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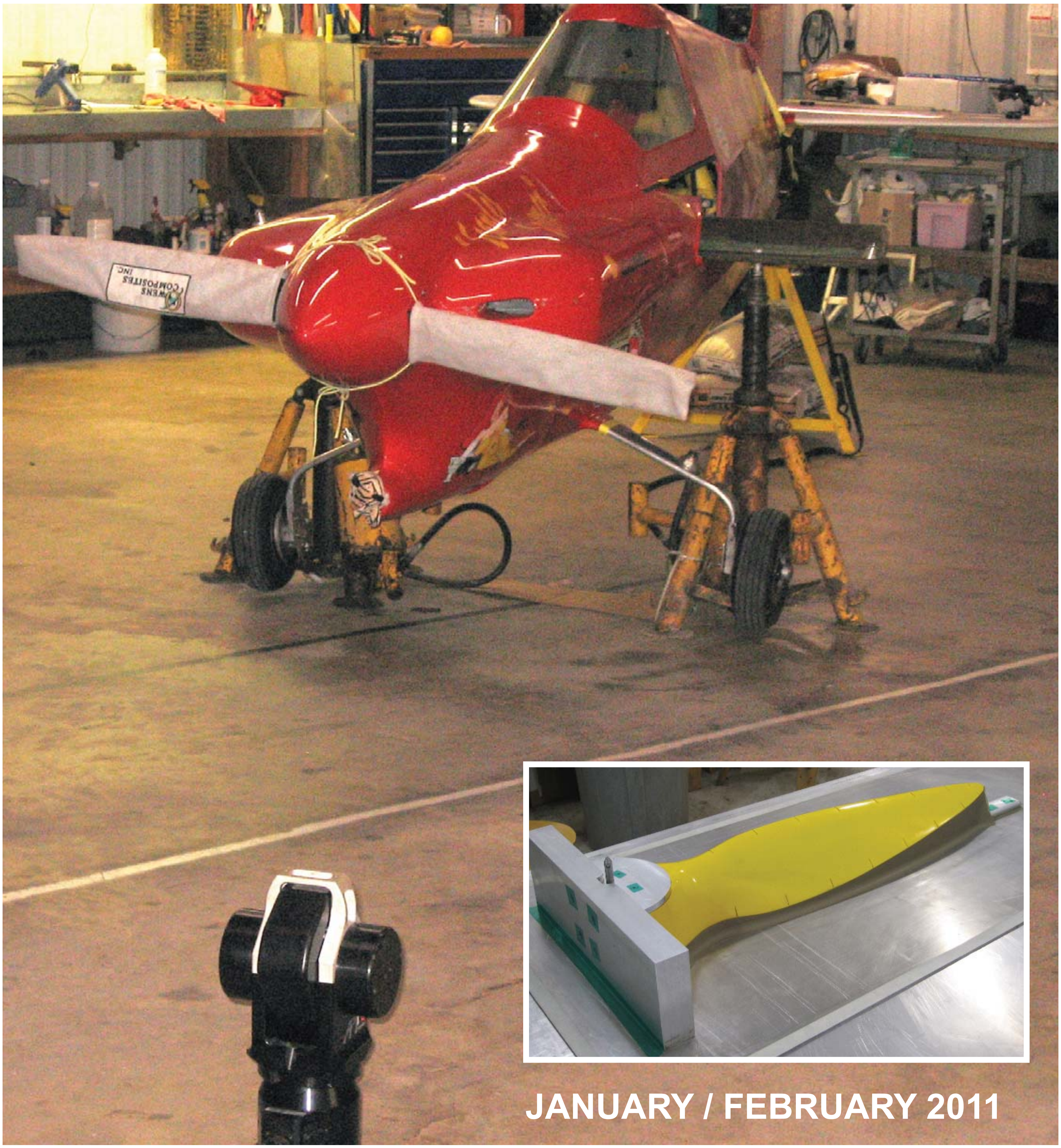


JANUARY / FEBRUARY 2011

The Hill Pearce Racing Propeller

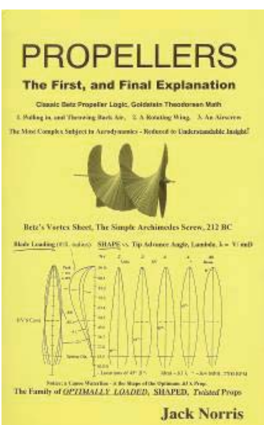
Photo by Lista Duren

Birgitta Nurmi is an air race writer and photographer who enjoys the people of IF1 and their passion for the sport. At various times in her life, she has also been a psychologist, college teacher, athlete, musician, and park ranger.

