellow inmates in need of counseling.

You might be curious about what affect this all has on folks who work for Electrex in the prison program. Nationally the recidivism rate is 70%. “Seven in ten people who get out of prison end up back...why?” Randy asked, “Because they haven’t got work skills, they have no money, and they haven’t turned their lives around.” In the state of Kansas, due in part to the partnerships with private industry, the recidivism rate is 35%. “Well the recidivism rate for people who go through our program is only 8%,” he emphasized.

This statistic provides purpose to Randy and the whole team. “People who may not be so interested in wire harnesses are blown away with what’s going on in these people’s lives. It’s a great example of living the principles of economic, spiritual and social capital that Electrex is built on. We’re not only providing great harnesses to our customers, but we’re having a real impact on the community where we live, and that’s the social and spiritual piece.”

Electrex’s revenues have grown significantly and they now have about

500 employees. They have facilities in Fresno, Zacatecas Mexico and, of course, at the medium and maximum facilities in Hutchinson. They build wire and cable assemblies, battery cables as well as complex control panel builds.

Like a lot of harness houses, the company started out as a build-to-print manufacturer, but that has evolved. “We serve OEMs who are producing complex electromechanical platforms like harvesting combines, large cranes, or equipment designed to put a pipe under a river. These are highly complex machines with a wide variety of configurations and revisions.” Randy noted.

These customers are experts at building machine functionality, but they don’t necessarily maintain a team of electrical engineers who are experts in optimizing the electrical harness system performance. “And that’s where we excel,” he explained. “We’ve got a team of engineers and technicians who have deep experience optimizing wiring systems for a wide variety of complex, specialty equipment.”

The handling of information between hydraulics, actuators, control systems and human interface components requires very specialized,



Hands-On Harness Work at Electrex

high value harness work, as Randy pointed out. That’s really Electrex’s core competency. “If you think about GPS links, auto-navigation and other complex features; these electrical systems are becoming the highest value components on many different platforms. How do you integrate all of these complex systems while minimizing downtime and avoiding launch issues?” It’s a complex task that Electrex has been built around. As he stated, “these systems aren’t spacecraft, but that they are much closer to spacecraft than they are to household appliances or other simple electrical platforms.”

It is not a surprise that most of Electrex’s new business is from word-of-mouth. “We’ve got a reputation in the industries we are in, and we get a lot of inquiries from companies we’ve never done business with,” Randy said. They also get referrals from component suppliers with whom they are allied because they provide something unique either in reliability or functionality. “When you’re a straight shooter, you do business the right way, and you have the kind of design capability and skill set that we are blessed to have, you’ll always have new opportunities,” he proclaimed.

Other Capital III Ventures

In addition to Electrex, Capital III is also the holding entity for Seat King, a manufacturer of specialty seating for the turf, mobility, agricultural, and specialty transportation sectors. They also operate Rio Energy, an en-

ergy development company building hydro power generation in Honduras. Enterprise Stewardship is a leadership and organizational development endeavor committed to developing virtuous corporate leaders. Capital III is also involved with Trinity Academy, a Christian School in Wichita, as well as many other community outreach activities, some of which they publicize and some of which they don’t.

Making an Impact

Randy certainly hopes this article generates some conversations about how to provide a better harness supporting increasingly complex machinery. But more than that, he and the management team at Capital III hope it will spark the interest of other business owners or CEOs who would like to have an impact on their community beyond just making money and supplying jobs. “That’s the message we want to spread,” Randy said. “I always encourage people who have an interest in community impact to join us via teleconference, or come visit us and talk about how to develop a faithful commitment to managing the profit entrusted to you.”

More Information

If you’d like more information on setting up your business dedicated to these principles, visit capitaliii.com. You’ll find inspiring videos that tell the story, as well as other resources to help in your endeavor. You can also contact Randy Johnson at randy@capitaliii.com.

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Connection bolt on aluminum conductor



Wire to terminal
Copper wire on MAK



IGBT application
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Wire splicing
Copper and aluminum combinations



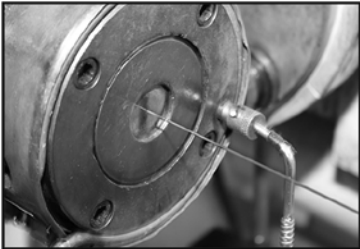
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Top 10 Concerns for Signal Connections

By Andrew Bogaczyk,
Joel Boone, and Loreen Katz
of Phoenix Contact

Introduction

Where do you find signals in industrial/semi-industrial settings? Everywhere. Generally, devices such as sensors, actuators, switches, valves and cameras need signal connections for control and monitoring. As more and more devices are added to the plant floor, secure and reliable connections are of absolute importance. Devices today must handle a wide variety of functions and include features that will ensure cost-efficiency,

reliability and safe operation. Based on customer comments and surveys, we have identified the following concerns that end users have regarding their device connection technology choices.

