

ENGINES OF INNOVATION

MISSOURI COMPANY IMPROVES INTERNAL COMBUSTION ENGINE EFFICIENCY,
LONGEVITY THROUGH MODELING OF CYLINDER ASSEMBLY COMPONENTS

For about as long as he can remember, Harold McCormick has been obsessed with the inner workings of engines. Two-stroke, four-stroke, the engines in cars and those in aircraft — all were of interest to McCormick, a mechanical engineer by trade.

The basic design for the internal combustion engine has stayed much the same in the years since its inception, but McCormick has devoted half his life to improving the technology. His company, C-K Engineering, has developed a program that models the function and behavior of engines to improve longevity and efficiency. C-K's work has extended from commercial consulting to the

U.S. Military, where its work has helped increase the time between maintenance for certain unmanned aerial vehicles more than 10-fold.

But the work, and the company's 32-year history, has not come without its struggles, which include overcoming difficult economic conditions, as well as the technical hurdles that go along with improving a refined technology.

"I'm probably typical of an engineer," McCormick said. "I enjoy a good challenge."

After studying engineering at the University of Missouri, McCormick secured a job at manufacturing giant

TRW Inc. (later acquired by Northrop Grumman), where he worked his way up to the position of director of engineering for piston ring operations and research and development. Over the span of several years, he cut his teeth in the world of piston ring/cylinder mechanics and engine development before setting off on his own in 1987 to create C-K Engineering as a consulting firm for the engine industry.

In the early years, the company was heavily dependent on cash flow to balance its books. With the economy recovering from the downturn on the 1980s, it was a tricky time, McCormick said, until he met Bill Simon. At the time, Simon worked as the chief operating officer of a St. Louis-based tech incubator, where his job was to “help companies with SBIR navigation and submission.”

Simon, now a full-time consultant, introduced McCormick to the SBIR program—a partnership Simon thought would be a perfect fit for the young company.

“(C-K) has many of the elements needed for success,” Simon said. “McCormick is a world-recognized expert in engine design and improvement. He has done work for everyone—GM, Cat, Allison Transmission, Detroit Diesel Corporation, John Deere, Briggs and Stratton. He also targets the topics that he can solve from several U.S. Department of Defense and other departments and finds partners—academic and industrial—to fill in flat spots and help with commercialization.”

With Simon’s guidance, the company’s first successful SBIR came through the U.S. Army’s CCDC Ground Vehicle Systems Center, where it worked on a contract to push the limits of its engine



modeling program.

Through a Phase I and Phase II contract, C-K “developed advanced models that are still used every day,” McCormick said.

Once McCormick and C-K found their way into the SBIR world, it felt like the perfect vehicle for advancing the company’s technologies, he added. Soon after its first, the company secured two separate SBIR contracts from the U.S. Air Force to model extreme wear on test sled slippers on the Air Force high-speed test track at Holloman Air Force Base.

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“What we’re working on now is reducing the oil consumption in the engine and reducing the friction within the engine, which is also important from a fuel economy point of view,” McCormick said. “But the foundation for all our current work occurred during those first SBIR awards.”

