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Expanding the Capabilities of Connectors

Many systems require a variety of different capabilities, such as air, fluid, and electronics, to be connected to a tool. As such, device manufacturers must ensure that each element is kept completely separate from each other. This can be especially challenging at the connection point. Hybrid connectors offer a solution to OEMs attempting to resolve these problems themselves.

By Jaime R. Erickson

With systems continually expanding in capabilities, there is an ongoing challenge to effectively connect all types of clinical, medical, and surgical devices and tools to them. The increasing complexity of these systems, many of which now include fluidics, pneumatics, and electronics in a single unit, challenges device designers to incorporate a more complex physical link between the controllers and their end devices. Often controllers are located up to several yards from where the device is used, so it is critical that connectors provide a streamlined interface between the device and its controller. This requires a new way of looking at connectors—the hybrid connector.

Common applications where these highly specialized connections are required include laparoscopic procedures, dentistry, cosmetic skin treatments, eye surgery, and liposuction. Any application where there is a need to transfer liquid, air, power, or data to a remotely used tool presents a challenge. Also, any time tools are removed and/or exchanged mid-procedure, a clean, safe, and efficient way to "hot-swap" is necessary.

Consider cosmetic laser skin treatment; in this procedure, each control unit comes equipped with several different end devices, or treatment heads. The treatment heads are physically connected to the controller by means of an umbilical containing a cooling loop and multiple conductors. During a procedure, several different treatment heads may be used to achieve desired results. To reduce the duration of treatment sessions, adding "hot swap" capability to the end device enables the operator to change heads rapidly thereby benefiting both the operator and the patient.

What device designers are challenged with is reduction of the number and complexity of connections on a device; a tangle of different cords and connectors looks unsophisticated and can be confusing for the operator. Any tool or device may have a multi-conductor data connector, separate power contacts, several fluid connectors, air for some pneumatic instruments, or temperature and/or pressure regulating connections, so it is easy to see how complicated the interface can become. Innovative engineers have discovered that integrating all connection points into a single, easy-to-use hybrid connector is the ideal solution.

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New Technology Brings a Solution

Hybrid quick connectors allow the device to have one single connection point to make all fluid, electronic, and other connections between a tool and its controller.

Initially, hybrid connectors were attempted in-house by device designers wanting to integrate simple fluid and electronic connections. Since liquids and electronics don't mix, this integration wasn't even feasible until dry-break fluid connector technology was fully developed. Dry-break technology eliminates fluid drips upon disconnection and enables fluid connectors and electronics to co-exist in close proximity.

Hybrid connectors can integrate fluidics, pneumatics, and electronics in a single unit.

Integrating all connection points into a single, easy-to-use hybrid connector is the ideal solution.

Until recently, device designers tackled the consolidation of multiple connections into single "umbilical" lines that connect their tools to the control units themselves. This was an extreme resource burden. As with any design project, there is a continual balancing act between relying on an in-house design team and recognizing when an external engineering source can be the most expedient and cost-effective option. Just as device designers would turn to a pump manufacturer

to design a new pump, they are now turning to leading connector manufacturers that can offer proven design capabilities to solve complex connector challenges. Working with a reliable external source yields creative results and real cost savings.

In addition, while quite feasible for any good medical device designer to tackle this on their own, handling this type of design challenge completely in-house brings about its own complications and associated costs. There is initial design time and testing, finding the right component fits, sourcing multiple vendors, overseeing incoming inspection, inventory stocking, assembly, and testing of the new connectors—all costs associated with internal design. In designing a controller/tool interface, an in-house device designer could work with up to a dozen or more different vendors to create a hybrid connection. If there is a quality problem, it becomes a task of back-tracking to the particular component that failed and using internal resources to resolve the issue. This is lot of work for just the connector solution; work that could be better spent in enhancing the next generation of the overall capabilities of the medical device itself.

Therefore, more medical device designers are teaming with custom connector developers for their specific applications. As a result, creative hybrid designs incorporating electronics and fluids in a single connector are a reality. Device manufacturers find that these connectors reduce device size, reduce the complexity for the end user, and increase the overall safety of their equipment.

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In laser applications, the need is for cooling the portion that is in contact with the patient. This can be a water coolant or, in the case of eye surgery, it is often a saline solution running fluid through the line that actually comes in contact with the patient, for both cooling and irrigation. Often air lines are needed when using pneumatic type instruments. All additional lines, regardless of what they are, feed into and through the connector which also contains the integrated electronic lines—one plug, multiple sources.

The single connection point of an umbilical interconnect makes connecting equipment cleaner in appearance and user friendly. Where multiple hand pieces are used for a particular procedure, a hybrid quick disconnect at the end of their instrument allows for a quick change to a different hand piece or device.

Added Safety

Taking the hybrid connector one step further is making it "smart." All types of equipment used in a wide range of aesthetic, medical, and surgical arenas benefit from tracking of the connection/use process. While definitely not the only area where this is a benefit, one that stands out is disposable instruments. While such components are monitored closely, re-use does occur and it can put the manufacturer in a dangerous position from a liability standpoint. Building safeguards into the initial device designs can reduce the likelihood that their disposable components can be improperly re-used.

A "smart" hybrid connector is one method for this type of safeguard. These connectors incorporate an embedded RFID tag which can be pre-programmed with data relating to batch number, date code, or whatever data that manufacturer deems necessary. Upon initial connection of the surgical instrument to the control device, the device will read the data that is stored on the tag located in the disposable portion of the connector to determine if the disposable component is approved for use. Once the procedure or treatment is complete, the device writes a code to the tag noting that the disposable tool has been used. This information is now stored on the tag and if the disposable component is connected a second time the control device can refuse to allow its use. The operator must then replace the tool with an unused one in order to complete the procedure.

This technology can also be utilized in procedures that require sequential tools to be used. The embedded RFID tag can be pre-programmed so that the tools cannot be connected in the wrong order. If there is an attempt to connect up tool B prior to tool A, a warning can be displayed on the controller.

The information stored on the RFID tag can be used in a variety of ways. The device controller can configure itself based on the hand piece tool or component connected, eliminating the need to set up or program the device. The device can record what components were used and when, or ensure that expired products are not used. Consider a procedure that uses two different pneumatic hand tools. Each of these tools requires a different input pressure to operate properly. The embedded tag can contain the data regarding what pressure should be output to the tool. When the hand tools are swapped out, the controller automatically detects, via RFID, what the output pressure should be and adjusts it without the need for manual adjustment or mechanical contacts. The applications for this technology are vast and broad.

Future Growth

Device manufacturers and their designers are experts in their specific technology, and are generally not experts in connectors or fluid transfer. Working with an experienced connector company to develop a complete connector solution, the device manufacturer can simplify the overall use of the end product for the doctor, aesthetician, surgeon, or clinical technician, thereby increasing safety and enhancing product reputation.

This is an area that is continually changing and growing. While all specialty designs are obviously proprietary to the end user, a connector company with a broad base of experience in special designs will naturally offer both a wide library of existing connector technology as a starting base, as well as the wisdom of a staff dedicated to continuing technology breakthroughs that will benefit the unique development of each new hybrid connection solution.

With the device manufacturer concentrating on bringing their best engineering and design expertise to the development of their end device and the connector supplier concentrating on giving this designer the exact hybrid connector that will enhance the performance of that device, it becomes a perfect partnership and results in a better end product that is more intuitive for the end user and safer for the patient.