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The Power of an idea: a father and son team up in the big race for greater fuel efficiency

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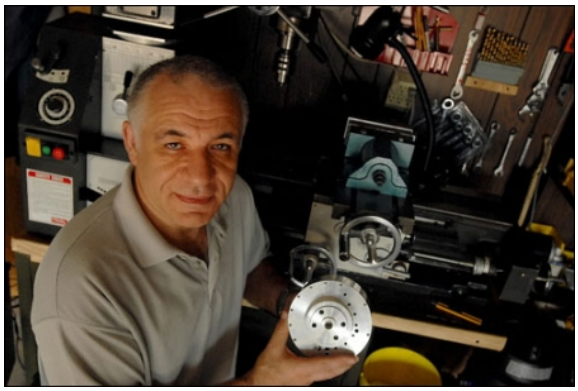

Nikolay Shkolnik of West Hartford says that, theoretically, the engine he's developing could improve average fuel efficiency by 2.5 times, putting the possibility of 100 miles per gallon in reach.

Photo: Tom Brown / The Hartford Courant

At first, designing an ultra-efficient engine was just a form of escape for Nikolay Shkolnik.

Shkolnik started thinking about engines in the early 1990s, when he was grieving the death of his father, who came with him to the U.S. from the Soviet Union. At about the same time, Shkolnik was forced to close his fledgling robotics company after it lost government funding

In the face of such emotional turmoil, some people might play golf, restore an old house or take up a new hobby -- anything to change the focus. Shkolnik, however, began pondering thermodynamics.

It was a way to unwind. And for a decade, that's all it was as he took jobs with Milton Bradley Co. and with a Boston consulting firm.

But along the way, Shkolnik, 54, joined by his son, Alexander, 26, began to think he might be on to something -- a truly original way to make the old-fashioned internal combustion engine much more efficient.

Shkolnik, a physicist, first started talking to his son about his idea when Alec was in elementary school. Over the years, Alec Shkolnik would become one of his father's biggest supporters and harshest critics, dismissing ideas he thought weren't practical. The two toyed with several inventions, from a single-handed keyboard to special holders for compact discs.

But the idea of radically redesigning the internal combustion engine lingered in the minds of both father and son. Over the years, they worked on the problem in their usual way: Nick Shkolnik came up with new designs and Alec Shkolnik found the flaws.

The venture suddenly accelerated recently with an infusion of cash.

LiquidPiston, the business formed around the idea, received a $1.25 million venture capital investment in late July from two firms, Adams Capital Management of Pittsburgh and Northwater Capital of Toronto. The money will be used to build a prototype engine from designs, calculations and experiments that were done in the basement of Shkolnik's home near Elizabeth Park. The company has also received a $70,000 grant from the U.S. Army.

Nick Shkolnik now has two years worth of funding to turn his ideas into actual moving parts. He left a consulting job at Gen3 Partners in Boston, rented space in Bloomfield and is now searching for an engineer to work with him full time on building a prototype.

"You've got to realize -- I'm 54. To go out at 54 to start a business is not easy. A lot of people say I'm crazy," Shkolnik said, seated in his nearly empty new office space. He paused and added: "To start this kind of business is triple crazy."

Shkolnik is not alone in his fevered work on the engine. Thousands of automotive engineers, university researchers and garage tinkerers are working to improve the internal combustion engine. With the possibility of increased federal fuel economy standards, gas mileage has become a focus in Detroit, auto industry experts said.

Engines have become more efficient over the years, but at the same time, cars have become heavier. It's taken plenty of engineering advances just to keep average fuel economy constant over the past two decades, said Zoran Filipi, an engineering professor at the University of Michigan.

Most entrepreneurs and inventors are trying to improve efficiency by tweaking the standard design of current-day engines, said Walter McManus, director of the auto analysis division of the Transportation Research Institute at the University of Michigan. But the auto industry quickly loses interest in ideas that go much beyond that because large-scale changes are difficult to adopt, McManus said.

