PennWell

CONNECTOR SPECIFIER®

EDITORIAL GUIDE

Wiring Harness Innovations

The industrial-grade wiring harness acts as the central nervous system to many device and vehicle electronics designs, particularly in the automotive and military-aerospace segments. As applications become increasingly complex, innovation in wiring harness design and manufacturing techniques becomes more critical. This Connector Specifier Editorial Guide investigates methods for more efficiently driving design data toward fully automated assembly processes, as well as ways to better analyze costs, to help ensure the successful design and manufacture of new wiring harness products.

Driving wiring harness design data toward manufacturing

By **ELISA POUYANNE**

THE ELECTRICAL DISTRIBUTION system (EDS) design process for automobiles and other transportation platforms is basically a sequence of steps performed in more or less serial fashion. The stages in the process begin with requirements definition, systems design and engineering and extend all the way through harness engineering including manufacturing documentation. The process as a whole must be organized to create manufacturable harness products that support the requirements (design intent) and meet the enterprise's quality and cost constraints.

Historically each stage has been an "island" with its own design tools and a complex local dialect that describes the components, inputs and outputs of the particular stage. Communication between the stages has often been cumbersome, requiring conversions and/or manual data re-entry at the input to each step.

Unfortunately the historical methods cannot meet the time, cost, and competitive pressures of the modern design realm. It is simply no longer feasible for consumer vehicle makers to live with the redundancy and delays that result from passing "lumped" data from island to island in the process. As a result, innovative software-based solutions have emerged to address these challenges.

The Concept of Digital Continuity

The solution for today's time, cost, and competitive pressures is a concept known as ***digital continuity***. In such an environment, data flows from one development stage to another without duplication, disconnection, or data re-entry. True digital continuity also enables critical information to cross to, and from, related processes occurring in parallel within the enterprise. These include: concurrent design using MCAD tools; harness configuration management; component inventory processes and databases; and product lifecycle management via Product Data Management (PDM) systems.

Two other issues have an impact on the nature of digital continuity. First, design changes are inevitable—sometimes a daily occurrence. A toolset that supports intelligent rules-driven design change management is essential. Only then can reliable up-to-date data propagate across domains and teams and over organizational and geographical boundaries.

And secondly, reaching the final stage in the design flow doesn't guarantee that the product will comply with the original design intent, reliability guidelines, and manufacturability objectives. But with the data accumulated over the course of the entire flow, it is relatively easy to confirm that goals and cost expectations have been met.

Where does digital continuity begin? *At the very earliest planning and requirements definition stage.* Enterprise-wide databases are a medium for continuity, as are consistent, compatible interfaces among the various development stages. A key enabling factor is a design toolset that raises the level of abstraction and automates more tasks. If an engineer can work with higher-level entities and symbols, then these entities can bring embedded knowledge of their own characteristics and behavior to the design. This in turn supports real-time rules checking, "what-if" prototyping, and more. Data continuity embodies data unification, integration, verification, and accessibility.

The Harness Design Flow, From Specification to Manufacturing

Harness development is a transition point in the vehicle design and manufacturing process. It is the environment in which critical design data matures into a buildable product. Modern ECAD software supports this process by enabling and imposing digital continuity. It spans process stages ranging from the earliest design effort (where electrical functional requirements and physical requirements are captured) to implementation. The deliverable is a completed harness product and ideally, thorough documentation to accompany it.

Figure 1 illustrates the concept of the design flow and symbolizes the digital continuity as data passes from stage to stage. Each step in the flow receives and

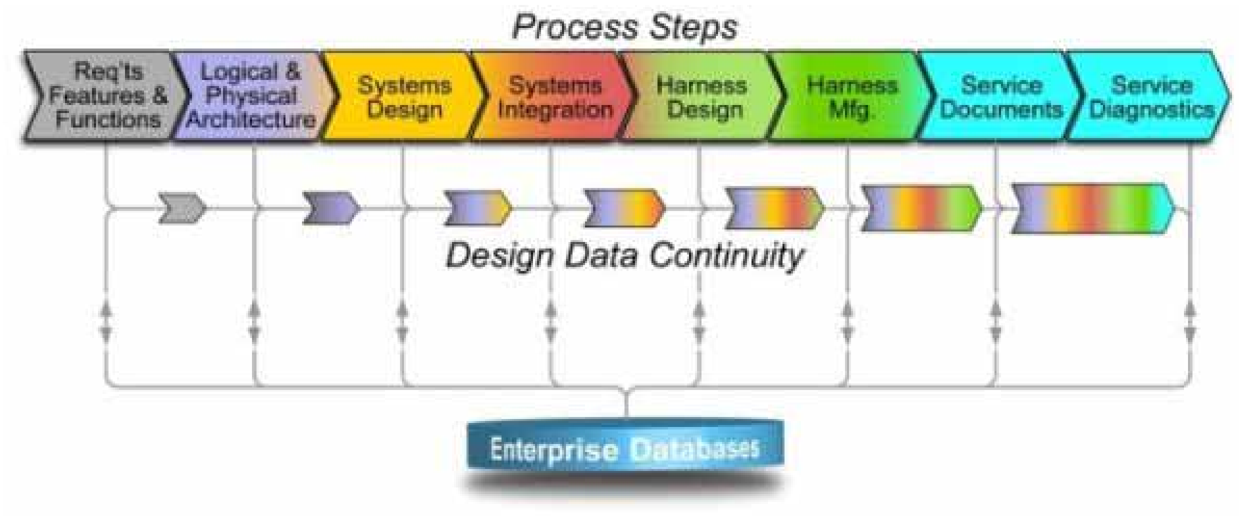

Figure 1: *Digital continuity implies a series of smooth transitions among all the steps of the design flow. Each process step (stage) contributes data to the subsequent steps. This information is preserved and reused, maturing as it moves ahead in the process.*

