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- How to Select a Polymer for High Temperature Wire & Cable

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Company Profile: Elettromeccanica Zuccoli

By Joe Tito
Wiring Harness News

We have a fan in Italy. Actually, we have a big fan. His name is Ercole Zuccoli and he is the President and Owner of Elettromeccanica Zuccoli - Cablaggi Elettrici ed Elettronici (Electric and Electronic Harnesses). Ercole has been receiving the hard copy of our publication since its inception. We were proud and honored to be able to highlight his journey in the harness industry in this issue's Profile. We had a wonderful Skype session with Ercole, his son Luigi, General Manager, and daughter Francesca, who was our interpreter.

Elettromeccanica Zuccoli was officially founded in 1970 by 33-year-old Ercole Zuccoli in Mandello del Lario, a beautiful town on the shores of Lake Como. Ercole had just taken

over Elettromeccanica Zuccoli - Motori Elettrici (Electric Engines) from his father Pierino, who had become increasingly ill. The business had suffered during Pierino's illness and had been reduced to two employees.

Ercole did a thorough analysis of the dwindling business. The engines they were making represented a narrow offering in a product that was well into its life cycle maturity. It would have been useless for him to spend money ramping up production in that field. Because he didn't have the capital to create a product line in another industry, he chose to specialize in the fabrication of an intermediate component as a contract manufacturer. Having read about the large per capita consumption of wire in everything from household appliances to automobiles, he decided to concentrate his efforts on wire processing in support of these industries.



Elettromeccanica Zuccoli on the Shores of Lake Como, Italy.

Being a meticulous soul, Ercole analyzed the personnel requirements along with the equipment he would need to reinvent Elettromeccanica Zuccoli with limited funds. He immediately brought on three additional employees knowing the assemblies would require a lot of manual input. He still remembers with excitement the arrival of his first Artos CS 15 cut and strip machine from the USA. It seemed like a treasure to him, and he keeps it as a memento to this day.

Work began coming in at a robust pace. They were building a gas boiler harness that represented 300 units per day, and another set of harnesses for a well-known, high-performance Italian motorcycle manufacturer. He quickly ramped up to 15 employees, all with a great desire to work, learn, and make sacrifices to produce results.

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Harness Manufacturer Takes Steps to be CMMC Ready

By Joe Tito
Wiring Harness News

In the last issue of WHN, we took an in-depth look at the new Department of Defense (DoD) cybersecurity requirement called CMMC. If you are currently doing any work directly or indirectly for the DoD, you should be making steps to complete the requirements now. You can take a look at that article for free on our website by clicking "Read Past Issues" under the "More" tab at www.wiringharnessnews.com.

In a nutshell, the new framework provides enhancements to DFARS 252.204-7020 and NIST 800-171 cybersecurity guidelines. There are new protocols, but the major difference between the old guidelines and the new framework is that the previous rules allowed for shelf assessment. CMMC will require a third-party auditor to assure compliance.

As we stated in the article, the DoD has yet to complete training for auditors. Nonetheless, some companies are completing the requirements to be CMMC ready. One such company is Certified Manufacturing of Holt, Florida. Certified Manufacturing builds harnesses almost exclusively for programs in support of aerospace, space, and land defense systems. Pamela Bechtold, President,

and Bob Bechtold Vice President/COO recently spoke about their journey through the new DoD cybersecurity framework.

A couple years back, the company was delivering an electromechanical assembly for a low-volume defense program. When they came back for the second round RFQ of that assembly, there was a new box to be checked. It was for a DFARS cybersecurity requirement that Certified Manufacturing hadn't seen before. "They called and said they were ready to place the order, but we hadn't checked the box. I told them I can't do that without lying," Bob recalled. The procurement office indicated there was no current system in place to verify compliance, they just seemed to want the box checked. But that just wasn't an option for Bob and Pamela. Integrity had always been at the forefront of the company's dealings, and that wasn't about to change just to get an order. They respectfully "no quoted" the business.

They started to notice the DFARS requirement popping up in subsequent quotes, so Bob and Pamela knew it was time to take action. "We decided we were either going to be in this game, or we weren't," Bob recalled. He equated it to their decision to become AS9100 registered back

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2021 Electrical Wire Processing Expo Postponed Until 2022

How managers of the 2021 EWPTE, WHMA/IPC and Wisconsin Center District staff met with the newly formed EWPTE exhibitor advisory board, who unanimously made the critical decision to postpone the event due to ongoing concerns with COVID-19. The advisory board is comprised of representatives from the following companies: Amphenol CTI, Anixter, Artos, Brady Corporation, Cesar-Scott, DIT-MCO, Dynalab Test Systems, Hellermann Tyton, IEWC, Komax, Molex, Schleuniger Inc., Southwire Company, TE Connectivity and Telsonic.

Because of extensive face-to-face networking and hands-on educational opportunities offered by EWPTE, the advisory board chose not to transition the event to a virtual one, focusing instead on providing the electrical wire harness, wire, and cable processing industries the in-person event they have come to expect the last 19 years.

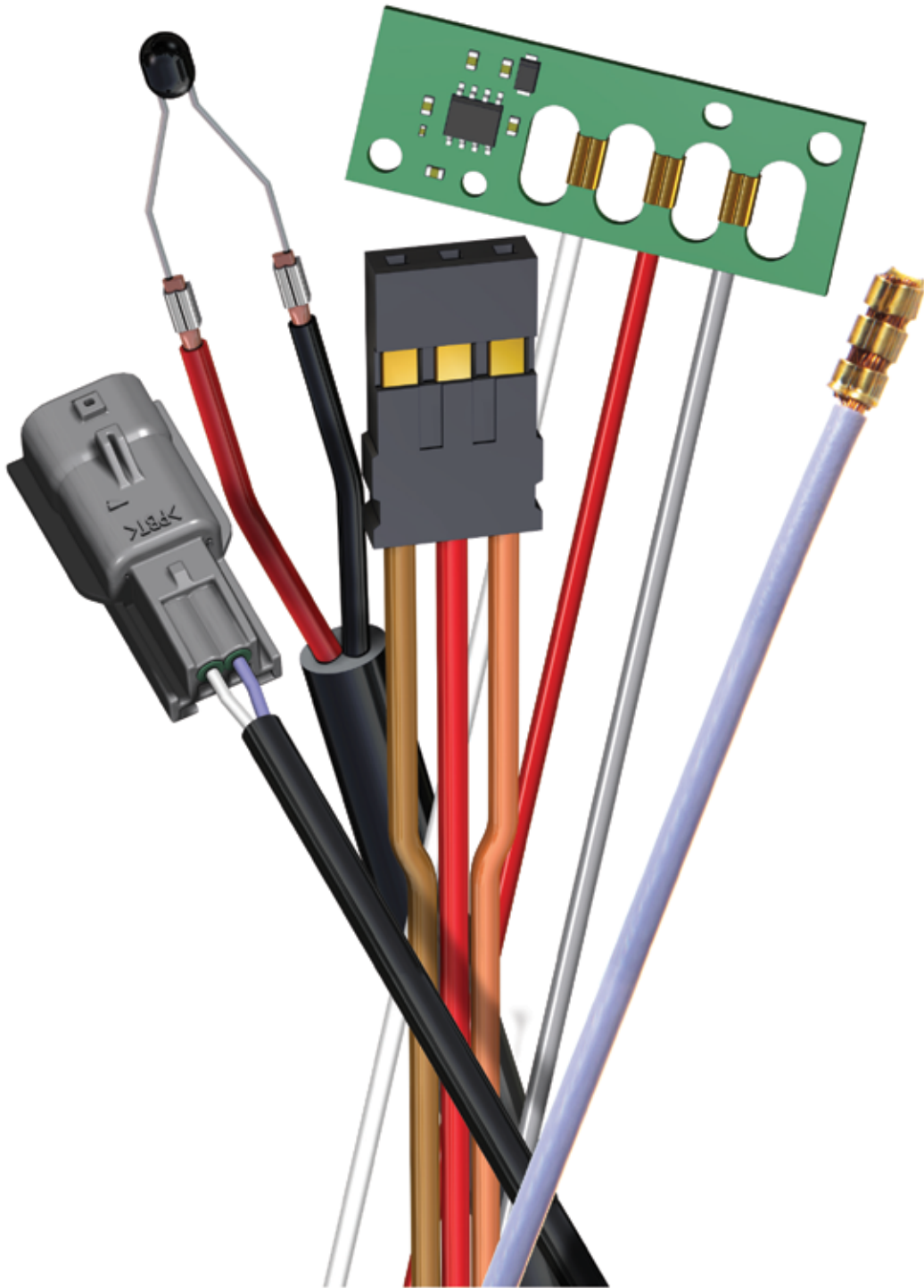
EWPTE will be held in the Wisconsin Center in Milwaukee, Wisconsin, May 10-12, 2022. Details regarding the event will be available soon; visit www.electricalwireshow.com.



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From the Editor

Greetings Readers,

Wow! It's hard to believe it's the March/April issue. I think we have another great one for you. Brent Stringham has an excellent article in our Focus: Mil/Aero section, but I would encourage all to read it without regard to the customers or industries you serve. We also have a great article that highlights some long-range opportunities in the Mil/Aero arena. And, as always, we've got some great technical content throughout the issue.

The folks we talk to are busy, so that's a good indicator as to the state of the industry. 2021 will be another year without any conferences or trade shows for harness manufacturers. We are certainly missing the face-to-face contact with all of you. But, please do connect with us via Twitter (@WiringNews), Facebook or connect with me personally on LinkedIn or email. I'd love to hear from you.


If you have suggestions for editorial content, give me a shout. We hope you look at Wiring Harness News as your research arm. If you are looking for more in-depth coverage of a particular subject, you can bet others are as well. As always, if you'd like to contribute some content to the publication, feel free to contact me. Check out our Editorial Guidelines under the More tab on our website. I'm here to help with writing if need be.

Kindest Regards,

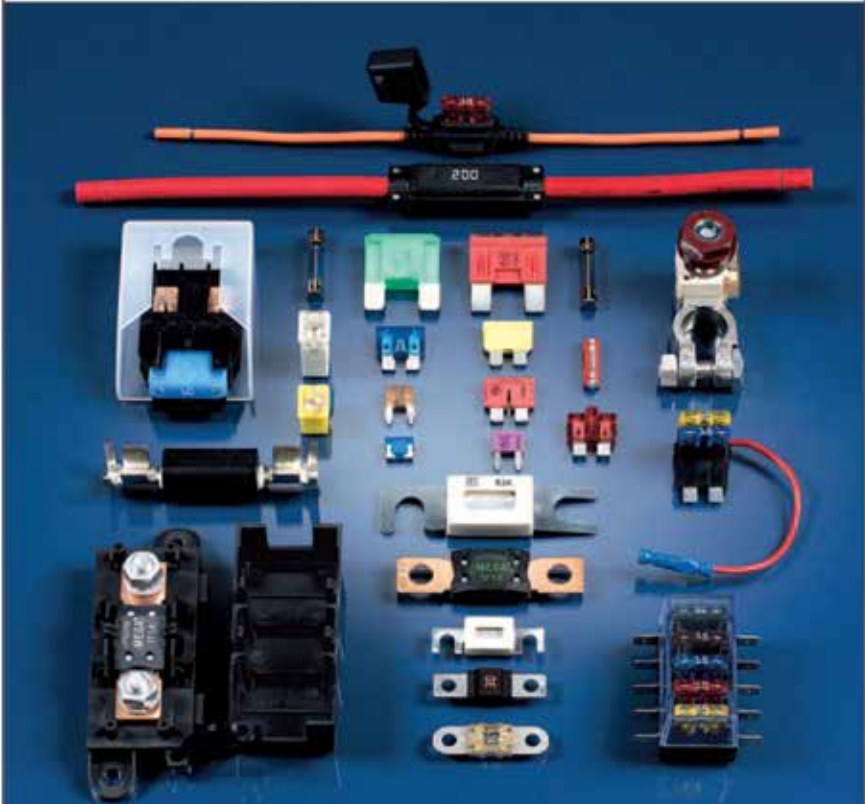
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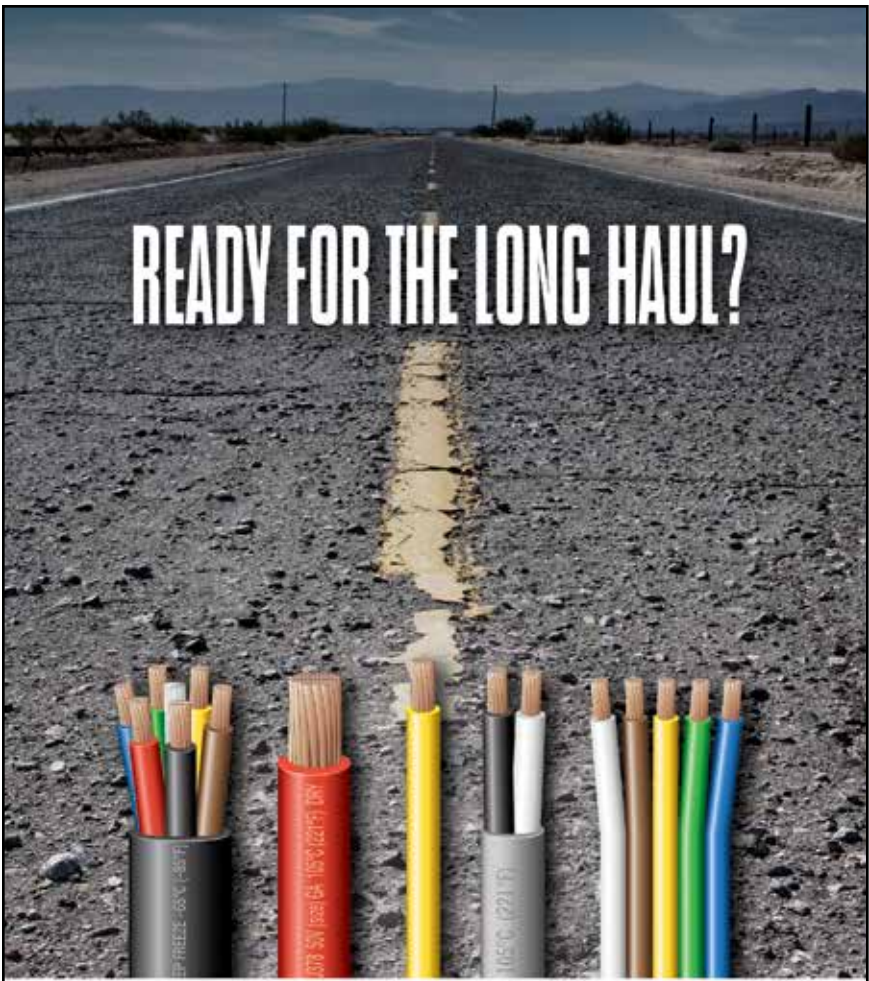


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Harness Manufacturer Takes Steps to be CMMC Ready

Continued from page 1

in the early 2000's. "Boeing said we were going to be AS9100 or we weren't going to be in the game, and we made the decision this would be another qualification we would need to hold to stay in business." They learned that the DFARS requirements were just the first step, and that the CMMC certification was the ultimate long-term solution as it was scheduled to come online in 2020/21.

