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Launching Your Company into Over-Molding
History of Connectors and Termination Tooling
Guidelines for Wire and Fuel Compatibility in Harnesses
Battery Show and Electric & Hybrid Vehicle Technology Expo Recap



Convenience Electronics Inc

By Joe Tito Wiring Harness News

onvenience Electronics Inc. (CEI) is a Madison, WI based company with over 30 years' experience providing customers with high quality, cost competitive, custom electronic cable solutions. Their customers range from original equipment manufacturers, to contract manufacturers, and startups. CEI operates in the medical, test/instrumentation, industrial, and consumer markets. Their products include wire harnesses and custom cable assemblies along with a multitude of electrical and electromechanical assemblies and sub-assemblies. Through their partner in China, CEI also offers high-quality custom molded cables and power cords.

The company specializes in small to medium volume outputs and prides themselves on the development of a manufacturing process to meet these levels. Specific to the process are quick set-ups, well documented processes, and a well-trained work force. They pride themselves on immediate responses to customer requests.

CEI is ISO 9001:2015 as well as UL certified. Employees are trained and certified to IPC/WHMA A-620 and they have two certified trainers on

Wire Harness Data Migration Success

By David Selliman Core Technologies

Free's the deal-breaker regarding retiring CATIA V4 UNIX workstations. With the need to retire the UNIX workstations comes the need to convert CATIA V4 to CATIA V5 with wire harness data. Up to this point, no company on the market had a solution. Moreover, the need to automate the process is a must with the needed requirement to include all information within the data set to be workable parametric in CATIA V5.

high-profile production programs to convert multiple CATIA V4 electrical wire harness datasets to CATIA V5, using an automated process with consistent results. The scope of this project was primarily for electrical harness installation datasets and their associated harness assemblies, of which may span or share relationships to multiple installations that are resident in CATIA V4. The 3D dataset needed to be validated against its original. LMC was seeking an automated solution that retained essential intelligence and associativity between the harness installations, harness assemblies, and unwrapped (flattened) harness authored in CA-TIA V4 during the conversion to CA-TIA V5. The end results were needed to retire the old UNIX workstations, in order to regain the ability to manage the wire harness in CATIA V5.

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board. Customers rely on their strict attention to high quality standards, industry trends, risk assessment, technologies, and innovation.

I learned all of this in an unusually brief dialog with J. Harry Lum, President and owner of CEI. You see, Harry doesn't take credit for the growth and success of his business over the past few years. Instead, he credits his team for making it all happen. I think his ideal plan would have been for me to interview all of his employees, but since that might be a tad impractical, he insisted I spend most of my time with his management team of Betsy Vanden-Wymelenberg, Sales Manager, Carrie Hall, Production Manager and Terri Giese, CEI's Lean Champion and Inside Sales Representative.

Like many harness and cable manufacturers, CEI's story is one of humble beginnings, and it was actually Betsy who shared the details. "Harry worked for a component distributor and had a customer ask if he could make a cable. He said, 'you know what, I think I can,' and started

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Launching Your Company into Over-Molding

he ability to over-mold cable assemblies is a capability many cable and harness manufacturers wish they had. It's sort of a glass ceiling that more than a few companies find themselves under. Many have said they would like to grow and/or enter some other profitable markets within cable assembly, but just can't without this crucial inhouse offering. Harald Giebel from ISC Engineering had a well-attended seminar at this past May's Wire Processing Show in Milwaukee covering a myriad of encapsulation technologies for cables. He graciously accepted WHN's request to provide a roadmap for bringing over-molding capabilities inhouse. First, a bit about ISC Engineering. WHN profiled the company back in the Jan-Feb 2018 issue. ISC Engineering specializes in custom molded cable assemblies and the technology that surrounds them. What is unusual about ISC is that they are also heavily involved in transferring over-molding technology to OEMs and other cable assembly suppliers. More on that later.

Harald began outlining some of the decisions that go into making the investment. "Look back at your quote history and see what RFQs you couldn't quote," he suggested, "then try to assess what other business you could get into should you have this technology." He suggested taking a look at other industries that could be approached and highlighted highreliability applications where assem-

This article outlines migration strategies at Lockheed Martin (LMC) that address objectives, return on investment considerations, quality issues, and best practices.

Objective

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Lockheed Martin Corporation (LMC) had a requirement on its

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blies must survive a harsh environment; and also the medical industry.

The conversation pivoted to gaining an understanding of the specific types of molding technologies by distinguishing between straight injection molding and insert molding; the latter being the type most commonly used for cable assemblies. "With straight injection molding, you are filling a cavity as fast as you can, with higher relative pressures, in order to get a good quality part," he explained. "With insert molding, you have to inject slowly with lower relative pressures so as not to damage the connectors, or move the wires around." He added you also have to be careful not to flow materials to areas of the

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Guidelines for Wire and Fuel Compatibility in Harnesses

hether by design or by accident, some wires in an aircraft will be exposed to jet fuel. Because of this, it is necessary to be prepared and select wires/cable types that will not suffer adverse effects of the exposure. Considering the impact of fuel on wiring is not idle musing about wiring systems; to quote the FAA AC120-97A, "Since 1959, there have been 18 fuel tank explosions on transport category airplanes".

To help the industry better understand and address the impact, the US Navy spearheaded work on SAE Aerospace Information Report AIR 6820 on "Electrical Wiring Fuel Compatibility". This report gathered data from several groups and make it available to the industry.

BACKGROUND

As a starting point, the AIR6820 discusses more than which wires are best suited for fuel tank environments and fuel compatibility. The first section of the main body addresses guidance for Electrical Wiring Interconnection Systems (EWIS) installation in and around aircraft fuel tanks. While much of this guidance mirrors the guidance in the AS 50881 standard, some of this guidance comes from the FAA Advisory Circular AC 25.981-1 (two articles on addressing the EWIS requirements of 25.981 #1 and #2). In particular, the ideas that are covered focus on avoiding fuel tank ignition and some of the best practices for wire system design and installation.

One area that is often an area of confusion with fuel tank ignition prevention is the amount of energy necessary to ignite fuel vapor. Section 4.2.4 specifically identifies the minimum ignition energy and an electric spark necessary to ignite fuel vapor is 200 microjoules. Systems with a maximum energy of 20 microjoules are considered acceptable.

The standard goes into several other means of igniting the fuel and fuel vapor including friction sparks, hot surface ignition, and high energy wiring.

FLUID RESISTANCE

For those familiar with AS22759 standard and the wires that are part of this standard fluoropolymer insulated family, may also be aware of the test fluids that are used to ensure compatibility with aircraft installation. In the fluid immersion tests (typically performed in accordance with AS4373 METHOD 601 that identifies 21 different fluids), a short length of wire is submerged (with the open ends of the wire above the fluid) for a defined duration at a given temperature. The test fluid exposure duration to may be as short as half an hour but no longer than one week. Further, the exposure temperature may not

Continued on page 6



Wire/Cable fluid immersion testing is intended to identify if insulation has rapid degradation to a given fluid. Current test methods do not help to identify the potential impact of long-term exposure.



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Guidelines for Wire and Fuel Compatibility in Harnesses

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be representative of the typical exposure temperature on aircraft. For example, the exposure of wires to turbine fuel is to be done for only 20 hours at about 70°F.

Obviously, part of the reason the fuel is tested at ambient temperature is to make the test accessible to more labs and to avoid possible fluid/vapor ignition that might occur if the fluid is heated. While this limitation is practical from a test perspective, it is not exactly representative of wires with regular exposure to fuel. The fuel may be at elevated temperatures and, over the course of the aircraft life, the wire/cable may be exposed for durations much longer than then tested 20 hours.

RESULTS

Much of the data is presented in the AIR was gathered or generated by the USAF and U.S. Navy Patuxent River NavAir group (Lectromec performed a subset of the work cited in the AIR). The presented data shows results from the evaluation of both virgin and aged wiring. Testing with the aged wire/cable (performed at ambient temperature for 168 hours) found insulation degradation for nearly all wire types. The AIR goes on to caveat these results stating the age of the tested wire/cables, their use in the aircraft, and duration of use is uncertain.

Testing of the virgin samples (submerged in 74oC jet fuel for 60 days) found limited degradation (within the margin of error in most cases). The results do not necessarily mean that degradation did not occur, but that the testing did not capture the insulation degradation if it did happen. In comparison to the aged wiring samples, the virgin samples had limited mechanical handling that might have further weakened the insulation.

CONCLUSION

For those seeking to select wire/ cables that will be exposed to fuel, understanding the testing outlined in AIR6820 is important. It covers the work performed by several organizations and highlights what issues may be caused when wiring is exposed to fuel. Ideally, the best solutions would be to avoid fuel exposure altogether, but that is not practical in all cases.

