The Quasiturbine

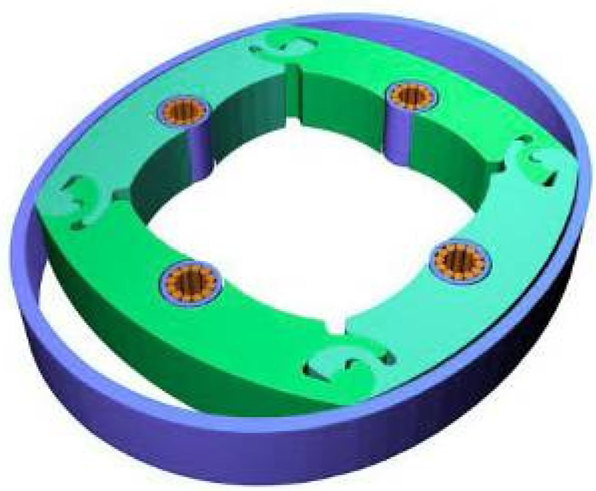
Gilles Saint-Hilaire on Next Generation Rotary-Engines

By Tim Ventura, April 24th, 2006

Most physicists don't spend their vacations designing engines, but Dr. Gilles Saint-Hilaire isn't like most physicists. After a thorough study of the limitations in most conventional engines, he designed the Quasiturbine – a next generation 4-blade rotary turbine and future plans for a high-efficiency photo-detonation engine with the potential to revolutionize the automotive industry...

AAG: Let's start with a bit of information about yourself: can you give us a few details about your background, and the vision that led you to develop the Quasiturbine technology?

Saint-Hilaire: I'm a physicist by training, with experience in nuclear and thermonuclear research. During a 3 year sabbatical on a sailboat with my wife and kids, we heard quite a lot of complaints about engines in the marine environment. Most physicists prefer studying the quarks or the cosmos, but we decided to have a look at the less prestigious problem of engines in general, including the piston, Wankel and turbine engine in particular.



The Quasiturbine: A 3D rendering of the stator, shown mounted inside a QT combustion chamber.

AAG: What are the fundamentals of the Quasiturbine technology? I understand that it's a 4-blade rotary turbine, but I'm wondering if you could give us a brief overview of exactly what this device is and what makes it so unique?

Saint-Hilaire: We found that for 200 years, everyone had assumed that sinusoidal crankshaft movement was the best way to convert linear motion (like a piston) to rotary motion, but nobody had actually proved it in relation to combustion. A closer look at the gas flow and combustion process has taught us that in reality, the sinusoidal crankshaft has actually been a major obstacle to the development of modern optimized engines.

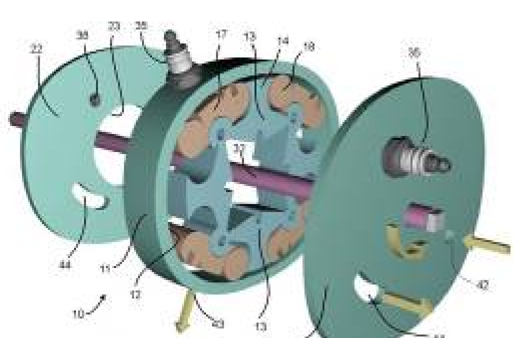


FIGURE 1

Cutaway: A Quasiturbine engine assembly detail, with carriages highlighted in tan.

In contrast, the Quasiturbine design allows us to shape in time the volume pulse in the combustion chamber, which is something that a piston or Wankel engine simply can't do. This really optimizes the thermodynamic efficiency for the Quasiturbine combustion-cycle. An example of this shaped combustion is the Quasiturbine AC (with carriages), which shapes the volume pulse into the shape of the cursive letter "i", making it unique, reliable in operation and allowing it to withstand the photo-detonation process we wanted for our engine designs.

