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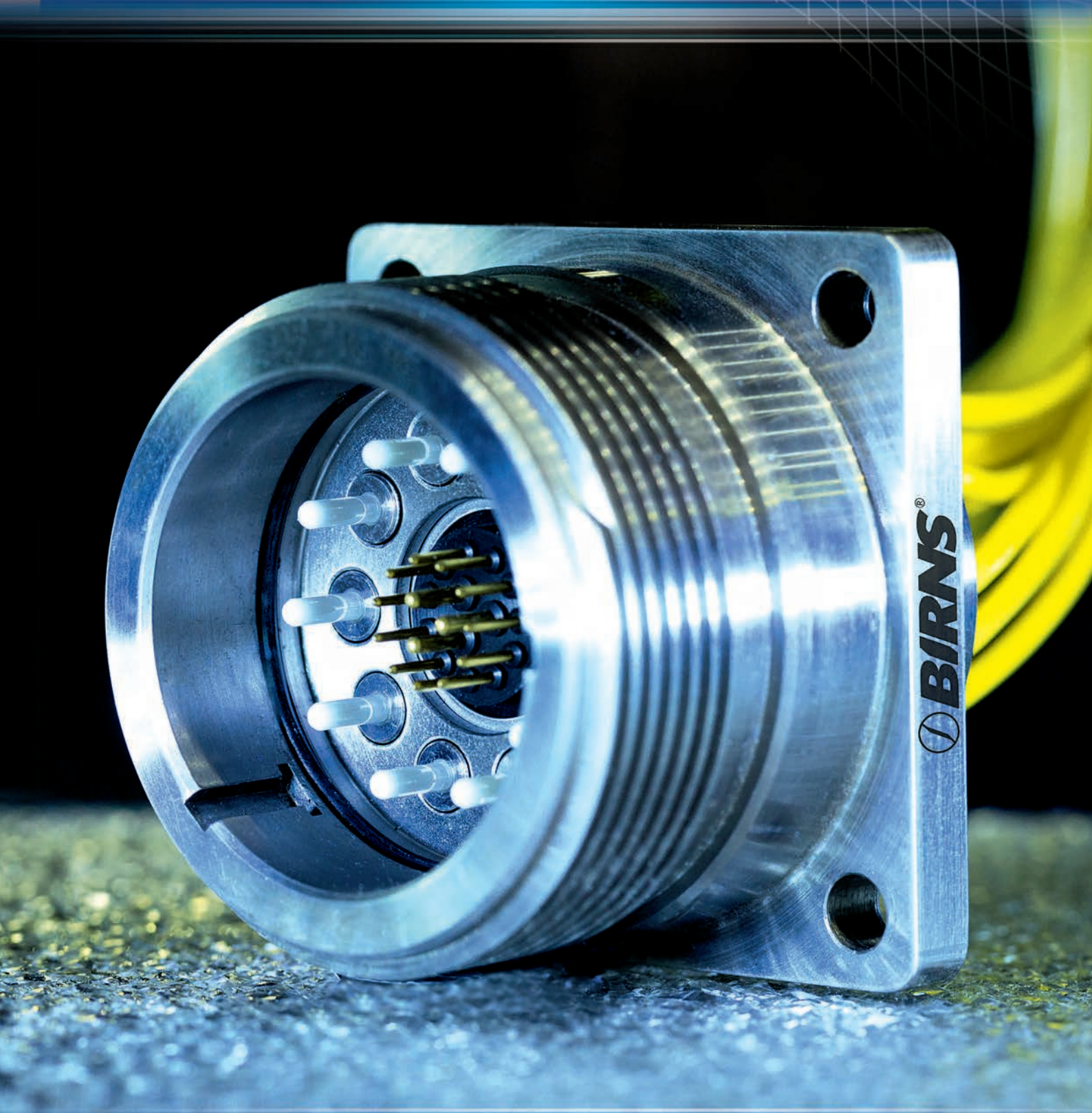
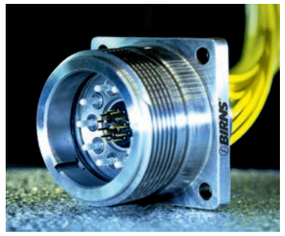


