by Murray McLeod

New and unflown Kriek-4 is powered by a flat-four Subaru engine.

Wagtail raises the commercial gyrocopter bar

A fleeting glimpse and quick photograph near Pretoria in August captured an image of another South African design project - a tractor gyrocopter developed by Somerset West resident Sabine Baring-Gould. The machine was on its way to Wagtail Aviation for some final fettling before its first flight. The aircraft is not the first locally-designed and produced gyrocopter, neither is it the first tractor-configured gyro originating from South Africa but it does symbolise the clever minds that continue to push aviation boundaries in the southern most part of the continent.

The Baring Gould machine is a two-place side-by-side fish-shaped gyrocopter that will run a Subaru engine driving a nose-mounted propeller via a long shaft and belt reduction drive. Initially called 'Football' - probably on account of its early half-sphere cabin shape, the final design is more tadpole than ball and if all goes to plan, it will take to the air for the first time either late in 2011 or early 2012.

Gyrocopters represent a fringe flying industry demanding of unusual technology. Whilst the principles of rotary wing flight are well known, there is far less expertise with intimate knowledge of gyro mechanics. The only company in the region to possess deep gyro know-how is Johan von Ludwig's Wagtail Aviation, based at Klipdrift Farm a few kilometres east of Parys. The farm is home to some interesting flying machines.

In late 2005, Johan appeared at the Klerksdorp air show with a very agricultural-looking but advanced tractor gyrocopter called the Springkaan. Fitted with an inline six-cylinder Toyota Supra car engine, the machine's high flotation tyres from an all-terrain vehicle promised an answer to one of the type's biggest drawbacks - control input sensitivity to rough field operations. Gyros are not particularly suited to unprepared airstrips - their airframes

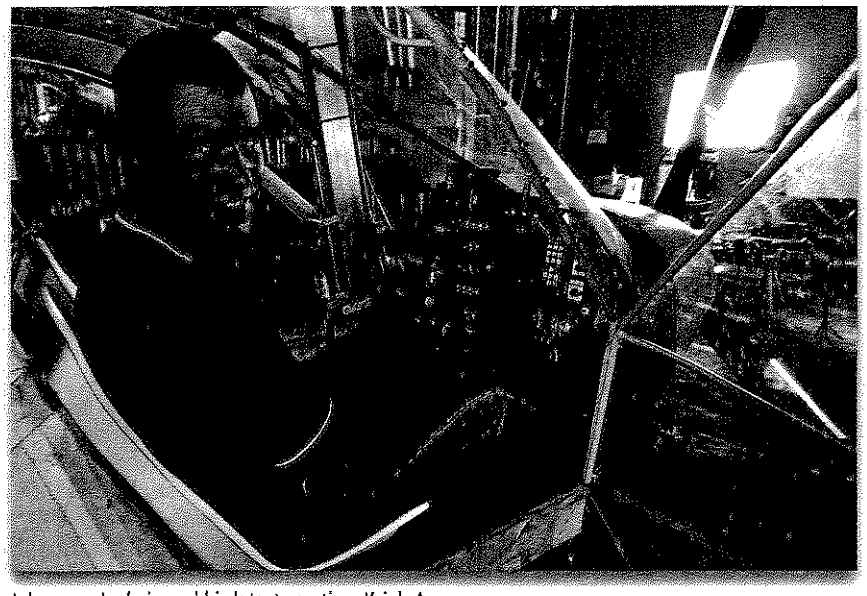
transmitting every bump and bounce to the relatively fragile rotor-head. The Springkaan and its pliant oleos and tyres easily accommodated rough landing grounds and for some years the big gyro was used to explore the boundaries of high-power tractor engines and their effect on the aircraft's performance. The machine was later fitted with an even bigger turbocharged Mitsubishi TDO6 engine, pushing out almost 300hp. The total thrust from the engine was about 75-per cent of the empty weight of the entire airframe. Eventually, the aircraft was damaged following a high power takeoff, which required some swift control inputs, resulting in a gentle roll-over on landing. The repaired Springkaan now resides in a Klipdrift Farm shed.

Alongside the ungainly looking machine at Klerksdorp was a second gyro - one that continued the rag and tube tractor theme but was substantially smaller and lower powered - this time by a Rotax 914 engine. Based on an adapted Bushbaby airframe, this smaller model was named 'Kriek' or 'cricket' in English. Johan is somewhat vague about the Kriek's eventual fate but is a great deal clearer about the lessons he's learn't from both gyrocopters and has since produced the curious looking Kriek-3 and much more recent Kriek-4. In fact the Kriek-4 has yet to fly but should be doing so within the next month or two.

41-year-old Johan is a chemical engineer but easily turns his fertile mind to almost any other engineering field, including aeronautics. He also has a sharp eye for commercial opportunities and disdaining fanciful aesthetics, is unconcerned his creations have the appearance of Jules Verne contrivances. With its crude aluminium cladding and clear-view cockpit, a closer look at the single-seat gyro reveals a meccano'esque interior made to fulfull a job of work rather than seduce recreational pilots. The Kriek-3, with some 700 hours total time has not only flown the length and breadth of South Africa, it will be spending time in West Africa and flying specialised geosurvey tasks. Like it's creator's Springkaan, the Kriek-3 utilises all terrain tyres.