When they first presented the requirements to their IT consultant, they hit a brick wall. "He said he couldn't even read

this stuff let alone guide us to compliance," Bob remembered. Certified Manufacturing turned to the consulting outfit, Florida-Makes who helped them find an IT consulting firm dedicated to getting them up to speed in 90 days. The IT Consultant did a gap analysis to determine the steps to get them where they needed to be. "We had about 40 computers and a server," Bob cited. "We are a small business, and we would just buy a new computer when one broke. We had everything from Windows

7 to Windows 10, with none of them running any real encryption."

The new IT consultant took all the old computers, destroyed the hard drives in accordance with proper procedures, and replaced them with new computers and a more robust server. They then programmed everything with cutting-edge encryption technology. They also installed proprietary software so Bob and Pamela's internal team could monitor the system in accordance with the

new controls. "If you have a breach on some high-level information, you have to guarantee you can identify it, contain it and fix it within the amount of time specified by the CMMC requirements."

The government has yet to complete the training for the new CMMC auditors, so the company is very careful about how they describe their achievements in documentation. "We say in all of our communications that we are CMMC Level III ready, implying that we are ready for certification."

Certified Manufacturing is already reaping the benefits. "We're actually bidding on a job right now for a major defense upgrade to one of the weapons systems, and we actually got written into the contract because we were Level III ready. I mean, we got in on a major job that is being implemented right now because of these efforts. We are seeing very big opportunities because we can say we are CMMC Level III ready. So, it's real!"

As they wait for their official audit, this is how Certified Manufacturing is relating their cybersecurity status:

Certified Manufacturing is 100% compliant to DFARS 252.204-7020, NIST 800-171 and 99.5% compliant to CMMC Level 3 (ready)

Read about the history of Certified Manufacturing in the next issue when WHN highlights them in the Company Profile.

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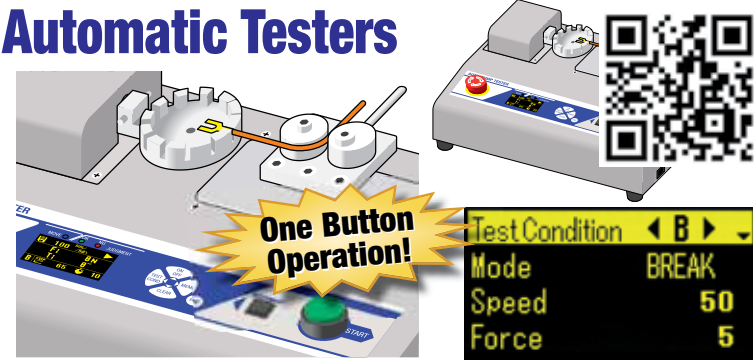
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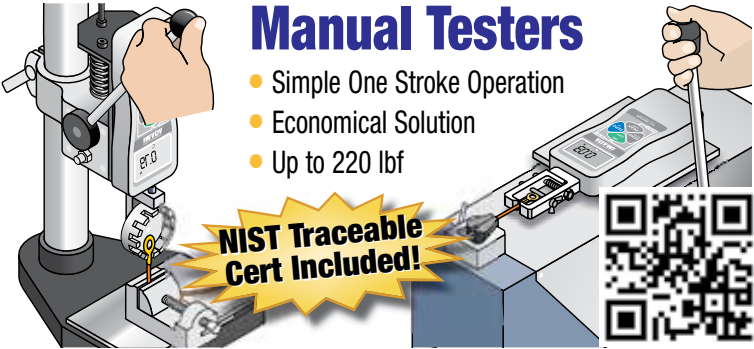
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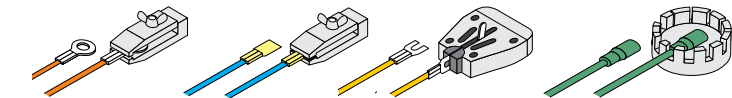
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LEADERSHIP

PUTTING INSIGHTS INTO ACTION

Three Reasons for Manufacturing's Resilience

By Paul Hogendoorn

The manufacturing industry in North America has proven to be very robust, resilient and durable during the Covid crisis. Even before the pandemic, there was a concerted effort by industry to secure their supply lines by reshoring to North America, and the motivation to do this has only intensified.

Through the aggregated productivity data that my company gathers for many companies across all the major industry sectors (automotive, heavy equipment, food and beverage, wood products, steel and metal processors), I see that over all "value adding activity" has, by and large, returned to pre-Covid 19 levels. Because the services my company provides are essential to these operations, I have had opportunities to visit some of these plants and gain key insights that offer an interesting narrative to support that data. Though not scientific or empirical, I'd like to offer 3 reasons for the resilience of our manufactur-



Paul Hogendoorn

ing sector, and why some have come through it stronger.

1. Demand for products. The demand for the products remains strong. North American manufacturers are primarily focused on 'higher value' products (as low value products have mostly moved to low-cost

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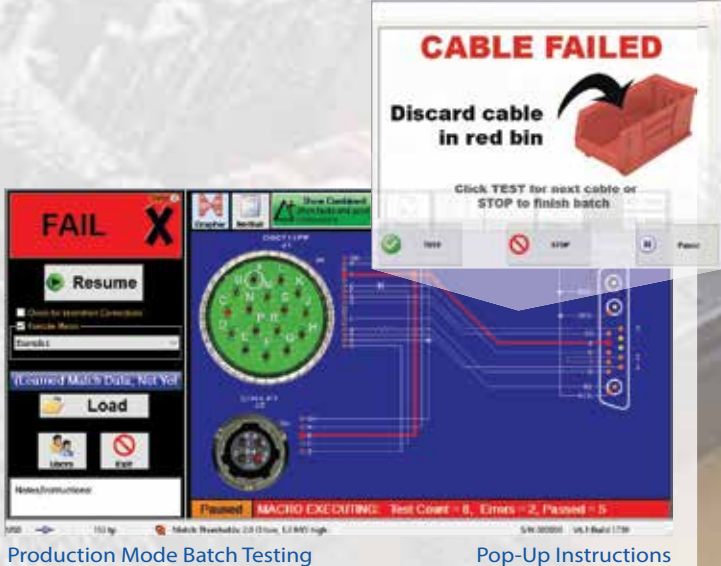
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Three Reasons for Manufacturing’s Resilience

Continued from page 8

regions of the world in previous decades). The products produced include cars, other transportation vehicles and components, appliances, building materials, food and beverages, medical devices and many more high value items. These companies sustain many decent, middle class jobs, and the people they employ continue to have a secure, sustainable source of discretionary income. That discretionary income (from the still healthy middle class at large) is no longer being spent on vacations, entertainment and services, but on homes, home improvements, cars

etc. - in other words, on high value “durables”.

2. Employees are their customers. We, as consumers, buy what we make. Manufacturing produces more than simply the products consumer’s purchase; it produces the jobs which help create and sustain the economic wealth that then supports a marketplace of consumers able (and willing) to purchase their product. (Case in point: car producers in North America are not laying off people because people are continuing to buy their cars). The goal of a sustainable manufacturing industry must include the people that build, and buy, the products produced. After visit-

ing a range of factories the last few months, I remained convinced that the leaders and owners of these companies are committed to their people, community and our society. About 20 years ago, when I was the chair of the London Region Manufacturing Council, I recall hearing Ray Tanguay, then president of Toyota North America, respond to a question about whether or not the value of the Canadian dollar would prevent them from opening their new Woodstock facility. His answer was simple: “we will build our cars (and trucks) where our customers are buying them.” Our factories create both the product and the market for the product, just as they did in Henry Ford’s day.

3. Great people. Certainly, we’ve heard about how special our front-line workers are, (and they truly are), but our manufacturing people are pretty special too. They are inventive, creative, dedicated, dependable and loyal. In short, they are hardworking folks that deliver tangible, tactile results that meet the objectives set every week, day and shift. Everyone involved depends on others to do their jobs too, every hour, every shift. No excuses. The rewards of their efforts are not just their paycheck, but the satisfaction of building, making, finishing, achieving something, every day. When there is no crisis or pandemic, they deliver. When there is a

crisis, they rise to the occasion, adapt, invent, and deliver even more.

On one recent plant visit, one worker shared with me that the world outside of the factory was pretty topsy-turvy. Life at home was different, he said; education was now at home, entertainment was curtailed, and social activity limited to ‘virtual’ connection (which is not really social at all). But, at work in the factory, life was pretty close to feeling normal. PPE was already a part of most jobs and interaction with others was already structured and limited to breaks. By their nature, most of his coworkers (he suggested) appreciate having their personal space and didn’t mind having it delineated a bit more. Changes in the workplace are there for sure, but comparatively, the workday has been a welcome period of near normalcy for many.

And lastly, I have to mention technology, and focus. Technology allows a lot of the administration and management to be done remotely, and most folks on the floor – those that add value to the product produced every shift and day - don’t mind that at all either. The companies that have come through this stronger have done so by sharpening their focus on their value adding activities, getting more done in less time, and by unleashing the adaptive, dedicated and innovative potential of their people.

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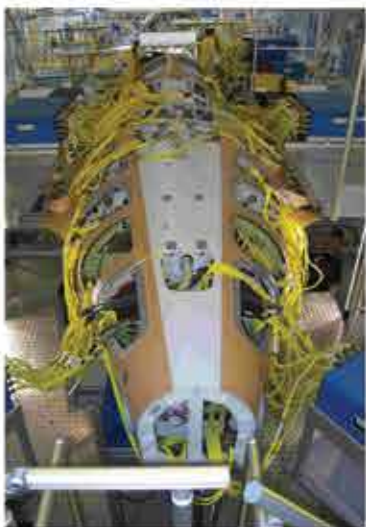


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Crucial Google Tools to Grow Your Wire Harness Business

By Christine Siebert
Siebert Consulting Group

I'm pretty sure that most people are familiar with Google as a search engine that can easily find answers to all questions (possibly a little ambiguous questions) and of course, to find businesses and products. I know before I do anything, I check with google for the best business for my needs and always check the competitors' websites. This process is no different for customers searching for your products and/or business.

Google is the most important search engine in the United States, controls over 85% of ALL internet searches. Whether your customers are searching on their desktop, mobile phone, or tablet, Google is most likely the search engine your customers will use.

Did you know that Google has different tools that can assist you in growing your business? In this article, I'm going to discuss three of my 'must-have' Google tools in my marketing efforts.

1. Google My Business

I'm a huge fan of Google My Business for all types of businesses. This is the tool your company will use if they are serious about having your business found online.

Google My Business (GMB), is a FREE easy-to-use tool your wire har-

ness business can use to manage its online presence while using the Google search engine. With over a billion searches each day, it is easy for a business to be almost undiscoverable and miss out on important opportunities. The GMB tool will help you build a stronger web presence and ultimately generate more leads. And who doesn't love more LEADS!

Google My Business gives you the ability to create, customize, and manage the information displayed on your Google business profile publicly in Google search and the key to showing up on Google Maps.

What's included on your GMB page:

- Business name & the category/industry of your services or products
- Business location & address
- Contact information
- Opening/Closing hours, Holidays to show when you're business is closed
- Links to your website and other channels (Facebook, LinkedIn)
- Product photos & video
- Reviews and star ratings

Google relies on three factors for search ranking:

- **Relevance:** How well your business profile matches a search query. The more complete/detailed

your profile, the easier it is for Google to determine relevancy.

- **Distance:** How far your business is from the location used in a search query.
- **Prominence:** How is your brand performing; Google measures online and offline prominence. The more prominent your wire harness business, the more likely you are to appear in search results.

Finally, Google My Business not only puts you in front of customers in Google search and maps, but it also provides useful information to help you gain a better understanding and how to further expand your online presence. GMB provides Analytics for your business. It will share data on where your customers are searching from and how they found your business.

2. Google AdWords

There are various platforms online that you can invest in with Search Engine Marketing but Google AdWords is definitely #1 in my book. Pay-per-click (PPC) advertising is, without a doubt, the simplest and most effective way to drive traffic to your business website. Google has revolutionized the PPC space, this style of advertising gives businesses the potential to grow any type/size of business.

Google Ads provides a competitive edge with some amazing benefits including:

- Highly measurable digital marketing tool
- Drives quality leads to your website and business
- Ability to increase sales and conversions
- Target highly defined audiences
- Access to Google Keyword Planner
- Work to your own budget & have clear control of your advertising expenses

Of course, there are some drawbacks to think about:

- Expertise of AdWords program
- It can take time to see results
- PPC can be expensive if you are not proficient with the tool

So how does Google AdWords work?

The simple answer is each company pays for each click their ad receives in the Google search engine. These are called Google Campaigns. The more organized these campaigns are with the right keywords, I suggest using the Google Keyword Planner, the more clicks you will receive from YOUR audience. Then after they click the ad, make sure you have a customized landing page. This is an important step if you are using AdWords to collect leads.

Continued on page 14

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Crucial Google Tools to Grow Your Wire Harness Business

Continued from page 13 _____

3. Google Analytics
Promote better business decisions with data. Analytics isn't just reports. It's analysis. Google Analytics can provide a wealth of data and information. The key is turning it into insights to continually improve your online marketing efforts. You can use your Google Analytics account to improve your current website, PPC, Social Media, and more. You will be able to find more visitors, track conversions and find the answers and insights that will improve your business and a deeper understanding of your customer experience.