Cost

Cost is frequently the driving factor when deciding on a connector style for device installation. Engineers and buyers consistently require cost-effective connectors that provide quality and value and meet the application requirements. However, purchasing personnel can overlook the applied costs versus the component costs. Extensive labor rates and downtime due to troubleshooting and loss of throughput during lengthy installations must be considered in addition to the component costs. A solution that can save time and money not only includes the best component pricing, but also brings more efficiency to the operation and installation of a device. Equally as important, connector manufacturers can evaluate the use of application-appropriate materials and designs, as well as global manufacturing efficiencies to offset some of the impact of rising raw material costs.



As PCB design becomes more complex, designers need to consider many factors to choose the best signal connectors for a specific application.

Continued on page 48



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Top 10 Concerns for Signal Connections

Continued from page 46

Environment

The environment where the connection is made often dictates certain criteria. For example, electromechanical interference (EMI) from drives, motors and other nearby noise-producing equipment can cause loss or

unreliable signal transmission. Using shielded connectors and cabling will eliminate concern for EMI.

There are several methods of shielding a cable; however, the most reliable manner is a braided copper screen with a minimum of 85 percent coverage around the conductors. The copper braid is terminated to the head of the connector on both ends of the cable to provide protection from EMI from the point of connection throughout the whole cable assembly.

Additionally, elements in the environment such as dirt, water, oils, chemicals, high/low temperature and sunlight can affect the performance of a connector. To alleviate



Figure 1. High-vibration industries, such as railroad, need connectors that will meet strict requirements to withstand shock and vibration.

these concerns, selecting a product with ingress protection rating of IP67 or higher and Viton gasket materials will prevent corrosion and damage of the housing.

Vibration

Mechanical stress during installation or operation of a device can cause substantial vibration to the PCB and connector contacts. Therefore, many industrial applications require connections that meet vibration and

shock resistance in accordance with IEC 60512-4 or EN 50155. Connectors designed to these standards will have construction elements such as locking screw thread, radial o-rings, mounting flanges, set screws, potting of the body cavity, which all protect against vibration.

Spring technology is another common method to protect against vibration. Spring technology has become the choice termination technology for the rail industry (Figure 1), because the spring termination can sustain a constant force on the wire throughout many environments prone to vibration.

High-density

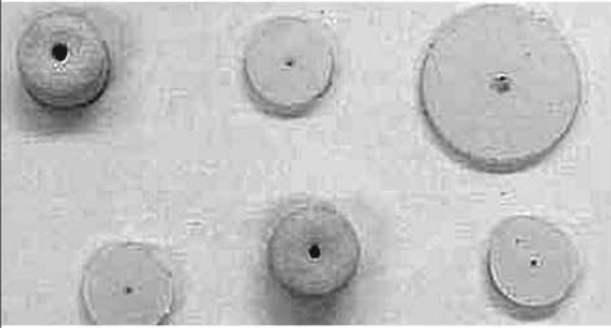
The overall trend in device manufacturing to reduce PCB size and increase I/O count has inspired connector manufacturers to offer high-density products. Many I/O terminations need to be made where space is limited, creating the challenge of connector density. This miniaturization limits the amount of PCB real estate dedicated to I/O connections. Multi-level terminal blocks and compact connector designs allow for more terminations in the same small footprint.

Signal integrity

Any breakpoint along the connection can affect signal integrity, but this is mainly a concern at the contacts. Without a reliable connection, system maintenance could become extremely costly, and resistance due to fretting corrosion could cause signal loss or open circuits.

To prevent fretting corrosion, two primary methods are employed. With tin surfaces, it is important to have a stable connection interface. This is accomplished with “high” con-

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tact forces, which assure that fretting corrosion due to micromotions does not occur. Gold-plated contacts are another way to ensure a reliable connection. Gold is a noble metal with good electrical properties and is not subject to corrosion issues. Gold-plated contacts do not require high contact forces for protection against corrosion. Therefore, gold is the preferred method for high pin count connectors, where high contact forces would lead to undesirable connector insertion and withdrawal force.

Fast connections

Making fast connections is usually necessary for an installer, especially when the job requires numerous connections. The faster the installation is, the less cost involved for the project. Often, these connections are located in hard-to-reach areas or in poor lighting, making it difficult to

see. Additionally, finger fatigue and cross-threading can plague the success of fast installation.