At the beginning of race week, 2008, *Scarlet Screamer's* new propeller was shrouded in its standard Twisted Composites cover. Few people knew about the new prop design, and the team wasn't talking or showing it off. The best way to keep a secret is to not let on that you have one.

In one short year, the *Screamer* team had designed and produced one of the few new propeller designs in fifty years. This is the story of the new Hill Pearce (HP) racing propeller, the achievement of a few talented, competent, and innovative men. What is unique about this new design is that, unlike the Sensenich design which is a compromise in response to various requirements, this new prop was developed with the singular goal of increasing IF1 race speeds.

The story starts with an enthusiastic and rather talkative guy named Jack Norris. During the 2007 races, Norris was scurrying about the IF1 hangar trying to get people interested in his book *Propellers – the First, and Final Explanation*. This self-published thick paperback with the yellow cover presents the development of propeller math and theory starting in 1865. Jack Norris collected and integrated all the information which he considered to be at risk of being lost.



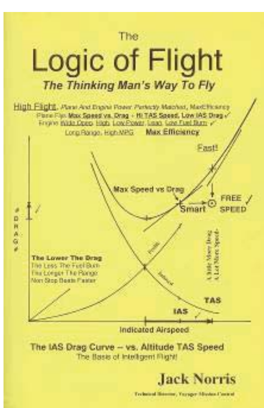


Photo by Lista Duren

Jack Norris did extensive research on propeller design theory. His book about propellers was the starting point for Stephen Pearce's design.

Norris has considerable aerodynamic and aeronautical experience, including working as an engineer on Rutan's Voyager team. He became interested in propellers when he was a champion model builder. While testing hundreds of competition props for models, he concluded that tapered tip props outperformed the more typical broad tip designs. Now a spry 81-year-old, he remains passionate about propellers.

Norris found a willing ear when he introduced himself to Stephen Pearce, Gary Davis' crew chief. Pearce says of that initial meeting, "We were busy loading up the trailer and getting ready to leave when Jack Norris came along. Since Gary and I were already looking at ways to optimize what we had, and evaluating the changes we could make, I was willing to listen to what Norris had to say. We chatted and I bought his book. I read it on the airplane on the way home and determined that yes, he had something there."

Pearce was particularly intrigued by references to the work of Theodore Theodorsen, who wrote *Theory of Propellers* (McGraw Hill, 1948). So after he exhausted the information in Norris' book, he read all that he could find of Theodorsen's original work.

In October 2007, Gary Davis and Stephen Pearce decided to proceed with the development of a new race propeller. Pearce was confident that he could design the propeller, but who would build it? Steve Hill was an obvious answer. But with only 10 months to complete the project they had to get right to work. In mid-October, Davis stopped off at *Twisted Composites* near Albuquerque for an initial meeting with Hill.

Steve Hill agreed to build the mold and the propeller prototypes. He knew that Davis' team had the necessary experience to tackle this project, and that Davis was willing to do the test flights, which was crucial. In addition, Hill hoped to end up with a new and better race propeller for the IF1 pilots.

Meanwhile Pearce remained in touch with Jack Norris who sent him the computer program that Andy Bauer, Norris' friend and colleague, had developed. Unfortunately Dr. Bauer, who had been an aerodynamicist at Douglas, Long Beach, CA, was not able to assist on this project, as he was starting to suffer the affects of Alzheimer's disease. Therefore Pearce had to rewrite the computer program on his own to adapt it to modern computers. As he worked with the program, he made some corrections. Pearce explains:

"I am an old engine builder. I've always enjoyed operating at the leading edge of what the rules allow us to do. Professionally, my field is numerical math and I am a computer programmer—that's what my business is. Thus when I took the time to look at Bauer's program, I figured out what the math could do. I also understood that you had to be able to map the cowling, then use that data to design the prop."

He added "I thought that designing and making a new prop would be less of a job than making changes, for instance, in the fuselage."

As it turned out, there was nothing easy about the process. In retrospect Pearce concluded, "The prop turned out to be a huge endeavor."

By the end of October 2007, Pearce was ready to consult with Steve Hill about the details of building a propeller from an entirely new design.

Hill immediately listed the tasks that needed to be done to correctly design a prop using Theodorsen's method. Only then would it be worthwhile to build a mold and then a new prop which would truly put Theodorsen's theory to the test. Hill's list of design tasks appears on the following page.

The list was a reality check for Pearce and a glimpse of how involved the process would be. He was not intimidated, however. He understood immediately that "this list of show stoppers" as he called it, was the best starting point that Hill could have given him as it detailed the questions he had to answer before the propeller could begin to take shape.

Another factor that played a significant role in this story: Pearce really enjoys a challenge. With a chuckle he explains, "It keeps me from getting bored." So the process began in earnest and Stephen Pearce set out "to do the impossible" because "I needed to have this prop built."

