MSD
MOTION SYSTEM DESIGN

Top 10 tips

Caring for cables and carriers

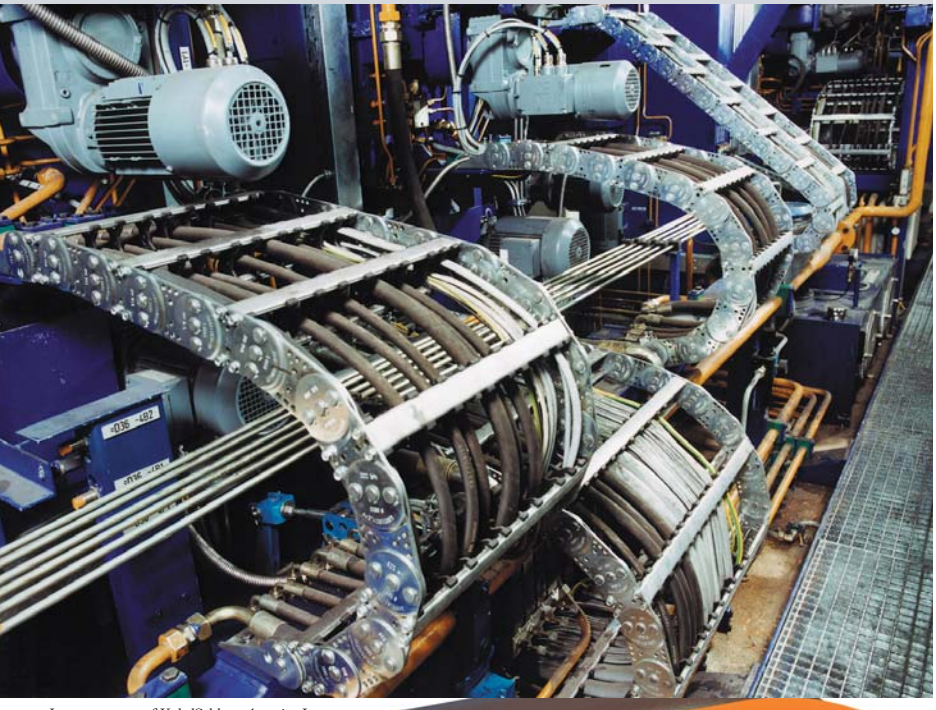

Image courtesy of KabelSchlepp America Inc.

Specifying and working with cables – the lifeblood of automated machinery and systems – takes an understanding of how they work and how to protect them. Check out these tips and tactics from industry leaders to keep your data and power lines healthy.