Some of these issues can be prevented at the design stage by using connectors with fast-connection technology (Figure 2), such as spring cage or insulation-displacement (IDC) and quick-locking or push-pull pluggable connections. These connection technologies allow more connections in a shorter time. Several time studies have shown that IDC can save 60 percent more time than traditional screw wire termination. Half-turn circular connectors can save up to 90 percent more time than the traditional threaded connectors.

Miswiring

The most common errors that technicians make in the field are

Continued on page 50

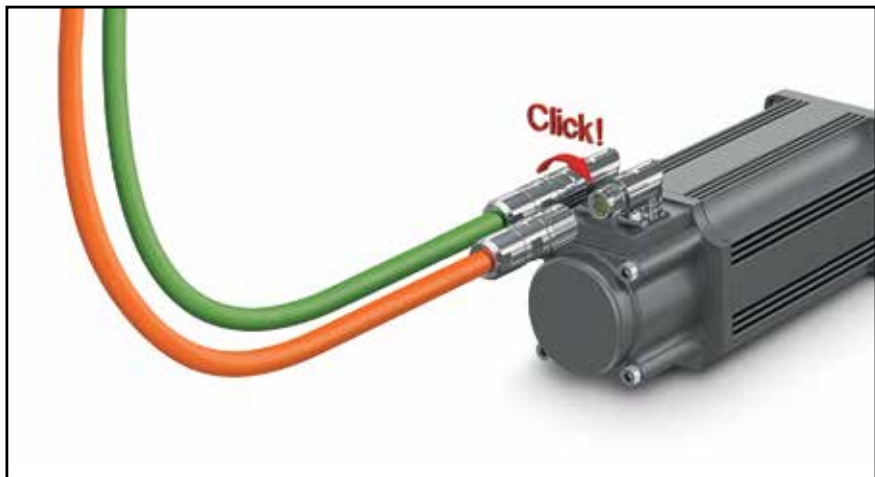


Figure 2. Connectors with fast-connection technology, such as the ONECLICK quick-locking system from Phoenix Contact, can reduce installation time and cost.

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Top 10 Concerns for Signal Connections

Continued from page 49

miswired I/O connections. Not properly terminating wires to the correct terminals can delay system commissioning and device start-up. Using color-coded terminal blocks or inserting markers on all wire/connection points can eliminate confusion and reduce time spent on troubleshooting errors in the field.

Quality, environmental and safety requirements

In today's global economy, engineers and product designers require a trusted connec-

tor source around the world. Partnering with a manufacturer who upholds strict quality, environmental and safety programs is essential. The manufacturer who meets international standards organizations' requirements will be a reliable partner.

Connectors that conform to industry standards and have agency approvals (RoHS, CSA, and UL) eliminate concerns with inspectors and users of the finished device. Connector manufacturers with in-house laboratories offer product testing and qualified solutions from prototype to series production.

Mismating

Mismating similar connections is another common concern – that is, where multiple identical connectors are used on the device. The confusion of plugging the wrong connector into the wrong socket is caused by having a row of connectors with the same configuration (thread size, footprint, pin spacing, pole count, etc.). In these instances, the addition of a keying or coding element can help to distinguish the appropriate cable or terminal block connection. Some circular connectors will offer standard coding such as A, B, C, D, S, T, X or Y. Terminal block connectors can be keyed in several different patterns, allowing only the correct plug to be mated with the appropriate socket. Cable labeling or color coding can also reduce mismating potential.

Mounting

Improper mounting of connectors can also cause problems. Many PCBs require plenty of hand-placed components. Also, many connectors can appear very symmetrical in design. Thus, it is quite common for such connectors to be positioned 180 degrees from proper alignment when being hand-placed. Polarization pins or non-linear pin arrangements can eliminate this very simple, but common, mistake.

Conclusion

When choosing an industrial signal connection, the user must consider many variables to determine the right connector for the job. Phoenix Contact's industrial plug connectors and PCB connectors work together to create signal connections for any application, on or off the printed circuit board. For more information about connectors for control, power, and networking, visit www.phoenixcontact.com/connectconfidence.

Many thanks to Andrew Bogaczyk, Product Marketing Manager, Joel Boone, Product Marketing Manager, and Loreen Katz, Integrated Marketing Manager at Phoenix Contact who authored this article.



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New Benefits with Automated Soldering Innovations

By Apollo Seiko

Soldering has long been considered a method of choice in the joining of electronic components to wire leads. When properly executed it produces a dependable connection that is vibration resistant and able to survive corrosive environments. Automation has advanced this process even further by eliminating the inconsistencies of hand-assembly. A soldering robot will unfailingly apply the same amount of solder, the correct amount of heat and produce an extremely precise solder joint. Furthermore, hand soldering has a reputation for being more costly than other forms of wire connecting while automating this process has proven to greatly reduce costs and material waste. Also, in the past 3-5 years hiring skilled hand solder operators has become exceedingly difficult.