matures relevant information from all preceding stages. New design data is of course generated in each successive step for use within that step. But each step also evolves the data received from the steps that precede it. As Figure 1 implies, the volume of data increases with each step forward. The data from the Logical Architecture stage, for example, passes to the Systems Design stage where it becomes an integral part of that stage's data, which in turn gets passed on. This flow underscores the importance of both consistent interfaces from step to step and data versioning and release management. Typically the data content is communicated via one or more databases.

Interpreting and Applying the Design Intent

"Design intent" arises from the Requirements and Architecture stages at the beginning of the process depicted in Figure 1. Intent includes not only a description of the functional needs that must be satisfied, but also details such as weight and above all, cost. It also includes methods to help designers satisfy these functional requirements. Harness engineers are responsible for achieving in general terms the design intent and requirements, including some constraints on installation into the vehicle, all in the context of a manufacturable product.

A harness definition is at the crossroads of data from the electrical wiring design and the digital harness layout mock up. Ideally it accounts for the diverse configurations that will be needed to support variations in the harness' electrical content. The design department's deliverable is a completed drawing that may form the basis of contracts between OEMs and Tier 1 suppliers, and is ready to be further processed by the harness engineering group.

The distinction between the disciplines of harness design and harness engineering may not be clear to those unfamiliar with harness development. The harness emerges from the design department complete in concept but not necessarily ready for production:

- It may not contain all the data required to physically build the harness.
- It may need to be enriched with certain parts necessary to support assembly of the harness into the vehicle.
- It may call out specification criteria rather than actual part numbers to describe wires, connectors and components.
- It may be authored as a superset/composite with the expectation that these will be broken down into variants/derivatives.
- It may embody some requirements that are unachievable and others that don't conform to best practices.

Therefore the next step is harness engineering, which transforms the design intent into usable manufacturing data. Figure 2 shows how multiple inputs are combined in the harness design and engineering stages to create manufacturing and business data that is ready to use throughout the enterprise.

Moving from Design to Reality

The harness engineer is assigned to produce a 100% accurate, error free data set—per variant/derivative—that can be fully costed and passed on to production for assembly. He or she must generate the full BOM and validate it against the design intent. Again, accuracy is crucial because the product is destined for high-volume manufacturing, where the cost of an error is multiplied by thousands or even millions of units.

In effect, the engineering phase of the process brings theory and planning face-to-face with reality, where "reality" includes laying out formboards, programming

