LiquidPiston Video

Alec: We started the company with the mission of improving the efficiency of the combustion engine and kind of doing that from a from a first principles perspective, going back all the way to thermodynamics of how an engine operates. We're looking to make more efficient engines. We're looking at working on new types of fuels.

Imagine the impact if we can have a solution that is ten times smaller and lighter than what they have fielded today. It's a game changer. The world is also trying to kind of move electric, right? We see electric powertrains everywhere that we go. In our view, the world should be going hybrid, because electric has a lot of great advantages to it. Things like regenerative braking where you put a lot of energy to accelerating a vehicle. It's great to recover that energy and put it back in your battery, but you don't need to carry a 1,200 pound battery everywhere you go. The environmental impact is also there too, right? It's more hidden, but it's still there to produce these batteries, to recycle them. So what we're offering is a hybrid power solution.

My father's a physicist. He actually came here from Ukraine. He's always just been thinking about the inefficiency of engines. We use engines in so many different places, and it consumes an enormous amount of fuel. It produces a lot of CO2. And from a physics perspective, it always just kind of bothered him. Why are engines so inefficient?

Nikolay: I studied the methodology called TRIZ - stands for Theory of Inventive Problem Solving. And one of the elements of this theory is feature transfer, where you combine alternative systems, which are systems that are performing the same function but differently.

Alec: A lot of people are familiar with the Wankel rotary engine. We turned the old Wankel inside out. They have a triangle rotor in a peanut shaped housing. We've got a peanut shaped rotor in a tri-lobed housing. Turning it inside out, we solved all of the big challenges of the old rotary. Over the years, we've patented literally dozens of different kinds of engines that could potentially embody this new thermodynamic cycle. What we have today is the fifth generation of this engine architecture. We call it the X-Engine.

It's a $400 billion market for internal combustion engines. The market is dominated by automotive and trucking. We're taking a little bit of a different approach here. We're initially focusing on niche applications. And for us that's the DOD and aerospace. These are customers that have a tremendous pain point today. They need smaller, lighter power solutions.

Today, the military is limited because they're trying to operate everything on jet fuel. They want a single fuel for logistics. They don't want to carry two fuels to the front line. And little known fact - it can take 100 gallons of fuel to push one gallon to the front line. And that's not just expensive, it's measured in lives. One half of the casualties in Iraq and Afghanistan were supporting logistics of fuel and water, pushing things to the front line. So this is really critical. We've got ten new contracts signed with the Department of Defense totaling over $20M of non-dilutive investment. They need this technology, so they're helping fund the development.

Matthew: The need for portable power and downsized, efficient mechanical energy, or electromechanical energy from liquid fuel is not going away anytime soon and in fact may be increasing when you look at emerging markets. So there's a real need for this technology. I can see this engine technology being applied to gensets, UAV applications, range extenders, even home appliance applications and emerging market applications.

Per: We have 77 patents with over 50 granted and the rest pending. There will be more. We have a rich pipeline, so the innovation house is here.

Matthew: I've worked with over ten startups at this point in my career, and I've never had the opportunity to work with so many smart people in one place. And not just intelligent and well educated, but energetic and hands on. And it's a really neat culture and blend of academic and practical experience and knowledge.

Alec LiquidPiston has conducted three Reg CF campaigns and a successful Reg A campaign, raising over $20 million from almost 10,000 enthusiastic investors. We are amazed and delighted by this show of support. The sky is truly the limit. It's been an amazing journey to get here and our team is working passionately day and night to

deliver the world's most advanced rotary diesel combustion engine. We look forward to what the future will bring.

Daily Planet Video

Narrator: Engines. They run our world. They're in the cars you drive, planes you fly, and even some of the tools you use. But they've been more or less the same for a century. But that's all about to change.

Speaker: Alec! I hear the LiquidPiston's giving a new meaning to "the little engine that could"

Alec: That's right. We're developing a new kind of combustion engine here. It's a little rotary engine, operates on a new thermodynamic cycle, and that's something that really hasn't changed in over 100 years.

Narrator: Today's cars run on piston engines. They use an oscillating motion to create energy, but they lose up to 80% of that energy to things like heat. By making the engine smaller and more streamlined, they're taking that energy back.

Speaker: So what are these guys up to right now?

Alec: These guys are installing our new 70cc X-Engine onto this go kart. We're not going into the go kart market, don't worry. But what we're doing is developing this new engine and putting it onto this vehicle for a demonstrator.