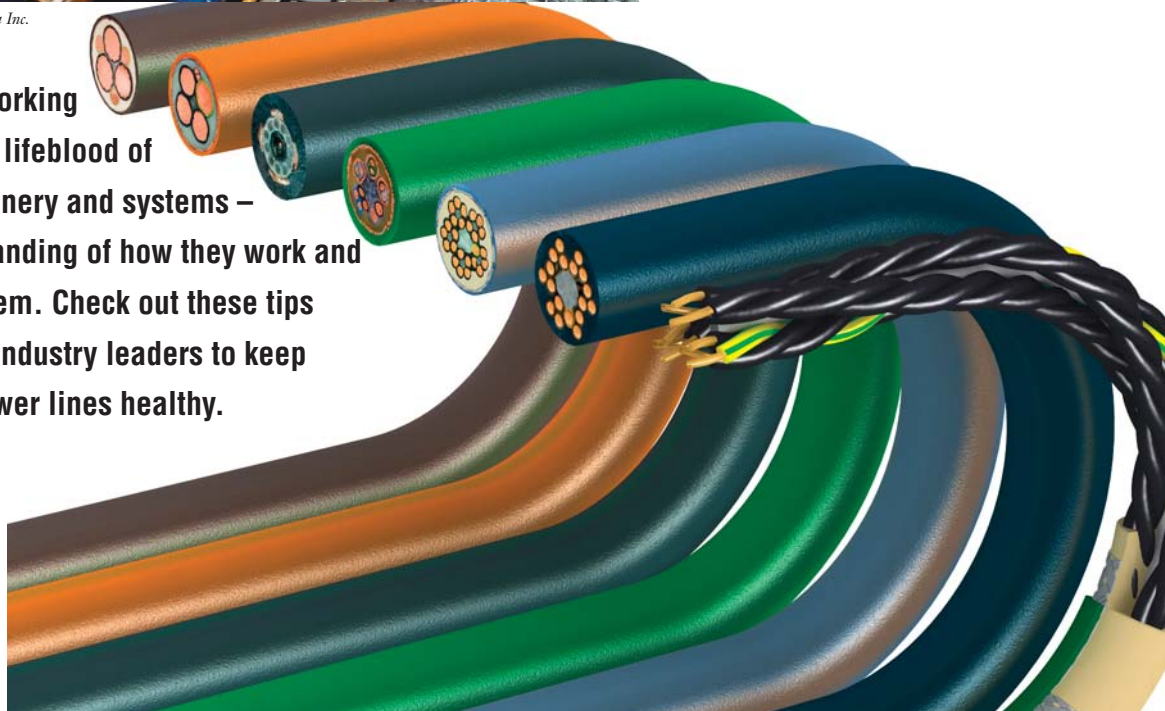

Image courtesy of igus Inc.

1. Pick the right bend radius.

One key cable carrier function is to ensure that the cables and hoses they are protecting do not bend tighter than their minimum rated bend radius. In other words, when specifying a cable carrier, it is critically important to make sure that the bend radius of the cable carrier is greater than or equal to the largest minimum bend radius of the cables and hoses being used.

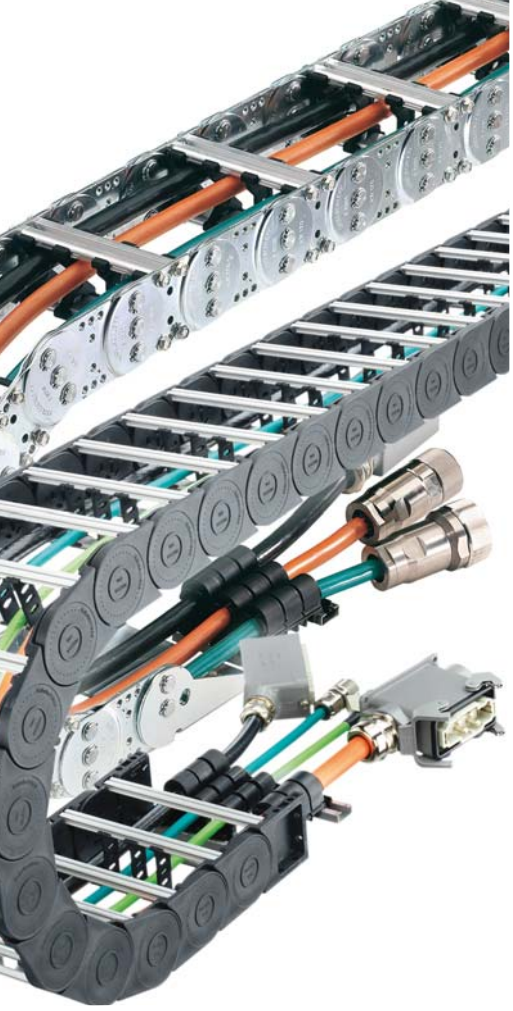

Image courtesy of KabelSchlepp America Inc.

If weight is an issue, consider steel carriers, which typically self-support greater weight over longer distances than plastic alternatives.

2. Ensure proper fit of cables or hoses in the carrier system cavity.

Cables and hoses should always be placed inside their specific compartments in the carrier system so they can move independently and freely throughout the entire carrier system length. Remember to always apply the recommended minimum cavity area clearances. Allow 10% extra room for cables and 20% extra room for hoses. If more space is needed, options include using a larger carrier, nesting smaller carriers inside the loop of larger ones, and placing them side-by-side or in opposing configurations.

3. Be careful not to exceed the maximum self-supporting length of the cable carrier.

Cable carriers are typically rated with a maximum self-supporting length that takes into account how much weight the carrier can support over a given distance. If they exceed their self-supporting distance, then additional accessories may be required such as support rollers or a guide channel to prevent system failure. Steel cable carriers typically self-support greater weight over longer distances than plastic versions.

Images courtesy of igus Inc.

4. Know the signs of impending cable failure:

- Excessive wear on the cable/hose jacket — often an indicator that the cable or hose has not been properly strain relieved
- Corkscrewing where cables twist in themselves
- Knotting of conductors underneath the cable jacket
- Cables twisting around one another or becoming entangled within a cable carrier system, which can usually be avoided by properly partitioning the carrier's cavity to keep cables and hoses neatly organized
- Cables sticking out between carrier crossbars and getting caught in the bend radius — usually an indicator that cables are either too long or have not been properly strain relieved
- Loss of signal or power as a result of broken cable conductors or hose leaks

Left, jacket cracking due to improper material selection.

