AT THE "BIKE SHOP," SECRETIVE DEFENSE WORK STARTS AT HOME DEPOT

Raytheon Engineers Fly High With Low-Tech Gear; Giving the “Whirl” a Whirl By Jonathan Karp

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TUCSON, Ariz. -- In an improvised testing chamber squeezed between a Pepsi machine and a photocopier, Don Lacey swivels his head to follow the spinning plywood frame he is manipulating with a model-airplane remote control.

"You have to kind of get dizzy watching it," says Mr. Lacey. His colleague John Liebsch describes the contraption as a "cross between a ceiling fan and a sailboat."

This isn't the hobby of some aviation buffs. Mr. Lacey is a member of a tiny, secretive unit of Raytheon Co., the big defense contractor, though it might not look that way. The work is being done in decidedly low-tech surroundings in a back room of a bland commercial complex.

Defense contractors spend many millions of dollars each year on product development. Some, like Lockheed Martin Corp. and Boeing Co., have well-known groups of scientists who dream up pie-in-the-sky flying machines. At Raytheon the radical thinkers of the company's research operation work in the Bike Shop, named for the bicycle shop where Wilbur and Orville Wright invented the airplane.

Engineers in jeans create prototypes of Raytheon's most revolutionary ideas in quarters about as impressive as a high-school science lab. The Bike Shop employs a corps of 15 handpicked scientists and engineers striving to bring advanced concepts to life – and to market – as quickly as possible. For its models, employees buy components off the shelf from stores such as Home Depot rather than order from big defense suppliers. As important as the inventions themselves, the goal is to help inspire a more creative environment at Raytheon. "We have more fun than is generally allowed on company time," says James Small, the team's chief and a former university physics professor.

Their current interest is the strange vehicle that Messrs. Lacey and Liebsch are working on, known as "the Whirl." It is an early prototype of what Raytheon hopes will turn into an unmanned aircraft capable of hovering in the same spot for days at a time. In the increasingly important world of military drones, the Whirl would carry advanced radar to provide surveillance. Its images would be clearer than what satellites provide, because it would hover inside the Earth's atmosphere rather than in space, and with fuel efficiency that would give it greater endurance than existing unmanned aircraft.

It could be years before the Whirl is used in combat – and it may never fly for the military. Right now, it looks a lot like a Frisbee with four wings. As Mr. Lacey spun a prototype's central disk on a metal shaft one recent afternoon, engineers finished wings made of wood and foam insulation covered by shrink-wrap plastic. Hobby-shop propellers were fitted onto the wings using lighting tracks from Home Depot, so that they could be tested in different positions.

The seed for the Whirl was planted in March in talks that Mr. Small had with a Pentagon official about ideas for aircraft that can stay aloft for days. The official had a particular need: a platform for radar to track moving targets. "We think we can do that," Mr. Small says he told him. "We'll be back in a week."

Mr. Small gathered three colleagues around his desk in the front of the Bike Shop to brainstorm. The aircraft would have to be unmanned and stationary, because a moving aircraft can't easily track other moving objects. It would have to fly high enough – at least 10 miles up – to elude antiaircraft missiles.

Gliders provided the inspiration for a hovering craft more stable and efficient than a helicopter. Mr. Small called upon his physics expertise and his own experience flying gliders 20 years ago to conjure up the Whirl's shape: long wings, which perform well at slow speeds, radiating from a rotor.

Lloyd Kinsey, a nuclear physicist, opened his laptop and ran spreadsheet analyses of the aerodynamics. Mr. Lacey dashed home to rummage through his garage for model-airplane propellers and a remote control. Chief mechanical engineer Mark Zepeda, who once owned a high-tech bicycle company, prepped the Bike Shop's machinists.

As promised, Mr. Small says, he presented the Whirl concept a week later to Pentagon officials, whom he won't name. He says they were enthusiastic but not ready to commit government funds to the project. Just two weeks after that, the Bike Shop team pushed workbenches aside, tethered a prototype with an 8-foot wingspan to a rope hanging from the ceiling, and began test flights.

What makes the Whirl radical is the guidance system. Slow-speed propellers keep the aircraft spinning, and rudder-like airfoils at the tip of each wing generate thrust. They do that by acting as sails, adjusting to the wind so the Whirl can either fly downwind or tack into it. The wingtip sails and the electronic brains that operate wing flaps to keep the Whirl stable in high winds are innovations included in a U.S. patent application Raytheon filed in July.

Mr. Small, who earned a doctorate from MIT in laser physics and taught for 14 years before joining the defense industry, himself has 20 U.S. patents. The 59-year-old says the Bike Shop has evolved over a decade, but got its name only last year.

The special-projects unit's first project was a miniature unmanned glider called Silent Eyes. Mr. Liebsch, a veteran of the Tomahawk cruise-missile program and now Mr. Small's deputy, fashioned a test launcher out of bungee cord. He had help from his then 11-year-old son (who now works at the Bike Shop). Messrs. Liebsch and Small improvised a wind tunnel by driving down a highway with the drone attached to a car. It worked: The Air Force recently bought Silent Eyes, which is dropped from other drones to assess battle damage, to conduct test flights.

Mr. Small built his team by scouring Raytheon for creative, eccentric and bored talent. To vet a laser operator, he asked a candidate to engrave his name on a penny. Mr. Small provides world-class equipment and a unique perk: credit-card privileges for the group – of up to $250,000 a month – to free them from Raytheon's bureaucratic purchasing procedures. The Bike Shop's budget is in the millions, say Raytheon executives. It's a tiny portion of the $487 million the company spent on research and development last year. Some of that was funded by government contracts.

The Bike Shop focuses on original research and products, but its staffers are reluctant to explain many of them. "Here are some projects we're not going to discuss," Mr. Small proclaimed during a tour for a reporter. A woman soldering wires looked up warily. Among a bank of glass vials was a three-year-old experiment that blows away a long-held theory of electron behavior, mathematical physicist Brian Davis said, refusing to elaborate.

The Bike Shop last month flew a Whirl prototype with a 20-foot wingspan to the ceiling of a secure Raytheon hangar and had it hover there. Next will come open-air tests at an undisclosed desert site. Then, the company will ask the Pentagon to finance the development of Whirls with enough fuel capacity to fly for four days.

Mr. Small estimated that a battle-ready Whirl will cost $1 million, compared with $50 million for Northrop Grumman Corp.'s celebrated Global Hawk unmanned spy plane, which can stay aloft for 36 hours. The Whirl also could fulfill civilian roles, such as plugging radar gaps in the U.S. air-traffic control system.

Mr. Small suggested that even the Whirl is mundane compared with the Bike Shop's "really imaginative" work, that includes something he referred to as transporter beams. He would not elaborate and the mere mention of the project had colleagues urging him to shut up. It's not quite, "Beam me up, Scotty," someone quipped.