Retrofitting Existing C4ISR Components with Modular Wiring Harnesses

By Robert Grzib, Product Manager, CDM Electronics

Outlining the challenges and solutions provided by CDM's engineering and design staff in providing wiring harnesses to support the U.S. Space and Naval Warfare Systems Command (SPAWAR).

While primarily known as a distributor of electronic connectors and cables, CDM Electronics offers innovative solutions to the most complex and demanding cable assembly engineering requirements and build-ups.

CDM was chosen to provide wiring harnesses to support the U.S. Space and Naval Warfare Systems Command (SPAWAR) Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) systems. These systems enhance situational awareness on U.S. Navy ships, submarines and shore stations, and demand optimum materials and manufacturing techniques. These systems are also retrofitted into the tight size constraints of existing vertical cabinetry located shipboard or on land bases – making impossible the conventional installation of one-piece wiring harnesses by the end-user. So what were the challenges, and more importantly what were the solutions provided by CDM's engineering and design staff?

When the nine 8-foot high cabinets were initially manufactured, the installation of the wiring harness and associated hardware was completed on a conventional, horizontal work bench. The cabinets were transported to their destination then permanently installed in a vertical orientation. However when retrofitting the cabinets for the new harnesses, a primary challenge was that the wiring and interconnects needed to be fed through the top of the now permanently installed cabinets. This constraint also demanded that the design incorporate the added complexity of utilizing existing strain relief supports that were originally designed for horizontal manufacturing.

Routing Challenge

Another significant challenge was to route the new harness components through and around existing video hardware that could not be removed during installation. Again, when the cabinets were initially assembled, the video modules were the last parts to be installed. This meant that a conventional "reverse engineering" of the existing harness would have been of little value, given the fact that the original harness was installed prior to the now-permanent obstacles.

And finally, the third major concern was that the cabinets could only be accessed from the front. This meant that, as opposed to the unrestricted access during initial manufacture, cables and interconnects would need to be very specifically ordered back-to-front. This, combined with the first two factors, demanded completely original thought from those designing the solution.

"This project had to be viewed with an alternative 'end-to-beginning' approach", said Lori Maeder, Director of Operations at CDM. "We immediately knew that engineered-in functional solutions would need to be included in the basic design and manufacturing elements." As such, final installation was the primary challenge that needed to be addressed in this inverse design methodology.

Given the size and obstruction constraints of the vertical cabinets in which the cables were to be installed, a conventional one-piece harness was not feasible. Therefore, the harness had to be designed as individual cables that would fit sequentially inside the cabinets, ordered back to front, around the non-movable

Figure 1 • A robust feed-through panel was vital for the vertical orientation of the installation.

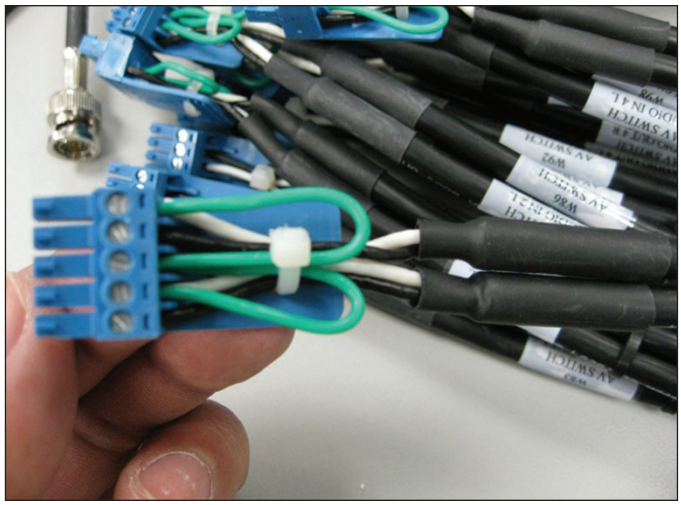

Figure 2 • Precise labeling was paramount to the correct sequential installation of the individual cables.

obstructions and still be adequately strain-relieved. "We had to think in a completely different way to conceptualize what was needed," noted Lemuel Agustin, Value-Added Engineer. "We had to create something brand new, yet meet a very specific customer requirement." As such, each cable was designed individually to consider multiple constraints and the order in which they would be installed.

