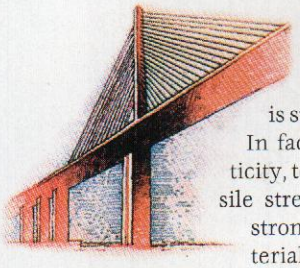
Technology.Today@worldnet.att.net Alan Pierce

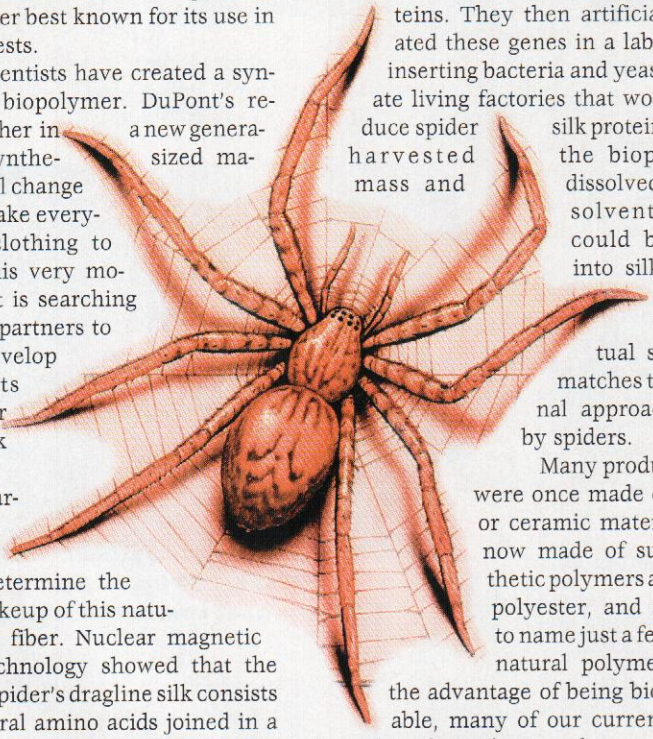
Biosynthesis of a Structural Polymer



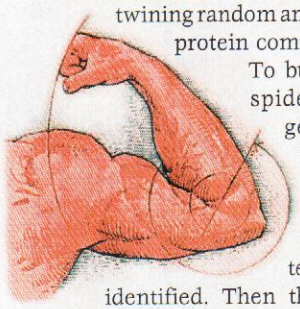
BY weight this polymeric fiber is stronger than steel. In fact its weight, elasticity, toughness, and tensile strength make it the strongest building material currently in existence. Until now, this building material could only be synthesized by spiders.

Of all the spiders in the world, scientists consider the orb-weaving spider (*Nephila clavipes*) to be the king of the world when it comes to creating super-strong spider silk. No synthetic can match this biosilk, which is much stronger than Kevlar, the fiber best known for its use in bullet-proof vests.

DuPont scientists have created a synthetic spider biopolymer. DuPont's research will usher in a new generation of bio-synthesized materials that will change the way we make everything from clothing to bridges. At this very moment, DuPont is searching for industrial partners to help them develop new products based on their spider biosilk process.



To create artificial spider silk, researchers had to determine the molecular makeup of this natural polymeric fiber. Nuclear magnetic resonance technology showed that the orb-weaving spider's dragline silk consists of seven natural amino acids joined in a crystalline structure. This structure gives biosilk its extraordinary strength by intertwining random and structured protein components.



To build artificial spider silk, the genes that form the molecular structure of the silk proteins had to be identified. Then the scientists needed to learn how to genetically engineer these genes into a living organism that would biologically produce the silk proteins. Once this task was accomplished, they needed to develop a procedure to harvest the biosilk proteins, spin them into useful threads, and eventually into thick super-strong cables.

DuPont's successful approach to developing an artificial spider silk included first developing a computer model that used all of the available knowledge about bio-polymer fibers, specifically the knowledge about the 22,000 genes identified as biosilk DNA. By using this computer model, DuPont scientists and engineers could sequence the synthetic silk genes necessary to create the spider silk proteins. They then artificially created these genes in a laboratory, inserting bacteria and yeast to create living factories that would produce spider silk proteins. They harvested the biopolymer mass and dissolved it in a solvent so it could be spun into silk spider threads. The actual spinning matches the original approach used by spiders.

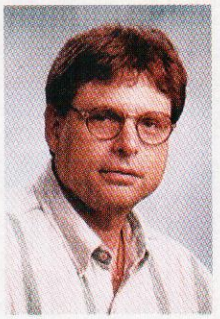
Many products that were once made of metal or ceramic materials are now made of such synthetic polymers as nylon, polyester, and acrylics, to name just a few. Since natural polymers have the advantage of being biodegradable, many of our current petroleum-based synthetic polymers will be cloned into biological factories in the future. The technology used by DuPont to create biosilk resembles in principle the technology used by a British chemical company to genetically alter plants and bacteria so they would produce biodegradable plastics.

DuPont's breakthrough in producing spider biosilk will lead to the development of many new polymeric materials that will be synthesized in plant and animal biological factories. We are on the threshold of a brave new world where scientists and technologists will continue to learn how to form biological entities to meet human needs and wants. TD

Illustrations courtesy of DuPont.

Recalling the Facts

1. Why aren't today's bridges built of synthetic spider biosilk?
2. To create the artificial biosynthesis process, what hurdles did the scientists have to overcome?
3. Describe the steps that DuPont followed to go from a computer simulation to a synthetic spider thread.



Alan J. Pierce is a professor, Department of Technology, Elizabeth City State University, Elizabeth City, NC 27909.