CONNECTORS/CABLES/WINCHES; OFFSHORE RENEWABLES/OFFSHORE TECHNOLOGY



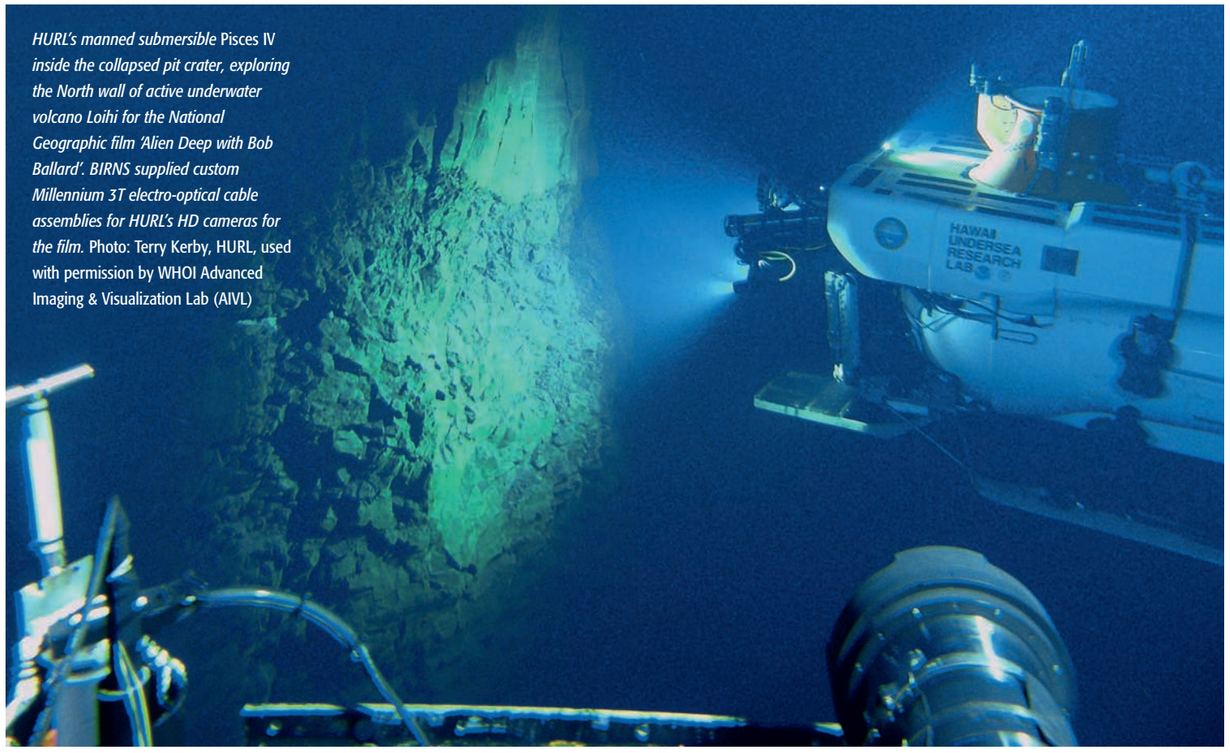
The changing face of the connector industry

By Amy Brown, director of corporate communications, BIRNS, Inc., USA

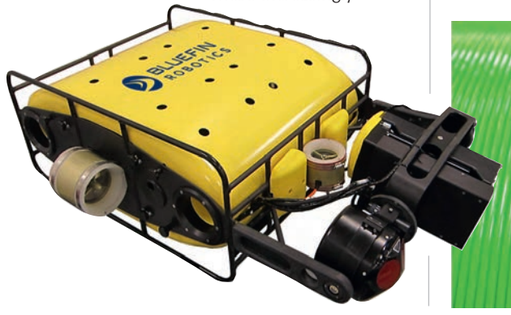
Following humble beginnings in the 1950s, subsea connector technology has advanced tremendously over the years. The technology continues to provide exciting opportunities for growth and innovation

Subsea connectors, like many continually emerging technologies, had fairly humble beginnings. In the early 1950s, manufacturers began developing simple connectivity solutions with a handful of electrical pins and simple rubber mating halves – with depth ratings of only a few dozen metres. Today, however, connector systems can be rated to six kilometres and deeper, and are developed with titanium, stainless steel and a wide range of different metals. Connectors include combinations of high and low voltage, optical fibres and coax contacts, often in the same high-density configuration. Modern underwater connectors are a key component of a diverse suite of marine systems from oil and gas, subsea science and military applications to communications, security and manned and unmanned vehicles.