The first task Pearce tackled was to measure the engine's horsepower and torque. A race engine's actual horsepower is not known, but he thought he had a pretty good idea what

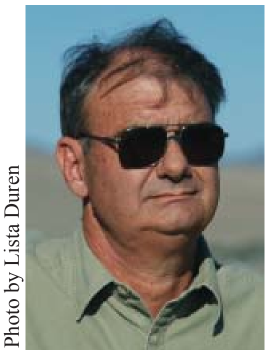


Photo by Lista Duren

Stephen Pearce measured the cowling, designed the propeller, and milled the one-bladed master prop.

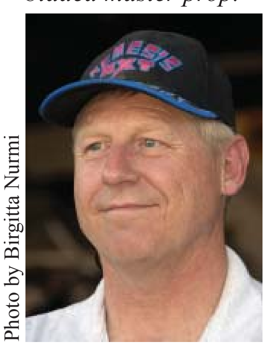


Photo by Birgitta Nurmi

Steve Hill guided the design process, built the mold from Pearce's master, and produced the prototype propeller.

Steve Hill's List of Difficult Design Considerations

Pearce says this list is best characterized as 'tasks that might be beyond the capabilities of some people.' Yet they need to be accomplished to successfully design a prop.

- What is the horsepower output of the engine?
- What is the speed at which the aircraft will operate and what is the thrust required to overcome drag at that speed?
- What should the diameter of the prop be which will allow the engine to run the desired RPM?
- How will the important take-off performance be addressed?
- The Theodorsen math that yields the blade angle and chord dimensions is difficult.
- Slowdown analysis requires a 3-D map of the cowling.
- Rankine Source-Sink analysis to perform the slowdown analysis is mathematically complicated
- Even with a prop design, an aluminum 'master' must be made
- Just because a prop design is "optimal" doesn't mean it is buildable, practical, or even safe to fly.
- When the prop is made someone has to be the first to fly it. Who will risk their life on a prop that might not work anyway.

The fixed pitch prop is a compromise at best.

it could be. He conducted a sensitivity analysis using his approximation of the horsepower, 15% more than that, and 15% less. As it turned out his guesswork was pretty good. He also found there is a big penalty for overestimating the hp, while underestimating it does not make as much of a difference. So he settled on the lower value.

Then Pearce went on to calculate the slowdown factors. He explains, "With a fixed propeller there are performance factors—in initial acceleration and at the top end of performance. The fixed pitch prop is a compromise at best. So every factor that influences the fixed pitch propeller needs to be considered. One of the factors relevant to performance is the way in which air slows down as it passes near the fuselage. Therefore what needs to be determined is the average slowdown factor at each radius, as though the fuselage and cowling were a single body of rotation.

"The very center of the prop—the first six inches—is covered by the spinner. At this point the cowling is in the closest proximity to the prop. This means that the air can get past the prop but is slowed down the most. Moving out to the periphery, as the cowling and canopy recede, the slowdown factor decreases until there is no cowling behind the prop and the air flows at the speed that the airplane is going.

"The implications of this are that if you take this slowing down of the air into consideration, you have to change the theoretical pitch of the various portions of the blade to something much different. When using the effect of slowdown, the pitch changes up to 17% near the spinner and to 0.3% at the tip from what it would have been using just a theoretical analysis without slowdown."

In order to calculate the slowdown, Pearce needed the exact shape of the cowling. So he clamped the plane firmly in place and mapped the cowling using an IFM/ADM laser tracker. In operation, the laser tracker continuously measures the distance to a hand-held retroreflector accurate to a thousandth of an inch. By moving the retroreflector along the cowling, Pearce was able to collect thousands of point locations relatively quickly. It took many thousands of differential measurements to produce an accurate 3D model of the cowling. He analyzed the data using the Rankine Source-Sink concept.

Once he had collected all the information, Pearce started working on the propeller design. Using the theoretical analysis, corrected for the effects of slowdown analysis, he determined the chord and blade angles. He defined “stations” at 6%, 12% and so on, and calculated what the angle of the blade needed to be at each station.

Pearce was working with one half of the propeller, from the center of rotation out to the tip. Hill had developed a method to make propeller molds using only one blade as a master. This not only minimizes the machining time and cost required on the master; it also results in some of the most symmetrical propellers ever built. Symmetry is an important factor for smooth running, high speed, high RPM Formula One racer props.

On March 12, 2008, Hill received the first design data from Pearce and started the work at his end. Pearce had supplied him with a simple list of chord lengths and blade angles at 11 stations along the length of the blade. Hill modeled the blade using Ashlar Cobalt 3D solid modeling software with the chord lengths and blade angles per Pearce’s design. He selected airfoils and thicknesses for each station from the NACA 44XX family of airfoils (plus a special tip airfoil). He then blended the blade into the necessary hub shape. At the same time, he developed the structural design of the propeller. Ten days later this job was done and the CAD models were on their way to Pearce.