So what exactly are the main benefits Google Analytics?

- It's free! You cannot beat that price!
- The data is collected automatically
- You can customize your reports to align with your goals/objectives
- Integrates easily with other tools like Google Ads and Google My Business
- Measure organic search traffic so that you can see the keywords your customers are looking for when searching for your products
- Helps you figure out why

your customers are leaving your website

- Helps you better comprehend your demographic, including age, gender, interests, devices and location

It's simple to start with Google Analytics. It can be set up with just a few simple clicks – then, you'll be presented with a JavaScript code that you'll need to have your webmaster embed into every page of your website. If it's a WordPress site, you can just download a plugin instead.

This FREE tool is a must for any business that has a website.

The data provided from Google Analytics helps you gain a better sense of awareness of the type of content that drives traffic, if it is driving the right traffic to the right pages and if your pages need to be optimized to help achieve your digital marketing objectives.

There are many tools at your disposal to help you in your Digital Marketing Efforts but Google tools should be at the top of your list. Now, these tools are great, wonderful, fantastic but they can be confusing and time-consuming. I would highly suggest that you have an expert, whether within your marketing team or a consultant, help set up and monitor your accounts.

Siebert Consulting Group is well versed in all Google products and will provide you with the support and guidance you require to accomplish your goals and maximize the return on investment, increase leads, and/or drive brand awareness. These platforms can get very tricky and can be a complete waste of money if not properly managed. With our experience, we can be sure to attract interested customers. If you are interested in learning more, please visit www.siebertcg.com or call/email me, Christine Siebert, at 630-299-9121, christine@siebertcg.com.

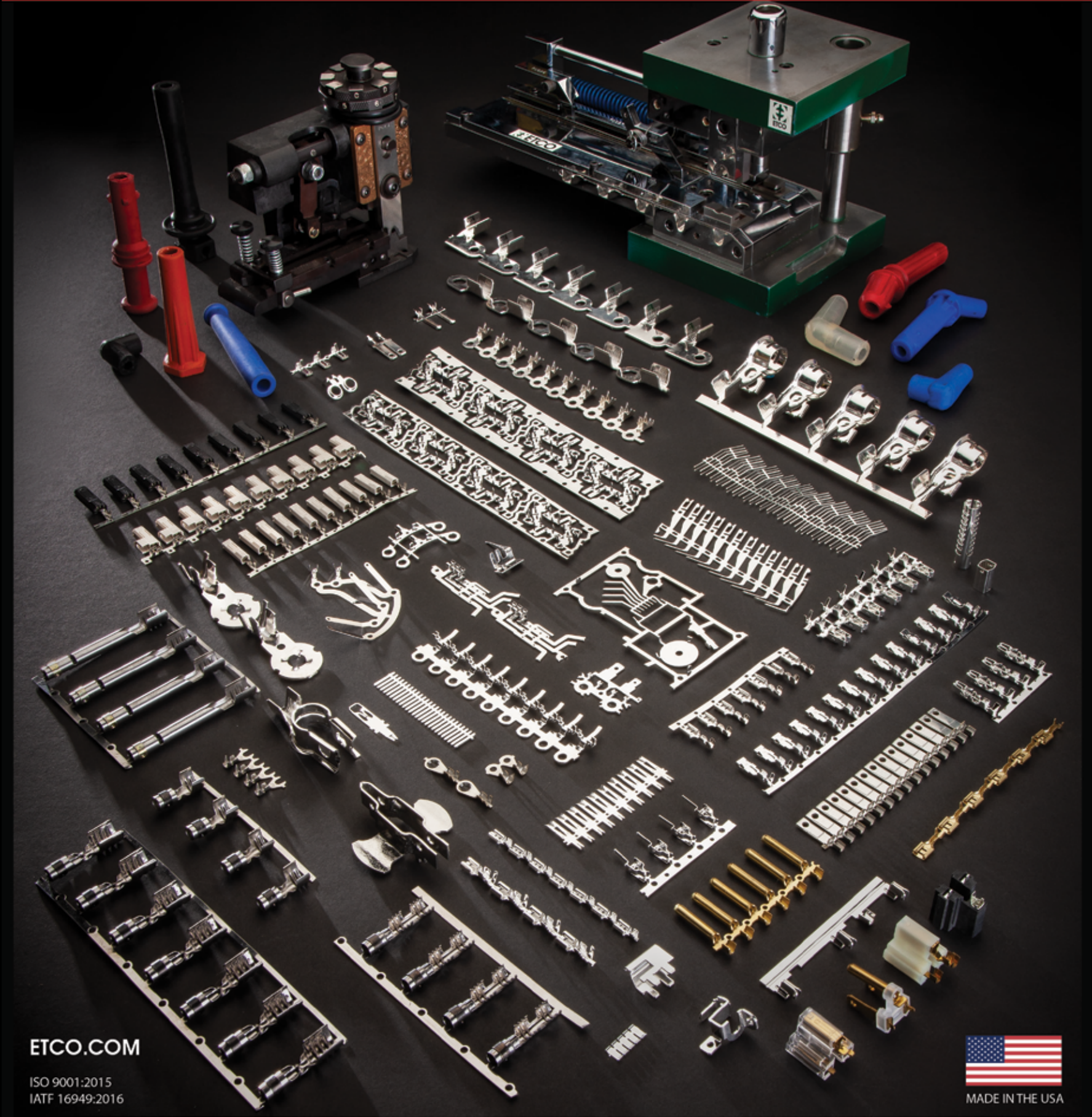


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Elettromeccanica Zuccoli

Continued from page 1

In 1980, Ercole traveled to the USA for the first time. He visited Artos, Eubanks, Kingsley and Lamcor, a harness manufacturer in Los Angeles. His goal with the latter was to learn from a large player in the country that was the trendsetter in worldwide harness production. He came away from this trip realizing that in order to grow and prosper in the industry, his company would have to get serious about automation.

Around that time, Swiss manufacturers were beginning to fill this niche, and Ercole visited the Lotech

company in Wallisellen as well as another fledgling company called Komax in Lucerne. He became fascinated with the innovative vision of Komax, and especially the founder, Max Koch. The two spent time in Max's workshop. At that time, it was located on the second floor of Max's fathers General Motors dealership. Ercole was so impressed, he purchased a Komax K40 and personally transported the partially disassembled machine back to his factory in his van (see depiction below). Ercole was the first to mount two applicators on the K40 manufactured by another new company, Mecal.



On the occasion of Komax's 25th anniversary, they presented Elettromeccanica Zuccoli with this vignette depicting Ercole transporting that first wire processor back to his facility.



By 1987, production increased considerably. The company added three additional Komax cut/strip machines, and a fully automated K43 cut/strip/crimp machine. An Italy based, multinational toy manufacturer outsourced all of their wiring to Elettromeccanica Zuccoli and they grew to about 20 employees. This necessitated the move to a much larger facility just two kilometers south in Abbadia Lariana, but still on the shores of Lake Como.

In 1995, Ercole attended the Assembly Technology Expo in suburban Chicago, and became fascinated with the technology to overmold connectors. He immediately purchased a Nordson WS 200 double-mold machine. The choice was a good one, bringing the capability to overmould connectors to Italy for the first time.

In the meantime, Ercole's son, Luigi joined the company and eventually took over the organization of production and staff. In 2005, Luigi spearheaded the company's effort to become ISO: 2000 Certified. That action further catapulted the company's growth in both customers and sales volume

In 2006 they purchased a neighboring small harness manufacturer. The owner was a competitor and friend of Ercole who was no longer able to continue his business. The five employees and customers list were melded into Elettromeccanica Zuccoli.

One of Luigi's great achievements was the corporate agreement he struck with Semar Italia. The company was a client of Elettromeccanica Zuccoli.

Continued on page 19

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M & A 101:
Lessons learned from decades of deals

Are US Wire Harness Plants Ever a Low-Cost Option?

By Loren Smith

My short answer to the above question is “Definitely.”

And why does this important, fundamental question continue to be asked? Probably because our perceptions are clouded by awareness of all the high-volume automotive and appliance harness manufacturers that have moved to Mexico, China and a variety of other “low-cost” locations. In actuality, however, multiple locations in the United States have low-cost harness shops with the capability to provide users a competitive product. These companies--many of them situated in low-profile towns around the country--enjoy strong positions with their customers despite threats from Mexico and China. Furthermore, in many cases their proximity to customers is a real advantage.

My initial awakening to skewed perceptions about geography and the people who populate our unsung towns occurred when I moved my wife and our three teenagers from Boston to Monona, Iowa--population, 1000--where I had bought a struggling wire harness manufacturer to become an entrepreneur. Particularly memorable is one of my first trips to the post office.

As I was opening our PO box, I noticed several farmers in coveralls pointing at me. Then one of them was designated to come over. Looking me up and down in a friendly way, he asked, “Do we know you?” And so began our acquaintance. Certainly, nothing this direct had ever happened to me in New England or in Cleveland, where I grew up.

After the first snowfall, when I slid off the road into a ditch, I was relieved to see the very first pick-up truck to come along pull up beside me. With what was now familiar Monona efficiency, the driver got out, hooked his truck to my car with a chain, and pulled me out of the ditch in under five minutes. Little conversation; no fanfare. These people were the kindest bottom-line types I had ever known.

It was only natural, then, that the workforce I was fortunate to be associated with in Monona consisted of exceptionally hard-working

and loyal people. And in the years since my time there, I’ve observed harness companies in many states in this country characterized by similarly dedicated staffs and high productivity, enabling them to compete with offshore “low-cost” labor quite effectively.

Moreover, the can-do picture I am painting is hardly restricted to small towns. I am familiar with an excellent low-cost wire harness option in the heart of Los Angeles. Directly across a freeway from a neighborhood that sports \$10 million homes, the plant sits in an enclave consisting mostly of recent immigrants eager to compete

with offshore workforces. From coast to coast, in pockets of major US cities and in towns like Monona, Iowa, our industry is blessed with plenty of high-quality, low-cost wire harness options.

I believe there will continue to be a vibrant mix of wire harness manufacturers in the US for many years--and, unfortunately, I expect that misconceptions about US low-cost options will continue for many years as well. I hope my view helps chip away at this perception.

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



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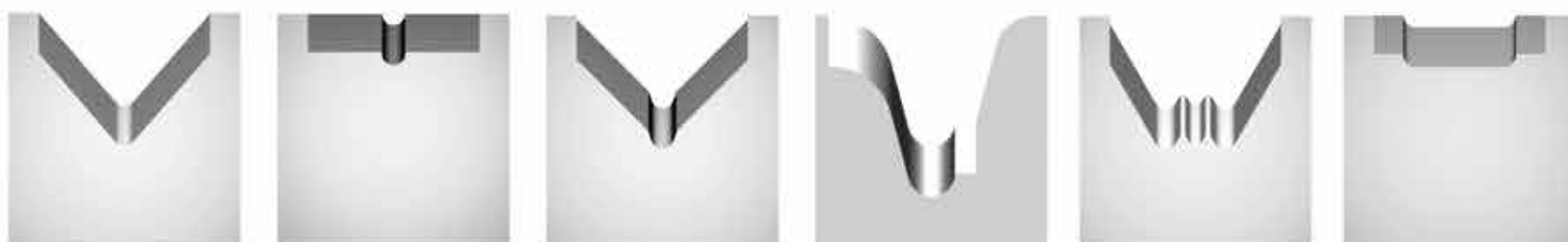
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Elettromeccanica Zuccoli

Continued from page 16 _____

coli and owned a subsidiary in China. It was a shareholding agreement by Elettromeccanica Zucconi and Semar China. The goal was to produce lead-acid batteries for toys in China with the special wiring necessary to meet US and European safety regulations.

The agreement was signed in 2008 and continues today.

Around 2010, Luigi saw an opportunity with quad ATVs that were quickly becoming popular in other parts of the world. He took advantage of the company's 40-year experience in the motorcycle market and struck a deal with the importers of these

Japanese and the American brands. Elettromeccanica Zuccoli would build the harnesses to make these vehicles compliant with European regulations. In more recent years, the company has done the same with eBike importers, a smaller but

growing niche. They take delivery of prototype vehicles and reverse engineer the wiring components to make them compliant. Completed assemblies are then shipped to the importers for final assembly.

Continued on page 20



Part of Elettromeccanica Zuccoli's commitment to the environment is repurposing that which might otherwise be trash. Here, are some Komax shipping crates converted into two stylish and comfortable work spaces. Fabrizio Scandella, Technical Manager.


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Elettromeccanica Zuccoli

Continued from page 19



Team Shot of Elettromeccanica Zuccoli.

Over the past few years, significant investments have been made to process improvements. They replaced some of the older machines with more modern, computer controlled Komax units. The QC department was enhanced with equipment to do cross-section crimp analysis. That's essential to verify proper setup procedures for their 400 plus applicators, mostly made by Mecal. Ercole designed and built shelves to house the applicators along with a myriad of dedicated spare parts.

Today, Elettromeccanica Zuccoli employs 41 people and turnover is almost nonexistent. That means a lot to their 80 plus customers, many of whom are large companies or multi-national brands.

Last year they celebrated their 50th anniversary with a company

gathering, but it wasn't just a party. The group used it as an opportunity for all team members to contribute their vision of the company's future. As a result of that interaction, the company installed a 60-kWh photovoltaic system to provide renewable energy to the building as well as charging stations for electric vehicles. The company has already purchased an electric car and plans to upgrade the company fleet with new green vehicles in the future.

Their proximity to such a pristine setting as Lake Como compels the team towards environmental responsibility. Rather than discard them as scrap wood, the company goes to great lengths to make use of shipping crates. They recently built two offices for shop floor managers out of Komax shipping crates.



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Covid-19 had a minimal impact on the company in 2020. They had to completely shut down from March 26th to April 13th by order of the Italian government. When they were allowed to open again, they had to stagger shifts and follow strict distancing guidelines in the office and workspace. Despite this, the company grew in 2020, posting a ten percent increase in sales.

About 15 years ago, Ercole looked around his factory and found the surroundings drab and unappealing. Having recently visited an exhibition of American painter Edward Hopper, he was inspired by the portrayals of lighthouses and sandy beaches. He hired a professional painter and had the halls adorned with murals depicting similar calming images.