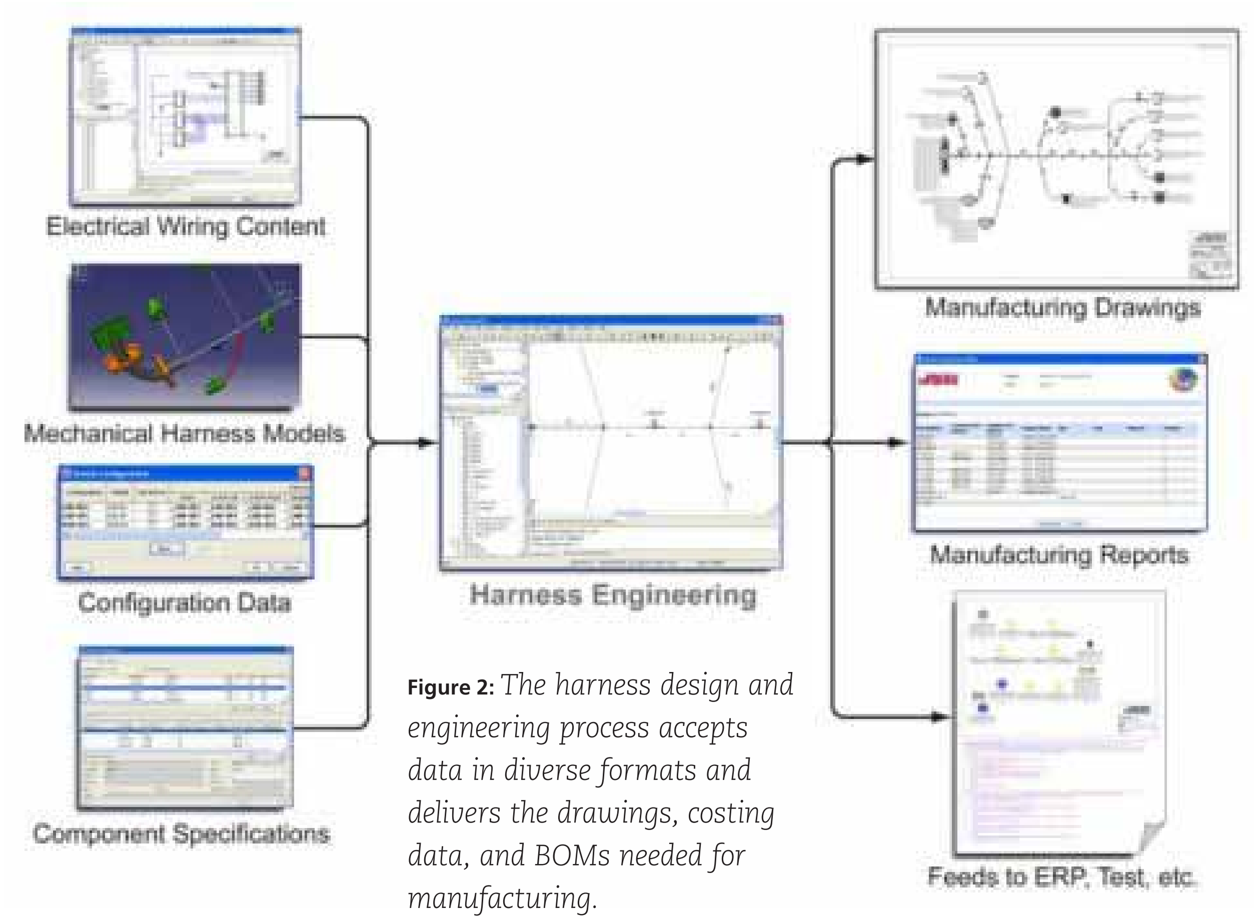

Figure 2: *The harness design and engineering process accepts data in diverse formats and delivers the drawings, costing data, and BOMs needed for manufacturing.*

test and production equipment, defining tooling requirements and wire cutting charts, and making cost calculations.

Software tools selected for the process must provide a 2D design environment supporting the large variety of harness components including bundle protections, clips and grommets, cavity components, and more. In turn this environment must be automated to help harness engineers manage discretionary steps including:

:: Component selection

Wires, terminals, seals, plugs, tapes, tubes must accommodate OEM specifications. For example, an OEM might specify a basic clip position but the harness maker must define the taping that surrounds it.

:: Splice position optimization and balancing

Here the harness builder must meet manufacturing and quality rules, including customized rules such as the choice of waterproofing materials (i.e., heatshrink sleeves). Similarly the OEM might specify a shielded cable while leaving it to the harness maker to define the solder-sleeve position and the drain wire connection.

:: Wire-color optimization

The harness provider must allocate wire-color definitions for manufacturing and service while taking the wire inventory into account:

:: Component sourcing verification

:: Assembly time calculation/prediction

:: BOM calculation

“Engineering for manufacturability” means different things to different people but most agree that it encompasses activities such as splice optimization and component selection; that part of the task is to confirm the availability of the selected components from preferred suppliers; and that there is an overarching responsibility to ensure that all contractual obligations with the OEM are met.

Figure 3 summarizes all these steps and processes.

All this must be done within the constraints of the very low margins that characterize the contract harness market. Production is often geographically widespread and logistically complex, making it difficult, but critical, to accurately predict product cost. But a small amount saved on each harness can save

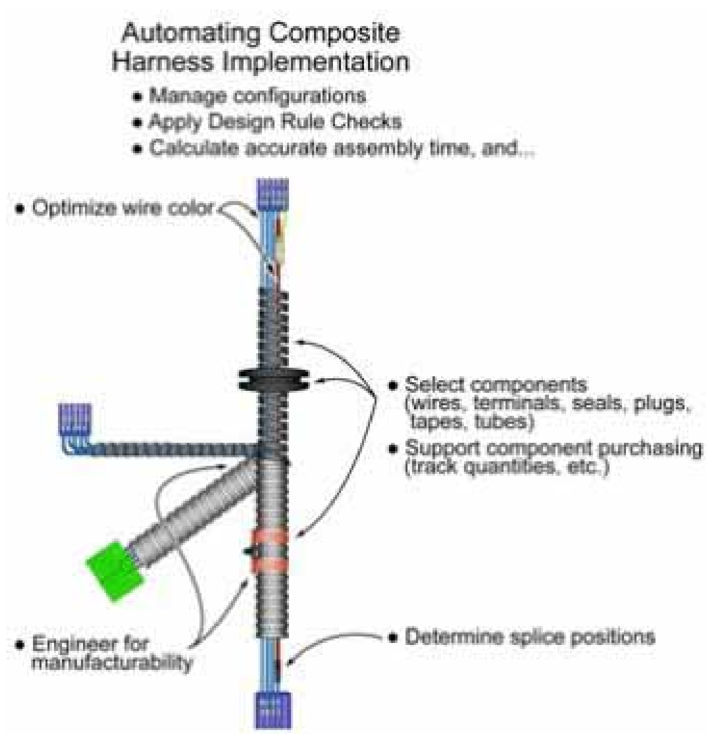

Figure 3: *One harness design forms the basis for many variants. Modern design tools automatically manage configurations for dozens or even hundreds of minutely varying harness types.*