Pearce started to prepare for the next step: machining the parts. He purchased three aluminum slabs 36 inches long, 4 inches thick and 6 inches wide, each weighing over 85 pounds. Working with a friend, Pearce intended to cut the master propeller out of one of these slabs. That work began on May 4, 2008.

Photo by Stephen Pearce

Scarlet Screamer’s fuselage is firmly clamped to three supports to hold it abolutely still for cowling measurements with the laser tracker.

But before Pearce started that process he spent some time looking very closely at Hill’s drawings. It was then that he became aware of something quite unexpected and so different that it concerned him. Pearce explained, “What I saw was that the propeller tips were awfully thin. How easily would they break or flex dangerously?”

“The ramifications are horrible. If you lose 2” off the prop in flight, the resulting vibration can tear the engine off the mount. And someone is going to be testing this thing and that person is a childhood friend of mine.”

He knew that prop loading goes to zero at the very tip. If the tip is wide, it creates a vortex, which manifests itself in noise and turbulence. So he knew that the prop needed to be smaller near the tip if it was to function efficiently. Pearce concluded that, since the data checked out, he had to trust it.

It took many thousands of differential measurements to produce an accurate 3D model of the cowling.

Photo by Stephen Pearce

Roughing the blank took two setups. Finish milling took two more. In all, it took about 16 hours to shape the single master propeller blade on the three-axis Fadal 8030 mill.

The mill gouged the edge of the nearly finished prop master when the team loaded the wrong software segment.

Photo by Stephen Pearce

The details of Hill's drawing were entered into the Mastercam software program to create the instructions to drive the CNC mill used to cut the master prop from the aluminum block. It takes a big mill to chew through nearly 85 lbs of aluminum to make the master. Pearce had a friend who runs a business with a three-axis Fadal 8030. The bed is nearly seven feet long and the mill weighs nine tons. Normally, it costs several hundred dollars an hour to get time on this kind of machine. One of the extraordinary facts in this story is the motivation of the people involved. Pearce's friend took his milling machine out of the production schedule for four days so that he and Pearce could continue their quest to build the perfect prop.

Cutting a master propeller out of a slab of aluminum was hard work that required precision and total focus.

Pearce mounted the hub end of the aluminum blank on a rotary table and clamped the tip end in a vice (as shown in the photo on this page). He mounted table and vice to the mill bed.

Roughing required two setups: Machine the first side, then release the tip end from the vice and rotate the rotary table holding the hub end 180 degrees. Grab the tip end with the vice again, reset the machine's coordinate system, load the next software segment, then machine the second side. Repeat all of this for the finish milling.

Each setup took time, particularly resetting the machine's coordinate system. Then there were tool changes when the cutting tool got dull, broke, or once, when the tool got loose in the tool holder and destroyed itself.

When the mill was running, coolant spray controlled the heat generated by the cutting. Over many hours of work, the shape of the new HP propeller started to emerge.

The gremlin struck late at night when they were nearly finished. Pearce and his friend had worked all day and both men were tired, but they decided to push on. So when the time came to change the setup, they looked at each other and, with few words, they repositioned the workpiece, loaded the next software segment, and re-started the mill.

For Pearce the memory of that moment is vivid: "We heard a loud pop followed by a spine chilling cacophony of screeching thumps and bangs."

They stood in shock as the machine cut a large gouge through the blade of the propeller. They were horrified to find that they had loaded the wrong section of the program.

With the air races not far in the future, Pearce and his friend started the milling process all over again with another block of aluminum—although not that night. By the end of May, they were done despite the speed bump.

Pearce commented dryly, “Nobody had told us that what we did was impossible. Had we known how difficult it was to make the machine master, we would not have done it. An aluminum master is almost impossible to produce but we got it on the second try. We were told afterwards that this was fabulous. Someone who knew about making those types of molds indicated that 10 tries would usually be more like it. Each attempt took 16 hours of work at the milling machine.”

On June 3, 2008, the master prop arrived at *Twisted Composites*. The surface was still a bit rough and showed the machining marks. Hill immediately set to work on the three critical preparatory tasks:

1. He sanded and painted the prop to make it completely smooth since all surface imperfections would transfer to the mold.

2. He scribed “stations” on the body of the prop. These are marks along the edge of the blade, measured from the center of rotation in 3 inch increments. They serve as standard locations for measuring and comparing prop angles.

3. He glued tiny wires (.015 inch in diameter) to the scribed locations so that the production mold has barely perceptable grooves. These grooves transfer the station marks to the finished prop, providing a consistent set of locations for future prop measurements.