Further, although wire/cables are subjected to material compatibility testing as part of the product qualification, it is important to understand how the component is tested. With some aircraft now using the fuel system as a heat sink, the exposure to high-temperature fuel is becoming a more likely occurrence. If there is a need to test your components and their fluid compatibility, CONTACT LECTROMEC; our ISO 17025 accredited lab is ready to help address any of your EWIS component testing needs.



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Profile Update: Semahtronix

HN profiled Semahtronix late in 2017.At that time, they were just a few months under new ownership with some exciting plans ahead. After a recent conversation with Travis Atkinson, Business Development - Engineer and Alex Stubenfoll, Director of Marketing and Sales, it turns out 2018/19 really was an exciting time, but with some interesting twists. The company managed to onboard 38 new customers and increase their revenues six-fold. In addition to the 65,000 sq. ft. facility in Flippin Arkansas and 25,000 sq. ft. facility in Newport, AK, Semahtronix is about to open another 25,000 sq. ft. in the same industrial park in Newport.

They brought many of those customers on through the traditional path of face-to-face sales efforts. They also had active campaigns on social media, and promoted some videos to address niche industries. "But oddly enough," Travis explained, "customer referrals are what propelled us more than anything else because we proved we can be extremely nimble and quick responding to customer needs."

That's where they are now, but it wasn't necessarily a smooth road. "We worked diligently the first few months pursuing new business," he said. When the POs came in, however, something became apparent. "In my mind at the time, the one thing we could do best was build harnesses; but after about one week attempting construction, I realized it was probably one of our greatest weaknesses." Travis recalled this with a bit of laughter, but at the time it was quite serious. "We literally shut down production and devised a work method to deploy the customer's assembly drawings to a manufacturing drawing, then on to a form board. We did

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Travis offering assistance on the shop floor.

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Profile Update: Semahtronix

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this in a unique way that allows us to divide and conquer within our facilities to produce high-quality complex products."

That bold step really changed the face of their business internally. The new work processes are extremely efficient and allow operators to easily understand work instructions. "That method has allowed us to be faster and respond even quicker with multiple complex assemblies,"Travis said.

Travis and the rest of the leadership team have also been concentrating on fostering a workplace that values employees, and an environment where they enjoy coming to work. They recently went to a four-day, tenhour shift work schedule, and the staff really like it. "We have about 30 employees who are at or near their golden years, and we allow them the opportunity to choose a schedule between 10 to 30 hours." These folks work very well with the younger staff, as Travis revealed, "Millennials get a bad rap in most workforces, but for whatever reason, they excel in our environment."

It's not like there's no competition with other employers in the region. "In our area of Arkansas, we've got Ranger Boats, Baxter Laboratories and Eaton Corporation. You'd think with the growth we've had, we'd be grasping for quality workers, but we're very fortunate that the workforce is coming to us, by word-of-mouth; and they turn out to be very productive."

There's been some heavy capital improvements over the past year too. "A large part of what we do is overbraided, so we put in five new braiding machines." They've also added Schleuniger and Artos wire processing machines, and a Telsonic ultrasonic welder. "We're investing in stateof-the-art equipment and developing adaptive processes that allow us to continue to be nimble and meet our customer's needs,"Travis said.

Most of their business is in what he referred to as low to mid volume assemblies. "I was looking the other day, and we had 550 different part numbers and about 22,000 pieces of material in WIP, so that's an extremely diverse capability."

There's a lot of American pride in what Semahtronix does. They are proud to be vertically integrated and to source mostly US made products. "There's only one component we source from offshore and we pride ourselves in being competitive, even with offshore manufacturing, for what we do," he revealed.

In his concluding remarks, Travis seemed delighted in the way Semahtronix works as a team. "I think one of the biggest things is our owner, Rusty Hayes, and the rest of the management team are actively engaged in the business - from strategic decisions to tasks down on the work floor. Probably 50% of my time is spent on the shop floor, and in today's times, that's somewhat unique."

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Redefining Success

By Paul Hogendoorn

s far as achieving success in manufacturing is concerned, it is often said that "what gets measured gets improved" and, "you can't hit a target you don't set". Both are true statements, and both are indeed critical to achieving success. However, what is worth a closer re-examination is what is being measured, and how is success defined.

If you were to ask yourself, or anyone in your organization, what success means, you would likely get some very quick and accurate, but very general descriptions. You would hear words such as "profitability" and "growth", if you were in ownership or management, "stability" or "job security" if you were on the floor, or "continuous improvement" or "better quality" if those you asked were tasked with those mandates. Sometimes you might get actual numbers or percentages as part of the answer, but rarely will you get a true and specific description of a tangible success worth aiming for.

For instance, several custom machining manufacturers I have worked with the last 2 years started out chasing the elusive goal of improving their OEE to what they believe are 'world class standards'. In that time, they have invested in new machines, retrofitted older machines, reorganized their shop, changed their processes, and trained and fully engaged their operators. Despite doing all these things and making these investments, their OEE number failed to improve significantly, if at all.

Part of the reason for that is that OEE is not easily applied to operations where every job is different, and the execution time varies depending



Paul Hogendoorn

on which machine the jobs are run on. In many shops, a machining job could be put on a number of different machines, some capable of running faster than others, and some easier to set up than others. Accurately calculating the OEE requires comparing the actual manufacturing time to the anticipated manufacturing time, which in turn requires calculating the expected operation times for every unique job on predetermined machines, and then setting and sticking to the schedule of which jobs will be run on which machines. Any minor event to a single job would cause a significant ripple effect to the entire machine schedule, and this is something that happens routinely in most custom machining shops; it is closer to the rule than the exception.

To account for this, some shops have chosen to simplify their metric by measuring machine utilization and set-up times instead. It is a far easier measurement to make and is an indirect indication of productive activity, as well as being a very good indication of how close a plant is running to its capacity, (or how much capac-

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Redefining Success

Continued from page 13

ity it has available). It was then discovered that the utilization metric all on its own would not lead to success because slower machines were scoring higher than faster machines. For instance, an old machine might take 6 hours to machine a job whereas a newer machine would only take 2 and half. As a consequence, the new machine would go through 3 set up situations per shift whereas the old machine would only have one. The old machine would end up with a better utilization score than the new. To account for this, they started tracking the number of set ups, and the set up time, and using those measurements as their primary indications of productive activity rather than OEE.

With these two metrics in full view, all decisions were made considering their potential impact on the goals of increasing overall capacity and decreasing average set up times. New machines with faster cutting rates were replacing older machines with slower cutting rates.A higher number of set ups would indicate a faster and shorter cutting time, and increased capacity. Palletizers and other devices were added to minimize set up times. Shorter set up times (and less downtime) would indicate more efficient use of machines, and of people's time too. Dynamic scheduling tools were then used to keep all the machines active and all the operators engaged.

The overall productivity results were indeed significant, with one shop increasing their overall capacity by 50%, far surpassing the minor improvement they were seeing if they looked at their OEE metric. The bottom line was, they accurately redefined what success looked like in a way that was relevant and important for everyone on the plant floor, and they measured only a couple of factors that would directly lead to that success.

It's quite simple, really. We have a tendency to aim for goals that others suggest are worthwhile and measure things that others say are important. Sometimes we just have to look past the goals and standards that others may have put in place and identify the ones that really make a difference in your plant or operation.

What does success look like to you, and how are you measuring it? Answer those two questions definitively, and you will be on your way to accelerating your continuous improvement journey.

Paul Hogendoorn cofounded FreePoint Technologies 7 years ago with the goal of giving manufacturers the benefit of cost-effective information technologies that inform, empower and motivate their most critical asset - their people. He can be reached at paul.hogendoorn@getfreepoint.com or www. getfreepoint.com

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2020 WHMA Annual Wire Conference

By Christine Siebert

s the weather gets colder, holidays are getting closer and they will come and go, what do we have to look forward to? The 2020 WHMA Annual Wire Harness Conference, of course!! As always, WHMA/IPC does not disappoint on location. This year our conference

is being held in sunny Las Vegas! I don't know about you but with the chill starting in the air, I've already signed up and am excited and ready to go.

Now, of course, it's not just about location. This year the WHMA conference committee has put together another great conference lineup. The 2020 WHMA Annual Wire Conference Harness is being held on February 18-20, 2020 at the JW Marriott Las Vegas Resort & Spa. If you've never been to a WHMA Conference, this conference has become one of the few investments that give their attendees an opportunity to learn, grow, share and discover new approaches to many aspects of the wire harness industry. The conference features presentations on topics important to wire harness manufacturers, OEM's and suppliers.