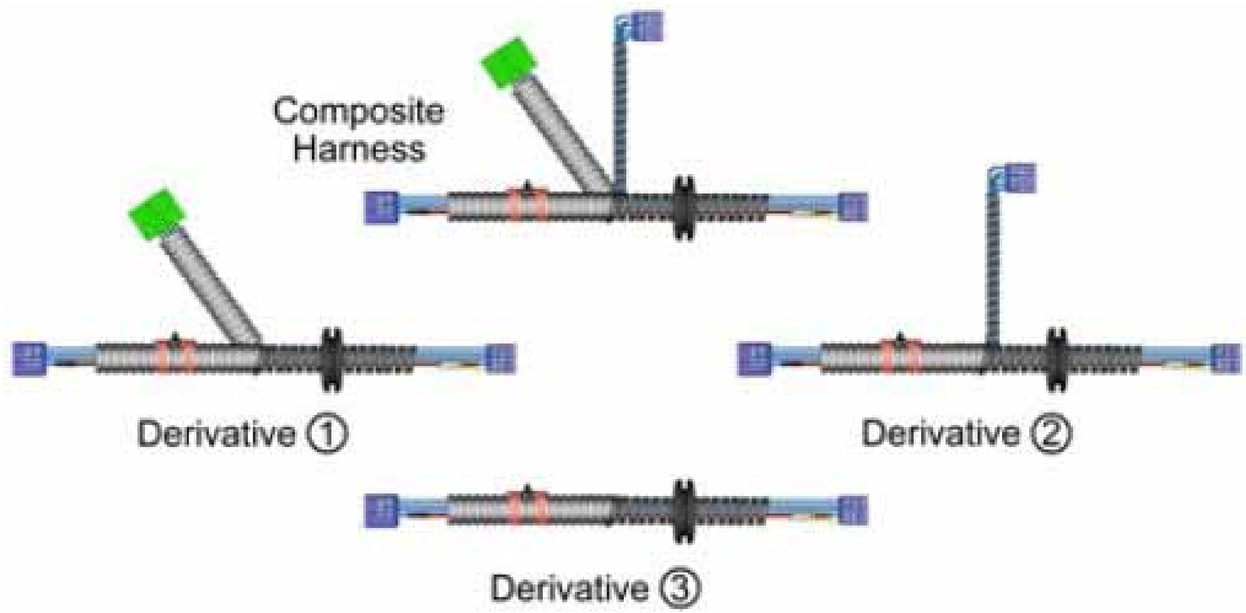

Figure 4: *Small variations can create a large number of derivatives. These three derivatives represent just a fraction of the hundreds that may arise.*

many thousands of dollars when volume production begins.

Fortunately, a full-featured harness design environment can manage a composite harness that encompasses all the anticipated variations in electrical content. Essentially this is the master design. All the variations are managed as a single entity but the differences—in electrical content as well as tubing, taping, and so forth—are calculated for every single harness product.

Importantly, this approach provides economies of scale in tooling and manufacturing planning. If a dozen harness variants use a specific length of black plastic corrugated tubing, then a single inventory of that part, prepared as a batch with one tooling setup, one cutting operation and one purchasing transaction, can serve the needs of all twelve variants. The data about the tubing can be used most efficiently when it is maintained in a components library that keeps track of components' individual attributes as well as all relevant compatibility and dependency rules. Figure 4 illustrates a hierarchy of derivatives. Note that this simple image intentionally depicts far fewer derivatives than a real-world platform might require.

Composite designs also allow design changes to be proliferated across a whole family of harness derivatives. If the tubing length in the master harness design gets changed, then that change automatically "trickles down" to the derivatives.

Comparing the Engineered Product with the Design Intent

The technique of embedding design rules within the software is the surest way to achieve practical compliance with the design intent. Design rules are a form of business logic that, together with a rigorous validation regime, ensures the production of fully-detailed harness designs data in minimal time. A rule is exactly what the term suggests: a requirement that, if violated, will cause an alert at the very least. A rule might state for example that gold-plated terminals will be selected for all safety-related function. Of course this implies that "safety-related functions" must be defined as well, and so on through a hierarchy of definitions.

Design rules checking (DRC) relies on basic definitions that are consistent throughout the harness. Examples include "all wires are allocated into a connector or splice at each end," "the path of each wire is unambiguous so that the length can be calculated," and many more. In addition DRCs also monitor manufacturability, ensuring that terminal and crimping combinations are correct for the wire cross-section.

It is important to note that DRCs are not uniform across the whole industry. The rules and their severity are always customized to a harness maker's specific best practices, and the design toolset must allow for this customization.

From Digital Format to Physical Formboard

All the foregoing steps pay off when it is time to prepare the drawings that will be used in manufacturing. At this point all of the components in the harness are selected and their placement is established. The bill of materials is accurately calculated and costed. A completed virtual harness exists in digital form. What is needed is a template for the actual layout and construction of the "hardware" harness.

While there is much talk about levels of abstraction in the design automation realm, one of the key deliverables of the design process is something that is not abstract at all: a full-scale map of the harness layout. Today's advanced designed tools can produce this "Formboard" document

Figure 5: *The formboard is one of the ultimate deliverables of the design-for-manufacturing flow.*

automatically, and it is more than just a map. It includes all necessary visual aids to support speedy and error-free manufacturing via steps such as wire insertion, bundle covering instructions, etc. It also lays out certain fixturing components that guarantee the harness will integrate into its mechanical environment. Considerations include the correct orientation of clips for easy assembly into the vehicle's panels and passages; orientation of connectors for safe insertion into ECUs, and so on. Figure 5 depicts a formboard in use on the harness production line.

