

The Philosophies of Fusion Splicing: Then and Now

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KEY TAKEAWAYS

- Fusion splicing, which has been around for 40 years, was originally an expensive, labor-intensive process with heavy, cumbersome equipment.
- Since the early 2000s, fusion splicing has become more accurate, has significantly decreased in price, requires only one employee, and has become more portable.
- Active clad alignment focuses on aligning the cladding and works best with modern, same-era fiber that has good core concentricity.
- Core alignment uses the properties of the fiber and additional cameras to achieve core visibility and achieve alignment.
- Ribbon splicers allow for the splicing of a dozen fibers at one time, increasing efficiency and cost savings.
- Fusion splicing product offerings and applications have grown over the last four decades to meet increasing demands for bandwidth.

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OVERVIEW

Although fusion splicing has been around for four decades, the evolution of its supporting technologies and applications has steadily expanded as the demand for bandwidth has increased in just about every aspect of modern life.

Today, fusion splicing technologies are more compact, less expensive, more exact, and require less labor to implement. Active clad, core alignment, and ribbon splicing are the most common technologies available today and are used in cable-to-cable, cable-to-pigtail, and cable-to-splice-on connections.

CONTEXT

Clay Franklin discussed the evolution of fiber optic fusion splicing from its early beginnings to present-day technology during a *Cabling Installation & Maintenance* webinar sponsored by Corning.

KEY TAKEAWAYS

Fusion splicing, which has been around for 40 years, was originally an expensive, labor-intensive process with heavy, cumbersome equipment.

Fusion splicing isn't new; it came into existence shortly after the innovation of optical fiber more than 50 years ago. However, in its early years, fusion splicing presented several significant challenges:

- **Investment:** With splicing equipment costing anywhere from \$12-40,000, contractors found it difficult to commit to the up-front expense.
- **Labor intensive:** A successful splicing project needed a team of at least two to three people. One person may sit at the optical time domain reflectometer (OTDR) while another would manually splice, tuning it to line up the actual fibers. The person with

Figure 1: Splicing in the Early Years



Mr. Franklin splicing in the early years

the OTDR would communicate via walkie talkie, directing the individual at the splicer to either stop or splice. Another person was often leveraged for additional oversight and project management.

- **Size:** The average weight of splicing equipment was around 30 pounds, making it challenging to use on a bucket truck or take to the top of a rack.

Since the early 2000s, fusion splicing has become more accurate, has significantly decreased in price, requires only one employee, and has become more portable.

Since the early days of splicing, several improvements have occurred. These include:

- **Less expensive:** Splicing equipment is now available for between \$4,000 and \$18,000, depending on the applications and features needed.

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- **Less labor:** One employee can effectively run today's splicing equipment.
- **Portable:** Today's splicers from Sumitomo Electric and UCL Swift weigh under five pounds.
- **Exact:** Most splicing equipment delivers a very close loss estimation during the splicing process, eliminating the need for continuous testing during the actual splicing. However, manufacturers recommend that both the fusion splicer and the system are tested from end to end once splicing is completed.

Active clad alignment focuses on aligning the cladding and works best with modern, same-era fiber that has good core concentricity.

Fiber is made up of the coating, the cladding, and the core. A single-mode fiber has a coating measuring of 250 microns, a cladding of 125 microns, and a core of 8 microns. An active clad alignment solution works to align the outer edges of the cladding, slightly thicker than a human hair, by holding the fibers in a v-groove, using electrodes, and moving them along an x- and y-axis. Cameras are used to assist in this analysis.

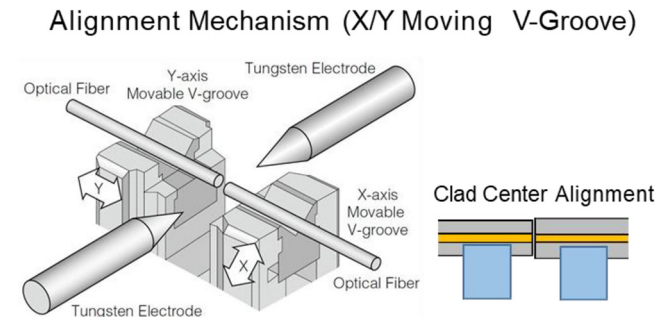
Fiber manufacturers have improved core concentricity, or where the core is located in the fiber, over the years. As a result, active clad alignment should not be used to splice a fiber manufactured in the 1980s with a newer fiber, since the core concentricity will likely be different.