Robotic soldering also resolves issues with high conductor counts and unique solder alloys.

Automated soldering solutions provider Apollo Seiko Ltd., in Bridgman, MI has experienced great success soldering notoriously problematic Nitinol alloy wires. Nitinol is favorably used in the manufacturing of stents, catheters, and heart valve replacements as well as other endoscopic instruments. It is revered for its shape memory and super elastic characteristics. This remarkable material is also able to change shape and length as a response to temperature changes or at the introduction of an electrical current. Due to the nature of Nitinol there are some additional engineering challenges to overcome. One of the biggest obstacles is the intrinsic titanium-oxide-rich exterior layer of the alloy that hinders access and bonding ability for the molten solder. Fortunately, advances in flux formulas have yielded both flux, solder wire and solder paste products that are able to remove the surface oxides and wet the solder to the surface. Apollo Seiko has had great success

using these special flux products to attach Nitinol catheter wires to stainless steel components. In addition to advanced alloys, electronics manufacturing is seeing a shift toward miniaturized wires and components. Apollo Seiko is providing laser soldering solutions to meet the technical challenges of nanosized component assembly. These laser soldering robots are capable of producing micro-sized laser beams for applications deemed otherwise too small for traditional soldering and assembly methods. Advanced optical technology provides a reliable solution

for micro and narrow pitched parts frequently used in high-density electronic equipment. This method is also good for soldering circuit boards that must withstand harsh environments. Because the energy intensity of the laser can be precisely adjusted, the risk of damage to peripheral components is minimized. Applications featuring unique alloys and unusually small components are not the only projects that benefit from automated soldering. Apollo Seiko has been able to provide

Continued on page 54

DIAGRAPH



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New Benefits with Automated Soldering Innovations

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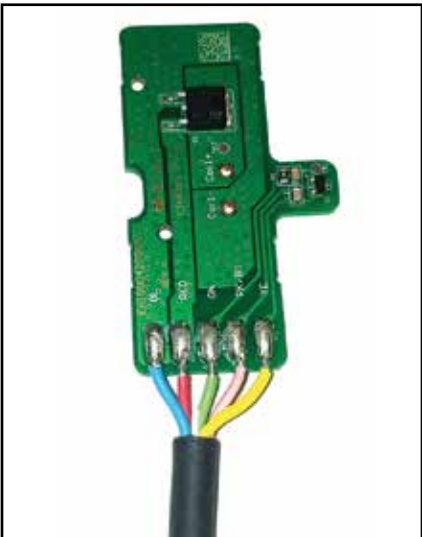
the optimum solution for traditional wire lead assemblies such as filling solder cups on connectors, soldering thru-hole and SMT style wire leads to PCB's, and soldering wire leads to



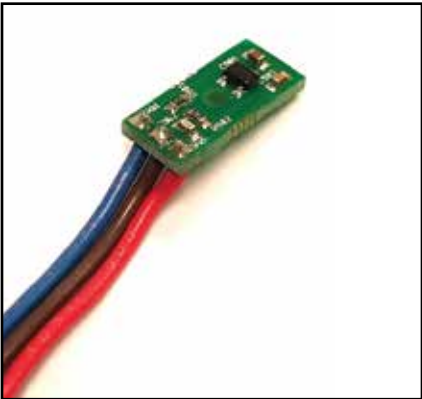
Solder Cups Filled on Connectors

USB connections.

These more traditional applications are typically accomplished with the use of iron tip soldering systems. These robots feature advanced accessory items such as temperature control units, position calibration units and highly engineered wire feeders. Apollo Seiko wire feeders have built-in roulette cutting blades. These blades perforate the soldered wire to expose the flux core. This prevents solder balls, which are formed when molten flux bursts free of the solder wire as it touches the hot iron tip. If the wire is pierced prior to reaching the tip, the flux can outgas from the wire before the solder melts, preventing solder splatter which can be dangerous to the integrity of electrical components. It also provides consistent flux coverage allowing the solder to melt on a clean, active surface.