Here again, digital continuity proves its worth. All necessary data accumulated throughout the design flow is ready and waiting to inform the final formboard drawing. No data re-entry is necessary. If there are late-breaking design changes in some part of the harness, these can be applied easily and will propagate throughout the affected branches and wires as well as all derivatives.

The design data accumulated over the span of the process has yet another use in manufacturing. Information can be delivered in the correct format to directly drive production equipment such as test systems, laser markers, and wire cutting machines. This eliminates the need for transcription or re-entry, bypassing a time-consuming step and ensuring error-free execution of the respective operations.

Conclusion

After decades of harness engineering performed manually, the old ways are fast becoming obsolete in transportation product manufacturing enterprises of every scope and size. Today's technical requirements, complexity, and time pressures are bringing electronic design methods to the head of the class. Solutions such as Mentor Graphics VeSys and CHS apply proven data-centric technologies to harness design and engineering for manufacturability, simplifying the whole process:

- Data-centric software enables digital continuity from requirements through implementation
- Change management is thorough and automated at every step thanks to a purpose-built data-model specialized for electrical harness engineering applications
- Configurable harness engineering and Design Rule Checks validate compliance with design intent
- Automated tools provide both formboard layouts and visual assembly aids for manufacturing
- Design data accumulates over the length of the harness engineering process and feeds production equipment with current and correct information

ELISA POUYANNE is Business Development Manager for the Integrated Electrical Systems Division of Mentor Graphics Corp.

An Eye for Innovation

Bringing Precision, Flexibility and Experience to Wire Processing

NEW PowerStrip 9550

- Measures, cuts and strips up to 2/0 AWG and jacketed cables up to 0.630” in diameter
- Servo driven transport units offer unparalleled speed andstripping power
- Turret guide on left side rotates to accommodate a full range of wire sizes
- Extensive libraries with predefined cable types and processes
- Modular design allows future upgrades to base models
- Complete range of options and accessories available for a customized system

visit www.schleuniger-na.com/cutstrip or call (603) 668-8117 for more information

NEW UniStrip 2300

- Fully programmable benchtop wire stripper
- Strips wires ranging from 32 – 10 AWG and jacketed cables up to 0.22” in diameter.
- Intuitive color touchscreen user interface
- No mechanical adjustments required when changing wire sizes
- Can strip inner conductors of jacketed cables with short breakout lengths
- Trigger sensitivity automatically adjusted based on wire size

visit www.schleuniger-na.com/US2300_am or call (603) 668-8117 for more information

Schleuniger®
To Be Precise.

Benefits of fully-automated wire harness assembly

Harness assemblies are becoming increasingly complex, making the process of manual insertion result in higher scrap rates and additional quality control issues.

BY **PATRICK BOYER**

FOR SEVERAL YEARS, benchtop and semi-automatic crimping machines have been the tools of choice for the production of wire harnesses. Many factors inside and outside the industry, however, have combined to merit a comparison of current crimping processes to newer, fully-automated and significantly less labor-intensive harness assembly technology.

Before the fully-automated process, suggested ways for reducing downtime included grouping jobs in terms of the longest change-over times in order to maximize runtime, staging all the necessary materials for the upcoming job to decrease operator wait time, and dedicating a tooling prep area where applicators are calibrated and inspected prior to use. Other suggestions have included networking the machines to go paperless so that cut sheets are stored off-line and sent as needed to the appropriate machines and operator to quickly verify the set-up before running production, and finally, calibrating all presses to a standard shut height.

Suggested practices for increasing uptime for benchtop and semi-automatic processing machines have included improving material quality and packaging to help assure that wire is relatively straight and concentric; providing periodic calibrations and preventive maintenance (PM) on the machines and tooling to assure top performance; performing on-going operator and service training to reduce the learning curve; and installing integrated QA devices directly at each machine to eliminate the time to walk over to the QA station.

