The compact guide:
Measuring Rowing Technique
with Quiske

The Quiske system is a rowing technique measurement, analysis and coaching tool for rowers or crews of any level and can be used on boats as well as on ergometers. It is easy to install, affordable, and provides instant feedback and cloud analytics. Quiske Ltd is a Finnish startup working for the benefit of any rowers who want to improve on their technique. Our vision is to give valuable data and insights to help rowers improve and get more enjoyment from rowing, not only on water but also indoors.

This guide explains how the Quiske system can be used to measure and analyse rowing technique. Any comments, feedback and suggestions are welcome!

We hope you find this guide useful.

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This guide is dedicated to all rowers who are interested in measuring, analyzing and improving their technique.

This guide explains how to use the Quiske method to measure and analyze rowing technique.

Feel free to share this Guide to anyone you think might find it useful.

Contact us with any feedback, suggestions, and questions: contact@quiske.fi
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Preface

Rowing can feel like dancing

We’re currently living in the golden age of sports technology. There’s more and more data available to analyze sports performance, and technique. Many sports, such as running and cycling, are ahead of rowing in terms of the availability of different types of gadgets you can buy and the numbers of metrics you can track. Recently a limited number of Apps and sensors have been specifically developed for rowers. This Guide is about the Quiske App and pod. A short summary comparison on some of the available measurement systems for rowers can be found on page 39.

Rowers and coaches have traditionally had limited choices for measuring rowing technique. There was the expensive and time-consuming option to hire an expert running complex wired equipment. This came with the hurdle of having to make sense of all the data only after downloading it once off the water. Additionally, the data wasn’t digitally shared with the rower, making it difficult to track changes in performance. Earlier only the world’s elite rowers could afford the expensive measurements and the vast majority of the active rowers in the world never had their technique measured. There are tens of millions of people rowing on indoor rowing machines in gyms worldwide, most of them with defective technique, moving back and forth on the machine without coordination. Rowing wrong not only feels uncomfortable, but can also be unhealthy, many studies prove that lower back and rib injuries are quite common among rowers.

Enter Quiske

The Quiske system comprises of a sensor, a so-called pod, a phone app, advanced algorithms, and a cloud service for data storage and analysis. The system is suitable for all rowers, elite rowers as well as for beginners and for club coaches. Additionally, the system allows rowers to coach themselves, is easy to install, gives instant feedback, and includes innovative cloud analytics providing facts for discussion. Instant feedback (feedback after training is not as effective because the rower quickly forgets what they were doing¹) allows constantly making small adjustments to learn faster, and the effortless measurement enables systematic tracking.

The Quiske system measures each crew member individually, through pods mounted on the oars and/or the seats. Each crew member is able to follow their rowing performance in real time via app which shows live graphs and relevant numerical metrics that help improve technique while on water.

¹ According to KIHU – The Research Institute for Olympic Sports, in order for any athlete to improve any feedback needs to be immediate, there mustn’t be too much of it and it needs to be easy to understand.
The Quiske system consists of

- A pod placed on the oar and/or the seat, or on the erg
- the Quiske RowP App, a phone application measuring and analyzing acceleration of the boat or the erg handle
- a cloud service to store, to analyze and to allow comparison of technique within rowers in a crew

Indoors the Quiske App comes with a Virtual Coach, which gives instant feedback on rhythm and timing, allowing anyone to get the hang of good coordination. The Virtual Coach brings much needed focus not only on power but also on technique.

Rowing requires perfect coordination which is difficult to train on water but can be easily practiced indoors. Instant feedback on rhythm and timing allows anyone to strive for the right coordination, which makes rowing more efficient and healthier for the body.

All recorded data can be uploaded and stored in the cloud to be accessed by the rower and also (with permission from the rower) by the coach and the data can be compared with peers for synchronizing crew technique. The coach can set clear targets for the metrics and the full crew can strive to reach synchronized technique via the instant feedback provided on water. The coach can also use the data in the web portal to put together the most synchronized crew in terms of technique-based facts. In the past choosing the rowers for elite crews may have had quite a bit of uncertainty. Having real facts on performance on water makes also crew selections more objective and fair.