This year's confer-

Responsible for the engineering integrity of all robotic planetary missions managed by JPL for NASA, Lee provided engineering oversight for the Curiosity rover mission to Mars in 2012, the Dawn mission to the asteroids Vesta and Ceres, the Juno mission to Jupiter and the GRAIL missions to the Moon. Previously, Lee provided oversight and guidance for the engineering aspects of the Phoenix and twin rover missions to Mars, as well as NASA's successful Deep Impact and Stardust missions.





ence keynote presenter will be B. Gentry Lee with his presentation titled "A Passion for Space Exporation". Buchholz is chief engineer for the Solar Exploration System Directorate at the Jet Propulsion Laboratory (JPL) and successful science fiction writer. During his keynote presentation, Lee will talk about the highlights of his exploration career and touch on the role of wires harnesses on and the most memorable spacecraft.

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2020 WHMA Annual Wire Conference

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Other presentations and topics to be covered at the conference:

• "Wire Harness Industry Economics - Managing in an Uncertain Economy" presented by Taylor St. Germain

• "Space Challenges from Wire Harness" presented by Robert WM. Cooke

• "Megatrends of CASE (Connected, Autonomous, Shared and Electrification)"

holding a Technical Education Workshop - The Evolution of IPC's Cable & Wire Harness Documents: IPC-D-620, IPC/ WHMA-A-620 and IPC-HD-BK-62 presented by Robert Cooke. This presentation will be a detailed, but often lighthearted and realistic, discussion on how the IPC's cable and harness assembly documents were created - from the submission of comments and technical content covering acceptance requirements for cable and wire harness assemblies to be included in the

New this year, WHMA is IPC-A-610 "Acceptability of Electronic Assemblies" document; into the IPC/WHMA-A-620 "Requirements and Acceptance for Cable and Wire Harness Assemblies" document; the Space Addendum IPC/WHMA-A-620x-S - Space Applications Electronic Hardware Addendum to IPC/WH-MA-A-620"; and then evolved to include companion documents covering design IPC-D-620 "Design and Critical Process Requirements for Cable and Wiring Harnesses", the handbook IPC-HDBK-620 "Handbook And Guide To IPC-D-620 and IPC/WHMA-A-620", and

> separate design and acceptance documents for optical fiber, optical cable, and hybrid wiring harness assemblies.

> This course will also include:

> How can the documents be used - and what does the acceptance code mean?

> • Why are there separate design, acceptance, and handbooks - and how they work together?

• When will there be new revisions?

• What does a handbook do / not do?

• "Hot" topics that are included in the documents

Of course, it would not be a WHMA Conference without a lot of networking and fun. The infamous golf outing this year will be held at the Tournament Players Course Las Vegas (TPC LV). View the latest innovations from the top suppliers to the industry in the vibrant exhibit hall and four hours of best practice roundtables. This is one event you do not want to miss!

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The Value of a CIM

By Loren Smith

ften, wire harness owners who retain me to sell their company will ask if developing a CIM (confidential information memorandum) is really worthwhile. I respond that although creating a CIM can seem a rigorous, time-consuming undertaking for the seller, I consider it just about mandatory.

The CIM enables prospective buyers to quickly grasp vital information about a company such as its management team, markets served, process, competition, and financial history. It should take a prospective buyer no more than 20 minutes to read while providing enough information for a buyer to ascertain level of interest. The following example illustrates the CIM's value.

A number of years ago, I was helping sell a \$5M West Coast harness company that had two huge question marks on its back: 1) The company did 85% of its business with one customer. 2) The owner of the company took his compensation in a convoluted way--entirely legal, but complicated.



Loren Smith CEO Blue Valley Capital

No problem. The CIM just needed to show that the relationship with the company's key customer was secure, based on performance and longevity, and it needed to clearly explain the past compensation practice as well as the key fact that future compensation would not be a cash drain on the business post-closing. (It was categorized as an add-back to EBITDA, representing the majority of the company's value.) In addition, the CIM included the all-important de-

Continued on page 23

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The Value of a CIM

Continued from page 21

scription of how a prospective buyer might grow the business.

After completion, the CIM was disseminated to a small group of highly qualified buyers, and we soon had plant visits scheduled with a few of them.

The first buyer we had scheduled sat down with the seller and me one afternoon to ask a series of questions based on his understanding of our CIM. Afterward, we adjourned for a casual dinner, during which the buyer said he would provide us with a preemptive letter of intent (LOI) that night. (This did not surprise me greatly because the buyer and I had a prior, trusting relationship, and I suspected that the CIM had been quite persuasive.)

When we received the LOI that evening, we saw that it exceeded our expectations. Now the harness owner needed to decide whether to immediately accept the first LOI or engage in dialogue with other buyers. He asked my advice. I told the owner that delaying our response created the risk that the buyer might find another opportunity, which could divert his attention and soften his enthusiasm for the deal, but that if he wanted to take this risk I'd be happy to continue dialogue with other prospective buyers. The seller wanted a day to think about it.

Sure enough, he called me the next morning, saying, "Because I'll be getting more than I expected, I want to sign the LOI today."

Although a competitive process is usually the path to optimal results, this sale process was atypical. A small harness company with extremely high customer concentration has limited appeal, and that was borne out when preliminary conversations with several potential buyers had failed to pique interest. Enter the CIM. Once we clearly and concisely laid out the company's attributes on paper, we were able to identify and clinch a deal with an ideal buyer.

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



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- **POWER WOMEN** OF THE WIRE HARNESS INDUSTRY

This edition of The Power Women of the Wiring Harness Industry features Natalie Wheeler, a Product Engineer at TE Connectivity.

Natalie's path into engineering was slightly unconventional. There were no clear engineering influences in her childhood in Minnesota. As a young woman, she attended many STEM events that sparked her interest in Math and Science, but they never made her think about pursuing engineering as a career. Later when her highly-educated, non-engineering parents relocated the family to Virginia, she approached the start of her college career with a dilemma. She was struggling to make a choice between what she thought were two competing interests-the arts and the sciences. While music was a passion, a conversation with her mother led her to realize that a career in engineering opened more doors for her future.

As luck would have it, Natalie found a program at Lehigh University in Pennsylvania that combined her interests in both Engineering and the Arts. She quickly enrolled and moved to PA where the snowy winters reminded her fondly of her early years in Minnesota.



Natalie Wheeler

Although the ratio of male to female engineers can often be a concern, Natalie was excited to discover that the gender diversity was split nearly evenly between men and women in her program at Lehigh. The diversity also extended into a plethora of unique backgrounds, interests and viewpoints relative to her fellow classmates. Following in her parents' footsteps, Natalie went on to pursue a Master's degree. The Technical Entrepreneurship program at Lehigh allowed her to gain a better understanding of how strategic and operational decisions are made in a company, rounding out her knowledge in engineering, the arts, and business.



Melissa Femia

terested in the variety and opportunity to learn new things in different areas of the business. In the program, employees rotate approximately every 15 weeks for two years among departments where she gained experience in a wide variety of engineering roles.

Currently working in the machines team within the Application Tooling Business Unit, Natalie has an exciting opportunity to support a product line on a global team. This machine product supports the MAG-MATE line of terminals, which are insulation displacement connections, on a variety of different small motor applications. She has also been able to pursue her interests in aesthetic design and continuous process improvement during her short time outside of the rotation program.

Natalie recommends engineering as a major to other females entering college, even if they have not previously considered the major or have additional interests outside of engineering. She has had positive experiences at college and at TE Connectivity and believes that there are various opportunities in engineering, especially for females. If a student enjoys building projects or solving problems, engineering can be a great fit. She advises that students need not worry if they are not the smartest





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Natalie was offered a position with TE Connectivity in spring, post-graduation. Aware of its rotational program's exposure to a diverse group of people and programs, she was inin the class as there are many, many options and opportunities available. There is not one type of person who can be an engineer, and she believes that diversity in our backgrounds leads to diverse solutions.

Thank you to Natalie for your time and interest in supporting our initiative to promote females in engineering.

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

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

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NEWS PLUGS



Executive Vice President Paul Gemelli is Elected to WCISA Board of Directors

Gem Gravure is pleased to announce that Executive Vice President Paul Gemelli has been elected to a three-year term as a member of the Board of Directors at the Wire and Cable Industry Suppliers Association (WCISA).

In a statement released by WCISA, the nonprofit group's Executive Director Mike Mc-Nulty said "WCISA is grateful for the volunteer service of our returning, exiting, and new board members."

WCISA is a nonprofit corporate membership organization of North American-based suppliers of machinery, materials and accessories used for making all types of wire and cable. WCISA's mission is to promote its members' products and services by providing members with representation, networking/social opportunities, and services at wire and cable trade events and conferences.

"I'm very excited to join the other members of the Board of Directors at WCISA, and I look forward to serving with them," Paul Gemelli said. "Among the many positive things that WCISA brings to the industry are annual scholarships awarded to member company employees and high school students whose parents work at member companies. In September, the Board granted over \$6,500 in scholarships to seven high school students and three member company employees, all of whom we are very proud to support."