After about 21 hours of preparatory work, Hill was finally able to turn his attention to making the mold itself. This undertaking consists of twenty separate procedures, each subdivided into smaller tasks. It requires about 80 hours of work.

In July 2008, Hill was ready to use the mold to build the prototype propeller. This is another very involved process requiring fifty layers of graphite fabric in the hub area of the prop and approximately eight layers in the blade area. Then the rest of the propeller is filled with strands of carbon fiber going from tip to tip. The entire process of building a propeller can take more than thirty hours.

“Nobody had told us that what we did was impossible.”

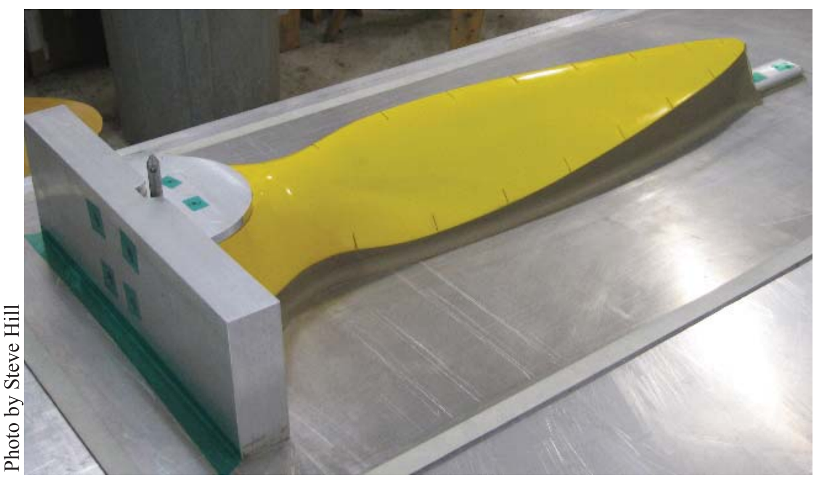


Photo by Steve Hill

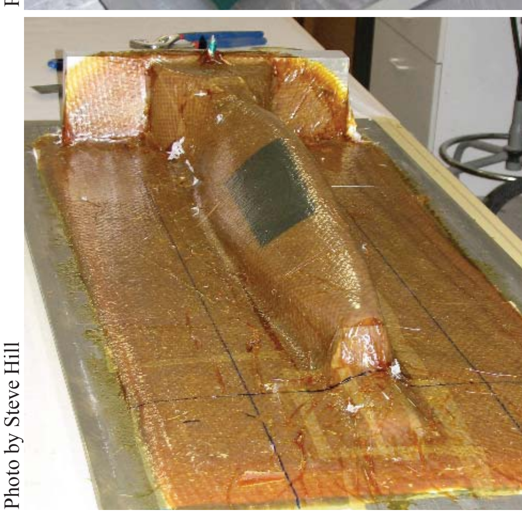
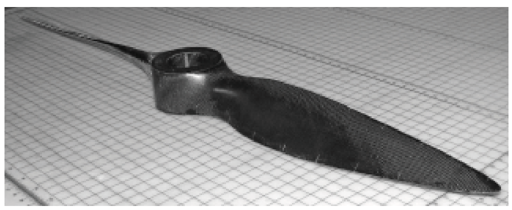


Photo by Steve Hill

Steve Hill smoothed and painted the master (above) before using it to create the mold (left). Station markings are visible at the leading and trailing edges of the master.

Photos by Steve Hill



Steve Hill used the single blade prop master to make the four-piece mold shown above. When assembled, this mold was used to create the one-piece prototype propeller (right).

“Crew chief mentality...I like to have spares of everything.”

Compared to the props Hill regularly makes, there were some aspects of this prototype that required special treatment. The differences were mainly related to the thin tips of the prop. He knew that this was the optimal aerodynamic design for a race propeller. But one question lingered: would the thin tips hold?

While Hill was busy in his shop, Pearce rebuilt *Scarlet Screamer's* engine. He also tightened gaps between the cowling and the spinner for better alignment. This meant he had to fill the old mounting holes with carbon fiber and drill new mounting holes. Then he realigned the cooling ducts.

In mid-August 2008, Pearce received the long awaited package from Steve Hill. When he unwrapped the new HP propeller he was amazed at what he held in his hands.

“It looked so elegant and so fast! Also, you need to understand, I had only been working with one half of of the prop. That was all I had ever seen of it. But here was this complete propeller in shiny black carbon fiber”.

His idea had become reality.

A second propeller was already in progress and would be sent out to them as soon as it was done. Not one but two? “Crew chief mentality” muttered Pearce, “I like to have spares of everything.”