SMT Style Wire Leads Soldered to a PCB

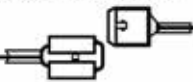


Thru-hole Wire Leads Soldered to PCB



Continued on page 56

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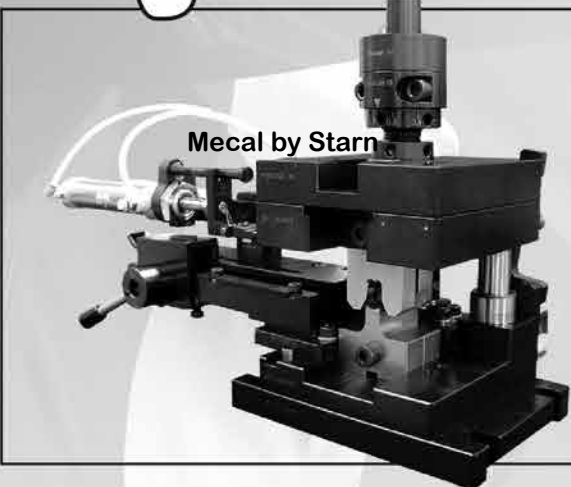
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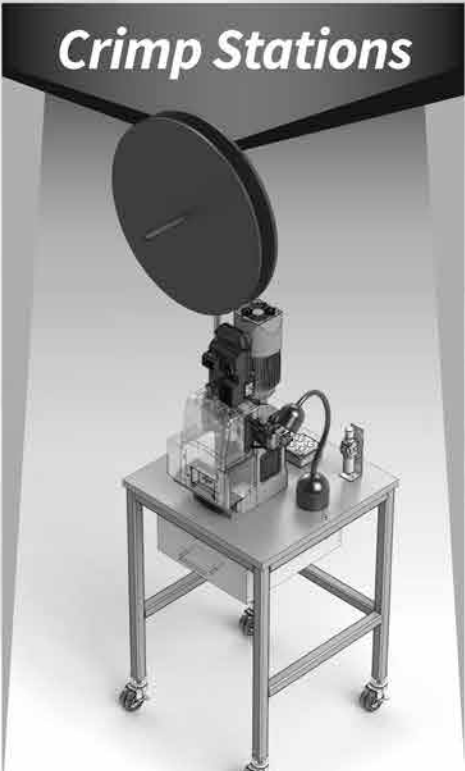
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New Benefits with Automated Soldering Innovations

Continued from page 54 _____

Automated soldering technology continues to advance well beyond wire feeding innovation. Apollo Seiko recently introduced their new ARC 5000 option. The ARC 5000 provides the ability to adjust the angle of the iron soldering unit using an auxiliary access function. This allows for the iron unit to tilt and position itself on a 5th axis beyond the standard range of movement. For more information about this new technology or to find out more about how automated soldering may benefit your assembly process please visit [www.roboticsol-](http://www.roboticsol-dering.com)

[dering.com](http://www.roboticsol-dering.com). Last year, 2019, marked 50 years of soldering excellence for Apollo Seiko. They are a global company with locations in 10 different countries. In addition to traditional soldering methods, they feature a specialized laser soldering system, sleeve soldering for desktop or inline as well as a new AF Series for in-line or off-line selective flow. From automotive to biotechnology, Apollo Seiko believes all electronics industries can benefit from automated soldering. Meet us in person at the IPC APEX EXPO in Booth #2051.



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Continued from page 40

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Author Oren Manor, from Mentor, A Siemens Business, explores the most important steps to consider when building a digital manufacturing company that transforms Industry 4.0 concepts into reality. Industry 4.0 has the power to drive quantifiable change in the manufacturing industry and transform how companies work, collaborate, and serve their customers; it can also create a positive, cultural shift across an organization.

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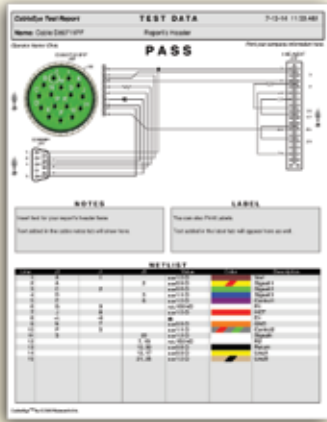
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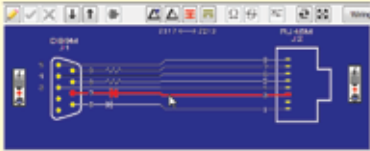
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3	4	6					Ground
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Continued from page 1



Figure 1. Original Cirris Tester

produce an algorithm to learn, verify and test the connections, cables and harnesses very quickly and economically.” That principle remains at the heart of Cirris testers sold today. Ironically, Cirris was able to buy back that first tester and the working unit sits in a case in Cirris’s lobby (Figure 1).

By the time he introduced that first tester, Marlin had moved his operation to State Street in Salt Lake City, and began to build his company. From there, his new team developed the next unit which was the Signature 1000 M, the M standing for memory. “They spent the first half dozen years expanding the number of test points from 128 on up to 1024 points” Joe chronicled.