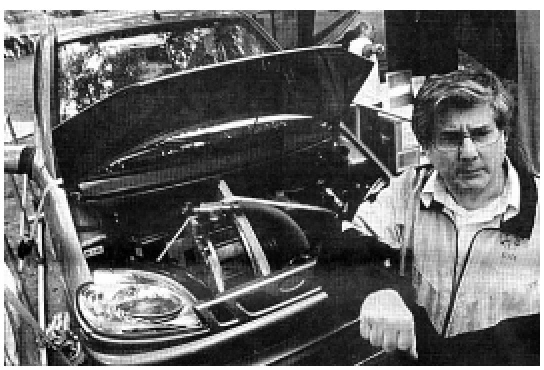
AAG: It resembles the Wankel rotary turbine -- did this provide any inspiration for your research?

Saint-Hilaire: It looks a bit like the Wankel, but the Quasiturbine is extremely different in both design and operation. The general concept for the Quasiturbine (with carriages) is defined by a set of 7 variables which allow the creation of a large number of very different looking engines for a variety of specialized applications. The simplest case is when the distance between two carriage wheels is set to zero which generates the Quasiturbine SC series, which looks the most like the Wankel, but does not have an eccentric crankshaft.

Quasiturbine Car: The APUQ zero-pollution pneumatic car at Festival Écolo de Montreal.

The Wankel engine has a one rigid triangular rotor synchronized by gears with the housing, and driven by a crankshaft rotating at 3 times the rotor speed, which moves the rotor faces radially inward and outward. The Wankel attempts to realize the 4 strokes with a 3-sided rotor, which limits overlapping port optimization, and because of the crankshaft, the Wankel has near sinusoidal volume pulse characteristics like a piston engine. The Quasiturbine has a four-sided articulated rotor, rotating on a circular supporting track with a shaft rotating at the same speed as the rotor. It has no synchronization gears and no crankshaft, which allows carriage types to shape "almost at will" the pressure pulse characteristics for specific needs, including achieving photo-detonation.

Thus, we've corrected a theoretical deficiency in the Wankel's design, and consequently the Quasiturbine does not have the same limitations. This allows an equal size Quasiturbine to produce almost double the power output, while maintaining optimum efficiency. In addition, because the Quasiturbine does not have a crankshaft and its concept can accept carriages, its volume pulse characteristics can be shaped use pulses with rapid rising and falling ramps with a tip duration 15 to 30 times shorter than the Wankel and piston-engines, which provide unique characteristics particularly suitable for detonation engine.



Public Display: A newspaper photo of the modified QT car in the Montreal Gazette.

AAG: In terms of integrating the Quasiturbine into existing applications, what type of equipment would this technology best be suited for?

Saint-Hilaire: Engine integration is a vast domain in which we would prefer not to get involved at this time, because it limits our role as engine supplier. However, just like the early years with piston engines, our first step in is toward pneumatic (air) and steam engines (quite a large industry), followed by Quasiturbine "Beau de

Rocha" (Otto-cycle) combustion engines and ultimately by a photo-detonation design -- an extremely efficient and clean mode of operation. Also, the zero vibration Quasiturbine increases efficiency in all mobile applications because of its reduced sizes and weight (to be carried over 200, 000 miles!), while thermodynamic improvement is in additional benefit.

AAG: How does it compare to conventional gasoline, diesel, or turbine engines?

Saint-Hilaire: First, let me say that turbines are efficiently designed for a single nominal power and load, which limits their efficient use for large steady power applications. Because conventional turbines are complex and costly, very small units make no economic sense, notwithstanding the fact that they do not under scale well in terms of the combustion process. Pistons are not compact in design, and because the piston is propulsive only 17% of the time, they somewhat drag the other 83% of each cycle. Consequently, the instantaneous piston peak power is 7 times is average power, which requires strong construction. Comparatively, the Quasiturbine average power is within 20% of its peak power.

AAG: What types of fuel have you been able to use with this? I understand that you've worked with steam, but how about gasoline, diesel, or alternative fuels? Could the same turbine run on multiple fuels, similar to Ford's attempts at a "flex-fuel" design?