Top, broken cable shield due to improper design; bottom, corkscrewed cable showing severe jacket abrasion.

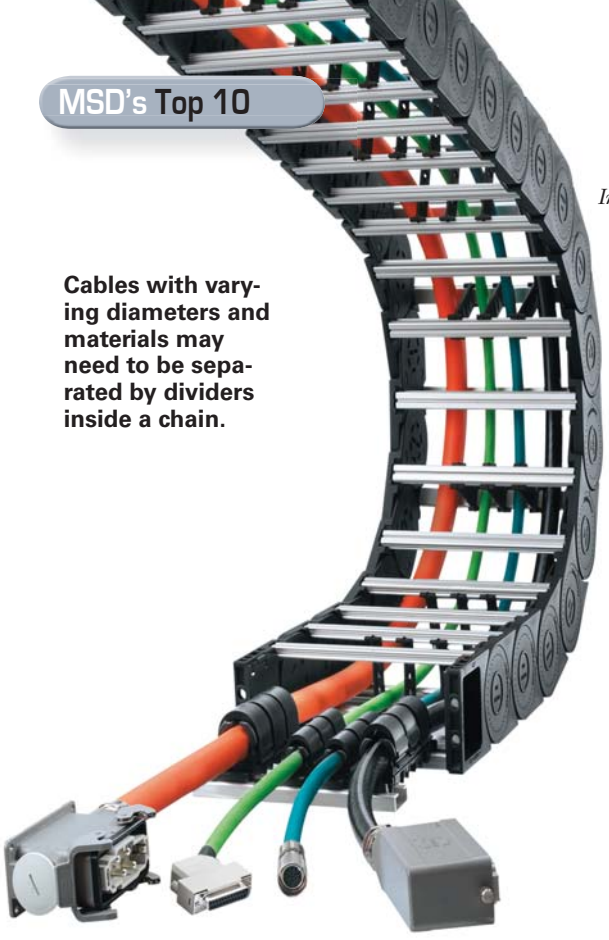

Image courtesy of KabelSchlepp America Inc.

Cables with varying diameters and materials may need to be separated by dividers inside a chain.

Tips 1 through 4 courtesy of Larry Harvey, KabelSchlepp America Inc.

5. Correctly size the cable carrier.

The most common mistake is sizing a cable carrier based only on an estimate of size and quantity of cables inside. Cable packages often increase, and frequently, the size of the carrier must be significantly larger than what is inside to meet application demands. Cable carrier sizing should be based on both the mechanical requirements of the application and the quantity and size of the electrical conduits inside. For example, if two ½-in. OD cables need to move 15 ft, it would be incorrect to choose a carrier that has a window size that suits the size of these cables. Instead, the carrier would need to be significantly larger in order to achieve the self-supporting span of 7.5 ft. Early communication between the electrical and mechanical engineering departments can prevent a lot of problems later in the design process.

6. Select cable suited for use in a cable carrier.

Many cables on the market today are classified as "flexible." However, flexible is often used in reference to the cable's ability to bend around a stationary object. Cables in a dynamic application, such as inside a cable carrier, must be designed so that they are also durable and capable of continuous flexing through thousands or even millions of cycles. Another critical aspect to cable selection is outer jacket material. Cables used in the tight space inside a cable carrier need a highly abrasion-resistant jacket material. Neoprene and other soft jacket materials do not hold up well when used inside a carrier.

7. Use interior separation when necessary.

Regardless of the cable selected, if it is not properly installed and positioned inside the carrier, it will not perform well. Cables should not be allowed to cross over each other inside of a chain. Also, cables of different diameters and jacket materials may need to be separated by horizontal and/or vertical dividers inside a chain. Most manufacturers are able to assist with design-