In addition to these scholarships given to individuals, the Board also recently granted two \$3,000 awards to the "Wire & Cable Industry Scholarships Fund" at Rensselaer Polytechnic Institute and Georgia Tech University.

Mr. Gemelli and four other newly elected Board members will each serve three-year terms through July 2022.

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TPC Wire & Cable Acquires Cicoil LLC.

Acquisition Adds New Manufacturing Capabilities in Flexible Flat Cable

TPC Wire & Cable Corp. (TPC), a portfolio company of Audax Private Equity, announced today that it has completed the acquisition of Cicoil LLC., a leading manufacturer and distributor of flat cable and flat and round cable assemblies. Based in Valencia, California, Cicoil's technology is widely used in mission applications Critical within industries such as Mil-Aero, Semiconductor and Medical. This acquisition allows TPC to expand its market reach and strengthen its portfolio of specialized wire and cable solutions to sophisticated, high cost-of-failure environments. In making the announcement, TPC President & CEO Jeff Crane explained, "We continue to execute our strategy of combining above market organic growth with acquisitions that diversify our product and service capabilities as well as the end markets we serve. We couldn't be happier to welcome Cicoil and all of their associates to the TPC family. Howard and his strong team have built a great and growing business. Their deep technical expertise and commitment to R&D, combined with our commitment to solving customer problems will enable us to build on the success both companies have enjoyed. We are confident that this acquisition will better position both TPC and Cicoil to capture significant opportunities today and into the future."

Of the transaction, Cicoil's President and CEO, Howard Lind stated, "Cicoil is very excited to become part of TPC Wire & Cable, as together we have significant capabilities that will allow us to expand our product and service offering and strengthen our market presence. We have been manufacturing mission-critical cables and cable assemblies since 1956, and the entire Cicoil team is committed to growing the company's legacy with the TPC team."

About TPC Wire & Cable Corp.

Founded in 1979, TPC is a leading designer and provider of high-performance wire, cable, connectors, assemblies, and accessories used in harsh, high cost-of-failure environments. TPC products are designed to withstand abuse from impact, abrasion, flexing, chemicals, and extreme temperatures, while exceeding customer performance specifications. The company's dependable products outlast ordinary cable in the most difficult applications to reduce downtime and overall cost. TPC serves a variety of industries including the steel, automotive, industrial automation, utility, transportation, food & beverage, oil & gas, wood, pulp & paper and defense markets. For more information, visit tpcwire.com.

About Cicoil LLC.

Founded in 1956, Cicoil has been a leader in designing and manufacturing high performance cable assemblies for technical industries. The company's Patented Flexx-SilTM Flat Cable Technology is used in thousands of demanding applications; including aircraft fuel control cells, semiconductor automation, and the International Space Station. By implementing the latest lean manufacturing production techniques, Cicoil designs and manufactures the highest quality products, with fast, responsive lead times for customers and a quality assurance system certified to the ISO 9001 (AS9100) standard.

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History of Connectors and Termination Tooling

ince the beginning of flight and early propulsion systems, electrical conductors have been used to transmit a signal throughout the aircraft. As air travel evolved, so did the requirements for wire harnesses and connectors used in these systems. Today, Electrical Wiring Interconnect Systems (EWIS) are very complex incorporating both traditional power and high speed data signal. This complexity in wiring requires connectors, contacts, wire, fiber optics, and other technology that require precision tooling.

CRIMPING: THEN AND NOW

The first multi-pin connectors were terminated by soldering the conductor to non-removable contacts. However, high temperature applications and the need for simple and reliable field service led to the introduction of connectors with removable contacts. These were crimped onto the conductor rather than being soldered.

The first standard crimp tool developed to crimp these new contacts was introduced in the early sixties. MS3191-1, a military drawing, defined this tool and its accessories.

The MS3191-1 utilized a fourindent crimp pattern together with a positive stop locator which controlled the travel of the indenters (crimp depth).

The MS3191-1 design was a compromise between simplicity of operation and crimp performance since the crimp depth for any given contact was not adjustable to accommodate the differing diameters of the conductors to which it would be crimped. It was, however, suitable for the crimp connectors of that era. An



Get started





improved tool design featuring independently adjustable crimp depths was soon introduced as MS3191-4.

The MS3191-4 had an internal adjustment, totally independent of the locator, which permitted the selection of seven separate crimp depths, allowing optimal crimping of conductors ranging from AWG 12 to 26 regardless of the wire barrel size of the contact. MS3191-4 also introduced the use of the double tipped indenter to produce an eight-indent crimp pattern which has consistently achieved superior tensile pull off values and mechanical properties.

MS3191-4 introduced the concept of a turret head containing three locators which could be used without separating any of them from the basic crimp tool.

In 1969 two military specifications for crimp tools were developed to replace the existing military drawings. They were MIL-T-22520C (Navy) and MIL-T-83724 (USAF) which defined a standard size crimp tool similar to the MS3191-4, but with an expanded eight step crimp depth range. These specifications also defined a miniature crimp tool to crimp conductors as small as AWG 32. Both documents were combined in 1971 into MIL-C-22520D. All previous military standards for crimp tools were then cancelled including the MS3191. This list includes specifications for indent crimp tools, terminal lug crimp tools, pneumatic tools, coaxial cable crimp tools and other specialized crimp tools.

MIL-DTL-22520 established a single specification which set forth performance requirements for all crimp tools to be used on military standard electrical connectors. This eliminated the waste and confusion which accompanied the overlapping applications of many different "standard" crimp tools called out by a deluge of unrelated military drawings.

Continued on page 31

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History of Connectors and Termination Tooling

Continued from page 29

THE CRIMPING CONCEPT

Crimping is a method of firmly attaching a terminal or contact end to an electrical conductor by pressure forming or reshaping a metal barrel together with the conductor. The forming of a satisfactory crimp depends on the correct combination of conductor, crimp barrel and tool. When applied with a properly matched tool, a union is established which has both good electrical and mechanical characteristics. The tool will provide these requirements consistently and reliably with repeatability assured by quality cycle controlled tooling.

There are several common configurations of crimped joint; several examples are shown below. The electrical resistance of a properly designed and controlled crimped joint should be equal to, or less than, the

with Crimp Barrels

Ratchet (Ref: MS3191)

previous specifications

Changed to MIL-DTL-22520

2016-Present Complete the change to SAE AS22520

1953

1957

1960

1961

1963

1965

1969

1974

1996

resistance of an equal section of wire. Specifications state the requirements in terms of millivolt drop at a designated current.

The mechanical strength of a crimped joint and hence its pull-out force (tensile strength), varies with the deformation applied (i.e. the crimp die of the tool determines the crimp configuration and deformation). Therefore, by properly shaping the deformation, a high pull-out force can be achieved. The dies in the tool determine the completed crimp configuration which is generally an element of contact and/ or connector design.

Some of the design considerations are: a) The type of contact, its size, shape, material and function, b) The type and size of wires to be accommodated, c) The type of tooling into which the configuration must be built.

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Boeing adopts MIL-C-26500 with Minuteman Program

MS3191-4 introduced by Daniels Manufacturing Corp.

MS3191-1 published as first Crimp Tool Standard

MIL-T-22520 published and dated to replace all

Changed to MIL-C-22520 w/ slash sheets added

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In every issue of Wiring Harness News Anixter will bring you informative articles about wire and cable technology.

Diesel Locomotive Cable (DLO)

What Is Diesel Locomotive Cable?

Diesel locomotive cable (DLO) is a flexible cable with a dual-extruded product consisting of ethylene propylene rubber (EPR) insulation and a thermoset chlorinated polyethylene rubber (TS-CPE) jacket. DLO comes with tinned copper Class I stranded conductors. The voltage rating for DLO cable is 2000 volts. DLO cable is suitable for use in conduit, ducts, troughs and electrical tray. It can be used in wet or dry areas. The maximum continuous conductor temperature for normal operations is 90°C in dry locations and 75°C for wet locations.Today, there are several manufacturers that are making DLO cable with a UL RHW-2 rating, which gives the cable a 90°C wet or dry rating.

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DLO has excellent resistance to oils, acids, alkalis, heat, flame and has outstanding abrasion resistance.

Diesel Locomotive Cable Applications

DLO today is a UL-listed cable originally developed to supply power to traction motors of the dieselelectric locomotives. Despite having the word diesel in the name, diesel locomotives use electricity to drive the forward motion. A large diesel engine turns a shaft that drives a generator, which makes electricity. This electrical energy powers large electric motors at the wheels, called traction motors.