Saint-Hilaire: Major car manufacturers have estimated that developing a new generation of piston engine could require 8 years of R&D and cost hundreds of millions of dollars. Obviously, this kind of development effort is not within the reach of a smaller research team like ours. The Quasiturbine technology is quite a recent innovation and priorities are now given to get the pneumatic and steam Quasiturbines at a commercial level in the short term. Meanwhile, several combustion prototypes have been made, and they've provided most of

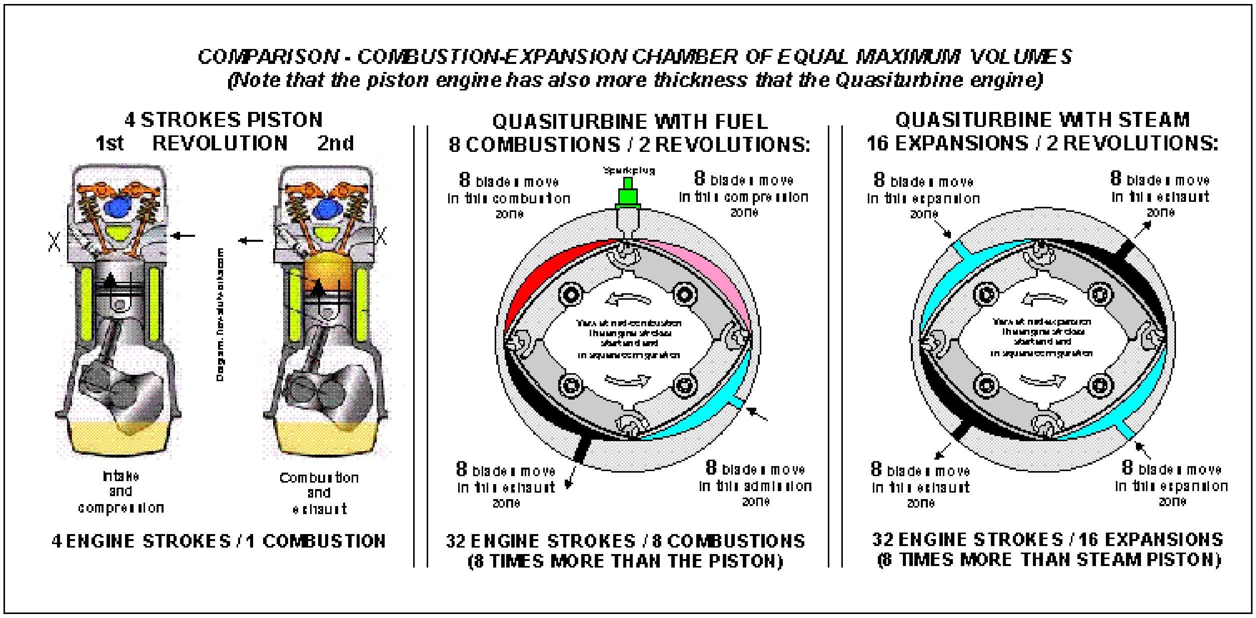
Quasiturbine Engine Components: These component closeups show actual prototypes of the combustion chamber (top), a carriage (middle-left), one of the four required stators (middle-right), and an assembled engine minus external drive components (bottom) for use in a 50-cc engine capable of delivering 14 horsepower at 3,000 rpm.

Dr. Gilles Saint-Hilaire has also performed calculations for a larger, 400cc engine at twice the physical size of the 50cc engine shown, which should produce up to 75 horsepower at 3,000 rpm. For additional design details and performance, click here.

the research data needed for pre-commercial prototype series to come. We're not ready to disclose any results yet, but I can tell you that our test-data fits very well with the theory.

AAG: Would the Quasiturbine have any benefits in emerging transportation paradigms, such as hybrid-vehicles, where the engine seems to be started and stopped much more frequently?

Saint-Hilaire: The reason for the hybrid is because of poor piston engine efficiency at low power load. In contrast, the ultimate objective of the photo-detonation Quasiturbine engine is to be efficient and clean at all power levels, which completely eliminates the need for a hybrid. Until then, the Otto-mode Quasiturbine combustion engine would provide a more compact, lighter and vibration free onboard generator...



AAG: What about rugged military applications? Would the Quasiturbine provide any advantages in humid or sandy environments that might foul a conventional engine?

