

The Leading Edge

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Propeller Pitch Distributions: (Part 1) Measurements

by Adam Kaplan, Chief Technical Officer
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If you attended the NMPA Convention this past November, perhaps you saw the panel discussion on repairing new propeller designs. Although many popular designs still use a flat-face, the industry has seen a notable increase in new, contemporary propeller designs such as Veem's Sportfish and Michigan's Marlin props. These propellers are deliberately designed for high performance and feature unique geometries that are manufactured by CNC machining. If you measure one of these new propellers, you are likely to notice that the local pitch varies across the blade surface. Let's quickly review some of these variations.

First, let's review the propeller from the **root to the blade tip**. On a traditional propeller, we would expect that the section pitch to be the same at all radii – this is referred to as constant pitch. For example, on a 20 inch pitch propeller with constant pitch, the 50R, 70R, and 90R all measure to 20 inches pitch. On contemporary propeller designs, the section pitch changes from the root to the tip in order to better match the inflow under the hull – this is referred to as variable pitch. We often see the highest pitch at the 70R, with decreasing pitch at the root and tip. For example, a 20 inch pitch propeller with **variable pitch** could have a pitch of 19.5 in the 50R, 20.5 at the 70R, and 19.5 at the 90R. The average pitch for the propeller is still 20 inches, but the distribution of section pitch is variable from the root to the tip.

Next, let's review the propeller from the **leading edge to the trailing edge**. Again, on many traditional propellers, the propeller face is flat – as a result, the local pitch is the same on the leading edge, the middle, and the trailing edge of the blade. In the previous example of a 20 inch pitch, this means that the first local pitch segment will measure as 20 inches, as will the second and third segments (and so forth). We refer to this as a **flat-face/constant pitch** foil shape (technically, the term is Ogival). However, contemporary propellers will have variation in

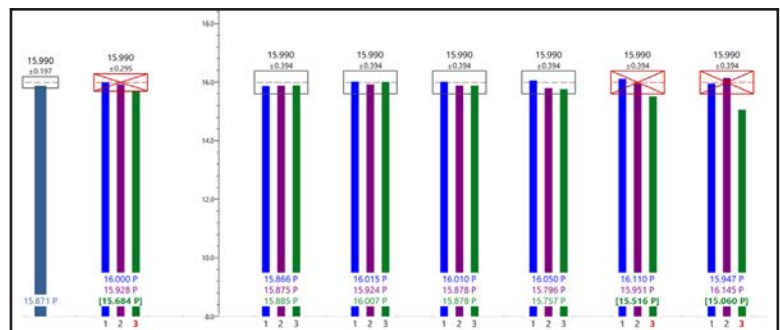


Figure 1 - Constant Pitch pitch measurements from TrueProp Software.

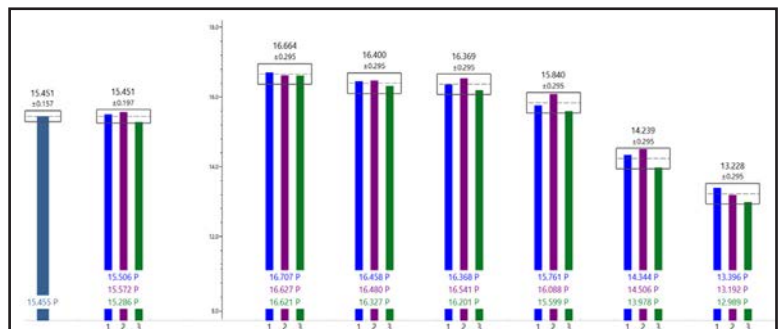


Figure 2 - Variable pitch measurements from TrueProp Software.

the local pitch from the leading edge to the trailing edge. This is because these propellers utilize camber (additional curvature in the face of the blade) to increase performance. Often, the local pitch increases from the leading edge to the trailing edge – so many people refer to these designs as a **cambered-face/ progressive pitch**.

