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The Prominent Factors Affecting Medical Interconnect Design

By Lee Burgess, Global Business Development and Sales Director at ENNOVI (formerly known as Interplex).

The healthcare sector places several precise demands onto interconnects. The following article will look at the considerations influencing their design and development in order to maximize their suitability in this context. This will particularly focus on what the considerations are going to be from a human perspective - both with regard to the medical professionals using them, and the patients that are receiving treatment.

Interconnection is an essential aspect of modern medical systems. Through the interconnects employed, data and power can be supplied. For example, they may be used to transfer measurements taken by a probe/sensor back to a piece of analyzing equipment. They might also be utilized for delivering current to portable monitoring devices.

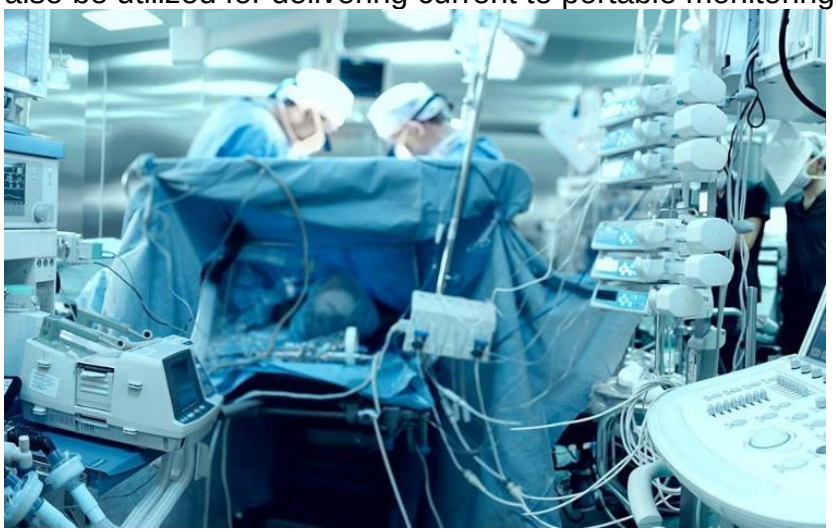

Figure 1: Operating rooms represent extremely challenging environments for medical interconnects

Application considerations

Healthcare undoubtedly presents high-pressure scenarios, where being able to act quickly could make all the difference, resulting in lives being saved. Anything that could cause even split-second indecisiveness or lead to mistakes being made must be avoided. For this reason,

how interconnects are handled is of paramount importance - and their external form needs to reflect that.

Having an external shape for which the orientation feels intuitive when picked up by the user is certain to be advantageous. Even better, is that it should actually feel wrong if the interconnect is not held in the correct way. The upshot of this is that users will plug the interconnect into the associated equipment quicker and without mating errors that could otherwise damage the contacts. It will not only mean that nurses and doctors are more effective in their work, but also ensure that interconnects last longer (with the outlay of having to replace them being lowered). Inclusion of a haptic element that the user will be able to feel will provide further guidance - as in these pressurized settings, operatives will often need to attach cables without having time to look at what they are doing.

As well as mis-mating, there are other things that can detrimentally affect connector lifespan. Whether equipment is being utilized within a clinical environment (such as a hospital ward), inside an ambulance, or by a paramedical out in the field, its connectors and cabling are going to be subject to rough treatment. Yet, any failure occurring could clearly have various serious implications, so a high degree of robustness must be expected. Hospital procurement managers want to have equipment interconnects that will last a long time. The less likely it is that they will need replacing, the lower the total cost of ownership (TCO) will be, thereby curbing the budgetary impact experienced.

Interconnect properties

In some medical settings, in particular A&E units and operating rooms, there will be exposure to blood and other substances. Likewise, harsh chemicals may be used in periodic cleaning regimes. Hence, interconnects must be fully protected against the prospect of liquid ingress.

Cabling needs to be able to bend sufficiently, as it will be subject to various torsion forces during the average working day. Items of equipment may be stacked closely against each other or pushed against the side of an ambulance wall. Consequently, cables can end up being bent at acute angles. Unless adequately protected against, then damage could occur that will cause interconnect failure. Also, if bending means that a gap appears between the cable and the connector, then liquid could enter and potentially result in a malfunction too.