ELETTROMECCANICA

ZUCCOLI

Ercole personally designed the logo in 1957 right after finishing high school. At that time in Italy, very few companies were identified by a personalized logo. But Ercole wanted his father's company to have its own logotype, and he wanted to create it himself. He wanted something that would intrigue whoever observed it. He searched for something multidimensional that wouldn't necessarily be easy to create with conventional drawing tools as there were no computers at the time. He built models various elementary parts he saw in his head - the circle with the electron, the sine curve and the diode symbol. He assembled them all and hanged the parts from the ceiling with fishing line. He took pictures from various angles and perspectives, then chose the one he liked most. The logo he created has been identifying Elettromeccanica Zuccoli for 64 years!

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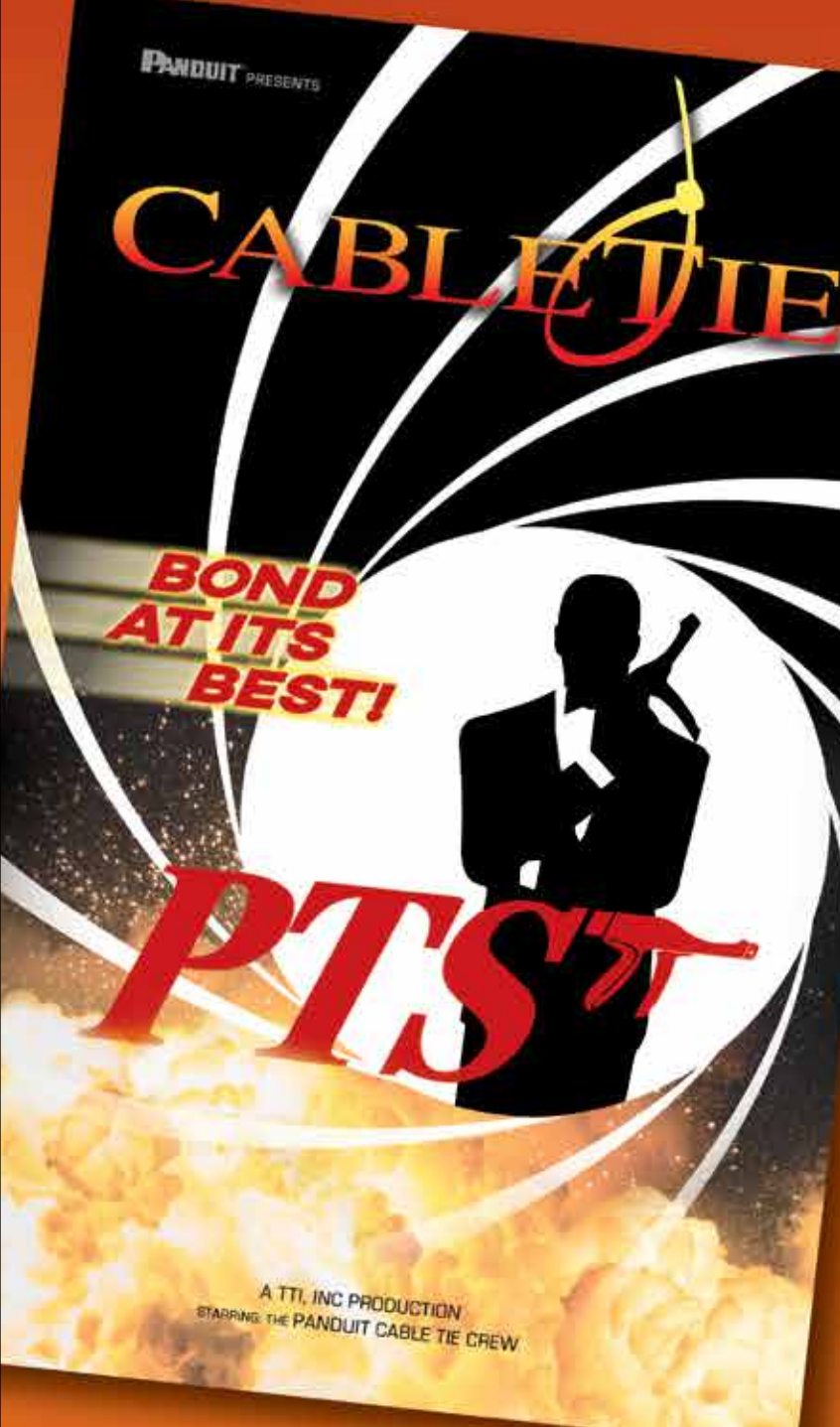




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Back to Basics

Soldering Vs. Crimping: Advantages & Disadvantages



You can have the ideal connector and cable for your application, but the wrong method of attaching that connector to the cable can result in an unreliable, problematic connection. Creating connections for cables involves one of two methods: soldering or crimping. Both methods can achieve a long-lasting, high-performance cable connection when applied correctly, but they each have their own advantages and disadvantages.

Soldering
Soldering is the more traditional method of wire termination, and it's also the most economical. Soldering involves melting and cooling an alloy composed of lead, tin, brass, or silver into solder cups to bond a wire conductor to a contact. This method is typically recommended for general-duty and industrial applications that require reliable signal and power connections.

Continued on page 27

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- 1 - EUBANKS 02940-05 Cut & Strip w/Prefeed, Coil Bowls
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- 1 - HELLERMANN TYTON Swiftmark Label Machine
- 1 - JST Press, Model AP-K2N
- 1 - JUNQUAN 2T Semi-Automatic Terminal Crimping Machine, Model SATC-20, 2007
- 1 - KODERA C551 Cut/Strip/Crimp Machine
- 1 - KODERA C373 Cut & Strip Machine
- 1 - KOMAX BT752 Bench Top Crimper, 2014
- 1 - KOMAX Gamma 333LCD Crimping Machine
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- 1 - SCHLEUNIGER SC200 Stripper/Crimper
- 1 - SPECTRUM Capris 50-300 Laser Wire Marker, 2005
- 3 - T&B Crimpers, Models 25000, 13500, 12050
- 1 - TE High Voltage Hydraulic Crimping Machine, P/N 528008-4, 2014
- 1 - TIE BOY Tyer, Model A206
- 1 - TRI-STAR TECHNOLOGIES Laser Marker, Model M-100L/FG-TT
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Soldering Vs. Crimping:

Continued from page 25

Unlike crimp terminations that require specialized tools, nearly any size wire and solder contact can be terminated with a basic soldering kit. Because the tooling is so minimal and the only materials required are solder and flux, there can be significant cost savings. In short, the primary benefit of soldering lies in its affordability.

There are, however, disadvantages to soldering. The soldering process generates heat in the contacts, the connector, and even in the cable. This unavoidable heat generation has the potential to cause problems, especially when the temperature rises above the operational limits of the insert. Additionally, a soldered connection will require a RoHS-compliant solder. This is problematic because many solders contain lead, which is banned by RoHS.

Soldered connections are also more sensitive to both corrosion and vibration, which can be especially problematic for applications that involve harsh environments. While sensitivity to vibration can be combated through the use of a backshell (which protects the connection and provides a degree of strain relief) there is an added cost associated with using a backshell.

The soldering process is also more time-consuming than the crimping method, and it can create problems with both quality and reliability if not performed correctly. For example, "cold" solder joints can result if the solder does not completely melt. This creates a rough, uneven, or lumpy surface, resulting in an unreliable bond. In fact, cracks may develop over time and cause serious issues. In addition, the filler metal used for the soldering connection will degrade over time and can cause the connection to fail.

Crimping

Crimping uses the application of pressure to attach a contact to a wire. This method requires a crimping tool, and the connection is made when the handles of the tool are squeezed together to crimp the contact and wire together to form a solid connection. Crimping is recommended for applications that require high reliability in harsh environments.

Crimping has several advantages over soldering. It is a simple, fast process that can be either performed manually or automated via a crimping machine. Crimped connections create an air-tight seal between the connector and the cable, resulting in long-lasting, reliable connections that are protected from environmental conditions such as moisture, sand, dust, and dirt. When a skilled technician is in charge of the crimping process, the connection may result in a highly durable "cold weld." Crimping is also more consistent than soldering, which can vary according to the method used or the skill level of the technician.

However, crimping does require tooling that is specific to the type of contacts used, which can get expensive. And the crimping process must be performed correctly to achieve a reliable connection.

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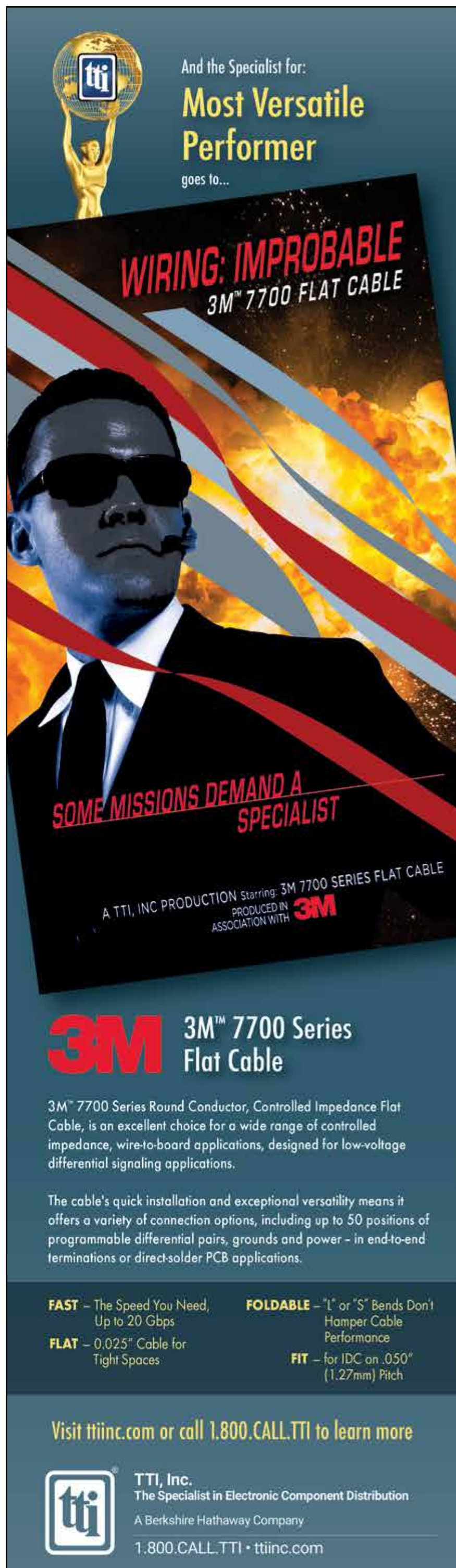
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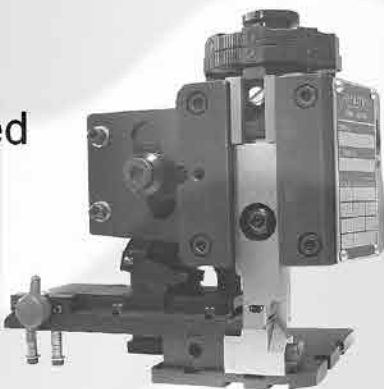
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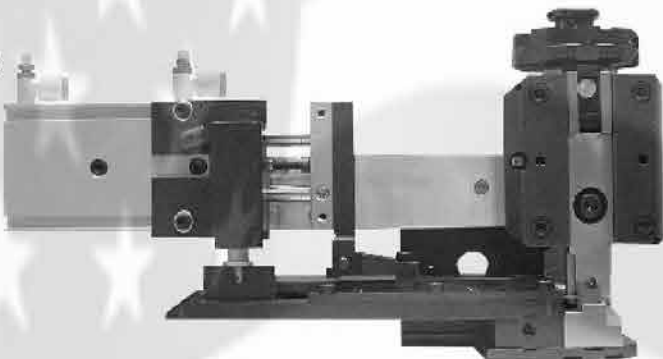


Model 1700

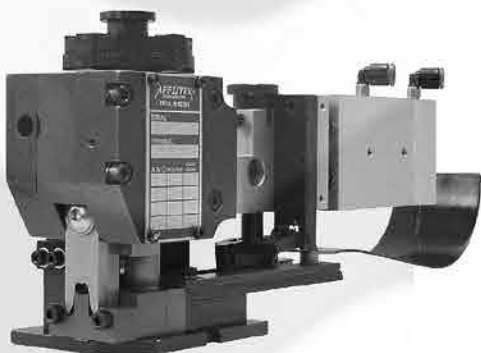


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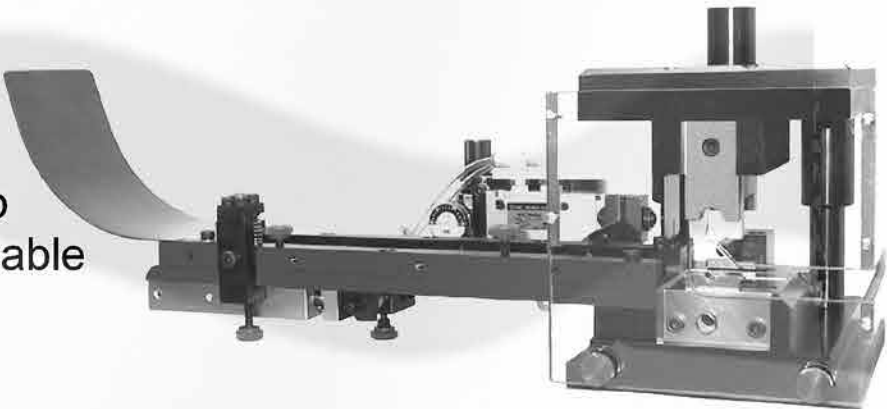


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How to Select a Polymer for High Temperature Wire and Cable

By Dick Chen
AEROSPACE Wire & Cable

High temperature wire and cable applications are getting more and more prominent. Their use and popularity have followed the trajectory of technology refinement over the past 100 years.

Advancements in technologies like robotics, AI and 5G favor the use of high-temperature wire and cable because of its smaller size, long length availability, along with excellent chemical, mechanical and electrical properties.

The original high-temperature wire insulation was PTFE. It was discovered by a DuPont scientist back in the 1930s. Through the years, it became the de facto solution for high-temperature environments and its popularity grew with military and aerospace applications. It is still popular today due to its special properties and the fact that it enjoys some long-standing military approvals and drawing inclusions.