When repairing propellers, it's important to review and understand the intent of the propeller's design. Is the variation

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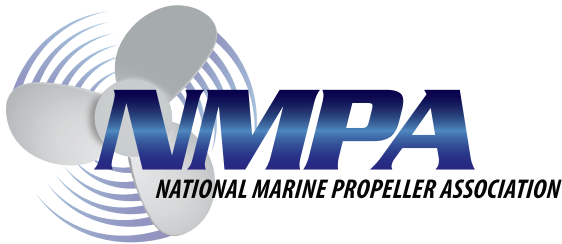
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PRESIDENT'S LETTER

Dear Fellow NMPA Members,

As you read this newsletter, January will have zipped by and most of you are probably into your winter work schedules and beginning to think about and also getting ready for what the rest of 2020 has in store. Such is the business cycle of propeller shops. If not for the -40 degree temperatures here in Alberta, Canada and the regular six inches of snow on the ground, I might not realize it was winter when I think about how busy it is in my shop. The strategy of establishing and providing additional and multiple alternative services that creates a balance in shop revenues during the slower non-boating season continues to be a successful strategy for Prop Masters. I mention this only to reinforce the tips and encouragement I share at Convention for others to adopt similar strategies with the hope that they work for you as they do for me.



STEW FOSTER, PROP MASTERS

Since our last newsletter and E-News communications we rolled out the NMPA 401(k) Retirement Solution, which is a fantastic benefit for our US members. The goal is simply to help you establish or manage retirement plans. Our hope is that you will take advantage of this benefit to either create a retirement program for you and your family, or that you will consider creating a retirement plan that your employees can benefit from through your shop. Emails have been sent with information on how to take advantage of this benefit and information is also included in this issue of 'The Leading Edge'. Due to privacy protocols we will not have any access to any information about member participation in the program outside of the number of companies signed up. We hope to see some good numbers and strong participation.

Your Board of Directors continues to focus and work out the details of the Mercury Buying Program we announced at Convention in November. As you might imagine, this initiative requires a great deal of discussion and follow-up work but know that we are actively working hard and making progress. You will soon see a survey which we need full member participation in order to try to estimate the annual volume of propeller purchases we can expect.

Thank you to all who continue to be loyal members of the NMPA. This association was formed in 1992 and our continuity throughout the years is as a result of those of you who proudly fly the NMPA flag, participate in our activities and pay your membership dues. February starts the 60-day window leading up to membership renewal date which is April 1st annually. I encourage you to renew early and I issue a challenge to you to help us grow by referring new member prospects to join the NMPA. Our member roll has remained steady around 100 to 120 for some time now and I would like to see more growth in 2020. Generally, the economy is good and shops should unquestionably be able to afford \$350 a year to be a NMPA member. We're planning some membership marketing outreach, but your help and referral of businesses who should be members is still the best way to make our association stronger.

Regards,

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*U.S. Department of Labor, Employee Benefits Security Administration, 2015.

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2019 Convention Photo Gallery



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CONTINUED FROM PAGE 1

in pitch due to damage or was that the design intent? Is this propeller a traditional design, where the face of the blade is flat and the pitch is uniform across all radii? That would be a constant pitch propeller with a flat-face... Is there more to the design? Is this propeller a contemporary design, with section pitch varying from the root to tip, like a variable pitch prop? Is

there variation in the local pitch from leading edge to trailing edge, like a cambered faced/progressive pitch propeller? These are important questions to answer before you begin reworking the blades! We wish everyone a successful 2020 and look forward to seeing all of you at the 2020 convention! For more information, contact measure@truepropsoftware.com.



Figure 3- Flat-face/constant pitch 70R line with consistent local pitch values from TrueProp Software.