Whether it is PVC, silicone or some other material being used, the optimal durometer must be selected. If it is too pliable then the interconnect will bend too far. Conversely, if it is too stiff, then it will not bend appropriately, and cracks will appear. The material must be durable, but also soft enough not to harm the patient if it is directly in touch with them.

If the design needs to be changed, with larger diameter cabling used that can accommodate a greater number of wires, then adjustments will be necessitated. After carrying out finite element analysis, the durometer of the cabling material or the length of the overmold might need to be altered - so that it is properly aligned with the required functional characteristics. The right balance of stiffness and pliability can once again be found and subsequently applied.

Bend/strain relief

In order to maintain continued operation, having bend and strain relief mechanisms will be crucial to interconnect implementations within medical applications. In some circumstances, backpotting may need to be included. This will add to production costs though, so it will normally

just be used when absolutely necessary. In many cases, strain relief will be provided by using a ribbed overmolding. The downside of this is that the grooves present in such overmolds will leave places on the interconnect surface which are very difficult to keep clean. The build-up of bacteria resulting from this is likely to increase the risk of patient infection. Having strain relief, but with a smoother outer surface, will mean that the collection of dirt and blood that can cause this bacteria build-up may be avoided.

Cost and logistical attributes

It should also be noted that items of medical equipment are expensive to procure, so they will generally remain in operation for a prolonged period of time (possibly two decades or more). Because of this, even if interconnect solutions feature new functionality or performance enhancements, they still have to be backwards compatible with the legacy connectors that were originally designed for that equipment.

For the manufacturers of medical interconnects, the vast majority of their work has focused on providing custom-built solutions. This regularly proves problematic for medical equipment producers though, as it means they have to make substantial upfront payments to interconnect suppliers to cover the tooling charges. The volumes required will also need to be enough to justify this investment, otherwise the costs involved will simply be too high. In addition, the custom process can take a long time to complete, with several months elapsing before the units are ready.

A better strategy

Facing a changing landscape, interconnect manufacturers need to make alterations to the way in which they deal with opportunities in the healthcare sector. Firstly, the solutions that they develop must fully take into account the needs of under pressure medical professionals - so convenient, fast-moving usage can be benefited from. Also, interconnect supply must properly match what medical equipment OEMs actually want. Rather than having custom-built designs, which come with all the inconveniences already discussed (like large initial expenses and long lead times), access to more economical solutions is going to be expected. These will provide such OEMs with more acceptable unit pricing and product availability from stock, alongside greater speed to market (so they can secure more orders). In addition, a well-defined upgrade path will be desirable - in order that new capabilities can be added while at the same time keeping compatibility. For this reason, compatibility with interconnect formats that are already widely used will be advisable.

Forward-thinking manufacturers are now offering off-the-shelf interconnects that provide cost-effective alternatives to customized production projects. These are able to eliminate the issues that have previously hindered the medical industry. Also, by having access to adaptable interconnect platforms, medical equipment OEMs' product validation processes are made much more straightforward. After one product has been validated, then this validation will be applicable to other products too.

Figure 2: Off-the-shelf ENNOVI (formerly known as Interplex) Sureline interconnects featuring proprietary overmold technology to maximize their robustness plus an external design that aids orientation

Conclusion

Utilizing interconnects that have ergonomic designs will facilitate quicker operation and accelerate the responsiveness of medical staff in critical scenarios where patients' lives may be in danger. Off-the-shelf solutions will minimize the investment that equipment OEMs need to make and enable them to complete their development projects within shorter timeframes and gain a larger market share. Innovative engineering can also protect against functionality being compromised and lower the TCO for purchasing departments. Finally, the ability to upgrade interconnect technology, so that retrofitting onto existing equipment assets is possible, is going to be very appealing too. These expectations are set to alter the way in which medical interconnect supply is approached.

About the Author

Lee Burgess is the Global Business Development and Sales Manager at ENNOVI (formerly known as Interplex), supporting the Medical Division. He is experienced in New Product Integrations (NPI) across all medical product lines and supports the design, manufacturing and assembly of medical components.