When placing an order for wire and cable, most harness manufacturers wish to order the longest length they can buy. The longer lengths will save them a lot of scrap and with the lowest cost in manufacturing. A big problem with PTFE is that it is difficult to get in relatively long lengths due to manufacturing challenges. Therefore, Dupont invented the PFA, FEP, ETFE copolymers of PTFE which can be produced in longer lengths to replace some of the high temperature applications

Another problem with PTFE is that it is not melt-processable. It requires special mixing with a lubricant to create a paste extrusion without melting. It is then sintered at a high temperature to get rid of the lubricant. By contrast, all PFA, FEP, ETFE and ECTFE materials are melt-processable; meaning you can use a conventional melt extruder. There are fewer steps as the material is simply melted, and the polymer is coated over the copper wire, thus reducing cost.

Engineers need to be aware of the different characteristics, properties, cost etc. of these high-temperature polymers in order to design a wire or cable which is suitable for their products in the modern world.

Here are some lists of high-temperature fluoropolymers:


1. **PFA** (perfluoroalkyl) is a fluoropolymer which has very similar properties to PTFE. It is melt-processable for low cost, is available in long lengths, and has a three times higher dielectric strength over PTFE. PFA has excellent electrical, chemical and mechanical properties. **The biggest advantage of PFA is its high temperature rating at 250°C (per UL)**

2. **FEP** (Fluorinated ethylene propylene) is a copolymer of hexafluoropropylene and TFE. It is melt-processable at an even lower cost than PFA. It has similar electrical, chemical and mechanical properties and is available in the longer lengths. The temperature rating is 200° C (per UL). **The main advantage of FEP is its low cost compared to PFA.**

3. **ETFE** (ethylene tetrafluoroethylene) is a fluoropolymer with similar properties as PTFE but is melt-processable with excellent mechanical, radiation resistance. It is light weight and is available in long lengths. The dielectric constant is 2.6 which is not as good as PTFE, PFA or FEP at 2.0. Flexibility is poorer than PFA and FEP, but it has better abrasion and better cut-through resistance. The temperature rating is 150° C (per UL). **The advantage of ETFE is its radiation resistance, toughness and light weight.**

4. **ECTFE** (ethylene chlorotrifluoroethylene) is a fluoropolymer with similar properties as PTFE but is more melt processable with the lowest cost. It has great mechanical properties, is light weight, and is available in the longest length of these four materials. The dielectric constant is 2.6 which is not as good as PTFE, PFA, FEP at 2.0. Flexibility is poorer than PFA and FEP, but it has better abrasion and cut-through resistance properties. The temperature is 150° C (per UL). **The advantage of ECTFE is that it is similar to ETFE but at a lower cost.**

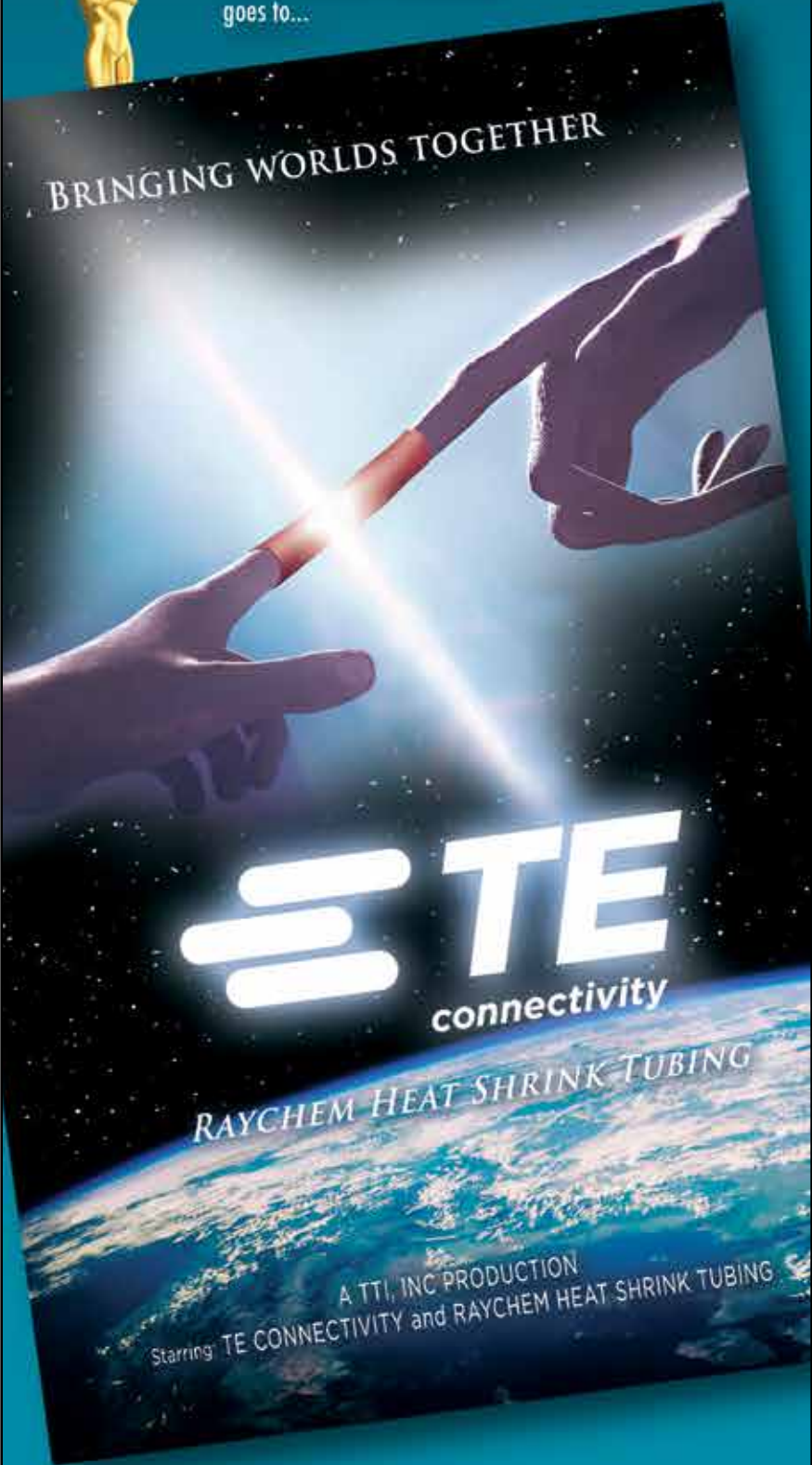
Conclusion: The above fluoropolymers are all excellent materials for today's high-temperature wire and cable applications. They share excellent chemical, mechanical, electrical properties, long length availability, are small in size and available at a relatively low cost. They match perfectly for today's technology demands and they are all UL approved.



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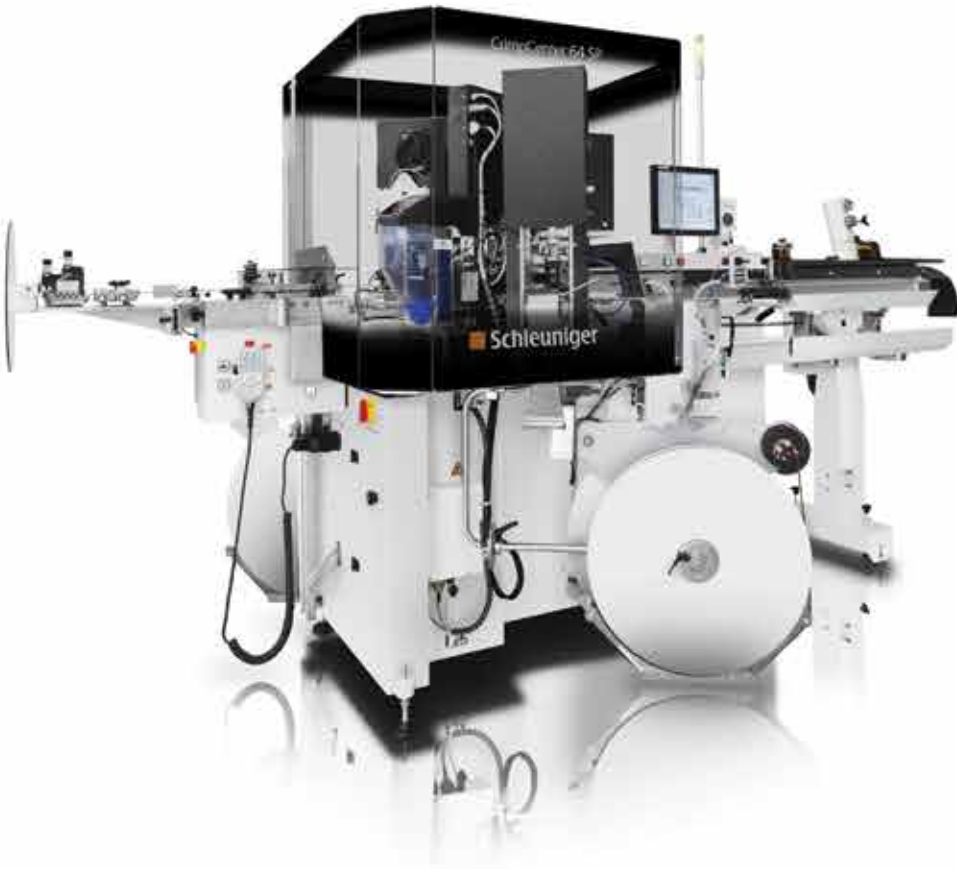
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Cable Insulation Levels

Cable insulation is designed to withstand the voltage stresses a cable will experience over its expected lifetime. An insulation level defines various insulation thicknesses within a single voltage rating. The two most common levels are 100 percent and 133 percent. Normally, 100 percent insulation level is used on a grounded system and is sometimes also referred to as a grounded insulation thickness. Likewise, the 133 percent level is normally used on an “ungrounded” system and is referred to as an ungrounded insulation thickness. A 173 percent insulation level also exists and is normally used on an ungrounded system where further fault clearing time is needed.

Insulation Thickness for Various Levels

The specified insulation thickness for each insulation level is similar among various industry standards. The thickness varies with insulation level, generally becoming thicker as the insulation level increases. Typical insulation thicknesses for many medium-voltage cables are shown in **Table 1**. Specific insulation thicknesses for voltage ratings up through

46 kV and various conductor sizes are given in National Electrical Manufacturers Association (NEMA), Insulated Cable Engineers Association (ICEA), Underwriters Laboratories (UL), Canadian Standards Association (CSA) and National Fire Protection Association (NFPA) publications.

Low-Voltage Cables

For cables rated 0 through 2,000 volts, the in-service voltage stress on the insulation is so low that the concept of insulation levels is largely unnecessary. For example, the operating voltage stress on a typical 600-volt cable is about 5 volts per mil of insulation thickness, i.e., each mil (0.001 inch) of insulation must withstand only 5 volts of electrical stress. On the other hand, the in-service voltage stress on a typical 15 kV cable is about 50 volts per mil or 10 times more than that for a 600-volt cable. 600-Volt rated cables have much thicker insulation per volt of applied electrical stress and are thus over-insulated from a voltage stress point of view. As a result, the cable insulation thickness specified by industry standards for use in a grounded (100 percent) electrical system is also acceptable for use on an ungrounded (133 percent) electrical system.

There may be some applications

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Voltage Rating (kV)	Insulation Level (%)	Typical Insulation Thickness	
		mm	mils
5	100	2.29	90
	133	2.92	115
	173	3.56	140
8	100	2.92	115
	133	3.56	140
	173	4.45	175
15	100	4.45	175
	133	5.59	220
	173	6.6	260
25	100	6.6	260
	133	8.13	320
	173	10.67	420
35	100	8.76	345
	133	10.67	420
	173	14.73	580

Table 1. Insulation Thicknesses for Insulation Levels

that require 173 percent insulation levels for low-voltage systems such as high-resistant grounding systems. 173 percent insulation levels are not addressed by most industry standards. However, NEMA and ICEA standards such as ICEA S-95-658-1999 *Standard for Nonshielded Power Cables Rated 2000 V or Less for the Distribution of Electrical Energy* recommends the use of a cable rated at least 1.73 times the phase-to-phase system voltage. For example, a 480-volt system would require the use of a cable rated at least 830 volts. Because of commercial availability, a 1 kV rated cable is typically used for this type of application in Canada and a 2 kV cable

would be used in the United States.

Areas of Insulation Level Use

The cable insulation level required for a specific application depends on the speed at which the protective relay is designed to de-energize the electrical system in case of an electrical ground fault. A ground fault is an electrical short circuit from one phase (one conductor) of the electrical system to ground. If the protective relay is set to de-energize the system in less than one minute, a cable with a 100 percent insulation level is adequate according to industry standards. If the protective relay is designed to de-energize the system

within one hour, a cable with a 133 percent insulation level is required. If the protective relay is designed to de-energize the system after an indefinite period of time, a 173 percent insulation level cable is required. If desired, a cable with thicker insulation than specified in industry standards can be used for maximum system re-

liability. Need help determining the best cable insulation level for a specific application? Contact your sales representative at WESCO and Anixter to be put in touch with one of our electrical engineers.

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Women Impacting the Workforce at Mecal by Starn

Melissa Femia is off slaying dragons, so we don't have a Power Women feature in this issue. But we were recently approached by the folks at Mecal by Starn about some outstanding women within their organization. These impactful women are key to the great products and customer service the company offers, and we thought they were worth recognizing.



Michele Bernoksy

Michele has been with Mecal By Starn since June 2004. She is responsible for many operations in the business including shipping, receiving



Willow Peterman

incoming orders and working with customers and manufacturing to ensure on-time delivery and customer satisfaction. She is the "hub" of the wheel at Mecal By Starn. Michele always exceeds our expectations with the work she performs and is more than capable of handling any challenge you give her. Thank you, Michele, for all you do to maintain our excellent reputation in this industry!