These increasingly sophisticated connector and cable assemblies are relied upon to perform in some of the most demanding environments on the planet, while delivering levels of data and power that would have been unthinkable even a few decades ago.



HURL's manned submersible Pisces IV *inside the collapsed pit crater, exploring the North wall of active underwater volcano Loihi for the National Geographic film 'Alien Deep with Bob Ballard'. BIRNS supplied custom Millennium 3T electro-optical cable assemblies for HURL's HD cameras for the film.* Photo: Terry Kerby, HURL, used with permission by WHOI Advanced Imaging & Visualization Lab (AIVL)



Millennium 3F single fibre connector provides precision optical alignment, with ≤0.3dB of optical loss, for Bluefin's HAUV

BIRNS has been leading the industry in connectivity solutions for the majority of its 60 years in business. Along the way, the company has developed advanced innovations that have helped enhance the way marine systems operate and communicate by providing extraordinarily high performance attributes in radically smaller packages. Open face pressure ratings to six kilometres are available with the BIRNS Millennium series, a high density metal shell line featuring diverse options of optical, electro-optical, coax and electro-coax configurations. These robust connectors are built for rigorous use, and include such features as positive stainless steel stops to preclude over-tightening, dual stainless steel keys and square threads to resist mechanical damage. Powerful connectivity is also delivered with the BIRNS Primum series for high voltage applications. This line of rugged, versatile connectors is rated to six kilometres and designed for use with solid or oil-filled cables and are tailored for the heaviest power signal, high voltage (to 3000 volts) and electro-mechanical applications.

FIBRE OPTIC TECHNOLOGY ADVANCES

Today's subsea system designers are often looking for a complex mix of attributes that must combine immense capabilities in a minuscule space. Fibre optic technology provides a good example of meeting such demanding requirements. BIRNS provided a Millennium 3F single fibre connector solution to Bluefin Robotics, USA, for its line of hovering autonomous underwater vehicles (HAUV-3) used in the US Navy's EOD HULS MK19 ship hull inspection system. This two-man portable AUV sends real-time vehicle telemetry to the surface, as well as high-resolution imaging sonar and video camera data over a thin fibre optic data tether. The solution, therefore, called for connectivity with large performance capabilities in a compact and lightweight package with a diameter of 19 millimetres (0.75 inches) and a weight of 130 grams (4.6 ounces). The 3F single fibre connector withstands high open-faced pressure to 6000 metres (8750psi/595atm). While small, this powerful connector delivers high bandwidth connectivity in a low profile footprint. BIRNS developed it carefully, and it provides precision optical alignment, with no more than 0.3 decibels of optical loss, while working seamlessly with applications requiring long cabling.

Larger connectors often integrate both electrical pins and optical fibres, as used in the Hawaii Undersea Research Laboratory's (HURL), USA, deep diving research submersibles during the making of 'Alien Deep with Bob Ballard' by National Geographic. HURL needed custom cable assemblies for the HD cameras used in the groundbreaking project in which manned submersibles *Pisces IV* and *Pisces V* explored and filmed Loihi, an active underwater volcano.

BIRNS supplied HURL with BIRNS Millennium 3T electro-optical cable assemblies, each with two optical fibres, eight high voltage conductors and four low voltage contacts. The two optical fibres on the connector inserts were a mere 0.3 centimetres (0.1 inches) from the three-kilovolt 14AWG contacts. This was the lateral distance from the pin to the closest point of the steel ferrule retainer. Great care was needed in the development of the inserts for these cable assemblies for them to perform perfectly and consistently during challenging conditions at depth and over extended use.