The next step: in-flight testing. Time was short now, and the team did not yet know what they really had. Only the actual flight-test could tell them that. A quote credited to test pilot “Tex” Johnson, applies to this situation: “A flight test is worth a thousand expert opinions.”

Mid-morning on Friday, August 22, 2008, Gary Davis, Stephen Pearce, Pearce’s friend, and a few others, met at Coulter Field, in Bryan, Texas. There were thunderstorms all around them so weather was going to be an issue. Another problem was that the runway was closed for construction and the narrower taxiway had to be used as the runway. Nevertheless they decided to go ahead.

Pearce had built two new engines. “They were as good as can be. We mounted a standard SH prop (54-65) to break the engine in and establish performance standards. Then we mounted the new prop. Gary and I had already talked about this. If this prop comes apart, I would prefer that it happen on the ground. So we ran wide open for 30 seconds. I stood in the prop line and saw the prop tips extend forward about 2 inches. Gary’s thought was that if it's going to come apart, it'll do it now. But it held. We repeated this process twice. We checked for heat. Everything tested out fine."

The team was nervous, especially Pearce. But Davis said he just felt excited as he looked forward to the first flight. He said that he had total confidence in Pearce.

Davis had been involved in flight testing earlier in his career. He said, "You just have to approach it very rationally. You have to know every step of the way what you'd do if something went wrong. It's not like at the Reno races where you're 50 feet above the ground which allows little room for error. At Coulter Field, I could get up at altitude which gives me more time and more choices if something were to go wrong. If a tip were to break, it might tear the engine apart. But with a retaining cable you might not lose your engine altogether and you might still be able to bring it down. But the most important thing is: you've just got to be ready for anything."

Pearce strapped a parachute on Davis and gave one last instruction: "If you're up high and the prop comes apart, you get out." Davis got into the cockpit and steadied himself. Pearce swung the prop and started the engine. Everything sounded good. Time to go and do this. Tension rose.

Pearce had written a test profile that was seven minutes long. Davis rolled out and prepared for take-off. "I climbed up, got it up to race RPMs, approximately 4000 plus, and then I got it back down so we could look at it." He shut the engine down and rolled up to where his team was waiting for him. He looked very pleased as he climbed out of the cockpit and told his team, "This is the smoothest race prop I've ever flown!" The engine was running more RPMs.

The test profile for the next flight was doubled to 14 minutes, and then increased for each subsequent flight.

After each flight the crew meticulously examined the engine as well as every fraction of an inch of the new prop. But the airplane and the prop were not all that demanded the small group's attention. They also kept a keen eye on the thunderstorms. They timed the thunder and lightning so they would know how close the storm cells were. Fortunately there was enough of a window between storms to allow for the test flights.

In late afternoon they started the fifth and final flight of the day. This flight was scheduled to be the longest one at thirty minutes.

Everything had gone perfectly, exceeding all expectations. There was no reason for concern. But near the end of the flight, Davis noticed a few raindrops on the windshield.

"Oh, oh, not good" he thought to himself. He knew that rain is potentially fatal to composite propellers. However Davis was ready for this, too.

He tells the story like he might describe having breakfast: "So I just turned off the engine and deadsticked it in. It was such an easy thing to do. I just shut the engine down, lined

"This is the smoothest race prop I've ever flown!"

The thin tip profile of the new propeller (top) contrasts with the traditional square tip racing prop (bottom) from Jay Jones' racer.

Photo by Bill Rogers

Photo by Lista Duren

"So I just turned off the engine and deadsticked it in. It was such an easy thing to do."

up with the runway—I had plenty of altitude—and just glided it in." Then he added, "but it was a good thing that I didn't radio to Stephen what I was doing." He chuckled, "I think those folks on the ground might have gotten very nervous."

When Davis put the plane down, the team knew that they had made aviation history. Perhaps in the eyes of some it was a small piece of history, but the group knew what they had accomplished: They had done what others said could not be done.

Davis was very pleased to find that the prop accelerated like a climb prop, that the take-off run was 11 seconds, and that it also flew as efficiently as a fast race prop. There was no vibration whatsoever. And the super thin tips? They held.

How did Davis feel after that day was done? "Thirsty," he replied laughing, "Texas is pretty hot that time of the year. And of course we were excited. But the excitement was muted. We had fully expected that everything would work out."

They went for a quick bite to eat at a nearby restaurant and Davis drove the three hours to go home. The work was done. Now the group was looking forward to taking this airplane on the race course at Reno. Everything else they needed to do was really just preparation to go racing.

Photo by Lista Duren

Crew member Gene Hubbard times Scarlet Screamer's qualifying laps.

Come early September, they packed up *Scarlet Screamer* and trailered her to Reno. On September 8, 2008, she took to the skies again for a few practice laps on the race course. Everything continued to check out perfectly.