Having gained a great deal of insight into the needs of his customers on the low voltage spectrum, Marlin began to explore high-voltage, or hipot testing capabilities. “Like the low-voltage testers, the hipot units on the market were very expensive, and he developed a low-cost unit that could perform the DWV (Dielectric Withstand Test) and the IR (Insulation Resistance) on the high voltage end,” Joe detailed. That unit was known as the 1000 H and opened up a large field in a myriad of industries for Cirris.

Not long after, Cirris developed the 1000 R that provided LV resistance measurement and also the ability to test and verify electrical components such as resistors and diodes. “I guess

the underlying thing about all of this,” Ray recanted, “is that everything out there was too expensive for small companies to afford, and Marlin really wanted to be able to fill that part of the market.”

It was a good place for Cirris to find themselves. “Marlin’s philosophy at that time was to stay in the blue water by providing solutions without having to compete with other, larger companies,” Ray said. “Our initial customers were the cable shops who supply the OEMs, so that’s what made the price point so important.”

Ray joined the company in 1992 and discussion had just begun about PC control of the Cirris line of testers. “When I was hired, they had just added serial communications to the testers, but we soon came up with commands that we call CTL (Cirris Test Language) that would send test programs to the tester and manage information and results from a PC.” This was about the time Windows was gaining a foothold as a PC operating system. “We decided to jump right in with the Windows market and came up with Easy-Wire™ software. It was the very first Windows software for running these types of testers, and it really helped us have an advantage over other companies who were using DOS based programs.”

These units were then given the “C” designation, C standing for computer controlled. On the high voltage



Figure 4. Rack-mount Custom System

side, the 1000 CH+ became a rack-mounted system with up to 100,000 test points (CH2). On the low voltage side, the CR units went up to 20,000 test points. Joe added, “Fifteen years ago we introduced the Touch 1, which had a touch screen and PC integrated into the unit, with today’s unit being the Easy-Touch™ Pro.” The units continued to upgrade to the current lineup:

- The Easy-Touch™ Pro with a built-in PC for an all-in-one test system.
- The CH2 compact high-voltage tester used for harness testing.
- The 4200 Series (Figure 3), the newest benchtop tester for easy testing.
- The CR, a versatile low voltage tester often used to test during assembly.

we have,” Joe stressed, “and we always get very high feedback from our customers on our customer service that are way above normal levels for similar size companies.

That intense dedication to customer service and product developments comes from the company culture Marlin instilled from the beginning. The team described the close-knit culture at Cirris as being very much like a family. As Sarah elaborated, “From the beginning, Cirris has been really good about taking care of employees. From free breakfasts and snacks to some great parties and events throughout the year.” Marlin always fostered an active culture at Cirris. Many team members are cyclist and runners and head out for exercise during lunch breaks.

Industry Resources

If it’s information you’re looking for, Cirris has accumulated a great deal of it, and Sarah suggested checking out the Learning Center on their website. “We’ve got thirty-five-years’ worth of free articles on our website. While many of these articles pertain to Cirris products, plenty of articles talk about general testing concepts that can apply throughout the industry.”

Custom Systems

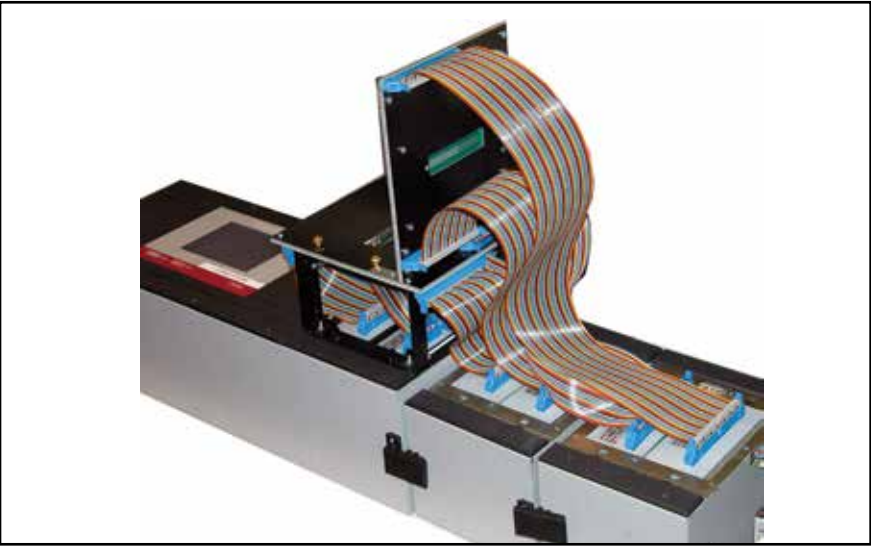
Sarah explained that companies often need specialized units to perform simple and accurate testing. Cirris also builds custom adapters, cable interfaces and racks for these needs. “These large rack-mounted test systems (Figure 4) can contain thousands of test points and dozens of connectors,” she explained “and our custom products group provides solutions to some really difficult situations.”



