

In the world of manufacturing, attaching part A to Part B is a \$50 billion-a-year business. Every product we use, from CD player to jumbo jet, is a collection of parts that must be glued, screwed or riveted together. It may seem a humdrum industrial backwater, but in fact, "Joining" Technologies are ultra high-tech.

Take welding, for example. Forget the guy behind the face shield at the auto-body shop. Welding is advanced materials science these days and getting even more so. There are techniques, like ultrasonic welding, that actually vibrate surfaces together to achieve a merging of atomic structures; and chemical techniques that use catalysts to trigger interactions between surfaces, according to Michael Francoeur, president of Connecticut-based Joining Technologies. "Imagine someday being able to paint the end of a composite I beam with a chemical, attach it to another I beam, and watch the two fuse," says Francoeur. Welding technologies are being perfected for use underwater, in outer space and for applications at nanotechnology scales. In the future, says M.I.T.'s Koichi Masubuchi, we will further refine the tools of intelligent robotic welding as well as employ "virtual welding," which will enable engineers to test new techniques—much as pilots now use flight simulators.

Even glues and tapes are looking exotic. The 3M company has a tape that is nearly as strong as a spot weld. Called VHB tape, it is used to join metal panels on transport trailers. Someday, we may tape whole additions onto our houses or use high-tech patches to plug toxic leaks. There are many glues as strong as—or stronger than—the materials they bind, and many others are formulated for very specific uses or unusual environments.

Medical superglues are already here, as are glues that can be used in space. And researchers are trying to bioengineer natural glues manufactured by living organisms. One of the most promising of these is produced by mussels.

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