Narrator: The real uses: car hybrids, drones, generators. Essentially anywhere engines already are.

Speaker: Okay, so I don't know a lot about engines. So how small are we talking here?

Alec: Well, the engine's really small. And actually, if we step over here, we can see the original engine that came off the go kart. So, this is a six horsepower engine, weighs about 40 pounds, and we're replacing it with our engine, where the core is about 4 pounds.

Speaker: Hold up, hold up 40 pounds versus 4 pounds

Alec: Correct. This engine produces about six horsepower and ours is currently making around three. So we're producing a little bit less power, but it's tenfold reduction in size and weight.

Narrator: They're limited to three horsepower right now for testing. When it's done, it should be hitting five horses.

Speaker: Are you kidding me? These are the parts of your engine.

Alec: These are all the parts of the engine. This is actually the engine core itself. What you have here is just extremely simple. The heart of the engine is this housing and rotor. And so this rotor spins around in this housing and you end up with three combustions every time that rotor turns around. So incredibly high power density and there's no valve train.

Speaker: That all sounds intense. And I mean, it's just looking at this, it looks like something that even I could put together.

Alec: I think you could. We've actually had finance guys in here that have done it before. So I have faith that you can do it too.

Speaker: Do you hear that? If a banker could do it, so could your friendly neighborhood tech guy.

Alec: We did start with a very small engine here for handheld applications or mopeds, but what really gets me excited is about electric vehicles. Today's electric vehicles require really big batteries, so they're expensive and they're heavy. And actually, they're surprisingly inefficient because we have to charge them with the power grid. We burn coal, we burn gas. So you're actually producing a lot of CO2 to charge your electric vehicle. Now, what we want to do is take an electric vehicle and reduce the battery by, let's say, 80 or 90%, so much smaller, lighter, cheaper. Now it's available for the masses. This engine can charge your battery pack and do it much more efficiently than by plugging into the power grid.

Speaker: Now, once you actually get all the pieces together for your engine, how do you test all this stuff out?

Alec: We have a complete dynamometer set up here, so if you like, we can walk over and take a look at how that works. So here we're actually running the engine right now. We're just spinning the engine on the dyno. And what we can do is we can actually fire it. So if you hit the button over here, you're going to start to fire the engine one chamber at a time.

Speaker: I'll do the honors. And this is what you were talking about earlier with those three chambers that'll fire. That's where the combustion takes place.

Alec: That's exactly right. So we have three spark plugs, and each button you hit, you're going to turn one of the spark plugs on.

Speaker: All right. Spark enable one.

Narrator: So what is actually happening inside that engine?

Alec: As a rotor turns around in here, it's actually executing the cycle in three different chambers simultaneously. So in addition to operating on the new cycle, it's very power dense.

Speaker: Never thought testing an engine could be so cool.

Alec: You're doing a great job. And if we're actually hiring test engineers, if you like.

Speaker: Come on. That's not code for intern, is it?

Alec: Looks like you're having a good time, Lucas. But if you like, I got something even better for you.

Speaker: Okay, Alec, I am pretty stoked. I mean, I saw the engine in action there. I've seen it, the pieces. But I'm having trouble wrapping my head around something that small is going to power this thing.

Alec: That's right. Here it is. If you want, you can take it for a ride.

Speaker: I'm going to be testing it out.

Alec: You can.

Speaker: All right. Confidence I like that I like that. All right. Cool. Small engine, small car. Alec, seeing is believing. Seeing how small that motor was inside there. I mean, I heard it work, so I know it works, but you don't get a sense of that power until you're out here. I cannot believe how fast that thing goes.

Alec: A lot of power from a 4 pound package, right?

Speaker: Unbelievable. Actually, it is believable because I just experienced it. Wow. You guys are on to something special here.

Alec: That's right. Thank you.

Speaker: But I gotta be honest with you, I think I need to test it just a little bit more. Just to be sure. Okay?

Alec: Okay. Go for it.

How It’s Made Video

The rotary engine that powers this go kart is one fifth the size and weight of the piston engine it has replaced. With less to weigh it down in the engine department, the go kart gains speed.