Willow has been with Mecal by Starn / Starn Tool since June 2013. Starting as a CCCTC drafting student and working at Starn part-time, she worked her way through every department, eventually moving into an

assistant position in Engineering. In 2017 she transferred into an Office Manager position, as the current manager of 48 years, Linda Maloney, was retiring. Willow learned and mastered the position quickly and advanced into the financial aspect of the job, becoming the Starn Family of Companies Controller. She now sits on the Starn Family of Companies Executive Team and is a voting member and Executive Secretary of the Starn Family of Companies Board of Directors. She always has an open door and an open ear to discuss all issues and challenges throughout the corporation. Thank you, Willow, it has been amazing to watch you learn and grow so quickly.



Diane Schlosser

Diane has been with Mecal by Starn since May 2018. She is at the heart of our Wire EDM operations at our secondary facility. Diane is responsible for multiple tasks including receiving, shipping, purchase orders, quality, and much more. Without Di-

ane, no jobs would hit the floor or leave the shop. Thank you, Diane, for consistently being a key part of our team. You are a big part of helping make customer satisfaction a given!



Hailley Ruhl

Hailley was a CO-OP student at CCCTC who began working for Starn Tool in June 2019 and transitioned to Mecal by Starn in March 2020. It didn't take long for Hailley to win our hearts and prove that once again women fit the Starn culture and thrive in the manufacturing environment. She has a great work ethic and always jumps into tasks with a smile on her face. She is more than capable of taking on whatever work we give her and always exceeds our expectations. This is why Hailley is now the head inspector of all our crimp tooling. Thank you, Hailley, for choosing the Starn family of companies. You have been and will continue to be a wonderful addition to the team!

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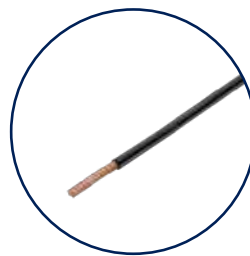
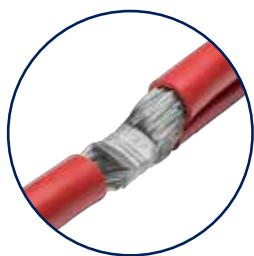
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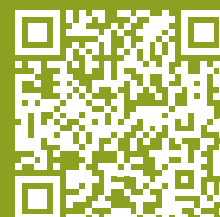
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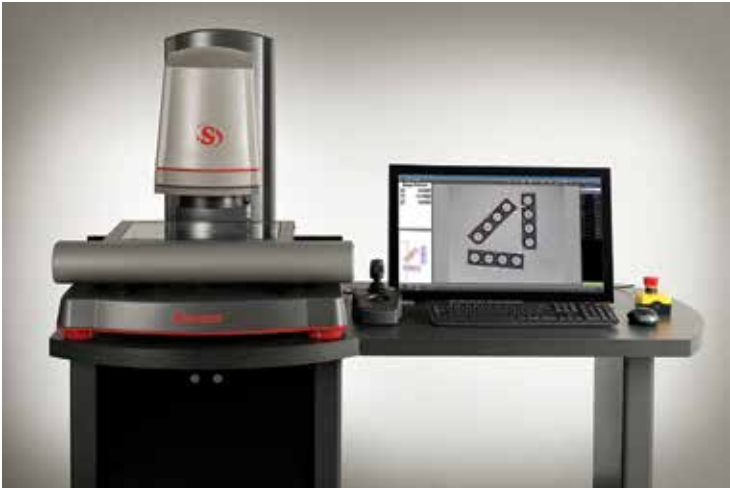
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NEWS PLUGS



Starrett Introduces Large Field of View Multi-Sensor Vision System

The L.S. Starrett Company, a global manufacturer of precision hand tools and gages, metrology systems and more, has enhanced its AVR300 Multi-Sensor Vision System with a 0.14 magnification lens featuring the largest field of view to date for Starrett on the AVR Series at 2.36" x 1.90" (60 mm x 48 mm). For greater efficiency and accuracy, more of the part can be viewed in every image on the new AVR-FOV 0.14X system. Due to "superimage" technology, which allows multiple images to be stitched together to form one larger im-



The Starrett AVR-FOV

age, together with the system's touch probe technology, the AVR-FOV 0.14X can accurately inspect a wide range of features on large or complex parts, as well as on multiple small parts. The AVR-FOV 0.14X automated part programs deliver accurate results to the micron level in a matter of seconds with

"Go/ No-Go" tolerance zones, and data are provided in one easy-to-interpret report. These features allow metrology users in manufacturing facilities or QC labs to produce accurate, fast, and repeatable results. "Building on the success of the AVR300 multi-sensor system, now customers can measure

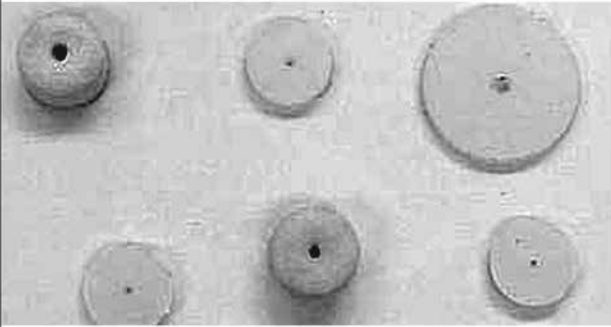
and inspect a wider range of parts, including those that are complex with intricate features," said Mark Arenal, General Manager, Starrett Metrology Division, "The interface on the AVR-FOV 0.14X is user friendly and intuitive so all users, including operators right on the shop floor, can complete the inspection process."

Equipped with the M3 software package from MetLogix, a traditional mouse as well as a touchscreen monitor make user interaction easy and intuitive. Auto part recognition enables creating a part measurement program that comprises the desired features of a part for inspection, which can automatically be saved in the system or

to a network. Programmable light output options can be built into the program as defined steps, including being called up as the part recognition program initiates. Once the program is created, placing that part within the camera's field-of-view allows for the saved program to initiate and run the inspection. A Renishaw Touch Probe may also be utilized for quick acquisition of discreet points along a part's profile as well as Z-axis measurements.

The AVR-FOV 0.14X has an X-Y-Z travel of 12" x 8" x 8" (300mm x 200mm x 200mm).

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_Continued on page 38



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THE POWERHOUSE OF ULTRASONICS

NEWS PLUGS continued

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The Starrett AVR-FOV 0.14X Multi-Sensor Vision System is made in the U.S.A.

About The L.S. Starrett Company
Founded in 1880 and headquartered in Athol, MA U.S.A., The L.S. Starrett Company is a leading global manufacturer of precision measuring tools and gages, optical comparators and vision systems and force and hardness testing solutions. Starrett also manufactures laser measurement systems, custom engineered granite solutions, custom gaging, band saw blades, power tool accessory saw blades, workshop tools and jobsite tools. The Starrett brand is recognized throughout the world for exceptional quality and precision. Skilled personnel, superior products, manufacturing expertise, innovation and excellent service and support have earned Starrett its reputation as the “World’s Greatest Toolmakers”. Starrett has over 1,600 employees worldwide and annual sales exceeding \$200 million. The company has six manufacturing locations in the U.S.A., including facilities in Massachusetts, North Carolina, Georgia, Ohio, Minnesota and California. Starrett also has three international manufacturing facilities. Plants are located in Brazil, Scotland and China, in addition to distribution centers and offices located worldwide. The L.S. Starrett Company is publicly traded on the NYSE, symbol SCX.

For more information contact The L.S. Starrett Company, 121 Crescent Street, Athol, MA 01331 U.S.A. Telephone: (978) 249-3551, Fax: (978) 249-8495, email: general@starrett.com, internet: (https://www.starrett.com).

Segue Manufacturing Services Expands Contract Electronics Manufacturing Footprint in North-east USA to Meet OEM Customer Requirements

Segue Manufacturing Services, a global contract manufacturer specializing in complex electro-mechanical integration, cable and harness assembly and engineering services, has completed its expansion into new operations in Billerica, Massachusetts.
Segue’s new Boston-area facility was custom-designed to optimize rapid New Product Introduction (NPI) and ramp-to-volume of its customers’ complex electronic products in Medical, 3D Printing and Robotics, Industrial and Defense. Responding directly to the



Segue Manufacturing Services Production Facility

growing needs of its customer base, the expansion was integral to Segue meeting the accelerated production requirements of its customers’ medical devices, in particular life-saving ventilators, during the 2020 global pandemic. The Billerica facility combines with Segue’s facility in Xiamen to offer both

Made-in-USA and China solutions.
The new 45,000 square foot manufacturing facility features an NPI Center with a team dedicated to optimizing the design and launch of its customers’ new products. The Boston-area manufacturing center employs a team of 100 manufacturing and engineering experts and features flexible manufacturing space for lean cell design and optimized product flow. The facility also has manufacturing cells for each of Segue’s core services which include large, complex electro-mechanical integration, complex cable and wire harness design, overmolding and potting, and an in-house machine shop. Segue also has an option to annex and expand into adjacent manufacturing space.
The new Segue facility is located just north of Boston, Massachusetts, in the master-planned office/flex BT-37 Business Park, less than 2 miles from the I-495/Route 3 Interchange with ample



Segue - Cable and Harness Expertise

Continued on page 41

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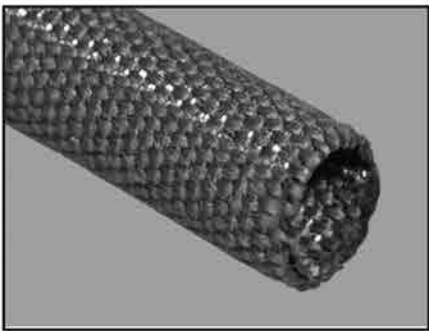
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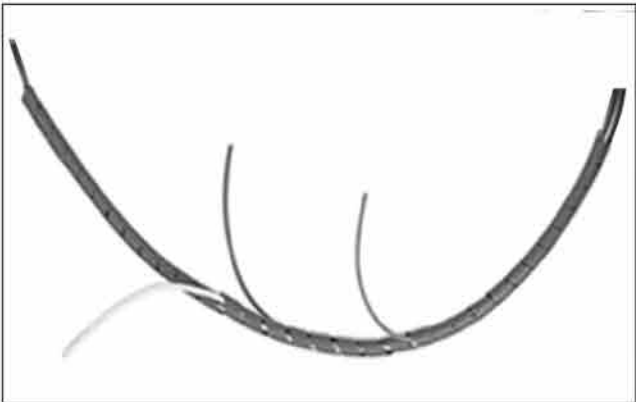
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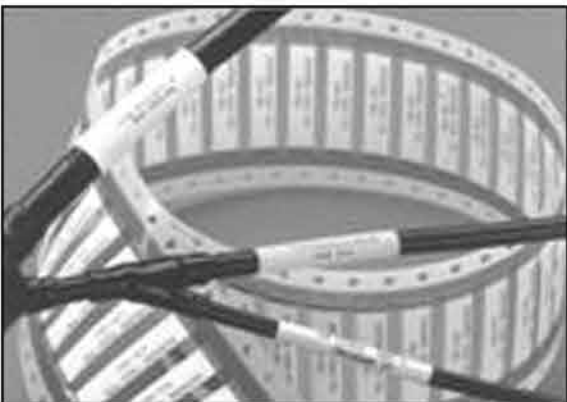
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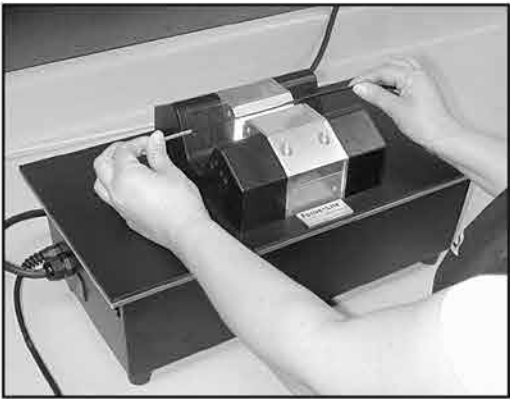
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NEWS PLUGS continued



Continued from page 38

parking and public transportation direct to the front door. The business park is home to technology companies like Segue Manufacturing, as well as companies specializing in business services and consumer products.

“As global supply chain and cost pressures mount, and regulatory requirements continue to evolve and tighten – particularly in the Medical space – our customers count on Segue for expert execution and a model that flexes to provide solutions that work in this real world of constraints,” said Roger White, CEO of Segue Manufacturing Services. “Segue is purpose-built to provide our customers with a proactive team of manufacturing and engineering professionals plus a fully integrated service offering, so our customers get maximum flexibility, quality and supply chain continuity. Expanding and investing in our North American operations is an essential part of our strategy.”

About Segue Manufacturing Services

Segue Manufacturing Services provides both Made-in-the-USA and China solutions to its OEM and Tier I EMS Provider customers in the Medical, Defense, Industrial, Transportation and Robotics markets. Since 1991, Segue specializes in manufacturing and engineering services from cable design, design for manufacturing, NPI and rapid prototyping, to electro-mechanical systems integration, test and logistics. With manufacturing centers in Boston, Massachusetts and Xiamen, China, and a fulfillment warehouse in New Hampshire, Segue Manufacturing Services specializes in the seamless transfer of its customers’ products from prototyping to full-scale manufacturing. Employing 600 people, the company is ISO 9001, ISO 13485 and ISO/TS 16949-certified, ITAR-registered and has MedAccred accreditation. www.segue-mfg.com

DIT-MCO Appoints David Shier as President

DIT-MCO International, a leading designer and manufacturer of electrical wiring test equipment, announces the appointment of

David Shier to the position of President, effective immediately. Current President and CEO John Kusek will remain CEO as he transitions the day-to-day management of the company to Shier.

Shier joined DIT-MCO in May of 2020, serving in the newly created role of Chief Technology Officer for eight months prior to being named President. Before joining DIT-MCO, he was the President and CEO of Shier Solutions, which provided hand-held wiring analyzers and software solutions to the wiring industry.

Mr. Shier has a long history in the wiring harness test business, including a number of years with California-based CK Technologies, first as Director of Sales and later as Vice President, Product & Test Strategy. “I have spent more than 30 years in this industry directly competing with DIT-MCO, so I have known and respected the excellent reputation the company has maintained with its customers,” said Shier. “I’m excited for the opportunity to lead this great company as we develop new products and services that will assure DIT-MCO remains the dominant leader in the wire/harness testing industry.”