Saint-Hilaire: Conventional turbines use near supersonic gas flow where any dust produces extremely rapid abrasion of the engine components. The Quasiturbine is much better in this regard. However, the greatest value for military applications is the specific power density, meaning that a smaller engine can produce higher output. For example, you can put a smaller and lighter engine on your zodiac assault craft, and thus pack more zodiacs in a helicopter, which ultimately means more soldiers landing on the beach in faster boats. Also, a plastic-air Quasiturbine engine running with hydrogen peroxide has the potential to eliminate the engine's radar-signature for use in unmanned aerial vehicles. There are even more unique applications for the Stirling-cycle Quasiturbine in submarines...

AAG: Speaking of extreme conditions, it seems that conventional automotive engines have all sorts of issues with cooling & heating, and I'm wondering if temperature plays any role in the Quasiturbine's performance?

Saint-Hilaire: All combustion engines require heat management. The less efficient an engine is, the more waste heat it will generate. This in turn requires more cooling equipment and makes effectively dissipating the waste-heat a difficult process. Because the Quasiturbine is more compact and the power density is higher, you might guess that heat removal could be more critical, but that's not the case. Since it has much higher efficiency, the relative amount of heat it generates is actually much less, and a lower heat concentration also reduces the problems associated with a steep heat gradient.

Wankel: Uses counter seal w/ variable rotation angle.

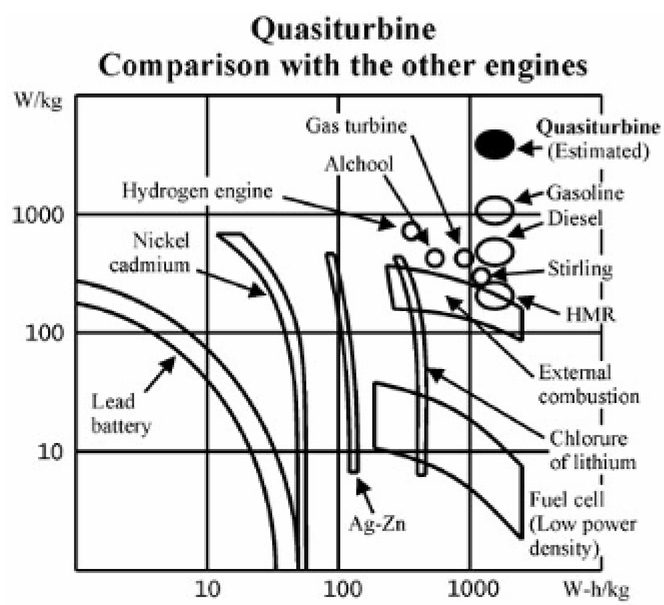
AAG: As I understand things, the Wankel rotary turbine has traditionally had issues with the side-seals giving way, and I'm wondering if this has been a problem in your design, and some of the techniques that you've to overcome this tendency?

Saint-Hilaire: Wankel uses an eccentric crankshaft that moves around a triangular piston producing strong internal stress and vibration, which is cancelled out by a second out-of-phase rotor. The Wankel contour seal makes a variable angle with the stator from -60 to +60 degrees, which further complicates the sealing, not to say the two contour bumps on which the seal pressure tends to become negative and leaks. The Quasiturbine uses no eccentric and the contour seal stays almost perpendicular to the stator during the entire rotation.

Additionally, the Wankel leaks as a result of the fact that the central crankshaft area is part of the oil pan, and a small quantity of oil tends to flow downward by gravity (through the side seals) into the lower chamber. Sealing in the Wankel is very complex, but most of the issues with it have been resolved in the past few years through continued development.

AAG: What kind of scalability does the turbine have? For instance, I understand that you've installed one of these into a compact car, and I'm wondering what kind of performance it has compared to a conventional vehicle powered by a gasoline engine?

Saint-Hilaire: The Quasiturbine has a very compact engine geometry, which provides much greater upward scalability than for something like a conventional piston engine, for example. This offers some interesting possibilities for applications in large marine vessels, including the possibility of adapting this technology for nuclear steam propulsion or electrical generation. The real concern is actually in miniaturization, where I suspect the Quasiturbine could reach the fuel ignition plasma limit before the power is substantially reduced.