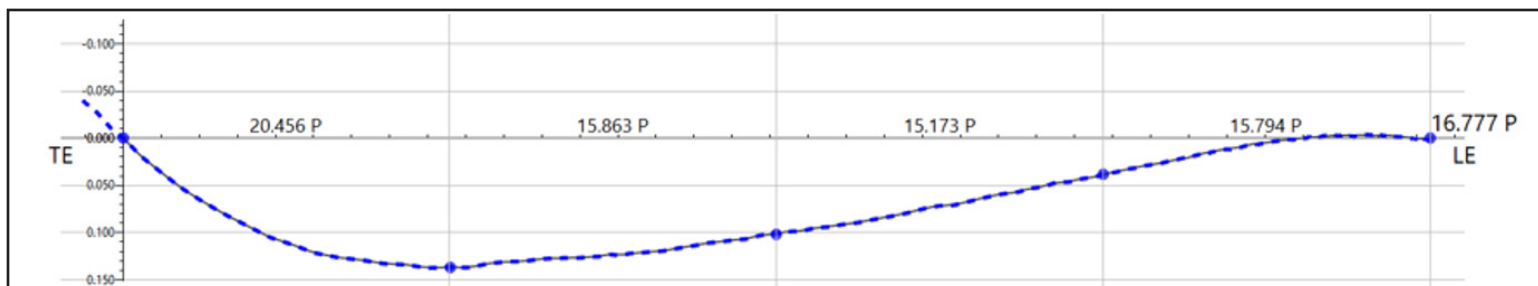


Figure 4 - Cambered-face/progressive pitch 70R line with varying local pitch values from TrueProp Software.

Mercury Propellers Announces New and Innovative Stainless Steel Prop Balancing Process

Adapted from Mercury Prop Bites- Propeller Info Series

In a brochure published recently, Mercury Propellers announced upcoming innovations planned for the implementation of the industry's first balance-by-addition process that dynamically balances stainless steel propellers, rather than utilizing traditional static balancing. The new Mercury concept proposes to add weight to the inside of the propeller hub to perfectly balance propellers. According to the propeller manufacturer, the weight will ensure 'they [the propellers] retain their engineered characteristics and provide the high performance you expect from all Mercury propellers'.

Balance-by-addition offers:

- **PERFECT BALANCE** - Mercury can dynamically and perfectly balance mass-produced propellers by adding weight for the best NVH (Noise, Vibration and Harshness) experience possible.
- **BLADE DESIGN MAINTAINED** - Perfectly balancing props by adding weight eliminates the need to grind away material from a highly engineered and carefully cast propeller blade.
- **CONSISTENCY** - Mercury can mass produce nearly identical propellers by using the balance-by-addition

process. Blade size and shape are more consistent, delivering more consistent performance directly out of the propeller box.

NMPA will continue to monitor for more information on this new concept as details are released.



Progressive Pitch Distributions: (Part 2) Performance

by Adam Kaplan, Program Manager – Propeller Tools,
HydroComp Inc.- Durham, New Hampshire

In our last article, we discussed the geometry of progressive pitch propellers and the differences between these new, contemporary propeller designs and the older, traditional designs. To quickly summarize, traditional designs used constant pitch from the root to the blade tip which resulted in many propellers with a flat face. If the propeller was a 20 inch wheel, then the pitch at every segment on the blade face was 20 inches. Contemporary designs have variation in pitch from the root to the tip (variable pitch distribution) and deviations in local pitch from the lead edge to the trailing edge (face-camber).

Repairing a contemporary design is more involved – and the same can be said about predicting performance. These propellers are notoriously difficult to predict and size. That old favorite “rule of thumb” regarding “an inch of pitch for X RPM” is especially unreliable here!

At HydroComp, we have purpose-built our PropExpert software for these type of sizing applications. Let’s take a look at the steps for representing a progressive pitch propeller in PropExpert...

Mean Effective Pitch

Since the propeller pitch varies at each radius from the root to the tip, what is the pitch of the propeller? The pitch stamped on the propeller is determined by the manufacturer and may not correlate well with the hydrodynamic performance of the wheel. Instead of using the stamped value, we measure the propeller and take an average of the pitch values. Our utility considers the chord length and the radius for each section in our integration – the utility is built into PropExpert!