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NEWS PLUGS continued



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Mr. Kusek welcomes this transition, stating, "There's scarcely anyone in our relatively close-knit industry who's not aware of David's expertise in all matters relating to automated wire testing. I have been most impressed with his contributions since he joined DIT-MCO and feel confident that I will be leaving DIT-MCO in very capable hands upon my upcoming retirement."

About DIT-MCO
DIT-MCO International LLC is a worldwide leader in automated cable/harness test systems with over 60 years' experience providing test equipment for interconnect verification. Engineering, QC/QA, manufacturing, and

test personnel around the world use DIT-MCO systems to verify the quality of their products. DIT-MCO testers are used extensively in the aerospace (military and commercial), defense, and transit/rail industries. Headquartered in Kansas City, Missouri, DIT-MCO has sales and service offices in the US and UK, plus authorized agents and distributors around the world.

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Application Purposed Cable & Harness Testing

By Brent Stringham
DIT-MCO International, LLC

Many articles have been written on the topic of electrical cable and harness testing. Most focus on the technical aspects of testing.

This article looks at it from a different perspective - purposed based harness testing. How does the intended purpose or end-use of a wiring harness effect the choice of tester, from test specifications to the challenges of adapting the tester to the device under test (D.U.T)? Technically, cable and harness testers are quite similar. They all apply a stimulus to a wire or group of wires, make measurements, and report pass/fail results based on those measurements. However, the challenges of testing simple cables vs. complex wiring harnesses are quite different; computer cables vs. automotive cables vs. medical cables vs. Mil/Aero cables vs., well, you get the point.

Not all harnesses are created equal

Cable assemblies and wiring harnesses don't know whether they are in a plane, train, automobile or washing machine! All wiring harnesses are basically the same thing made up of wires, connectors, ring lugs and terminals, splices, etc. Some are soldered, some are crimped, and some are terminated via IDC. However similar harnesses are, there are significant differences when it comes to the manufacturing and testing processes, depending on the intended application.

Industry classifications of wiring harnesses

Although the lines can be somewhat blurry, there are a number of industry classifications of wiring harnesses that tend to correspond with different classes of tester requirements. The Bishop Report*

published in 2017, identified 10 end-use categories: Computer, Business/Office equipment, Medical, Test/Instrumentation, Industrial Equipment, Automotive, Transportation non-automotive, Military/Aerospace, Telecom/Datacom and Consumer Electronics.

The WHMA-IPC A-620 Standard classifies cable assemblies into three distinctive tiers, Class 1, Class 2 and Class 3. Once again, the lines tend to blur between the three, particularly when trying to determine which A-620 tier each of the 10 end-use harness classifications fall into.

It is the author's experience that, for electrical testing, the distinction between Class 1, 2 and 3 is uncertain. I would submit the following table represents, in general terms, the matching of industry harness classifications with A-620 testing classes:

Electrical testing requirements per classification, or harness type

The A-620 standard primarily focuses on build methods but also includes an electrical test requirement section, 19.4. Prior to publication of the A-620 there were few electrical testing standards for the cable assembly industry. The most prominent, Mil-Std 202, still is the primary test spec for Mil/Aerospace/Defense cables.

Not all testers are created equal

Just as the wiring harness doesn't know where it is, the cable tester doesn't know, or care, either. However, there are significant differences in commercially available testers with regards to size, price and capability.

When looking for the most suitable cable tester for your needs the following questions should be considered:

Continued on page 44

Industry classification	A-620 Class 1	A-620 class 2	A-620 class 3
Automotive/White goods (includes non-defense such as bus, truck and agriculture)	X	X	
Computer, Telecom/Datacom, Business/Office equipment, Industrial Equipment, Consumer Electronics		X	X
Medical Electronics			X
Mil/Aero, Transportation, non-automotive (Defense & Rail)			X

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Application Purposed Cable & Harness Testing

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1. How many test points are required?
2. Is high current or High Voltage required? (required for A-620 Class 3 and Mil-Std 202)
3. Besides wires, does anything else need to be tested? This might include resistors, diodes, capacitors, coils, switches etc.
4. Is there a requirement for the tester to supply external power? Sometimes referred to as latching matrix (LM) or external energization (EE) power, this is usually required when there are relays to activate or lamps to light.

Plugging the cable in – test adaptation

One of the biggest challenges in testing harnesses with automatic testers is plugging them into the tester, which requires some kind of adaptation scheme (for a great look at this subject, see Mark

Molnar’s article Wire Harness Testing Evolution and the Advent of Test Fixtures in the Sept/Oct issue of Wiring Harness News). Usually referred to as the “test interface,” “test adapter” or “test fixture”, these can take the form of adapter cards that snap directly into the tester, adapter cables, or test tables with customized test modules. Regardless of the method used, the testing interface must have the requisite number of mating connectors to plug in all of the connectors of the D.U.T. Small, end-to-end cables with only a few connectors are generally the simplest to adapt to. Large, multi-legged harnesses with dozens, or even hundreds of connectors are the most difficult.

This is where major differences surface when it comes to choosing the right cable tester for the job, based on the nature of the cables, i.e. how large, how complex, how accessible. To reiterate, it’s not only the complexity of the testing requirements that define the difficulty of testing different types of cables,



Figure 2. Automotive test table. (Photo Courtesy TSK)

but rather the difficulty of the adaptation.

“Big” vs. “Small” harnesses

Defining “small” or “big” harnesses can be misleading. It doesn’t always connote physical size. You may have an incredibly dense circuit card assembly or black box that fits on a tabletop that has 10,000 interconnection points to be tested, or a harness of only a few hundred wires that is hundreds of feet long and weighs hundreds, or thousands of pounds.

Small cables are fairly simple to test

End-to-end cables with a few, to a few hundred, wires are generally tested on the bench with a smaller tester, either plugged directly into the tester or through short adapter cables. (See Figure 1)

Automobile and White Goods – Very high-volume production

There are over 60 million automobiles produced globally each

year and around 450 million major appliances so imagine the number of wire harnesses to be tested! It is unfeasible to test these harnesses using the actual mating connector. Automotive and white goods harnesses are mostly tested using dedicated test tables with spring probe test fixtures, commonly with the wiring analyzer buried inside the test table. Although physically larger, automotive harnesses generally range from a few, to only a few hundred wires, so while the test table might be sizeable, fairly small testers are all that is required. (See Figure 2)

Mil/Aero/Defense Harnesses present unique adaptation challenges

Cables in planes, trains, ships, weapons, satellites and space vehicles tend to be the largest, most complex and therefore most difficult to interface to for testing. These types of harnesses vary greatly from small to large, both in number of wires and physical size. Elec-



Figure 1. Testers with interchangeable adapter boards for easy switch over between cables. (Photo Courtesy of Cirris)



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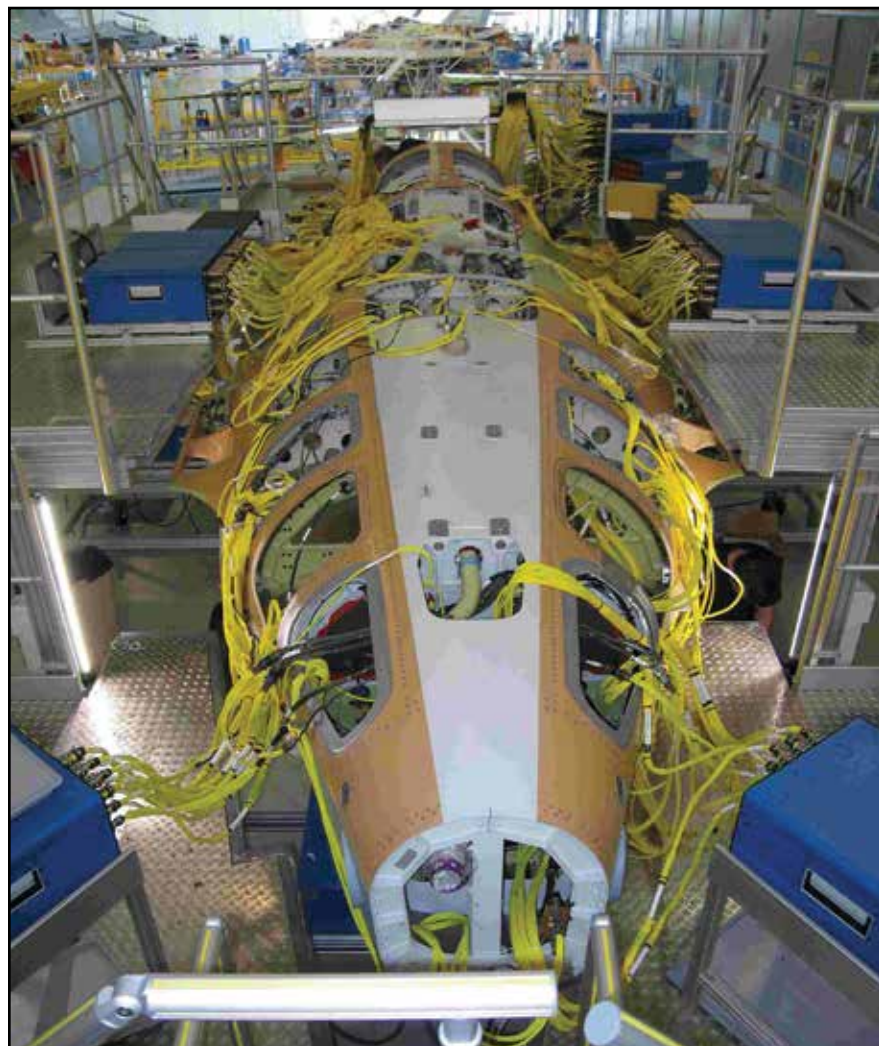


Figure 3. Distributed wiring analyzer.

(Photo Courtesy DIT-MCO International)

trical test specs are generally the most stringent due to both A-620 Class 3 and MIL-STD 202 testing requirements. Wiring analyzers that can expand in size, i.e. number of test points, and that are modular are required for most of these large-scale testing applications. Mil/Aero harnesses generally must be tested not only at the point of fabrication but again after being installed in their final application, be it a missile, vehicle, aircraft, ship, satellite or rocket. Modular analyzers generally have a central control unit, and multiple switching modules that can be distributed around the U.U.T. be it on the build board or in-situ, allowing for much shorter adapter cables. The switch modules are connected via single daisy chain cables that carry not only the voltage and current stimulus to each module, but also the 110 or 220V mains power eliminating the need to plug each module into its own power supply. (See Figure 3)

Hook up time vs. test time vs. troubleshooting time

Another key consideration is the time to plug the harness in vs. the time it takes to do the test vs. the time to troubleshoot failures. In high-volume applications thruput is critical. If you're testing hundreds or thousands of cables per day, quick plugging and unplugging as well as fast tester cycle times are critical, hence the discussion of adapter based testers and spring-probe test tables above. In the case of large complex cables, it is not uncommon for the build time to be several days. Likewise, when testing these harnesses in-situ it may take hours or days to position the tester and plug all of the adapter cables into the D.U.T. In this case actual test time

isn't so critical. A 10 or 20 minute test isn't too inconvenient compared to 2 days to plug everything in. What is important in these situations is providing easy-to-understand error information to help technicians quickly locate and repair failures. Additionally, wiring analyzers that offer "random" or "smart" hook up capability tremendously speed the hook up time. This feature utilizes smart chips imbedded into each adapter cable which allows the adapter cables to be plugged randomly into any location on any switch module. The tester reads the smart chip and re-addresses the test program accordingly.

Common test programs (TPS's)

Another key element of Mil/Aero harness testing is the heightened requirement for documented and verified test programs sets (TPS's). While proper test programs are important at all levels of cable testing, it becomes a whole different world when weapon systems and aircraft are involved. Government regulations often require stringent traceability and verification of TPS's. It is this requirement, in part, that often drives military end-users to require their cable assembly suppliers use the exact same test equipment at fabrication that they use for their end-of-use testing. That way TPS changes required for harness modifications and engineering change orders can be shared with cable vendors assuring proper testing at all levels of the supply chain.

In Summary

Cable testers, like the cables they test, come in many sizes, shapes and prices. When considering the best solution for your application be sure to consider all aspects and remember, one size rarely fits all.

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FOCUS: MIL**AERO**

More-Electric, All-Electric Aircraft: Overview & Opportunities for the Harness Industry



Joby Urban Air Mobility Vehicle

By Joe Tito
Wiring Harness News

For years, futurists and engineers have dreamed of all-electric aircraft (AEA) taking to the sky with passengers. While no solution is in sight to replace fossil fuels on commercial airliners, there are some all-electric aircraft flying that promise to fill some unique roles. Many more such aircraft are on the way.

What is coming soon to an airliner near you is an effort to replace traditional hydraulic, pneumatic and mechanical systems with electrical actuators. This step in the electric

evolution of systems is referred to as more-electric aircraft (MEA).

Wiring Harness News chatted with Michael Traskos, President of Lectromec, to get a better understanding of MEA and AEA, and help focus harness manufacturers towards current and future opportunities with both.

More Electric Aircraft

The current \$1.5 B MEA market is highlighted by technological advancements in power electronics, fault-tolerant architecture, electro-hydrostatic actuators, flight control systems, high-density electric motors and power generation/conversion systems. The market is project-

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ed to reach \$3.3 B by 2025. “For 80 years, you had a way of building aircraft where a combination of hydraulics and pneumatics actuated flight controls and landing gear,” Mike instructed. “Now you can get enough power through the electrical system so that those systems can actually be controlled by electronic actuators.”

Mike pointed out that each engine on a 787 has two 250k VA generators. Together, the powerplants produce 1.2 MW of power generating capabilities, in addition to providing the thrust to propel the aircraft. That’s enough to power about 1000 homes. “Before, you had a lot less power, so you relied on other systems to handle heavy requirements.” He maintains this is all being made possible through increased engine efficiency combined with enhanced reliability through technological advancements in wiring systems. “With MEA, if you can remove the hydraulic system and all of its components. That’s going to reduce the complexity of the aircraft; lowering maintenance costs while reducing the weight of the aircraft,” Mike assured.