Look beyond the utility appearance of the Kriek-3 and those with more than a passing knowledge of gyrocopters will notice the raked rotor mast and tricycle undercarriage configuration. With several years of studying and piloting these flying machines, Johan has unlocked several principles and applied them to his own aircraft. Some of these are based on the premise that the pilot needs to be able to get the gyro airborne without undue attitude changes at the point the aircraft is ready to fly. The most obvious is the rearwards raked rotor head, which better accommodates the high angle of attack adopted by the rotor disc as the blades speed up to takeoff rpm. This angle of attack becomes much less as the gyro takes to the air and to avoid a sharp change in attitude required of a taildragger configuration, the nosewheel holds the fuselage in a more level attitude. This means the pilot isn't required to exercise a high level of skill when 'flying' the rotor disc and the aircraft gets airborne with much less drama.

It's commonly known that tractor gyros are more stable during flight and can thus handle much more power than a pusher. Johan likes to remind interested observers that pusher gyros were championed by Ken Brock and Dr. Igor Bensen who designed their machines for the enjoyment of recreational pilots rather than commercial use. The lengthier fuselages



Johan von Ludwig and his latest creation: Kriek-4.

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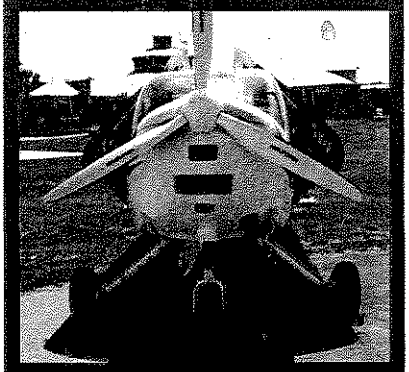

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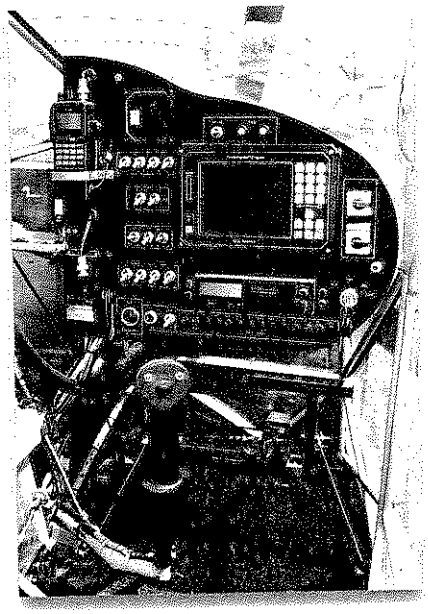
Kriek-3 (above), and (below) Kriek 4's instrument panel.



are one thing but Johan goes further than merely extolling the virtues of tractors. His studies confirm that gyros are prone to opposing vibrations and need a complex raft of airframe qualities that allow both flexibility and yet provide a high level of stiffness. The most influential 'exciters', as expected are the rotor blades, rotor head and mast. Until Johan experimented with blade technology, it was commonly believed the maximum rotor diameter that could be flown without major balancing difficulties is 33 foot. Most gyros use 28-foot blades, which is a limiting performance and payload factor, especially at South Africa's high density altitudes. The advantages of providing a greater 'wing' area are obvious and Johan has managed to push the rotor blade length to a comfortable South African designed and built 36 feet and maintained a level of smoothness that allows his company to operate sensitive geophysical survey gear - in particular magnetometers.

In order to provide the greater performance margin provided by a 36 foot rotor blade and still have very low fuselage vibrations, Johan has developed a unique test rig that simulates the rotor head vibrations for which the rest of the mast and airframe can be 'tuned'. Called a 'Super Shaker' the rig is made up of two electric, computer-controlled motors with offset weights and is applied to the head with the rotors static. 36-feet almost doubles the rotor disc surface area so attaining a low vibration level is essential if the gyro is to be used for commercial flights. A feature of the Kriek is the laminated main mast and extremely close but flexible control-rod tolerances that transfer pilot stick inputs to the rotor head. The head and blades are also finished to a high quality and this combination of flex and rigidity has to then allow the rest of the aircraft to fly smoothly and without any disturbing harmonics that will upset the sensitive recording devices carried during a survey.

Whilst gyro technology might at first appear simple and by definition inexpensive, like any other commercial operation, Wagtail is obliged to provide gyro crews and specially qualified maintenance personnel. The company's gyros, which also include some highly modified ELA tandem pusher aircraft, require mechanics familiar with the vibration characteristics of the main rotor blades as well as airframe and powerplant knowledge and how they all interact. These skills are not widely available and are not of great benefit to pure helicopter operators. Whilst the Kriek is being used to survey areas a long way from home, it has to carry an entire support team.

Using a turbocharged Rotax 914, it became apparent that Kriek-3 needed more power for some applications. Rather than bolt on a converted motor car engine to the existing airframe, Johan, who is partial to automotive power, has designed and built an entirely new Kriek-4 powered by a 2.5 litre flat-four Subaru boxer engine with a double-redundant custom engine-management system. Like Kriek-3, the new aircraft is less than impressive from an aesthetic quality but is highly practical and robust. The tube and fabric Kriek-4 shares the high flotation tyres and tricycle undercarriage as well as Johan's swept-back mast. It will fly a three and a half hour sortie with a comfortable 40-minute reserve on 100 litres of Mogas, plus 160kgs of payload but excluding a pilot. The somewhat more streamlined fuselage also seats two and has tremendous visibility using an enveloping clear perspex cockpit surround. Like its predecessor, the Kriek-4 is designed solely for commercial use under the CAA's part 96 regulations. Whilst there's a long term goal for full type certification, Johan says he would currently decline any approach to build a similar gyro for recreational use. By the time this article goes to press, Kriek-4 should have flown. •

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