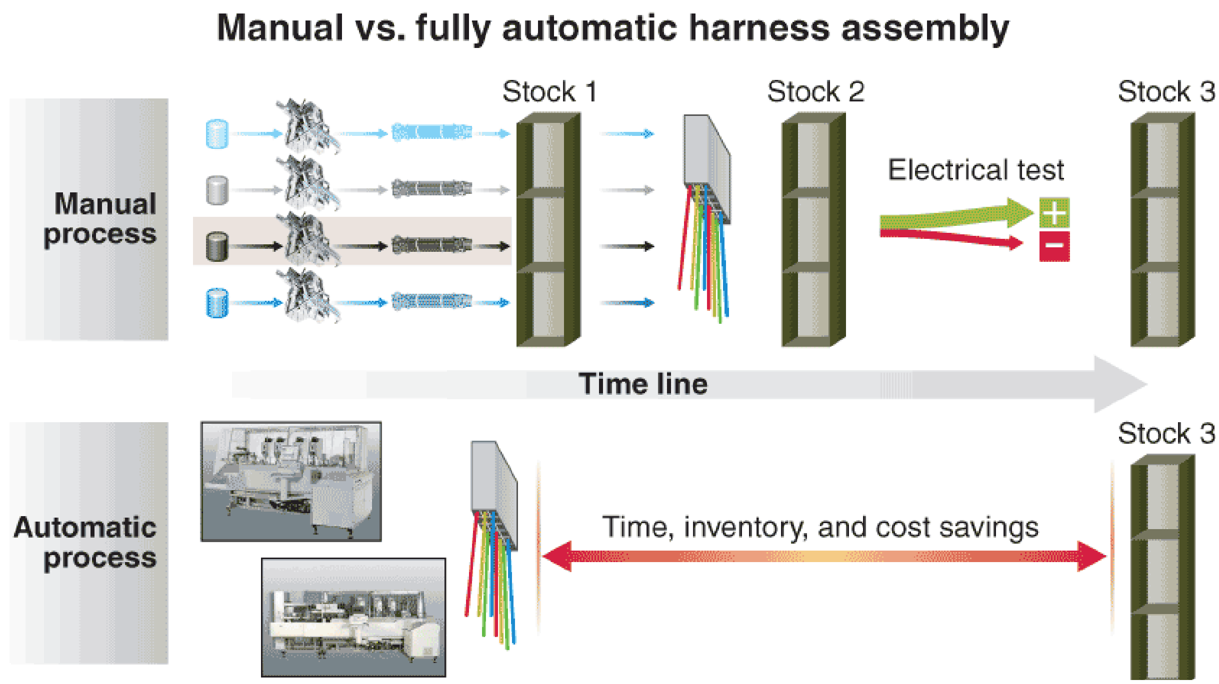

FIGURE 1. *A comparison of a manual wire harness assembly process using conventional benchtop or semi-automatic machines (top), and a fully-automatic process using harness machines (bottom).*

But many of the above best practices are dependent on the skills and training of the operator, as well as on work conditions to obtain optimum quality and productivity.

Companies and industries are facing circumstances that make the full automation of wire harness processing more advantageous. Harness assemblies are becoming increasingly complex, making the process of manual insertion result in higher scrap rates. The increased complexity and handling of wires also causes additional quality control issues.

Toward full automation

To save cost and weight, the automotive and white goods industries have sought smaller wire sizes and components, making it more difficult to process manually. In addition, many companies that have outsourced their production to low-wage countries are now facing rising labor costs–up to a 78% increase over a five-year period. Companies

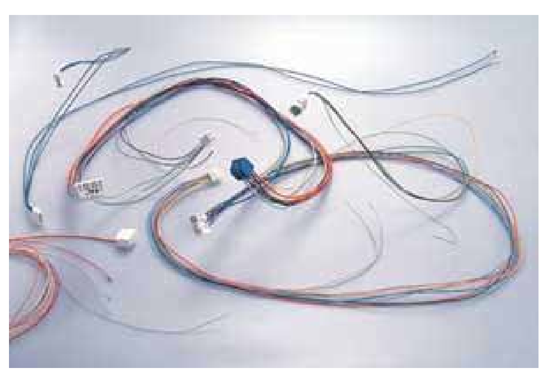

FIGURE 2. *These wire harnesses were produced on a fully-automatic machine.*

are also facing variable costs that are out of their control, such as fuel surcharges and customs duties and taxes. For many other industries, leaving the U.S. for production is not an option. Lengthy transit times from foreign production often cause work-in-progress, inventory, and engineering rework costs due to the time factors involved.

FIGURE 3. *Fully-automatic wire harness assembly systems, such as this Komax Zeta 633, are designed to maximize productivity and control costs.*

For these reasons and others, companies in both high- and low-wage countries are increasingly evaluating and investing in fully-automated wire harness assembly systems, according to figures from Komax Corp.

Compared to the cut-and-crimp process, the main advantages of fully-automated wire harness production include increased repeatability and accuracy of full automation results in guaranteed quality of products, integrated quality checks can be traced and completed throughout the process, and the cost of full automation is more manageable–and profitability shifts from labor to material costs.

In addition, manual labor may be moved to less repetitive tasks, thereby eliminating inherent fatigue risks. Product lead times are reduced to 2 to 3 weeks or even to 2 to 3 days by placing fully automatic machines near or at the final assembly plants. Work-in-Progress (WIP), physical production, and inventory space requirements are also reduced, permitting the implementation of high mix, low volume with JIT and Kanban production, increasing productivity while decreasing logistical requirements.

These factors apply to fully-automated equipment installed anywhere in the world, regardless of whether it involves a high- or low-wage country.

PATRICK BOYER is a 14-year veteran of the wire processing industry, and works for Komax Corp. as harness machine product manager and automation project manager.