As far as opportunities in the MEA arena for harness manufacturers, Mike pointed to the obvious OEMs like Boeing, Airbus, Bombardier, Gulfstream, Embraer and their downstream partners like Safran and L3. He does see some low-lying fruit with companies doing VIP and standard modifications for aircraft. Much of this work involves replacing legacy systems with enhanced electrification for the customers comfort and convenience as these aircraft are transformed. “If your changing things like entertainment systems, it’s all wires and cables, and those systems need to be created, verified and done well to meet those aftermarket needs.” He indicated there are dozens, or even hundreds of such companies around the world. Some good search terms for finding companies in this category would be: Aircraft Modification and Completion, Aircraft VIP Modifications, Aircraft Conversion

Center or Aircraft Refurbishment Center.

All Electric Aircraft

Mike gets a chuckle when he discusses his role in AEA development. Ten years ago, he argued the absurdity of such an idea. “You’re going to put all this technology into the aircraft and you’re going to create all these new maintenance problems, because nobody cares about the wire to begin with,” was his edict back then. But things have changed, and companies like Lectomec have elevated Electrical Wiring Interconnect Systems (EWIS) to a much higher status. “I

mocked it (AEA) relentlessly for so long, and now I’m apparently the expert in terms of high-voltage requirements for these types of vehicles,” he confessed.

There are currently many electric aircraft flying. They tend to fill two niches - the short haul/limited passenger and piloted urban air mobility realms. Pipistrel, a Slovenian light aircraft manufacturer, is producing the first type-certified aircraft with an electric engine, the Pipistrel Velis. It was certified in June of 2020, carries two passengers, and is designed predominantly to be a training aircraft. Magnix,

Continued on page 48



DIAGRAPH

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More Electric, All-Electric Aircraft: Overview & Opportunities for the Harness Industry

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an electric aircraft motor manufacturer headquartered in Everett WA, is test flying a Cessna 208 Caravan fitted with its engines.

Joby Aviation, with its corporate headquarters in Marina, CA, has the vision of being the first aerial ride sharing service. The U.S. Air Force designated its first ever eVTOL (electric vertical take-off or landing) to its Agility Prime program (a safety endorsement) when it recognized Joby's urban mobility vehicle. Uber recently sold its air taxi service to Joby. "The energy density of batteries is starting to reach the point where it is now viable for

future commercial aircraft designs, and certainly these piloted urban air mobility vehicles," Mike detailed.

Other companies to watch are Israel based Eviation (164 suppliers from 21 countries), Los Angeles based Ampaire, Denver's Bye Aerospace, and Bothell WA based Zunum Aero, who just received funding from Boeing and JetBlue to build a 12-seat hybrid electric plane.

A lot of these companies are Silicon Valley startups with engineers and experts from automotive electric vehicle backgrounds. "There are probably about 300 companies that are working in the air mobility arena alone," Mike detailed, "but there will



Magnix Powered Caravan

probably be about 20 or so on the other side when everything settles down." He compares the current status of this segment to the VLJ (very light jet) aircraft market. "If you go back 20 years, jet technology had come to the point where you could throw a jet engine on a four to six passenger aircraft and have a commercially viable product. Consequently, about 30 companies entered that market with basically Honda and Cessna and Cirrus coming out the other side," he chronicled. Still, there is an opportunity to help those companies that may eventually fall out, or be consolidated, with profitable prototype harnesses now.

We asked Mike about the FAA's involvement. He indicated that the FAA has been funding research into this area for more than a decade. They have supported a variety of energy storage and energy generation projects. From a regulatory perspective, much of the same regula-

tions are applicable. An AEA may have more batteries and a more complicated battery system, but the regulations on energy storage are mostly the same. It is incumbent on the applicant to verify system safety.

Whether it's a more-electric 737, or an all-electric commuter or urban mobility aircraft, they all have one thing in common according to Mike. "All of them are going to need reliable high voltage wiring systems in order to get the power from storage to propulsion." Where commercial airplanes would historically use 115 to 230 volts, some of these projects are using up to 30,000 volts. "And in order to make sure you don't have cables that are a foot in diameter, you're going to need to ramp up the voltage," he stressed.

Visit the blog section of www.lectromec.com for more insightful information on MEA, AEA, and EWIS in general.



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NEWS PLUGS continued

WAGO Introduces Three New Modules for use in Harsh Environments

WAGO has added a new Ethernet-based PLC controller and two new I/O couplers for use in extreme environments. These new modules, part of the 750 XTR Series, have two switched Ethernet ports for feedthrough cabling and support any of the XTR digital, analog and specialty I/O modules.

The new PLC controller (750-890/040-000) has the ability to be programmed with WAGO-I/O-PRO based Codesys v.2 software and supports MODBUS TCP/UDP fieldbus communications. It offers the latest hardware technology, providing faster processing speeds and more memory than previous generations.

The new distributed I/O couplers (750-362/040-000 and 750-363/040-000) offer dedicated fieldbus ports with faster boot-up times. The 750-362/040-000 supports MODBUS TCP/UDP while the 750-363/040-000 supports EtherNet/IP communications.

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Sonobond Ultrasonics' Advanced HMI with Smart Touchscreen Improves Metal Welding Results with its Data-Driven Capabilities

Sonobond Ultrasonics, the company that invented ultrasonic metal welding in 1960, announces its Advanced HMI with Smart Touchscreen, created to add the data-driven capabilities

necessary to better meet customer specifications.

The Smart Touchscreen enables easy access to multiple functions that are designed to produce the highest quality welds. The main features include:

- Four welding modes, including time, energy, height, and height with energy.
- Real-time monitoring and adjustment of energy, power, pre-height and final height weld parameters.
- Sequential job selections to run multiple, separate jobs consecutively.

Sonobond's Advanced HMI with Smart Touchscreen

- Feedback on weld results, displaying graphs of pressure and power ranges, system settings, and adherence to pre-set Acceptable and/or Custom weld limits.
- Weld history log that saves data on the last 1000 welds and exports it via USB interface for analysis and trending projections.

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- Dual Head SpliceRite™ Wire Splicer,
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Security and Selection Features

In addition to easy set up and operation of functions that ensure quality welds, Sonobond's Advanced HMI with Smart Touchscreen includes features that provide operational security

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NEWS PLUGS continued



Continued from page 49

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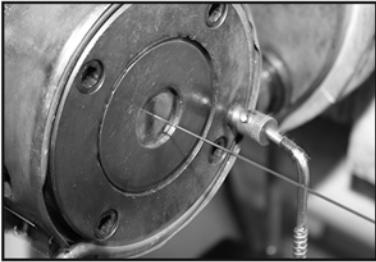


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FreePoint 2020 A Year in Review



ShiftWorx Plus Single-Machine View

With the help of our partners, clients and employees, 2020 has been a year of change and growth for FreePoint Technologies. As we approach the end of the year, we like to reflect on our biggest accomplishments as well as the individuals that made them possible.

2020 started with a bang as we released **ShiftWorx Plus**, a revolutionary addition to the ShiftWorx platform that drove end-to-end real time insight into every aspect of the manufacturing floor. ShiftWorx Plus unlocked manufacturing data related to:

- Jobs, Parts, Work Orders
- Scrap, Waste, SKUs
- Operators, Team Leads, Supervisors

As demand for our ShiftWorx product suite grew, our custom software team shifted their focus to exclusively manufacturing. This was coupled with an acquisition of FreePoint's non-manufacturing clients by Direct Impact Solutions who continued to serve the non-manufacturing CoreSolutions customers.

This renewed focus propelled significant growth and improvement in our cutting edge product offerings as we launched:

- A New Reporting Module
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- Digital Andon/Call Box Functionality
- Threshold KPI Functionality
- FreePoint Connect - which opened more connection flexibility (Kepware, OPC-UA) and allows you to manage your machines connected right in ShiftWorx!

Like all businesses this year, we would be remiss if we didn't mention the COVID-19 pandemic. This presented unprecedented challenges and a changing work environment for manufacturers, as we saw production pauses and an increased focus on remote monitoring. As the manufacturing industry restarted, we saw

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ShiftWorx Machine-Monitoring

strong manufacturers emerge from the pandemic stronger and with renewed commitment to IIoT technologies. Data collected during the pandemic revealed some very interesting observations and our own team transitioned to working remotely, which the majority continue to do today.

2020 brought new relationships and strategic partnerships with world class ERP and manufacturing solutions providers like MIE Solutions, 3IS, and CIMX. These partners align with our corporate vision of prioritizing deep technology-driven insight, technical expertise, and actionable data in an easily understood format to help manufacturers increase production capacity, enhance

employee engagement, and ultimately drive sustainable growth.

2020 also saw us selected as Qualified Service Providers with Canadian Manufacturers and Exporters (CME) and has allowed us to work closely with many Ontario manufacturers through their Technology Assessment Program (TAP) and Grant.

It has been a very productive and exciting year for FreePoint Technologies. To our valued clients, loyal partners and dedicated employees, we would like to express our deepest gratitude to you for accompanying us on our continued journey.

We have big things on the horizon for 2021, and we can't wait to share all that comes in the new year with you.



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Line	HDR-64 B1	HDR-64 B2	Value	HiPot Results	DC Current	DC Voltage	DC Isolation	AC Current	AC Voltage	AC Isolation
1	28	28	16 mΩ	✓	< 1 μA	1499 V	> 1 G	0.150 mA	996 V	7 M
2	30	30	32 mΩ	✓	< 1 μA	1499 V	> 1 G	0.173 mA	996 V	6 M
3	32	32	63 mΩ	✓	< 1 μA	1499 V	> 1 G	0.189 mA	996 V	5 M
4	34	34	125 mΩ	✓	< 1 μA	1499 V	> 1 G	0.204 mA	996 V	5 M
5	36	36	249 mΩ	✓	< 1 μA	1499 V	> 1 G	0.204 mA	996 V	5 M
6	38	38	500 mΩ	✓	< 1 μA	1499 V	> 1 G	0.200 mA	995 V	5 M

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WIRED IN **WHMA UPDATE**
WHMA
 Wiring Harness Manufacturer's Association

WHMA/IPC Provides Online Training Course for Wire Harness Assembly Operators

By Christine Siebert

Responding to industry demand and member feedback, WHMA/IPC created the Wire Harness Assembly for Operators (WHO) course to address the skills gap in the wire harness industry. A recent IPC study on the skills gap in U.S. electronics manufacturing revealed that two-thirds of companies have difficulty finding skilled production workers. The cable and wire harness manufacturing industry is in a comparable situation. Companies cannot expand, innovate, or take advantage of new ideas. Employees cannot grow and learn to become an integral part of their industry.

The Wiring Harness Manufacturer's Association is dedicated to advancing the cable and wire harness manufacturing industry. Staying true to their main goals, LEAD, EDU-

CATE, and CONNECT, WHMA/IPC is launching this training course to overcome the challenges posed by the skills gap while simultaneously providing opportunities for employees to build skills and develop their career.

Effectively trained employees help employers:

- Reduce turnover
- Improve customer satisfaction
- Meet and beat production, performance, and profitability goals
- Plan for the future with greater accuracy

The WHO training course will give each participant the ability to identify and use the key tools, materials, and processes that wire harness operators need to reliably assemble quality harnesses. The program is composed of 14 modules. The first seven modules are mandatory and cover


subject areas the industry determined are critical for every wire harness operator. The second set of seven modules are optional and include more detailed information about specific job related functions. Students that complete the mandatory modules and at least one of the optional modules earn an IPC certificate that identifies them as a Qualified IPC Wire Harness Operator. These certificates are serialized with a unique ID number that can be utilized for validation and are valid for a two year period.

Mandatory Modules

1. Introduction to Wire Harness Assembly
2. Safety
3. Engineering Documentation
4. Materials and Components
5. Tools and Equipment
6. Wire Preparation and Processing


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- 11. Connector Assembly
- 12. Coaxial Cable
- 13. Labeling, Securing and
Covering
- 14. Finished Assembly
Installation

The WHO program’s modular structure allows organizations to implement the course to suit their needs. For example, they can opt to have their team members complete

all 14 modules or opt to have them complete the first seven and only those optional modules that relate directly to their specific job role. Since each block of seven modules requires an average of 12-16 hours to complete, the maximum duration of the course does not exceed one week.

The IPC Education team worked closely with a volunteer group of industry subject-matter experts to ensure that each topic is aligned with the skills and competencies vital to a wire harness assembly operator. Moreover, each module contains meaningful opportunities for students to actively engage with the

content and apply what they learned in real-world contexts. The program’s carefully curated video presentations, detailed illustrations, interactive activities, and practice quizzes are all formulated to make even the most complex topics easy-to-understand and master.

The WHO program is currently in Beta testing, a trial run with representative users who provide valuable feedback on the accuracy and efficacy of the program. “Beta tests allow us to address any issues and ensure that the program meets the needs identified by industry stakeholders before it is released to the wider pub-

lic,” said Carlos Plaza, Sr. Director of Education Development at IPC. So far, the response has been very positive. One WHMA/IPC member who is beta-testing the course states, “Explanations and examples used in the WHO Program are relative to daily life”.

Other comments from WHMA/IPC members in the beta-version stated, “I really like the safety module that you have added. This is a great thing for employees that are just getting into the wire harness business and I believe that this is very helpful”, “Excellent Content. Great explanations of each block on an assembly drawing, great interaction with students” and “I have been working with wire harnesses for 3.5 years and this video was extremely informative and taught me things I didn’t know. The info is very useful and answered questions I’ve had but couldn’t get answered.”

The WHO program is planned for release in March/April 2021. It will be available 24/7 via the IPC EDGE learning management system in both self-paced and instructor-led formats. Self-paced courses can be completed independently from any device with an internet connection. The instructor-led format allows instructors to stream the course to their students from any connected device. Students in instructor-led courses will also access the IPC EDGE online platform to complete exercises and assessments. In either format, organization instructors may track student progress through the IPC EDGE platform.

To learn more about the Wire Harness Assembly for Operators course, visit www.whma.org or www.ipc.org.



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- Benefit from the advocacy work done by **IPC Global Government Relations** as they proactively engage policymakers in the United States, Europe and Asia to adopt policies that strengthen the talent pool, bolster the value chain, and right-size regulations to spur greater technological innovation and economic growth.

“ **WHMA membership has provided our company the opportunity to share ideas, discuss challenges and innovate through networking opportunities. We have built relationships with colleagues, competitors, and industry specialists. Those relationships have been invaluable to our organization.** ”

Jason Zoubek, Absolute Quality Mfg., Inc.

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For more information, contact [Norm Sagon](#), WHMA/IPC sales representative.

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