Face-Camber Ratio (FCR):

For propellers with progressive pitch (leading edge to trailing edge), we must also compensate for the performance effects of the additional curvature in the face. The face curvature is known as face camber. We use a ratio of the face camber to the chord length, called FCR. FCR is calculated by measuring the depth of the face curvature and dividing by the chord length. For example, a face camber depth of 0.125 inches over a 10 inch chord length gives an $FCR = 0.0125$. The FCR can vary at each radius. Typical FCR values are between 0.01 to 0.03. The FCR ratio is averaged into a effective FCR for the propeller – again this calculation is fully integrated into PropExpert!

Predicting Performance

Using the calculated the mean effective pitch and the face-camber ratio, we can make very accurate performance predictions for contemporary propellers! In HydroComp PropExpert, the effect of the FCR is very similar to the effect of cup!

If you have any questions about sizing propellers with new designs, we would love to discuss the topic with you further! We wish everyone a successful 2020 and look forward to seeing all of you at the 2020 convention!

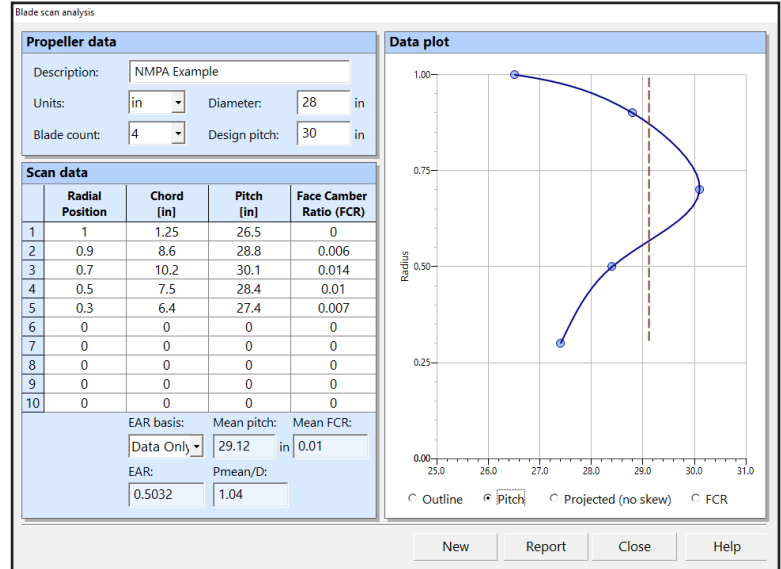


Figure 1 - Calculation of the mean effective pitch and face camber ratio for a contemporary propeller.

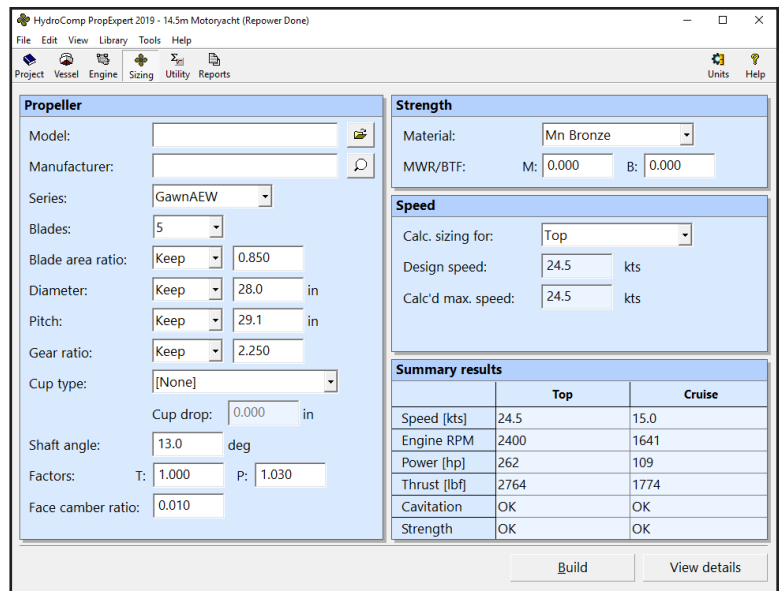


Figure 2 - Implementation of performance calculation with mean effective pitch and face-camber ratio.

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