Engine Comparison: This graph by Dr. Tukaski Suzuki illustrates the QT's higher energy efficiency.

AAG: I'm guessing that you can probably scale the performance up for dedicated applications, right? How much power do you think you could squeeze into an automobile, if the gas-mileage remained consistent with an automotive engine?

Saint-Hilaire: Automotive reality will have to change, and it will change for sure. Today, a powerful car uses on average only about 15% of the maximum available power, which is to say that the available peak power is about 7 times the average power used. However, from an energy point of view, a car engine that operates for one hour a day utilizes about 0.4 HP on an average yearly basis – a low average consumption that also illustrates why electric utilities can handle millions of electric cars without much investment.

Hand-Tools: A pneumatic chainsaw concept prototype using a Quasiturbine motor.

From a business standpoint, it doesn't make a lot of sense to install a 200 HP system if you're going to use less than 1 HP -- but given the varying demands of the driving environment, it's also nice to have the entire 200 HP when you need it. This illustrates the reason behind hybrid-electric designs: it provides the instantaneous available power of a conventional gasoline with the efficiency of an electric-drive system when only low average power is required. However, it is expensive, complex, and a generally inelegant solution to what basically results from a design shortcoming in conventional piston-engines.

Our work in developing a Quasiturbine detonation engine is to provide high efficiency at all power levels, meaning that a 1000 HP engine could be put in a car without a penalty in efficiency! This is where engine business has to go, and only the Quasiturbine detonation engine can ultimately provide the solution.

AAG: On a smaller scale, have you considered selling smaller versions of this to build a market in tooling -- such as maybe high-output drills, saws, and other entry-level technologies that could build company finances to embark on larger projects in the future?

Saint-Hilaire: Paradoxically, mass-produced products are not a good base to launch a new engine technology with. A much better environment is in industrial applications, where the engine can be regularly serviced by competent technician, and the uses can be rigorously controlled, thus creating a perfect environment for technology to mature.

Steam Engine: A steam powered Quasiturbine.

AAG: Speaking of applications, I couldn't help but notice a steam-powered version of the engine on your website -- I understand that there's been a resurgence of interest in steam-power in the last few years, and I'm wondering what the advantages of the Quasiturbine are compared to more traditional steam-engines?

Saint-Hilaire: Steam has traditionally been considered a very dangerous technology; it is extremely well regulated, and as such the steam-power industry does not welcome small users. Conventional steam engines are consequently never small, and typically reserved to power utilities and large companies. The Quasiturbine is unique in that it offers a compact steam engine that accepts saturated steam, and it's suitable for low to medium pressure & flow rates like a solar thermal system or wood stove. Furthermore, because the Quasiturbine is simple and compact, it can be directly heated and flash steam produced within it, which suppresses the dangerous boiler and line, and which may ultimately put it outside of a great deal of existing pressurized steam legislation.

AAG: I'd like to ask how your company is going -- is there a growing interest in the Quasiturbine technology, and what types of markets are you getting involved with?

Saint-Hilaire: Pneumatic equipment is a gigantic industry -- consider, for example the prevalent use of compressed air systems in mining operations for safety reasons. The Quasiturbine has some great possibilities in this area, without the liability and unnecessary complexity present in competitive solutions. At the moment, there is no one filling market needs in the 10 to 60 psi niche, where inexpensive plastic Quasiturbines have the immediate potential for a real technological revolution. We believe the Quasiturbine should first establish credibility on this fundamental level before we enter more competitive markets.

AAG: As I understand things, this is something of a family business -- you've talked about your sons working in the IT industry down here in the states, but also continuing to help out with the company. Can you tell me a bit about the role of your family in the business?

Saint-Hilaire: In the early stages of R&D, scientific ideas driven by passion are the key ingredient in making an idea a reality. Having family in the USA makes it convenient to answer local requests from the most powerful economy in the world. We use the internet for brainstorming ideas & long-distance collaboration, but I worry that between their assistance in this project and their own families & careers that we might end up consuming all of their spare time in the process...