Figure 2. Easy-Touch Tester



Figure 3. 4250 Tester



Small Custom Tester

Employee Ownership

In 2013 Marlin Shelly decided it was time to think about retirement, and decided to sell the company. But rather than finding an outside buyer, Marlin sought to place his company in the most capable hands — those of his employees. “We were able to secure an SBA loan and convert the company to an ESOP (Employee Stock Ownership Plan),” Joe noted. “We appreciate the opportunity he has given us to be shareholders moving forward, and the company has doubled in revenue since the ESOP.”

Facilities and International Affiliations

The company has always been based in Salt Lake City. “We’ve had three facilities over the years, not counting Marlin’s garage,” Joe joked. “We were on State Street for about 10 years and then Marlin bought a 16,000-sq. ft. facility, and we were there for well over 20 years. Three years ago, we bought a 27,000-sq. ft. building here in what’s called the International Center near the airport,

and it’s been a great location.” Cirris has representation on every continent now, with direct offices in Great Britain, Germany and China. “I want to mention that those particular three affiliations have been key components to our growth,” Joe emphasized, “they were more than just distributors, they were almost divisions of our company.”

Challenges

The subject changed to some of the challenges Cirris is facing these days, and Ray quickly quipped, “Well, the water isn’t so blue anymore.” Other larger companies have entered into the market space Cirris had carved out. As such, they need to remain at the cutting edge of innovation to hold the top spot.

Ray pivoted another challenge, the task of managing the efforts of what is now a much larger company. “We’re no longer a mom and pop shop so we have to make sure we have the right processes in place.” It’s not like it was in the early days with Marlin at the top controlling everything. There’s

now a board and management team in place. He further asserted, “We are careful to grow at a planned rate so we don’t grow ourselves out of business.”

Recent AS9100 Certification

Cirris has been ISO 9001 certified since 1994. One of the more recent challenge hurdles, however, has been the jump to the AS9100 certification. Sarah explained that these processes were already in place, but certification just made them more formal and will ultimately provide even better quality to customers. She was proud to say, “The auditors told us it takes most companies two to three years to become certified, but we did it in nine months.”

Conclusion

Cirris had a great start and was given a solid foundation under Marlin Shelly. He handed the employees a great company, and through their market savvy and determination, they’ve made it even better. The team wished to relay they are committed to providing reliable products with excellent customer service, and are always looking at innovations to meet market needs. Joe summed it up nicely saying, “About 80 to 90% of our business is with repeat customers, and that speaks volumes about our relationship with our customers. We are appreciated, and we appreciate the many customers we have had through the years.”