Some locomotives use DC generators and others use AC. Modern alternating-current locomotives have better traction and adhesion and are used on trains that carry heavier loads. DC is still sometimes used because it is less expensive to manufacture. DLO cable is used to transmit the power from the generator to the electric-drive motor. It is available in conductor sizes ranging from 14 AWG to 1111 kcmil. It is also used in many other applications where a flexible, tough cable is needed due to tight bending radii.

DLO cable is recommended as a portable cable for drilling rigs, onshore and off- shore applications, railroad and transit car wiring, and electric earth-moving equipment. It also extremely well-suited for other applications like shipyards, power and control jumper cables, motor leads, and sometimes as a telecom power supply.

Due to DLO cable carrying a UL RHH/RHW-2 or CSA RW90 rating, the AHJ (authority having jurisdiction) will allow its use in many other applications. These may include other electrically driven moving equipment, motor or power leads, UPS backup systems, fuel cell systems, battery banks and backup generators. DLO cable in sizes 1/0 AWG and larger is generally cable tray rated, allowing for use in industrial facilities. DLO cable may be an allowable substitute for welding cable. DLO can be thought of as a very heavyduty welding cable due to the dual construction (insulation and jacket) and will at times be used as welding cable, especially for high-current applications. Welding cable is not to be used a substitute for DLO; it is generally only allowed on the secondary circuits of an electric welder as part of welding leads.

How to Terminate Diesel **Locomotive Cable**

The major lug manufacturers offer special lugs for finely stranded cable, called flex lugs. These lugs are re-





quired for DLO cable, welding cable, Type W, G, G-GC and SHD-GC cable. Section 110.14 of the 2017 NEC requires that conductors more finely stranded than ASTM Class C be termi-

nated in specially identified connectors. Care should be taken by users when stripping the cable in preparation for termination to not allow the fine stranding to become frayed.

	Welding Cable (600 V)		UL Style 1283 (8-2 AWG)5 UL Style 1284 (1 AWG-500 kcmil)+		DLO (2.000 V) Type W (2.000		1000 V)	
Gauge Size (AWG/kcmil)	Insulation Thickness (in.)*	Strand Count*	Insulation Thickness (in.)	Strand Count* (multiple options)	Insulation Thickness (in.)	Strand Count*	Insulation Thickness (in.)	Strand Count*
8			0.060	-	0.055 (0.085 w/ jacket)	37	0.060	133
6	0.070	259	0.060	19/133/266	0.055 (0.085 w/ jacket)	61	0.060	133
4	0.070	413	0.060	19/133/420	0.055 (0.085 w/ jacket)	105	0.060	259
2	0.070	651	0.060	19/133/665	0.055 (0.100 w/ jacket)	147	0.060	259
1	0.070	840	0.080	133/259/833	0.065 (0.110 w/ jacket)	224	0.080	259
1/0	0.090	1050	0.080	259/1064	0.065 (0.110 w/ jacket)	266	0.080	259
2/0	0.090	1323	0.080	259/1330	0.065 (0.110 w/ jacket)	323	0.080	259
3/0	0.011	1666	0.080	259/1330/1672	0.065 (0.110 w/ jacket)	418	0.080	259
4/0	0.011	2107	0.080	259/551/2109	0.065 (0.130 w/ jacket)	532	0.080	259
250 (DLO: 262.6)	0.125	2450	0.095	2451	0.075 (0.140 w/ jacket)	646	0.095	427
300 (DLO: 313.3)	0.125	-	0.095	3458	0.075 (0.140 w/ jacket)	777	0.095	427
350 (DLO: 373.3)	0.125	2350	0.095		0.075 (0.140 w/ jacket)	925	0.095	427
400	0.125		0.095				0.095	427
450 (DLO: 444.4)	0.125		0.095		0.075 (0.140 w/ jacket)	1110	0.095	427
500 (DLO: 535.2)	0.125	5054	>0.095		0.075 (0.140 w/ jacket)	1332	0.095	427

*Common construction, subject to change per manifact

Table 1: Insulation Thickness and Strand Count of Common Flexible Cable

Most barrel-compression lugs sized for DLO cable have a chamfered barrel to help guide the conductor into the barrel. Be careful to not break off any of the strands when stripping the insulation and jacket or allow any of the strands to bend back on themselves.

DLO cable is heavy and expensive compared to more common copper power cable, such as THHN or XHHW, due to the labor that goes into producing the fine stranding and the more expensive insulation compounds and curing methods. DLO is a premium product that provides many benefits in the appropriate use case.

For questions or more information, contact your Anixter representative or visit anixter.com







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The MultiStrip 9480 cut and strip machine is now being offered with SmartDetect for advanced quality monitring. The sensorcontrolled system monitors the complete stripping process in real time and detects any contact between the stripping blades and the conductor, improving production quality without sacrificing high performance.

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NEWS PLUGS continued

Heilind Electronics Expands Industrial Cable Selection with Alpha Wire's Pro-Met Metric VDE Control Cables

Heilind Electronics, a leading global distributor of electronic components and authorized distributor for Alpha Wire, is now stocking the manufacturer's Pro-Met industrial cable. Pro-Met is a line of flexible industrial cable highly resistant to both oils and resistant to UV damage.



Standard features include two to twelve conductors, grey or transparent jacketing options, and unshielded or tinned copper braid shielding with a 300/500 voltage

rating. In addition, customers can select from 50, 100 and 300 meter lengths. This multitude of options makes Pro-Met a flexible solution for industrial automation systems.

Alpha Wire's Pro-Met cable is designed to provide consistent reliability, resulting in more uptime, fewer errors and precise operation of equipment. In addition, Pro-Met's round construction makes it easier to install, seal and route.

Pro-Met cable is ideal for a wide range of applications, including automotive, industrial automation, aerospace and defense, commercial electronics, medical devices and food and beverage.

Visit Heilind's website for more information about Alpha Wire's Pro-Met industrial cable.

Heilind Electronics, Inc. (http://www.heilind.com) is one of the world's leading distributors of connectors, relays, sensors, switches, thermal management and circuit protection products, terminal blocks, wire and cable, wiring accessories and insulation and identification products. Founded in 1974, Heilind has locations throughout the

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Alpha Wire designs and manufactures industry-leading wire, cable and tubing products for factory automation, packaging, automotive, alternative energy, medical, semiconductor fabrication and other technically advanced applications.

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NEWS PLUGS continued



Next-generation AMP MCP **Connectors are Flame Retardant and Easily Fit into Existing Bulkhead Cut-outs**

Offering improved safety and ease of assembly over other industry models, TE Connectivity (TE), a world leader in connectivity and sensors, launched a new addition to its unsealed connector portfolio for the transportation industry. The AMP MCP 18P monoblock connector offers trust and reliability in harsh environments for industrial and



commercial transportation with its flame retardant composition and new lever design.

Ideal for bulkhead, in-cabin and fuse-and-relay-box applications, these unsealed monoblock connectors use the widelyknown AMP MCP 2.8 contact system, have a reduced mating

force below 75 N, and can easily be used for new or existing designs. They conveniently fit into existing bulkhead cut-outs and the required secondary locking feature helps to keep contacts aligned.

"Electrical networks become more and more complex while

regulations are constantly increasing. That's why it's imperative that truck, bus, auto, construction and agriculture-equipment operators have connector solutions they can trust, thereby minimizing one potential aspect of complexity," said Girish Medh, product manager, Industrial and Commercial Transportation, TE Connectivity. "Our design and engineering teams heard what transportation operators said about the need for a next-generation connector. We met that need with these state-of-the-art connectors and will continue to innovate by keeping our customers involved with our product design and development."

The flame-retardant UL 94 V-0 material from which the connectors are made increases their safety factor, as does the required secondary locking feature. In addition, the four available colors ensure proper mating and help ease assembly.

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to Expand Hi-Rel Offering

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Included in Heilind's extensive AirBorn offering are cable and board mount connectors qualified to MIL-DTL-32139, MIL-DTL-83513 and MIL-DTL-55302 specifications. These products include rugged boardto-board, Micro-D,



nanominiature and circular connectors with high-density and high-speed configurations. Customers will also be able to order from AirBorn's complete listing of proprietary interconnect part numbers.

"We are very pleased to have Air-Born as part of our Hi-Rel portfolio," said Alan Clapp, Vice President of Supplier Business, Heilind Electronics. "Our customers will now have access to a wider selection of the most cutting-edge harsh environment products in the market."

AirBorn products span many industries, including aerospace, energy, geophysical, industrial, instrumentation, marine, medical, military/defense and space exploration.

Visit Heilind's website for more information about AirBorn.