It wouldn't be in your best interest to use active clad if you're using two fibers from two different eras.

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Both Sumitomo Electric and UCL Swift offer active clad alignment splicers that have user-friendly interfaces, fiber-to-fiber, and splice-on connectors.

Figure 2: Active Clad Alignment



Core alignment uses the properties of the fiber and additional cameras to achieve core visibility and achieve alignment.

Instead of focusing on the outer edges of the cladding, core alignment is achieved by studying the light, movement, and different properties of the fiber. These splicers still use a v-groove and electrodes and operate on the x- and y-axis. However, multiple cameras look at the properties of the fiber. For instance, the core glows brighter than the cladding, allowing accurate alignment for the splicing.

Both Sumitomo Electric and UCL Swift offer core alignment splicers with easy-to-use touchscreen interfaces and a variety of features.

Figure 3: Core Alignment Splicer Examples



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Ribbon splicers allow for the splicing of a dozen fibers at one time, increasing efficiency and cost savings.

As demand grows for denser fibers that can fit in smaller spaces, cable manufacturers are increasing the production of ribbon fiber. Ribbon fusion splicers have six v-grooves that simultaneously align 12 fibers in a flat alignment. Cameras are designed to pick up offset errors.

Ribbon splicers are becoming a bigger piece of the puzzle as people are trying to get more density, more fiber in a smaller space.

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Both Sumitomo Electric and UCL Swift offer ribbon splicers with touchscreen interfaces that can splice multiple fibers at one time.

Fusion splicing product offerings and applications have grown over the last four decades to meet increasing demands for bandwidth.

Although cable-to-cable splicing was the original type of splicing, today, cable-to-pigtail and cable-to-splice-on connectors are growing in popularity to meet new application demands.

- **Cable-to-cable.** This type of splicing can be used outside a plant, aurally, in a pedestal, or direct buried. Typically, cable-to-cable is single mode and can be either single or ribbon fibers. Professionals recommend using core alignment, and it is frequently used in emergency restoration and repair.
- **Bandwidth demand drives changes.** Manufacturers are working to make fiber optic cable easier to install, repair, and update. At the same time, the cost of electronics as well as splicing technologies continues to drop, making it easier for contractors to justify the investment. This demand investment is crucial in meeting the network demands that surround us today, catapulting the industry away from simple cable-to-cable applications and leading to additional splicing solutions for a more diverse application portfolio.

Why are people doing more splicing? The big push is for bandwidth. We all want more [bandwidth].

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- **Cable-to-pigtail.** Typically rack- or wall-mounted, cable-to-pigtail splicing takes place inside a plant. These are frequently used for repairs, adds, moves, or changes. Both single and multi-mode, and either single or ribbon fiber, can be used. Core and active clad alignment are both effective.
- **Cable-to-splice-on connectors.** Usually used inside the plant, cable-to-splice-on connectors require fan-out kits and are tight buffered. These are often used for repairs, adds, moves, or changes. Both single and multi-mode, and either single or ribbon fiber, can be used as well as either core or active clad alignment.

Things to Remember

- Fusion splicing has been around for over 40 years and is a proven termination method.
- Fusion splicing is found in all network applications today.
- Key drivers of the growth in fusion splicing include:
 - Adaptation of single mode in all networks
 - Decrease in the cost of single mode electronics
 - Decrease in the cost of fusion splicers

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As the push for lower loss systems
with more bandwidth are needed,
fusion splicing will continue to grow.

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ADDITIONAL INFORMATION

To learn more about current fusion splicing technology from Sumitomo Electric and UCL, contact those companies directly.

BIOGRAPHY

Clay Franklin

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Clay Franklin is a Senior Product Specialist for our fiber optic joining point (FOJP) product line management team at Corning Optical Communications. He has 23 years of experience in the industry, working in engineering services, splicing and test equipment product line management, enterprise marketing, and fiber optic joining point product line management. Prior to working for Corning, Clay spent 4 years in the United States Marine Corps. He is a graduate of Gardner-Webb University with a bachelor's degree in Business Administration.