Another unique concern was that of how the segments would be connected, which also dictated how the final product would be designed and engineered. As there was a mix of video, audio, power and I/O signal cables on each harness, determining the optimum solution for each interconnect was vital for the design and painstaking for the engineers. "High volume manufacturing of cable assemblies is nothing new to CDM" said Laurie Burger, Production Manager, "however the number of individual cables with specific purposes in this particular project was staggering." As such, over 100 individual wires and thirteen different types of connectors were utilized on each assembly.

While designing the multiple-piece harness was an exercise in engineering flexibility, the manufacturing staff was immediately up for the challenge. CDM's 24,000 square foot facility features modular manufacturing cells that can be reconfigured in a matter of hours. Value-Added Engineer Nick Sarin's 30+ years of manufacturing facilities experience has provided insight into overcoming manufacturing challenges. Says Sarin, "CDM has the unique ability to quickly modify any location throughout our facility to meet out-of-the-ordinary requirements with little or no delay." This meant that once the design was complete, the talented and ambitious manufacturing staff could immediately begin the precise and innovative build that included over 700 feet of wire and 216 connectors.

Special Construction

While the manufacturing process for each individual component was eagerly undertaken, it was far from routine. Because of the anticipated complexity of the installation and volume of components, each assembled cable

needed precise labeling and storage. As such, maintaining the highest level of organization was paramount. Special manufacturing bucks were constructed for the assembly cells that would keep the parts in order, avoiding additional handling and aiding in CDM's quality processes.

With over 300 man-hours spent planning, manufacturing, inspecting and testing the nine assemblies, the final challenge was that of installation itself. As an engineered-in solution was to design the harness as a series of individual and sequential components, the ultimate design element was that of the CDM staff installing the product at the customer's location. "This approach saved the customer time and mitigated the possibility of damage to the harness" said Mark Henry, Engineering Manager at CDM. The sequential segments of the harness were held in place by the existing strain-relief supports in the cabinets (now being utilized for vertical wiring), individually fed through and around permanent obstructions, then the interconnects were mated. Performing this painstaking assembly were Mark Henry and Krystyna Zaremba, CDM Lead Harness Technician, who has extensive experience in spacecraft assembly and launch support. Onsite CDM Quality Assurance personnel performed final inspections and testing.

While all retrofitted cabinets were ready for immediate use to enhance situational awareness on U.S. Navy ships, submarines and shore stations, only eight went into ser-

Figure 3 • Each completed assembly was installed onsite.

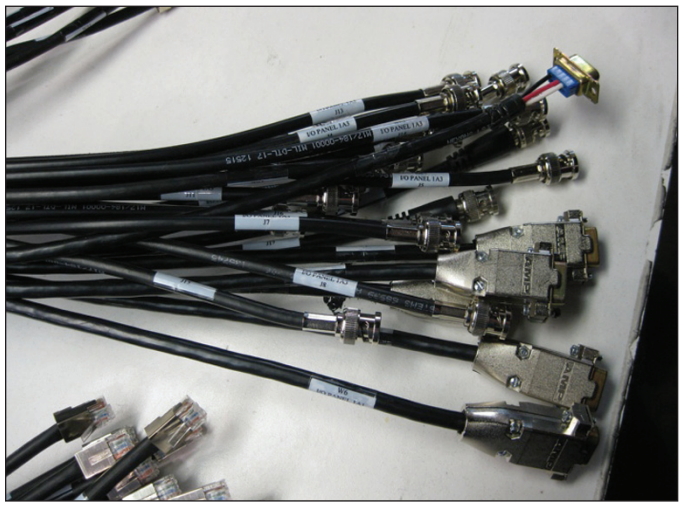

Figure 4 • Thirteen different types of connectors were used for each assembly.

vice. One cabinet was subjected to destructive survivability testing, including the effects of a submerged explosion. The cabinet and retrofitted cable assembly was satisfactorily retested.

Throughout the speedy two-month start to finish timeline, CDM's unconventional solution to a complex customer requirement worked perfectly, resulting in on-time activation of the C4ISR systems that the harnesses supported. "We're very proud to have provided such a unique and innovative solution for what seemed to be a daunting task" said CDM CEO Carmen J. DeLeo. "This is a testament to our customers' trust in CDM, no matter how challenging the circumstance."

About the Author:

Robert Grzib serves as a Product Manager at CDM Electronics.