About Heilind Electronics

Heilind Electronics, Inc. (http:// www.heilind.com) is one of the world's leading distributors of connec-

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tors, relays, sensors, switches, thermal management and circuit protection products, terminal blocks, wire and cable, wiring accessories and insulation and identification products. Founded in 1974, Heilind has locations throughout the U.S., Canada, Mexico, Brazil, Germany, Singapore, Hong Kong and China. Follow Heilind on Facebook at facebook.com/Heilind and on Twitter at twitter.com/Heilind.

About AirBorn

For over sixty years, AirBorn has been serving OEMs (original equipment manufacturers) with specialized harsh environment connectors, cable assemblies, flex circuit assemblies and other electronic components. These products are engineered and manufactured to the highest quality, using Six Sigma and lean manufacturing principles. AirBorn solutions are relied on by defense, aerospace, medical and industrial leaders to operate their most critical systems in the most demanding environments.

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shift," Mando reports. Customers report something unusual too:

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Products, for example, writes how Mando takes time to answer questions, explain machine operation and even gave "tips on stripping some shielded cable that others said could not be done."

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Continued from page 1 _

making cables in his basement," she shared. It wasn't long before the hiss and clamor of the stripper and crimp press became too much for the family, and Harry was banished to the garage with his little side hustle."He parked himself there for a few months, but winter came and his wife wanted to park her car in the garage," she continued. Harry was forced to find a building for his venture, and CEI as a company was born.

Most of our discussion centered around CEI's explosive growth in the past few years, and the changes that helped them achieve this growth. Carrie began, saying, "In 2017/18 our company experienced 25% sales growth, which meant we were understaffed and under the gun and behind on almost everything." She had only been with the company a year or so, and was brand new in her role as Production Manager. They needed a way to rapidly improve the flow on the shop floor, so Carrie and her team established a dedicated crimping department and reorganized the cellular flow of the production floor. "That extra step meant the wire was prepped and ready to go by the time it got to the production cells.," she recalled, "and that helped greatly with the throughput times."

CEI also made some improvements to their leadership structure on the floor in order to focus on the individual strengths of their supervisors. "We have two supervisors now, where we had one prior to 2017; so, we went from a floor with one supervisor and three leads watching the entire floor, to two supervisors with four leads who have dedicated

personnel they are responsible for," Carrie detailed."This helped us really focus on getting scheduled products through lines much more quickly."

Carrie also described the assigning of skill levels to each individual assembly they produce at CEI. "Our assemblers also have skill level designations, so we can put the right skill level work with the appropriately skilled employee. This has helped us to standardize a training schedule that rapidly grows the skill set of our workforce, and allows us to better organize our production schedule for maximum throughput." Simply put higher-level assemblies are assigned to higher level employees. The result is improved Quality across all assemblies and better job confidence for all production employees.

Since training is such a key aspect in the wire harness industry, I pressed Carrie to provide even more detail. She mentioned they use a training matrix to document each skill an employee has been trained for, and signed off on. Personnel are trained by a trainer, and then shadowed by a trained employee until they prove proficiency. "We have specific training documents we use to teach people how to, for example, set up a crimping machine, or how to solder different types of connectors." They slowly level people up from entrylevel (level 1) jobs that are good for training new employees, to where're they perform more complicated operations. "Level 2 employees get into more complicated connectors and cable solders, and Level 3 folks deal with the most complicated harnesses consisting of many connectors and cables," she described.



Inspection of assembly at CEI.

It wasn't all easy to implement these changes, especially led by someone relatively new to the group. Carrie recalled,"I was getting used to them and they were getting used to me, and we needed to make a lot of changes very rapidly." The workforce had not typically been receptive to change. The management team was able to convince employees the changes would make them more proactive instead of reactive, while greatly reducing the stress and chaos that had ensued. "It's funny looking back at how quickly they've adapted to this mindset, and now it seems that this is the way it has always been. They remember the chaos, but they

can't really remember what caused the chaos, and they definitely don't want to return to or re-live the past."

There are even more process improvement goals set for 2020. "Next year, we will be implementing more lean training than we have in the past couple of years," Terri mentioned, "and we will have more activity-based team-building/communication and training to enable the departments to streamline what they do and communicate more effectively."

I pivoted to marketing and asked the group how they attract customers at CEI, and Betsy revealed that

_____ Continued on page 45





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Continued from page 42

about 95% of new business comes from word-of-mouth. "Madison is a fairly tight-knit community and there is a lot of medical and test/instrumentation manufacturing in the area. People, especially engineers, tend to bounce around from company to company and we get to know them," she pointed out. "They know what we are capable of, and it just snowballs from there."

I asked the group what makes them an unmistakable asset to their customers and Betsy jumped in saying,"I think the biggest thing our customers like is the personal attention they receive." CEI salespeople are assigned to specific accounts and they work hard to get to know people, especially the engineers. "They become receptive to giving us a call and saying, 'I've got a 26-pin widget that needs to do this or that, so let me know what you suggest and I'll put it on my drawing." That's the perfect scenario for CEI as they get in on the ground floor of product development. "We don't design here per ISO, but we can certainly suggest designfor-manufacturability options that help both them and us. It gets them a better price, so the purchasing folks are happy, and they avoid parts that take four years to get, which makes the engineers happy."

Betsy furthered, saying, "We all go the extra mile to help them out. Of course, on-time delivery, quality and price are important, but at the end of the day, if you don't have the level of service they need and have come to expect from us, it's just easier for them to say 'ok, we'll give you a try,' to our competitor when they come knocking on their door."

I got enough great information from Carrie, Terri, and Betsy to easily fill another article. But suffice to say they all love working with their team at CEI. All seemed to be especially fond of the open-door atmosphere, the different hats they get to wear and the camaraderie that has developed. Betsy added,"I guess the thing I really like about working here is our customers. We have a really cool customer base and because I've been here for a while, I've gotten to know them really well. They make some amazing products and it's just great to be a part of it."

I'll let the final words of my brief conversation with Harry sum things up at CEI:

Everything we do is focused on exceeding our customer expectations. We take pride in a workforce that embraces a culture of customer service, quality, training, teamwork, innovation and drive which helps us maintain 100% on-time delivery. As we grow and add additional employees, we team them up with experienced teammates to train and learn the correct processes and methods of manufacturing our products.

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Wire Harness Data Migration Success

Continued from page 1

Background

The manual process for converting electrical harness data did not produce an output that was usable or desired. A substantial amount of post process cleanup was required, with inconsistent and invalidated results. The labor-intensive manual process failures after migration from CATIA V4 provided a good insight into the requirements needed for software development. The automated solutions would include:

Harness Installation Dataset

A LMC harness installation is a 3D representation of all the parts listed

in the bill of materials that are necessary to complete the installation of the harness assembly in the specified location in the aircraft (Figure 1). These parts include the harness assembly, supports (clamps), and necessary attaching hardware (nuts, bolts, etc.). Also, the harness installation will contain reference geometry. The reference geometry includes items that are not part of harness installation's bill of material, but provided context for the installation. The reference geometry will consist of structural members such as bulkheads, stringers, skins, as well as tubing and equipment that may also be installed in the surrounding area. The structural members generally include a sec-

Figure 1. 3D representation

ondary support structure, like brackets to which the harness supports are attached. This 3D data is used to create a traditional 2D drawing depicting the harness installation. Note that a harness assembly called out in a

single installation may be included in other harness installations and, in such a case, will have associations to multiple harness installation datasets.

Harness Formboard Dataset

The harness formboard is a representation of the unfolded or unwrapped harness assembly lying on a 2D plane. The harness formboard data is more than a simple projection of the harness to a plane. The unfolded harness retains the actual trunk and branch lengths of the 3D harness assembly and correctly positions connectors, back shells, and other parts that make up the harness such that twisting of the harness is not required upon installation. A traditional 2D drawing (the Harness Assembly Drawing [HAD]) is a part of the Harness Formboard Dataset and depicts the unfolded harness assembly as it will be

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ded manufacturing formboard tool. The drawing includes part callouts and other necessary assembly fabrication information.

Harness Data Conversion - Requirements Definition

The CATIA V4 3D harness installation .model files shall be migrated to CATIA V5. The solution shall preserve the CATIA V5 associativity between the harness installations and their respective harness assemblies, flattened 3D harness, and formboard after the migration of the model. The result of the migration shall produce four CATIA V5 CATProducts:

- 1. The 3D Harness Installation CATProduct
- 2. 3D Harness Assembly CATProduct
- 3. The Flattened 3D harness assembly CATProduct
- 4. CATIA V5 CATDrawing of the Formboard.

The provided solution shall replace all the migrated CATIA V5 standard parts in the harness installations and harness assemblies with CATIA V5 parts from LMC's provided electrical standard parts catalog, and recreate the links between all branchables and their associated electrical devices.

The provided solution shall also re-establish links between electrical devices (e.g., Branchables, Supports, Connectors, Backshells, Shells and any other electrical devices) in the 3D harness installation, 3D harness assembly CATProduct and Flattened 3D harness assembly CATProduct.