The analyzed data is and remains the property of the rowers, and even when they change coaches or clubs they can show their history in technique through the cloud service. Rowers can share/unshare their data for analysis to any number of coaches, enabling also remote coaching. This also opens up new business opportunities for professional coaches around the world, allowing coaches be a more shared resource among a larger number of rowers. The metrics can also act as a kind of translator between older experienced coaches with their wealth of silent knowledge and younger rowers accustomed to measuring themselves and having data to back up claims and prove progress. The metrics can corroborate the statements by the coach, the measured facts can act as a bridge of understanding between the coach and the rower.
Coaches will always be needed. A talented coach can see subtle things, but many of these things, such as for example blade washout or timing related issues, can be read from the measured data and graphs. The pods can tirelessly measure and analyze your every single stroke, which means that once you know the ideal stroke profile you’re aiming for you can get help from the instant feedback and work to make your every next stroke better.

Getting the hang of the correct coordination and rhythm can make rowing feel like dancing. The Quiske App, pod, and cloud modernize and democratize the sport of rowing due to superior feedback, analytics and virtual coaching which can be afforded even by leisure indoor rowers.

This guide is the first we’ve written to introduce the Quiske rowing measurement system. We hope that it will not only help with getting the most out of the system but also give an appetite for thinking more about what makes a boat move efficiently. Rowing is a beautiful rhythmic sport and thinking about the fluid rowing motion gives a lot of pleasure, at least to us, it’s a kind of physical poetry. We’re physicists but we hope it won’t turn you off, we’ve tried to translate the measured data in a meaningful way and also visualize the instant feedback in a way that can help anyone enjoy rowing more.

This guide is about measuring and analyzing rowing technique. Rowing technique is a vital part of getting a boat to move faster but it is not the only key to success. Good fitness is also needed, and although measuring and analyzing fitness is immensely interesting and important it isn’t included in this guide.
Rowing data categorization: Per Session, Per Stroke, In stroke

To understand the bigger picture of rowing technique measurement it helps to look at the types of data available and to categorize the data depending on what is measured. Here we’re adopting the categorization by Sander Roosendaal of Rowsandall.com and categorize according to granularity into Per Session, Per Stroke, and In Stroke data.

Per Session is data that overall can describe the training. For example, was the training good or bad, hard or easy? Other examples of Per Session data are the duration of the training, the distance covered or your average heart rate.

Diving into finer resolution next leads to Per Stroke data, which is one value of data for each stroke. This could be the stroke length, the average boat speed each stroke, or for example, the stroke rate.

Most interesting from our point of view is the final and most detailed category the In Stroke data which gives detailed information on how the boat and the rower are performing within each stroke, during the drive and during the recovery. Analyzing detailed data from within the stroke gives valuable information about rowing technique and can also contain details on not only the dynamics of the boat movement but can also show the rowers are moving their oars or their seat during the different phases of a stroke.

![Per Session, Per Stroke, In Stroke data categories](image)

*Figure 1 We are using the rowing data categorization by Sander Roosendaal, and dividing the data into Per Session, Per Stroke, and In Stroke data.*

The Quiske system contains data of all three categories but most of the value is in the In Stroke data and the detailed data from within each stroke in every phase: the catch, the drive and the recovery. Quiske is one of the first companies focusing on In Stroke analysis.
Measuring rowing technique

This Chapter explains how to measure rowing technique on water and indoors, and what the measured data means. First, we look at boats on water and then at ergometers indoors.

Measuring rowing technique on water

Let’s start with the basis of everything, the boat acceleration.

**Boat acceleration: how it varies during a stroke cycle and what you can learn from it**

Acceleration is the rate of change of velocity with the unit meter per second squared (m/s²). The acceleration and velocity of the boat fluctuate in rhythm with the strokes, constantly changing with a cyclic pattern and you can learn a lot about how a boat is being rowed simply by measuring the acceleration. You can measure boat acceleration with your phone and there are a number of Apps to facilitate it, the Quiske App being one of them.