Shkolnik said his engine -- at least on paper -- could improve average fuel efficiency by 2.5 times, putting the possibility of 100 miles per gallon in reach.

The technology could have dozens of applications, from lawnmowers to cars to generators. It also could be altered to use gasoline, diesel or various alternative fuels. His plan is to start with a niche market: diesel-powered electric generators that tractor-trailer drivers use when they idle for the night. The decision was made because it's easier to enter the market with a new product, said William Frezza, a partner at Adams Capital.

"You don't wake up one morning and retool Detroit," Frezza said.

Shkolnik is quick to warn that he doesn't have an engine built yet -- a fact that potential investors remind him of often. But he has confidence in his calculations.

"This idea seemed grander than many of his others -- a real world-changing technology -- and that is exciting," said Alec Shkolnik, who still works on the engine project with his father as he finishes his doctorate at the Massachusetts Institute of Technology.

"My natural reaction in the beginning was that surely someone else must have thought of these ideas, and if not, why not?" he said.

Nick Shkolnik says his approach has been different. Rather than start with an engine and try to change its existing design, he started with the principles of thermodynamics and looked at compression, expansion and volume. As a result, his idea represents a complete redesign of a traditional engine's geometry. Shkolnik calls his invention the high-efficiency hybrid cycle.

A major change to improve efficiency comes from moving the combustion cycle from single cylinders, the way it's done with the traditional piston engine. Instead, his design separates the combustion process into two chambers, something Shkolnik says can produce more energy from the same amount of fuel and ensure that less energy is wasted through exhaust.

To improve fuel economy, the engine borrows concepts from designs for both the gasoline and diesel engine, such as the diesel characteristic of compressing only air and not an air-fuel mixture. The pistons' up-and-down plunging motion is replaced with the circular motion of a rotor.

The final product is expected to be far more fuel efficient, especially when the engine is running at less than full power. That means a more efficient engine, since drivers use full power only rarely, such as when rapidly accelerating.

If Shkolnik's conclusions on paper turn out to work in an actual engine, the reward could be immense. The market for the internal combustion engine is estimated at $250 billion. Also, a more fuel-efficient car engine could help solve major issues like U.S. reliance on foreign oil and global warming.

"It is a big problem. I don't like small problems," Shkolnik said.

The engine's compressor, which has already been made as a prototype, could be a product on its own for use in refrigerators and air-conditioners.

For many years, Nick Shkolnik's engine idea seemed destined to remain an intellectual exercise, another entry in his thick book of invention ideas.

But Alec Shkolnik didn't allow that to happen.

Nick and Alec Shkolnik have the inverse of the typical father-son relationship, said Brian Roughan, who got involved with LiquidPiston while a graduate student at MIT's Sloan School of Management.

Nick Shkolnik, the father, is the idealistic dreamer. His son is more focused on practical applications and creating a business.

"I am usually discouraging of his ideas, but with every new iteration of the engine design, I liked it more and more," Alec Shkolnik said. "So at some point ... I grew excited enough about the idea to really try to help Nick with developing and commercializing the engine."

That point came around five years ago. Alec Shkolnik started calling big companies that use lots of engines, like John Deere, the tractor and equipment manufacturer. The typical reaction was either "bring us a prototype," or "thanks, but we're already working on that," he said.

Shortly after starting his doctoral studies at MIT, Alec Shkolnik decided he and his father should form a business team. It included Roughan and other M.B.A. students as well as the two Shkolniks. Frezza, from Adams Capital, became the team's mentor.

They entered the MIT $50,000 entrepreneurship competition in 2004 and were runners-up, receiving $10,000, which paid for the first patent application. Nick and Alec Shkolnik then went looking for investors. There were months of meetings with venture capital firms and other possible investors. Adams and Northwater Capital eventually agreed to invest after months of meeting with firms to pitch the idea.

Now Nick Shkolnik must make his idea a reality and see if years of calculations, design and debate with his son result in the revolutionary product he first envisioned.

"If it comes anywhere close to theory, we have a company," Frezza said.

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