The provided solution shall re-establish the associativity between the 3D harness installation CATProduct and 3D harness assembly CATProduct and the V5 CATDrawing formboard. The solution provider shall ensure the CATIA V4 identifiers are applied to the reference designator, instance names for all CATIA V5 converted 3D harness assemblies, and 3D flattened harness assemblies. Finally, the solution provider shall re-establish links between electrical devices (e.g., Blanchable, Supports, Connectors, Back-shells, Shells and any other electrical devices).

Solution:

When CoreTechnologie received the request for proposal, the internal discussion was simple. LMC had already been a customer under CoreTechnologie's interoperability solution for a decade; therefore, a choice to not submit a proposed solution was not a choice at all. More importantly, not having the expertise in wire harness conversion and the unknown to answer without phase one of the development plan was a known fear from both LMC and CoreTechnologie. Along with the statement of work, LMC provided a sample dataset in CATIA V4. After two weeks of discovery, the proposal process began. Before LMC made the final decision, the team members requested a pre-decision conference call to the selected solutions provider. The two most interesting questions were; Can this be done? and Can CoreTechnologie meet the project time constraints?

Gauthier Wahu, CTO of CoreTechnologie stated, "Anything can be done when you have the correct resources from both sides (LMC and CoreTechnologie) and that the solution would take a close relationship, with strong communications when alpha release is provided". David Selliman, Vice President of CoreTechnologie responded to the second question, "In regard to timing, knowing it could make-or-break the selection of CoreTechnologie, I do not believe, based on our discovery phase, and the unknowns of correctly mapping the data, that we can meet the timelines. I would add (6) months to the project". The selection of the solution to have CoreTechnologie deliver was very simple for LMC. They needed a partner that was going to be transparent with strong communication, as an extension of the LMC team.

Although LMC provided an example solution they tested in the manual process, an automated process was essential. CoreTechnologie developed its automated process in their well-known EDM (Enterprise Data Manger) tool; allowing multiple users to log in and submit jobs as shown in Figure 2. After the alpha release, it was recommended to allow the

_ Continued on page 48

Maraton Pallace	Migration Options		General - Migrate Harne	ss Directory All Files
Options	Skip Migrate V4ToV5		Input directory	Ci/In_data
	Skip Restruct		Replacing Parts directory	Ct/replacing_data
	Skip Substitute Farts		Output directory	C:/out_data
	Skip Relink Harness 30/Flatten			
Migrations	Skip Relink Harness Flatten/Drawing			Add migrabl
Apply Script Directory All files	Skip Compare			
Apply Script File	Tolerance (inch)	0.04		
Configurator	Compare Telerance (inch)	0.1		
Link Installation	Compare Branchable Only	10 ·		
Higrate Directory All Files				
 Nigrate File 				
Figrate Barress file	30b Queue 30b Finish Mg Q	Queue Mig Finish Logfile		
PreProcess CATIA V4 F/e	Status (1908 Provi (Scal Status (Ho	ac 340		
 Simplify Exact 				
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Figure 2. Enterprise Data Manager tool screen

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Heat Shrink Processing Machines

Wire Harness Data Migration Success

Continued from page 47

users to "skip" specific functions in the process. This included "restrict", "substitute parts", "relink harness 3D/flatten or drawing", and also "validation/compare." This was very helpful to understand bugs, enhancements or user errors in the debug mode. As LMC ran several scenarios, they allowed for isolating any existing problems through the migration steps. The first step in the process was to ensure the file was extracting the CATIA V4 file correctly, which included the linked backshells, flatten parametric, and support orientation. David Selliman recalled, "I found a bug where the script would pull the standard parts from LMC database, with full parametric from CATIA V5 to replace the standard parts from CATIA V4 and it failed consistently. This time-consuming bug was a simple fix, but LMC needed to have the reading of CAITA V5 with features in its license configuration to complete this step and move on to the next process. Fortunately, CoreTechnologie feature-based reading technology reads the CAD file from the binary code without access the API from

Dassault CAD systems."

When the beta release was provided, LMC moved the process on to a more powerful machine to speed the testing process as well as to run more complex files through the process. At each step of the process, a file folder was created with a ".toinst" extension. This file was deleted when the next step had been completed. The file is used by LM_link_installation script. The results and logs had a folder for each process shown in Figure 3 (blue folders). In the case that the resulted folder had a failure; as an example - the link between the 3D and flattened data is not correct you will find in the output/harness the V5 relinked folder a file with the ".tofix" extension. This must be fixed, then the above step can be retried with the usage of a skip step if not needed. During the migration and within the link installation, LMC could change migration tolerance (in inches or metrics).

With a success of 90 percent of the data migrated to CATIA V5, there were some post processing activities that still needed to be addressed. As an example; the bundle segment defi-

Figure 3. Data log folders

nitions-bend radius algorithm needed to be selected by slack, length, bend, and straight bend. Further, protective coverings tend to get linked and form extremity points that were often incorrect. With that stated, LMC may not require that all the data be migrated after the dataset post process within the EDM.

As LMC was pleased with the time-

APPLICATORS / CRIMPING PRESSES / TOOLING

line and the results of the migration of the

F13, they decided to include the F35 in the migration tool developed by CoreTechnologies.

Migration Lessons Learned

David Selliman reflected on some valuable lessons on the project:

"In our 'Lessons Learned' meeting and the ambiguous nature of the migration, we discovered that the proper settings in CATIA affect the outcome, and consideration of data management should have been addressed within the PLM early in the process. LMC and Coretechnologie should have addressed the verification of the E3D data and removal of unnecessary details - the percentage of the migration would have increased. And as always, any successful project should embrace the technology, resources, and process with strong communications that assist in understanding failures. We believe that training should have been done along the way and more frequently." For more information, contact David Selliman at d.selliman@ us.coretechnologie. com, or phone 810.923.6481

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Launching Your Company into Over-Molding Continued from page 1

Figure 1. Molding Machines. From left to right, stationary, shutter table, rotary table.

connectors where they may inhibit mating or electrical contact.

Because of the propensity for damage of the wires and connectors that Harald described, molding of cable assemblies generally requires separate pre-mold and over-mold operations, as well as separate materials. "You generally use polypropylene for the pre-mold to keep the wires in place and not blowing everything apart, and then use PVC, TPE, TPU or similar softer materials for the cosmetics and strain relief on the final product."

Next, he highlighted some of the capital equipment and costs. "First you need a molding machine and that can be anywhere between \$60K and \$120K depending on whether you buy new or used." He warned the

choice of used equipment adds risk and requires good mechanical support and more intricate knowledge of the equipment - an ability companies new to the process may not possess. "A new machine, in my experience, requires very little or no maintenance for the first five years of operation."

Options for thermoplastic molding equipment would be stationary table, shuttle table, or rotary table machines (Figure 1), and would depend on the volume of production (higher volumes would tend towards rotary equipment) the size and length of cables, and the ease of loading your particular molds. "The most common is the stationary table since cables are often attached to the over-mold, but even here we have options [for automation]."

The conversation moved to auxiliary equipment. "You will need a chiller to cool the machine, and that will run around \$8K. Next you will need a thermolator to keep the mold at an even temperature (about \$2K) and a material dryer that will run between \$8K and \$12K." Harald also mentioned a workbench at around \$2K and added that used options are more appropriate for the auxiliary equipment since it is simpler in design, and generally requires less maintenance.

From a facility standpoint, he advised you would need a minimum of an 8-ft. wide by 12-ft. space (includes space for operator) and some additional space for racks used to supply prepped cables for the operator, and the same for finished goods. "Electrical requirements are usually 360 V. It's good to assure the chiller and secondary equipment are in line with 360 V, and they can usually be purchased accordingly."

As one can imagine, the Human Resources aspect must also be taken into consideration, since insert overmolding (unlike the more common straight injection molding) requires specific technical knowledge for premolds. "It's not easy these days to find people who know this technology. Since the early 2000's, we have pushed much of the stamping and molding overseas, so we just don't

Continued on page 50

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Launching Your Company into Over-Molding

have a pool of trained people in this field," he advised.

Personnel requirements would generally be a setup technician for the molding machine, as well as a machine operator. Generally, there needs to be adequate staff to run the machines non-stop through process runs. "Bathroom breaks and phone checks are not nice to molten plastic material as it degrades in the machine if it sits for a minute or longer." He added that process times per process for pre-mold and over-mold are in the 30 second range.