Pneumatic Motor: Closeups of two variants on the QT motor for pneumatic applications.

AAG: As a physicist, you're familiar with a variety of emerging technologies. How would you answer critics who might claim that the time is past for the development of improved internal combustion engines?

Saint-Hilaire: The future of energy requires strategies involving resources, efficiency, distribution and mobility. Large electric utility companies currently produce electricity with higher efficiency than small distributed stations or your car engine, so for at least a while, hybrids, fuel cells, batteries and electric motors will be a proposed as more efficient substitutes for today's inefficient internal combustion engines.

However, as paradigm-changing technologies like photo-detonation engines begin to emerge in the marketplace, this trend away from internal combustion may very well start to reverse itself. After all, small engines with the efficiency of a large utility station completely eliminate the need for storing electrical-energy by producing clean power on demand. Only then will distributed electric generation will become reality, and because of fuel mobility, specific energy, and power advantages, efficient internal combustion engines will then have no substitute!

The issue of declining petroleum resources will still have to be addressed, but the most likely solution will be toward synthetic fuels similar to conventional fuels, because the best and most convenient way to store hydrogen is to bond it with carbon atoms and make a conventional liquid fuel. This new type of synthetic fuel allows us to take advantage of emerging energy-sources such as solar-power and nuclear energy and combine them with the existing benefits of today's infrastructure to create a new generation of high-efficiency, environmentally-friendly vehicles powered by extremely efficient internal combustion engines. The energy-density of petroleum fuels is a big reason why no foreseeable technology is going to replace the internal combustion engine in the long term... so our goal must be continued research and development to build clean, efficient engines to best utilize liquid fuels while recognizing both the economic & environmental issues at stake.

AAG: Are you open to collaborative partnerships? For instance, Mark Beyer has been developing a concept for a Rank-Hilsch vortex-tube that he thought might work well with the Quasiturbine, but that's only one of many integration possibilities for the technology itself. What kinds of collaboration have you been seeking, and are there any particular technologies that would integrate well with the Quasiturbine technology?

Saint-Hilaire: There is so much to do, we will never be able to do it all ourselves – collaboration is a prerequisite for success. However, we are cautious not to precipitate commercialization before our products are thoroughly tested and sufficiently mature. Manufacturing consideration is more and more integrated in design. Priorities go now to demonstration projects with potential partners, and hopefully some government and institutional support.

AAG: Where do you see as the future of the Quasiturbine technology, and how do you see your efforts & the company continuing to grow & evolve over the next few years?

Quasiturbine Academic Kits: Interested in experimenting with the quasiturbine technology? The technology itself is still experimental, but kits are available for academic use. Click the link below for additional details: click here

Saint-Hilaire: Thinking big isn't my first reflex in this case. Niche markets have more of an immediate interest for me right now, and they offer a number of advantages that the mass market cannot. This technology needs friends, supporters, and partners – and networking is never a small task. Technology resellers seem to be on the front line for building public support & acceptance, but I worry that there are entrenched interests who might lobby against seeing the Quasiturbine become a part of environmental strategies to build cleaner, greener automobile engines. Big business has a lot of inertia, but the pressure is building, and sooner or later the dam will burst. When the time is right, it's best to be ready for the opportunities that present themselves, and have as many friends as possible ready to show up and help!

AAG: Is there any way that the general public can get involved to help this technology along?

Saint-Hilaire: This technology is not as obvious to everyone as it is for you, and could suffer a certain credibility gap if we don't carefully manage public perception. For this reason, we support several educational projects in conjunction with colleges and universities. I'd also like to urge the public to contact their local college or university, and suggest that they initiate a Quasiturbine student project. This is the best way for any citizen to help the technology, the community, their youngsters and eventually themselves -- by building interest & promoting awareness for this revolutionary new technology...

Dr. Gilles Saint-Hilaire is a nuclear physicist & independent inventor from Montreal, Canada. His detailed research and development into the Quasiturbine technology are available online at the following URL: http://www.quasiturbine.com