An Eye for Innovation

Bringing Precision,
Flexibility and Experience
to Wire Processing

NEW CrimpCenter 36

- Priced under $80K
- Flexibility with up to 6 processing stations
- Wire cross sections from 26 to 12 AWG
- Easy operations with touchscreen and icon-based EASY software
- Simple network integration in existing infrastructure with standard TCP/IP
- ToolingShuttle for changing applications in minutes
- Best price / performance of comparable 6 station machines

visit www.schleuniger-na.com/cst_am or call (603) 668-8117 for more information

NEW JacketStrip 8310

- Unique floating blade system for processing round, out-of-round and twisted pair cables
- Cross sections from .10” - 1.0” with no blade change required
- Universal centering system, eliminates need for mechanical changes
- Intuitive programming via color touch screen
- Digital display of axial and radial blade depths
- Unlimited slitting lengths

visit www.schleuniger-na.com/JS8310_am or call (603) 668-8117 for more information

Schleuniger®
To Be Precise.

Building wiring harnesses to save costs in chassis and racks

A cost benefit analysis can help you determine when a wiring harness should and should not be used.

By **DARRELL FERNALD**

MOST ELECTRONIC BOXES and equipment racks have in common a large number of interconnections. These interconnections run the gamut of signal wires (shielded and unshielded), power connections, coaxial cables, and ground bus wiring.

In the early stages of equipment development, the boxes and racks are often wired point-to-point to quickly prototype them to check out the electronics and the design. But the accurate wiring of any electronic system is critical to its performance. One loose or mis-wired connection will prevent the system from operating properly and can even severely damage the equipment.

Wiring point-to-point can be hit or miss, and the dress and routing of the wires are extremely operator-dependent. Repeatability of wiring in a point-to-point system is difficult, if not nearly impossible.

Wiring harnesses are often not recognized as the most consistent and cost effective method for wiring the equipment, but a properly laid out harness lends itself to automatic testing for continuity, correct wiring, insulation resistance and hi-pot. It is relatively straightforward to program an automatic tester to check for proper wiring and lack of shorts.

Harness types

Depending on the end use and the environment to which the harness is to be exposed, there are at lease three types of harness:

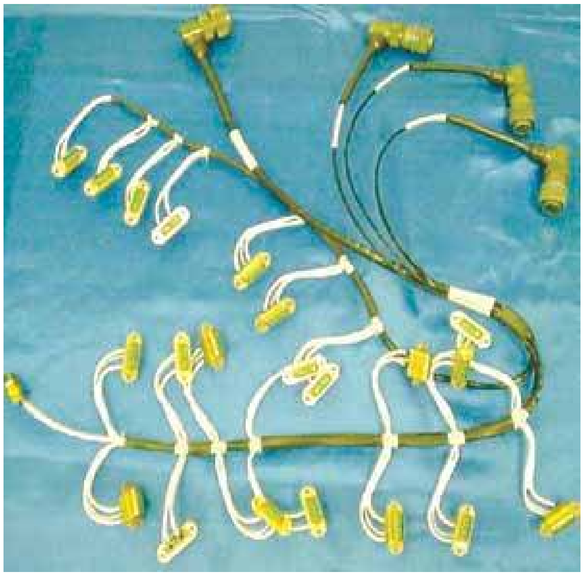

FIGURE 1. *An open harness is most commonly used for internal wiring of units.*

Open bundle. Wires are attached to connectors, terminal lugs, etc., and are tied into bundles with various breakouts by means of plastic tie wraps or waxed lacing twine. (Fig 1.)

Closed bundle. Wires are bundled with a covering, such as pulled-on braided tubing, braided-on Nomex or nylon, or in some cases, metal braid. (Fig 2.)

FIGURE 2. *This combined harness is an example of a harness that can be used to connect multiple units together in a benign environment.*

Waterproof harnesses. Legs are covered with tubing, such as neoprene. The junctions between the legs and backshells of the connectors are overmolded with a material such as urethane or rubber compounds. In some cases, PVC tubing and molding are used. (Fig. 3.)

Typical usage for open bundles is internal wiring in chassis or racks. Closed bundle harnesses normally will be used when hooking multiple chassis together, such as in a training system where the system does not experience harsh environments. The most common place to find a waterproof-type harness is in field-deployed military equipment or in industrial facilities where fluid, dirt and debris are present.

FIGURE 3. *The molded harness is fully protected and suitable for use in harsh environments where it may be exposed to moisture, dirt and other hazards. It is abrasion resistant and will not degrade when handled roughly.*

Braiding over wire harnesses is a very skill-intensive process. A harness is inserted one leg at a time through a hole in the base of a specially modified New England Butt Braider, and a metal or fabric braid is applied over each leg of the harness in turn. When braiding shielding over the harness, special care must be taken not to leave voids at the junction points of the breakouts. Any voids in the braid will cause EMI shielding effects to be adversely affected.

The base fixture for a wiring harness is known as a harness board. A drawing of the harness in a 1:1 scale is affixed to a substrate (usually a sheet of plywood), and special headless harness nails are driven into the board at specific locations to route the wires. Cut lengths and connector positions are detailed on the drawing. Tie positions (for tie wraps or lacing twine) are also marked. These manufacturing aids assure repeatability of the harness from one to the next.

Between automatic testing and harness board layouts, each harness will be virtually identical to all others made with the same board. This repeatability assures ease of assembly into the chassis.

Troubleshooting problems in systems that have wiring harnesses installed is significantly easier than in systems that were wired point-to-point. If the harness has been proven and a record of the automatic electrical test is available, the wiring harness can easily be eliminated as a potential problem leaving one major component of the system out of the troubleshooting tree.