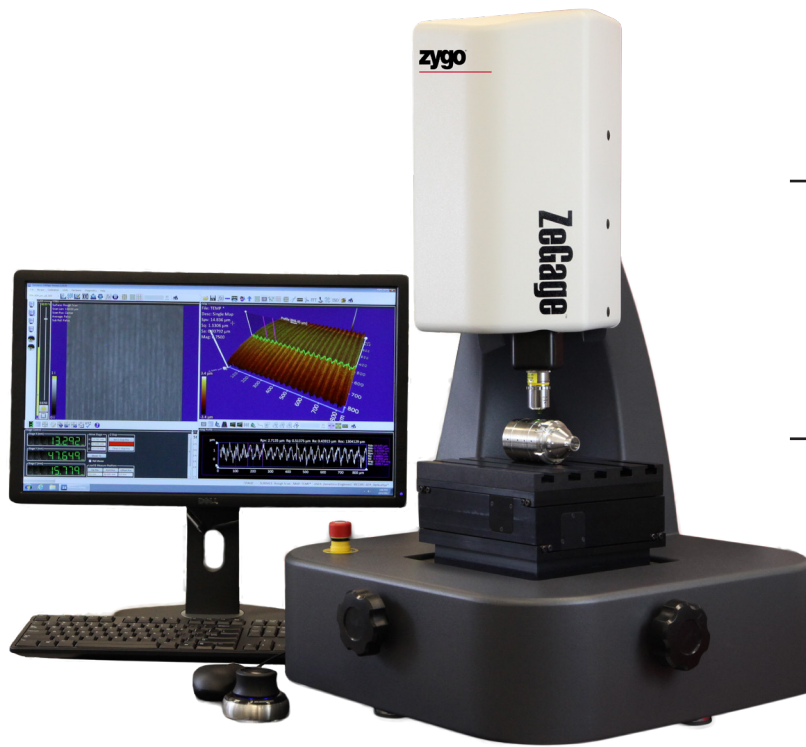
Over the years, the company has also expanded its commercial consulting side, working with Caterpillar, Cummings, Polaris, and Briggs & Stratton, among others. The most common task, McCormick said, is to try to improve the efficiency of engines while simultaneously cutting down on their wear. For any internal combustion engine, oil is required to keep the pistons firing smoothly, but as

the oil is consumed it builds up, causing sticking and loss of power. But by machining pistons that fit more precisely into their cylinders, as well as using materials with less friction, McCormick said he hopes to one day eliminate the need for oils in 2-cycle engines altogether.

This goal is playing out in real time through the C-K’s most recent SBIR contract (a current Phase I is providing funding in support of this effort) with the Air Force. In 2017, the agency tasked the company to help it improve the time between overhauls for its fleet of unmanned



Harold McCormick



C-K Technologies has created an array of specialized and proprietary testing equipment, including the C-K SEE 3D, a system for quantifying cylinder bore finish.

aerial vehicles, which are typically powered by a 100cc Boeing engine that costs roughly \$20,000 apiece. With its modeling program, C-K has been able to increase the mean time between maintenance by more than ten-fold. And the company president is hopeful for further improvement.

“By design, we’ve been able to go from 35 to 400 hours between overhauls for the Air Force unmanned aerial systems,” McCormick said. “Part of the effort with that objective is to push that number to over 1,000 hours.”

McCormick said he believes the company isn’t far off cracking the code for an oil-free 2-cycle engine, and credits its progress to the work of his team, as well as the SBIR program, which not only helped the company get off the ground but pushed it to continue to innovate once it had matured.

“In our case, and in the case of other organizations, it’s very difficult to come by funding that can be used for high-risk research and development in the mechanical area,” McCormick



said. “The SBIR program provides funding for high risk research and development that a small business would never be able to support. It also provides continuity of funding over time so that you can make good use of the money and make good progress. And to me, that’s invaluable.”

From a problem-solving perspective, the SBIR system is about as good as it gets, added Simon, who has been working with the program since the mid-1990s.

“The SBIR program is valuable to the small business community since it allows technical solutions to acknowledged problems to be solved by the business, and sometime they can sell the solution immediately to the government,” he said.

C-K will continue to utilize the SBIR program where it can in the future, McCormick said, and will never forget the role it had in shaping its growth.

“You don’t walk on water, you make use of other people’s help,” he said. “This company’s work would not have progressed in the same way without the SBIR program.” 🌟

C-K Technologies, LLC

Modernization Priority: General Warfighting Requirements (GWR)

Ballwin, MO • SBIR contract: FA9200-06-C-0320 • Agency: Air Force • Topic: AF05-289, Accurately Validated High-Speed Wear Prediction Code

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