Once the equipment and personnel are in place, Harald broke down some of the tooling costs to take into consideration. "For straight injection molding you are paying big time for molds, usually \$20K on up to \$50K." Because volumes for this technology are generally in the tens of thousands or millions, hardened steel alloys are needed and are more expensive to machine. Insert molding is generally associated with lower pressures and volumes runs in the hundreds or thousands range; and aluminum is generally the more economical option. "So, the cost is generally around \$6K, but it's wise to have a spare set. Insert molding is more operator dependent, and lends itself to human error in loading. This will damage the softer aluminum tool and cause flash or extra rework on the final product," he instructed.

So how can ISC help in a decision to bring over-molding in-house? Harald launched into a discussion of a current customer as a typical illustration. "It's a sensor house and we have actually been running their product

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for two years. Six months ago, they came to us and said the volumes are enough to bring it in-house." Harald and his team advised on the selection of molding equipment. "Right now, I'm working on a mold base for the machine as well as helping with the design of the mold," he detailed. ISC will make the molds and test them at their facility. "When it comes time to run the product, we will train their people here, then transfer the mold base and mold into their facility."

ISC also acts a problem solver for companies looking to replace current suppliers. "We've got another company that does data collection on water, electrical, and gas meters. They were buying their existing molded connector from China and it wasn't providing a watertight seal, so they asked us to improve it and we are now starting

WHMA

An Affiliate of IPC

Continued from page 49

that production line. So, in this case, we didn't just transfer or copy it, we actually improved it to meet IP 60-A approval."

ISC is definitely a problem solver when it comes to over-molding of cable assemblies, and Harald suggested WHN as a conduit for Q & A on the subject.As such, feel free to comment on the electronic version of this article, or email the author at joe@ wiringharnessnews.com. We will forward to Harald and get back to you, then publish the questions and responses at a future date.Alternatively, if you would like to contact Harald directly, you can do so but emailing him at hgiebel@ISCEngineering.com, or by phoning him at 909-342-7439.

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New Injection Molding Equipment Hits Market

SI Automation is proud to introduce Atlas, a new line of vertical clamp injection molding machinery designed specifically for insert molding and wire harness applications. The first in the Atlas line is the PMG-30. This machine features a C-frame design with 30 tons of vertical clamp force via dual hydraulic clamp cylinders. Its designed to allow the injection unit to be mounted in either a horizontal or vertical configuration. The customer has the flexibility to reconfigure the injection unit to fit their molding needs. A second injection unit can also be added for 2 component molding.

The Atlas features a user friendly 10" diagonal touch screen display with intuitive screens for easy navigation. The control can hold up to 1000 mold recipes and programs are easily backed up using an on-board flash drive. Other standard control features include trending graphs, change log screen, production monitoring and includes different levels of password protection. Screen configurations them as close to new as we could." As the equipment out in the market aged, however, it has become harder and harder to source parts and bring these machines up to date. The company decided to give their customers the option of buying something new. With years of experience disassembling and reassembling a myriad of molding machines, they went to work designing a totally new one from the ground up.

One of the unique things Mark revealed about the equipment, is that the customer can convert it from injecting material vertically to horizontally (from the parting line). "In most cases, you buy a dedicated machine to shoot that material either vertically or horizontally, and it will always be that way." Mark detailed. "It's not a pull and tilt changeover. It takes the customer some time to do it, but the ability greatly ads to the versatility of the equipment."

Mark shared details about one of the initial customers to take delivery, and what made them choose this equipment. "They are building expensive harnesses for the military, and with a harness that sensitive, you need much more control of the equipment so you don't damage, say, a 12 ft. harness," he explained. "We had the customer in our facility and we dialed in the right shot almost immediately. He could never get what he wanted cosmetically out of his old machines, and he was very impressed with the part quality we were able to give him."

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The PMG-30 is available as a stationary lower platen, side-to-side shuttle or a 2-4 station rotary table. Custom machine options are available to meet specific customer needs.

WHN Inquired Further

There hasn't been a totally new entry into the injection molding equipment market in many years. Intrigued by a new player, WHN caught up with Mark Garrison, Mold & Machinery Sales Manager for QSI Automation. He explained that the company has made a name for themselves mostly by refurbishing old equipment. "We were taking machines that were maybe 20 or 30 years old and making

If you'd like more information on the equipment, you can email Mark at mgarrison@qsiautomation.com or call him at 260-693-1500. He's been in the industry for a while and just may be able to solve some of your molding issues.

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Case Study: Schleuniger Helps Premier Cable Solutions Ensure Commitment to Quality!

remier Cable Solutions, LLC located in Shullsburg, WI, specializes in the manufacture of custom cable assemblies, wire harnesses, control boxes and console assemblies for a wide range of industries. As co-founder of Antenna Plus, LLC, Bill Liimatainen drew on over twenty years of experience in the design and manufacturing of low profile antennas to build PCS. When Bill sold his stake in Antenna Plus, he knew that he had a talented pool of experienced professionals available from which he could build this new enterprise. Bill was already very familiar with Schleuniger's line of coaxial cable stripping machines, having previously processed millions of feet of cable, which made Schleuniger the logical choice for his new venture.

For any successful manufacturing operation, the key is to be able to automate as many processes as possible, without sacrificing quality and attention to detail. According to ElizaBeth Kimball, plant manager, "The quality of the equipment as well as excellent customer service is what has prompted us to continue to invest in Schleuniger. As we've grown, we've continued to buy Schleuniger equipment in an effort to automate more and more of our processes." Premier Cable Solutions has found a partner in Schleuniger, who has demonstrated the desire to work with them to help identify specific needs and test potential solutions to improve production.

Premier Cable Solutions currently owns a MultiStrip 9480 automatic cut & strip system with accompany-

> ing PreFeeder 2200 and CableCoiler 1300. The flexibility of these machines enables them to process a variety of wires and cables in a wide range of sizes. In addition, they have a UniStrip 2300 wire stripping machine and several CT 32 S and CT 60 pneumatic crimping machines. By utilizing this equipment, they have freed up two employees to work on other aspects of the production process, which has resulted in more flexibility and growth. ElizaBeth added "We have found Schleuniger equipment to be very intuitive, which makes it easy to train and/or crosstrain employees in all processes."

> When asked about the current state of wire processing and what to expect for the future, ElizaBeth responded "As more and more manufacturers are going to Mexico, we maintain that our commitment to the highest quality standards, quick turn-around and value-added services have helped us to develop a niche in this industry." There's no doubt Premier Cable Solutions' dedication to these principles will guarantee the best quality products for its customers and ensure continued growth and success.

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Battery Show and Electric & Hybrid Vehicle Technology Expo 2019 Recap WHN Was There!

tric & Hybrid Vehicle Technology Expo 2019 took place September 10 through 12 at the Suburban Collection Showplace in Novi, Michigan, where leaders in the automotive and advanced battery space including engineers, technologists, and innovators convened to discuss the new trends and technologies progressing the electrification of transportation. The show welcomed more than 700 suppliers displaying products and services from every continent around the world, as well as 150 expert speakers, and 9,000 attendees made up of buyers and conference delegates representing over 50 counties across the globe. By all measures, the show met and exceeded expectations in terms of number and breadth of exhibit participation and growth of professional attendance, reinforcing itself as North America's largest and most comprehensive advanced battery manufacturing trade show.

Reflecting on the steady rise of hybrid and electric vehicles' mainstream adoption, the show has continued to see year-over-year growth with 2019 up 20 percent from the year prior. Add to that the remarkable technologies displayed across the showroom floor and 70+ hours of unparalleled industry education presented in the Open Tech Forum, it was hard to leave without some amount of elevated optimism toward the future.

One such attendee included vocal environmentalist Ed Begley Jr., who keynoted the third day of the event where he revealed, "What I see out

The Battery Show and Elec- there on the showroom floor is so good for us, good for climate change, good for our pocketbook." Such showroom floor displayed a variety of remarkable technologies including computer simulation software, battery test systems, connectors and cabling, battery packaging and venting systems, motors and controllers, chargers, battery cells and packs, and more. Additional keynote presentations were given by leading automakers, Bob Taenaka, senior technical leader, Electrified Vehicle Battery Cells/Systems, Ford Motor Company and Mark Verbrugge, director, Chemical and Materials Systems Laboratory, General Motors - each of whom touched on how carmakers will deliver on customers' electric vehicle demands.

> The Leaders' Roundtables, which followed the daily keynotes, were also of great interest to conference delegates in which attendees remained to learn leadership views on the need for electric vehicle infrastructure, solid-state battery feasibility, and when automakers can expect to see a profit on electric vehicle sales. Other session topics included how to qualify a lithium-ion cell, next-generation batteries, battery safety, and the off-road electric vehicle market.

> Following its continued interest and growth, the show is poised for additional expansion in the year ahead. The Battery Show and Electric & Hybrid Vehicle Technology Expo 2020 is scheduled to take place September 15 through 17, again in Novi's Suburban Collection Showplace.

See more photos on page 57

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