September 9, 2008: Qualifying. Normally Davis consulted with Pearce about the "qualification profile", i.e., "the perfect line of flight." Their usual consultation did not happen this time.

Davis, thinking that the new prop might require a different strategy, decided to loosen his normally "tight line" on the race course. That turned out to be less than optimal. The qualifying time was 237 mph, and the crew was taken aback. "We all knew we could do better than that."

Davis now realized that he was not only flying for himself. He was also flying for the people who had put in an incredible amount of energy, time and effort; who had sacrificed a chunk of their lives in order to develop this new prop. He was deeply disappointed.

September 11, 2008: Heat Race 1A. Davis was ready this time, but he had to deal with the fact that, as a result of the lower qualifying time, he was in 6th position. This meant that he was on the inside on the last row. There were five planes in front of him and two to his right.

He was totally focused. The green flag went down. The planes were off. Davis knew what he had to do.

"This was to be the most exciting race of my career. I was on the edge of the cliff with that one. It was a gamble to do what I did. It was a very busy start. As you know, with the IF1 starts, there are a lot of airplanes going for the same point in space. Doug Bodine was in the lead. Smokey and the others were on the outside of Bodine. I tucked in on the inside of Bodine. I flew real tight on the pylons. That kept me inside and safe from everybody else. I tucked in there and kept going. I did most of the passing in the first 45 seconds, before I got to Pylon One. All the passing I could do was completed by the time I reached Pylon Three. All I had to do now was fly a tight course for eight laps to finish second, which I did at 238.42 mph."

Davis admitted: "Yes, it was quite the debrief afterwards. Passing on the inside like I did is not a technique I'd recommend to anyone. There was, and still is, a lot of controversy about that strategy. But the prop did great!"

Davis continued: "We always called the Twisted Composites 55x62 the 'Shotgun Prop'. It accelerates like you were shot out of a gun. The new HP also accelerated like a 'Shotgun Prop'. And that is what allowed me to make it to Pylon Three ahead of six other airplanes in that heat race. But, unlike the 55x62, the top speed of the new HP prop was right there with the fast Gold race props."

Now the cat was out of the bag, word raced around the IF1 hangar that there was something new happening in Gary Davis' pit.

In Heat 2A Davis was able to stay with front runners Bodine and Senegal and finish third in spite of a faulty start. In the Gold race, *Screamer's* peformance matched *Yellow Peril's* performance throughout the race, and Davis took second place, beating Doug Bodine by 0.467 seconds. With the new prop, *Screamer's* speed increased by 10 mph over his 2007 speed.

This story does not end here, though. Three HP propellers continue to accumulate air time. The prototype is still on *Scarlet Screamer*, now owned and raced by Vito Wypraechtiger.

After the 2008 races, Hoot Gibson test flew the second HP prop on his Cassutt. He sums up the results:

"I certainly got increased performance. It was actually faster than any prop I've ever run, probably 10 mph faster. It certainly accelerated faster. There seems to be more thrust and horsepower coming from that prop. "

Photo by Neal Nurmi

Gary Davis races the new HP propeller in 2008, Heat 2A. Scarlet Screamer moved up from 5th in the Gold in 2007 at 229.032 mph, to 2nd in the Gold in 2008 at 239.332 mph.

The team that did the impossible: Steve Hill, Gary Davis, the HP prop, Stephen Pearce, and Jack Norris.

Photo by Lista Duren

While this is a very promising design, it is still a highly experimental prop with minimal history.

Gibson’s written test report is available on the Twisted Composites website at www.twistedcomposites.com/Twisted_Composites/Gibson_Report.html

Smokey Young also tried the second prop on *Sly Dog* but elected not to race with it in 2009.

Doug Bodine purchased a third HP propeller from Steve Hill and flew it on *Yellow Peril* in 2009.

Steve Hill points out that there is still much to be learned regarding the practical nature of pure Theodorsen propellers. He says, “There was a huge investment by the team to produce this prop, but how much do the cowling shape corrections contribute to the performance? Can the priceless master be used to make props of another pitch (by rotating the blade relative to the hub) or does a new master need to be created for each pitch?”

Hoot Gibson indicated that his cowling is very similar to *Scarlet Screamer’s*, but Smokey Young, who has a very different cowling shape, reports not finding much difference using the HP propeller versus his customary prop.

Doug Bodine raced an HP prop on Yellow Peril in 2009.

Photo by Lista Duren

At this point, the dynamics of the propeller with different cowling shapes are unclear, but one thing is obvious: If the production of each HP propeller requires the exact fuselage configuration or the racer it will be used on, then this becomes a pricey and complex venture.