ELECTRICAL BREAKTHROUGHS

Electrical connector technology continues to rapidly advance as increasingly complex systems require high performance solutions paired with many pins in a compact space. For example, BIRNS was called upon by Sensor Technology Ltd in Ontario, Canada, to provide an ultra-high density connector solution with numerous electrical pins in a small footprint. The requisite connector pair was for a transducer that would be mounted on an underwater vehicle for mine detection for a project with a defence contractor customer. The 100-metre rated transducer was a mere 20.32 centimetres (eight inches) in diameter and required a large number of channels, so BIRNS developed a custom cable assembly for the system that included a BIRNS Millennium 3T connector pair with 161 22AWG pins. This configuration was one of exceptionally high density, as the 161 pins were in a connector of approximately five

BIRNS developed a custom cable assembly that included a Millennium 3T connector pair with 161 22 AWG pins for Sensor Technology's 20.32cm diameter transducer

centimetres (two inches) in diameter. Terminating such a connector might seem daunting, however BIRNS connectors feature scalloped solder pots that face outward, and the inserts have no wings or other obstructions that might limit soldering access – a key component in terminating so many small pins in such a tight formation.

To facilitate mating and un-mating in the field, the connectors also featured new keying methodology, keys that are fully machined as opposed to commercially available press fit versions. These robust keys are precision engineered with a squared silhouette, providing greatly increased strength and making the keying process secure and user-friendly.

PUTTING ARTISTRY IN STATE-OF-THE-ART

BIRNS is often called upon to overmould terminated connectors, made by BIRNS and other companies, to cable, as well as repair and splice a diverse suite of such assemblies in the BIRNS NAVSEA S9320-AM-PRO-020 certified moulding facility. The development of complex connectors and cable assemblies requires stringent protocols and disciplines, as does the testing of such systems. The company has a robust, high volume helium testing capability and tests its own connectors, cable assemblies and penetrators, as well as serving as an independent testing resource for the industry. BIRNS has a state-of-the-art hydrostatic pressure testing

Above: A technician inspects a Millennium 3P connector insert with 83 electrical pins with BIRNS' CMM. Below: A custom titanium fixture for testing Millennium 3P FR titanium connectors to withstand pressure for oil filled cable assemblies

system, with a range of vessels rated to 20,000psi, 10,000psi, 5000psi and 1000psi (1361atm, 680atm, 340atm and 68atm). For this demanding testing, BIRNS uses a range of advanced equipment, including a custom automated Kikusui, Japan, 16-channel hipot and insulation resistance (IR) cable testing system which stores 99 test programmes. The hydrostatic testing is further enhanced by new automation software that allows precise control in taking the range of testing from one depth to another.

Other advanced techniques and equipment BIRNS uses for the testing of connectors and cable assemblies include a direct computer control (DCC) Mituyoyo, Japan, coordinate measuring machine (CMM), which allows users to download 3D engineering models into the machine to measure a part directly from the model. This technology provides nine-micron accuracy and three-micron repeatability in inspecting complex connectors, and allows computerised geometric inspection of connector pins, shells and other components on three separate axes. BIRNS also utilises a Video Measuring system, new technology that combines the power of an optical comparator with digital video, high-resolution cameras, telecentric optics and LED illumination. Precision is needed to accurately align electrical contacts and optical fibres – lack of alignment and/or engagement in connectors can result in signal loss and poor results for a connector's performance. Considering that the core of a singlemode optical fibre is roughly the size of a red blood cell, for example, it is crucial to utilise technology like CMM and other specialised equipment to provide great accuracy beyond the naked eye.

Further, to test and measure loss on miniscule, delicate optical fibres, BIRNS uses equipment like the OptoTest OP940, a highly specialised meter that allows its technicians to make simultaneous measurements of insertion loss and return loss at two wavelengths without requiring termination of the fibre's distal end to measure the return loss.

GOING THE DISTANCE

While subsea connector technology has advanced in tremendous ways since its inception, it continues to provide more exciting opportunities for growth and innovation. As ocean systems become more sophisticated, so too do the high performance connectivity solutions that link their communications, power and other key components. And as man continues to push the boundaries of the ocean environment, connector manufacturers will have more opportunities to create connectors that are smaller, better and faster, while becoming increasingly more powerful.