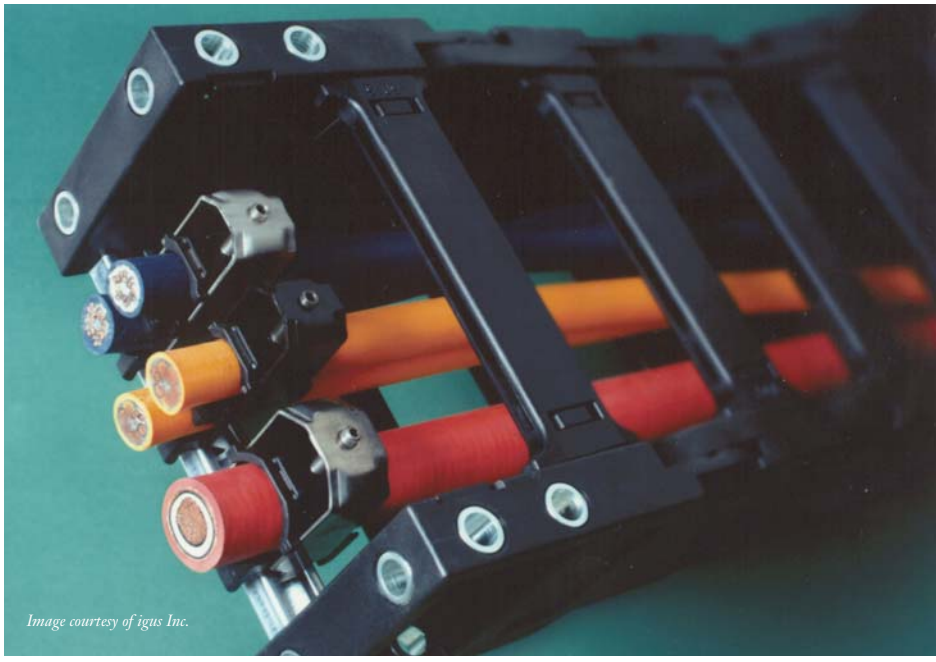

Image courtesy of igus Inc.

Strain relief products installed at each end of a carrier hold cable in position and keep it from being pulled during operation.

ing the proper interior separation for a given cable and hose package.

8. Be sure to properly strain relieve cables.

The most critical aspect of installing a cable inside a carrier is its position in relation to the curve of the carrier. If a cable is pulled either too tightly against the inner radius of the carrier, or too loosely (so it can move out between crossbars or tangle around the other cables), it will fail prematurely. Most manufacturers offer strain relief products that are installed at each end of a carrier to hold cable in position and prevent it from being pulled during operation. For example, options include brackets that have integrated plates for plastic cable ties, as well as steel and plastic cable clamps that can hold up to three cables each for heavy duty applications.

Tips 5 through 8 courtesy of Joe Ciringione, igus Inc.

9. Don't underestimate the importance of cable management.

Engineers often fail to consider the importance of cable management when specifying and working with cables and cable carriers, which has ramifications throughout the life of both cable and carrier. Specific issues that affect cable performance and reduce flex life include the following:

- The cable carrier that is initially specified is often smaller than recommended because of limited space. As a consequence, engineers tend to overfill the carriers. This lack of space causes cables to creep, walk, and twist as the carrier moves, eventually compromising the conductors inside the cables.
- A cable jacket that is too soft or too flexible can cause the cable to fail prematurely because of abrasion due to creeping, corkscrewing, and kinking.
- If the carrier's bend radius is smaller than the cable's recommended use, the carrier will put too much stress on the conductors inside a round cable, causing conductor and shield failure.
- Cables and carriers used in high acceleration, high velocity applications have more force placed on the cables and their conductors. Additional force increases friction and puts additional stress on the cables, yet another cause of premature cable wear.
- The mass of cables and cable carriers affect the positioning accuracy of high-precision linear systems. Low vibration, linkless cable chains tend to bounce after motion has stopped, affecting the accuracy of the system's positioning.

10. Consider using flat cables to eliminate several issues and improve cable performance and life.

As motion control systems become more sophisticated, engineers need to evaluate the long-term impact of cable management as they begin the initial design and specification process. Consider the use of flat cables, because they eliminate several cable management issues by:

- Increasing space in the carrier due to eliminating the need for shelves and dividers
- Reducing friction among the cables and carrier, which decreases stress and abrasion
- Preventing cable movement within the carrier (creep, twisting, and corkscrewing) with the flat surface of the cables distributing the force caused by carrier movement
- Reducing cable thickness, which significantly increases flex life and reliability for cables used in applications with a bend radius less than 3 in.
- For cleanroom environments, the most important consideration is to reduce potential sources of friction as much as possible. Engineers should specify chains that are designed specifically for low particulation and low-vibration use and select flat cables to eliminate dividers and shelves, a common source of particulates. In addition, depending on stroke length, it is possible to eliminate carriers completely by using trackless cables.

Tips 9 and 10 courtesy of Paul Warren and team, W.L. Gore & Associates Inc.

Industry expertise

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For more information on cable and carriers, visit motionsystemdesign.com and search "cable."