This rotary engine also aims to boost fuel efficiency and cut emissions. Produced on a limited scale as they perfected the prototype is small enough to fit in a knapsack. The housing starts with a solid block of aluminum. Computer models will be used to generate machining instructions. Traditional rotary engines have an oblong shaped housing, and a triangular rotor that spins within. This new design is just the opposite. Computerized tools profile the triangular housing, creating combustion chambers on the inside, and cooling fins on the outside. They transform a solid, hardened steel cylinder into a hollow crankshaft. The cylinder turns in a lathe as a series of computer driven cutters sculpt it, creating a hollow crankshaft that will funnel air and fuel into the engine. Computerized tools mill a piece of steel to a precise geometry. This peanut shaped rotor is the heart of the rotary engine. They immerse the rotor in deionized water, as an electrified brass wire generates a spark that cuts into the steel. It forms a ridged hole in the center that will mate to a gear. This pinion gear will engage with the ridged profile in the center of the rotor. A worker inserts it in a vessel and fills it with liquid nitrogen. It freezes it at -190°C, causing the gear to shrink a bit. He transfers the frozen pinion gear to the rotor using a press. He drives the pinion gear into the rotor to a specific depth. As the pinion gear thaws to room temperature, it expands to its original size, and this seats it snugly in the rotor gear.

Another computerized machine carves into a piece of cast iron steel that's held in the fixture by numerous bolts, creating a seal for the engine. With a thickness of just one millimeter, the seal is sliver thin and tightly engineered. The seals are critical parts. They'll keep the rotary engines working chambers airtight. The seals will slide between the rotor and one of the engines’ chrome-plated side plates. An automated grinding wheel gives the side plate a level and mirror finish. Heating the side plate causes the center bore to temporarily widen. A worker inserts a bearing into the bore, and as it cools, the bore shrinks to the bearing. There are ten times fewer components than in a comparable piston engine. The assembler inserts the crankshaft in the side cover. He turns the assembly over and slides a ring gear into the cover. He sets the fixture in an

upright position. He turns the crank shaft to confirm that it revolves smoothly. He slides the rotor by now equipped with one of the seals onto the crank shaft. He assembles the housing to the motor. He tests the rotation of the rotor. As it turns, it forms chambers in which the combustion cycle will take place. He slips a bearing and counterweight onto the shaft, followed by a bell mouth. The exhaust cover has three ports to discharge gases and one in the center through which the bell mouth protrudes. He attaches an engine intake adapter to the bell mouth. After the components have been secured with bolts, a dynamometer machine runs the engine and measures its performance. Capable of running on a variety of fuels, this new rotary engine is ready to start powering things.

Demonstration of Hybrid Electric X-Engine

The X-Engine from LiquidPiston represents a quantum leap in combustion technology, but this technological advancement didn't happen overnight. The development of the X-Mini multifuel rotary engine represents the work of dozens of members on the LiquidPiston team and spanned well over a year. From multiple design iterations created using state of the art CAD software, to the various design mules used as operating prototypes to refine the engine to its present state, the X-Mini is now taking on the next challenge in power for propulsion.

Based on the company's patented HC thermodynamic cycle, the X-Mini features an exceptionally high power density of up to 1.5 horsepower per pound, and with only two primary moving parts. It's comprised of ten times fewer parts compared to a piston engine, making it extremely quiet, reliable, and fuel efficient. Offering unmatched fuel capabilities, the X-Mini is compatible with multiple types of fuels, including Jet A or JP8 fuels, making it the leader in cross-platform accommodation. It is truly power reimagined. Following this success of our prototype and to demonstrate the outstanding flight capabilities of the X-Mini, it was time to prove the engine in the air.

Running on Jet A fuel similar to JP8, the X-Mini successfully completed both ground testing and flight testing. Currently, the propulsion system is set up in a parallel electric hybrid configuration. Here, an electric motor works in combination with a combustion engine to provide an added boost in power during takeoff. Eventually, the system will be adapted so the electric motor will operate as a generator in flight, charging on board batteries to enable VTOL operation.

LiquidPiston has developed a patent pending technology to rapidly start its engine on jet fuel. A parallel hybrid configuration, coupled with rapid engine start capability, allows for new modes of UAV operation, including the in-flight switchover to quiet cruising mode using electric propulsion. Here we remotely shut off the combustion engine. The aircraft is now powered solely by the electric motor in quiet cruise mode. Once the vehicle completes the stealth part of its mission, the engine is turned back on and the vehicle can recharge its batteries and return home. This quiet electric cruise with in-flight engine restart capability is a unique function of the LiquidPiston Hybrid X engine platform. It's

not currently fielded by the Army, but it's ideal for supporting the propulsion requirements for future unmanned tactical aerial systems.

LiquidPiston. Power reimagined.