When to specify a wire harness

Several factors should be considered when specifying a wiring harness, including:

1. Is the quantity of expected items over their lifetime large enough to justify the cost of preparing the documentation necessary to specify the harness (1:1 drawings, parts list, notes, etc.)?
2. Are there enough discrete interconnections (wires) in the harness to require harnessing?
3. Will a harness aid in troubleshooting the unit?
4. Can a harness be assembled into the unit without damaging either the harness or other parts of the unit?
5. Does your time to market allow for the proper design of a harness for the first units?

6. How much time savings will result from the application of a harness versus point-to-point wiring?

You can use a cost/benefits analysis to determine the desirability of using a wiring harness in any particular application.

The following example shows one straightforward method. (A score below 50 indicates that a harness is not desirable, while a score above 80 indicates that a harness should be used. Any score between 50 and 80 indicates that a harness is desirable, but not mandatory; this becomes a matter of cosmetics and personal preferences as well as past history with harnesses.)

Each of the six specification items listed earlier are assigned points as follows:

1. Quantity to be manufactured (during lifetime of design).

Quantity	*Points*
1-2	0
3-10	5
11-25	10
26-50	20
51+	25

2. Number of interconnections

Number	*Points*
<10	0
11-25	5
26-100	10
101-200	15
>200	20

3. Troubleshooting aid

Aid	*Points*
No	0
Yes	15

4. Assemble without damage

No damage	*Points*
No	-15
Yes	10

5. Time to market sufficiency

Sufficient time	*Points*
No	-5
Yes	5

6. Time savings

Percent saved	*Points*
0	0
1-5%	10
6-10%	20
>10%	25

Your decision to layout a harness for construction in a unit is better made as part of the design process, since it may well affect the final layout of the components in the unit.

Once a score is determined for the cost/benefit analysis and your decision is made, a few more design considerations should be weighed during the documentation/drawing process.

Design considerations

Harness drawings can be produced in either 2D or 3D format using CAD software; however, a 2D format lends itself better to harness construction since the 1:1 drawing is normally attached to the harness board as a template. A 3D format, while very explicit, does not lend itself to this application. There are, however, drawing packages that produce both 2D and 3D versions from the same native file.

Some of the basic considerations for harness design include component placement, wire runs, electrical considerations and space considerations. A checklist can be a handy way to determine if all of the considerations for your harness have been looked at. The following is a sample of the types of items that you should check and plan for in your design:

1. Have I left enough room for the harness to run without interfering with other components and not contacting heat sources? A good rule of thumb is to calculate the wire bundle diameter (including any shielding, etc.) then multiply that diameter by 1.25 to assure ease of installation.
2. Have I left the wires long enough at the ends to allow for service loops when installing the lugs, connectors, etc., that are the end terminations of the wire?
3. Have I allowed a turn radius in the harness for installation around corners in the unit?
4. Have I separated any wires (signal vs. power) that might cause crosstalk or interference during operation?
5. Have I kept in mind the minimum bend radius for coaxial cables and fiber-optic cables in the harness?
6. Is my grounding scheme consistent with best practices?
7. For an open harness, have I specified tie points that are sufficient to keep the shape of the harness intact during handling and installation?
8. Are all of the components (lugs, etc.) properly sized for the wires that are being used?

If these items are carefully considered, there is a much better chance that the harness will fit the intended unit and will be producible.

Once you have decided to design a harness and have done a layout keeping in mind the above considerations, a good practice is to manufacture one harness using your drawing and attempt to install the harness in a prototype unit.

If at first you don't succeed...

Unless you are extremely lucky, your first attempt will not fit properly and you will need to "go back to the drawing board" to make adjustments. But once you have a design that works and lays in the unit easily, you should have a cosmetically pleasing, functional harness that will last for the life of the unit.

DARRELL FERNALD is engineering manager at Cooper Interconnect, and national president of the International Institute of Connectors and Interconnect Technology (IICIT).

About Schleuniger

Whatever you do.

Ranging from semi-automatic benchtop machines to fully automatic processing lines, Schleuniger offers a wide range of innovative solutions for stripping, cutting, sealing, crimping and marking of all types of wire and cable, including single conductor wire, coaxial cable, glass and plastic optical cable, flat cable and multi-conductor cable to name a few.

Wherever you are.

Schleuniger strives to live up to its commitment to the American market – providing innovative wire processing solutions while offering a variety of value-added services:

- Preventive Maintenance
- Repair Service: In-House or On-Site
- Extended Warranties
- Cleaning & Calibration
- Installation Services
- Seminars & Training Programs
- Engineered Custom Applications

Schleuniger's highly skilled Technical Service Specialists are focused on providing customers with the pre- and post-sales support they need. They are trained to recommend the appropriate Schleuniger machine for each customer's unique application(s) and are available to ensure trouble-free, profitable wire processing for their company by helping to set-up, program, troubleshoot, and even discuss any new application(s) they foresee as their company grows. To learn more, visit www.schleuniger-na.com.

LINKS:

- New PowerStrip 9550: A class of its own
- New UniStrip 2300: A new dimension in benchtop wire stripping
- Schleuniger Sales and Service
- 2011 Upcoming Events
- Technical Articles