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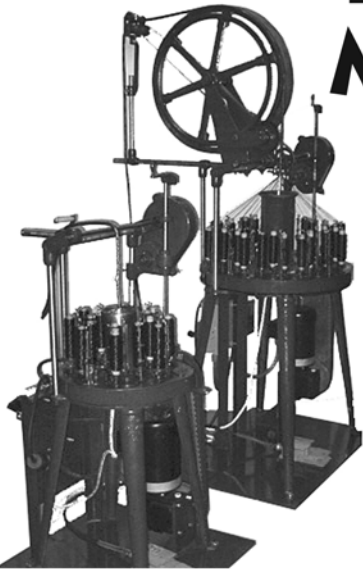
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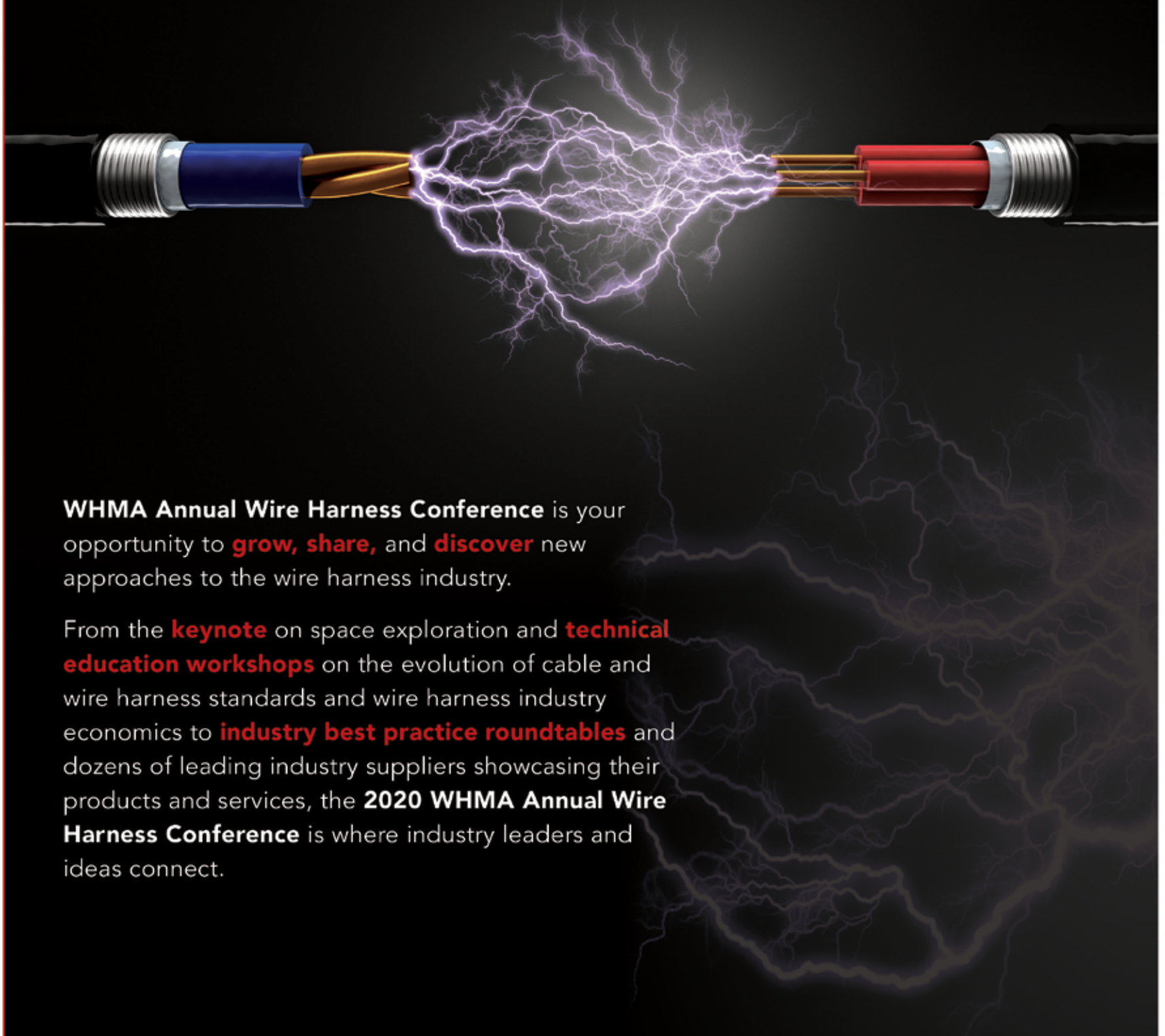
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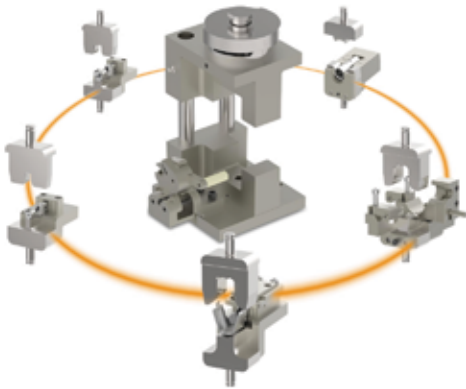


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Increase production with powerful, flexible and affordable high force crimping solutions from TE Connectivity (TE). Our HV-20 and HF-20 bench-top terminators are powerful enough to produce up to 178 kN (20 tons) of crimp force and process wires up to 120mm². Our innovative modular die platform offers greater application flexibility by accommodating a wide range of easy-to-install HV die sets. And don't let it's compact size fool you, our HV-20 bench-top presses are loaded with additional features like an integrated vacuum system, Crimp Quality Monitoring and Industry 4.0 compatibility.

Download our whitepaper on the Challenges of Large Wire Crimping at te.com/hvtooling

Put a driving force behind your production by contacting our sales team at 717-810-2082 or ToolingSales@te.com



For added flexibility, our unique modular platform accomodates a wide variety of die sets with different processing orientations to handle both TE and non-TE terminals.

EVERY CONNECTION COUNTS

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RAZOR-SHARP PRECISION



40
YEARS
CUTTING
EDGE

MIRA 340 wire stripper

The programmable Mira 340 is designed for universal use while maintaining maximum precision.

It is perfect for processing wires and insulation material with demanding requirements. The Mira 340 is fitted with a rotary head with 4X-blades and offers unique functions designed to reduce production time and increase quality. Thanks to sequential processing, multi-conductor cables and multi-layer insulation material can be processed quickly, thereby saving time and increasing productivity.

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