What is known, however, is that Steve Hill has invested many years of his time and money to develop and build propellers that have been proven to be safe, and his is the propeller that most IF1 competitors are currently running successfully. To Steve Hill, safety is imperative and he is not willing to compromise on this. For those who might be considering flying the new HP prop on a racer, Steve emphasizes that, while this is a very promising design, it is still a highly experimental prop with minimal history.

Meanwhile, there is a small group of people for whom this project is finished. Stephen Pearce has the satisfaction of having done the impossible and he didn’t get bored while doing it! The participants in this project achieved what they set out to achieve. They managed to push the edge of possibility a bit further “out there.” And they did this for the sheer joy of being engaged in a very challenging process. They had to solve new and complex problems every step of the way. The process of innovation was their mountain to climb. They did it because the challenge was there and they knew they could.

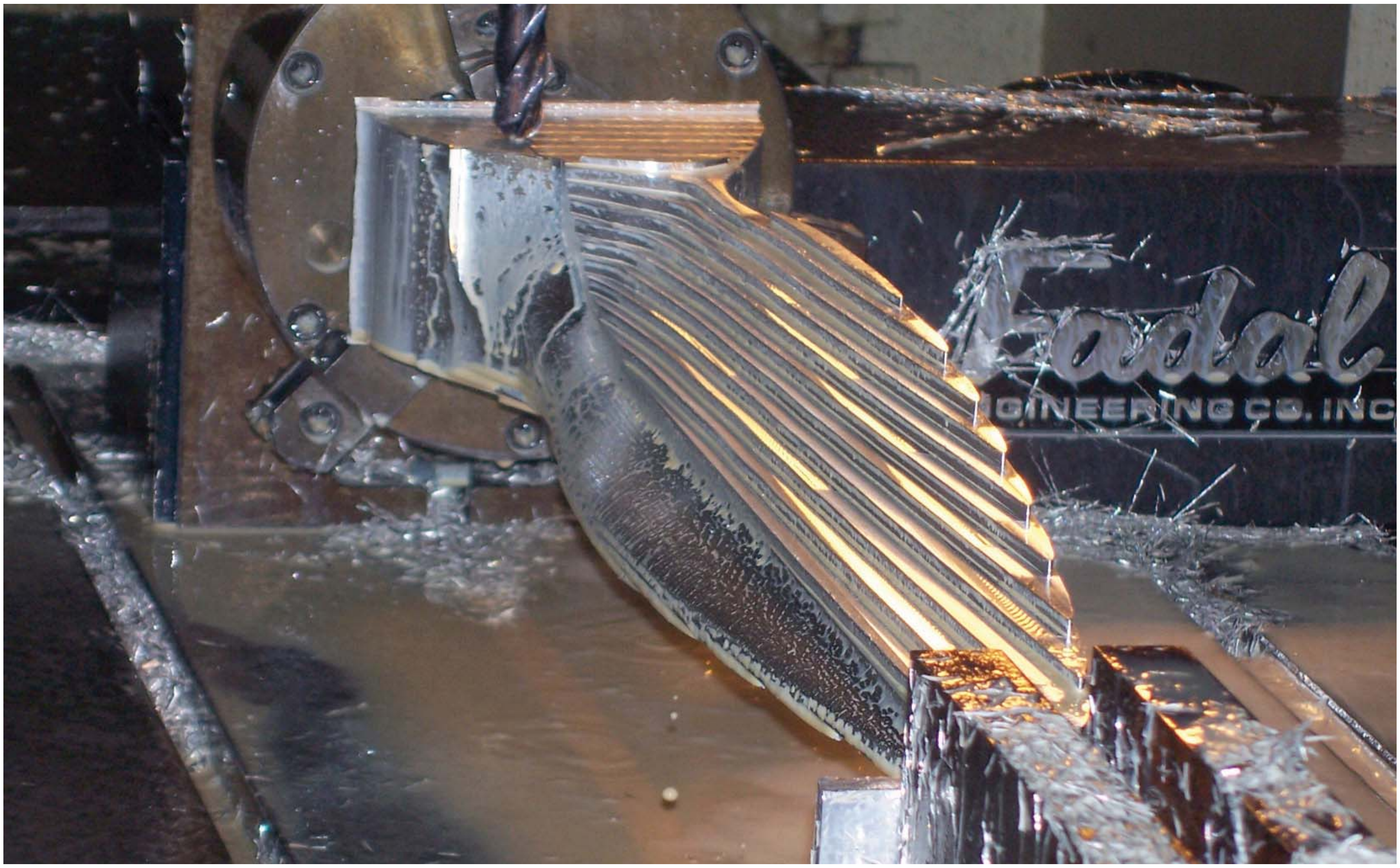


Photo by Stephen Pearce

Roughing the master for the Hill Pearce propeller, first used on Scarlet Screamer, Reno 2008.

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