The Quiske App measures acceleration at 100Hz, meaning 100 measurements per second. The acceleration is the basis of the analytics and in order to measure the acceleration accurately it is critical that the phone is firmly attached to the boat.

![Figure 2 The phone needs to be rigidly attached to the boat somewhere where you can easily see the instant feedback on the display](image)

Note that attaching the phone *firmly* is important not only for the quality of the data, but also so as not to lose your phone as we did during one measurement session where an oarsman in Denmark knocked the phone into the water with his oar! Also, make sure to attach the phone somewhere you can easily see
the display to benefit from the instant feedback. There are different types of mounts to attach the phone to the foot stretcher or the rigger of the boat. In fact, you can also use Dual Lock™ tape to attach the phone to any existing SpeedCoach holder, we’ve found this works very well.

How do we define the stroke cycle?
Our algorithms detect the rhythmic pattern of the strokes and divides the data into stroke size chunks. Rowing strokes are recognized by sniffing for changes in acceleration and each stroke cycle begins when the boat acceleration is at its minimum, we call this starting point of the stroke cycle the Moment of Minimum Acceleration or MoMA.

Figure 3 shows a typical boat acceleration curve of a big boat (M4-) at 22 strokes per minute (SPM).

![Image](image3.png)

**Figure 3** The boat acceleration graph during the period of one stroke cycle. The starting point of the stroke cycle is at the moment of minimum boat acceleration, the MoMA, marked with red dot. The MoMA is normally happens close to the catch (the moment the oar changes direction) but before full entry of the blade into water, more on that later.

**Definition of the MoMA**
MoMA= Moment of Minimum Acceleration. This is the point of time, which is used as a synchronization point for all data.

The MoMA is the starting point of each stroke cycle and also the point of synchronization which allows comparing the timing of the oars and seat movement within a crew. All data measured with the RowP system is broken up into cycles that start at the MoMA, also data from the oars and the seat are chopped up into cycles that run from one MoMA to the next.
What can you learn from the boat acceleration curve?
The boat acceleration graph gives lots of insight into rowing performance and it is useful to start with this graph when you start using the Quiske system. Especially in a single scull it is interesting to experiment with how changes in rowing technique influences the boat acceleration. With the Quiske App you get almost instant feedback, you always see the previous stroke metrics right in front of your eyes, so it is easy to learn causes and effects while rowing on water.

Let's analyze the acceleration graph in more detail in Figure 4. The graph starts at the MoMA, where the acceleration is at its minimum (=deceleration at its maximum). After this moment the deceleration starts decreasing until it reaches zero (point 1). At this point the boat stops slowing down. We’re now in the drive phase, where the oars are locked to the water and the boat is speeding up, this region is marked blue below. After the finish during the recovery the boat acceleration is normally close to zero, see the green area below, but it can also be positive at the latter part of the recovery due to the redistribution of the center of mass when the rowers approach the stretcher before catch. During the last part of the recovery the acceleration becomes negative (red area, this can also be defined to be part of the recovery period) when the crew changes from pulling the stretcher to pushing it.

Figure 4 The boat acceleration during one stroke cycle. The approximate drive proportion of the stroke is marked blue and the recovery phase is marked green. The time around the catch, where the acceleration becomes deeply negative is marked red.
To help visualize the cyclic nature of the stroke two acceleration graphs are stitched together in Figure 5:

Figure 5 Two stroke cycles stitched together to help visualize the cyclic nature of how catch, drive, and recovery phases join together.

The magnitude of the negative acceleration peak depends on stroke rate and boat type and the best crews tend to have a deeper but narrower peak. The acceleration reaches zero and peaks faster in better crews and at higher stroke rates. After the first acceleration peak there is sometimes a hump in the acceleration followed by a second peak caused by the trunk and arms of the rowers. Sometimes there is a little finish hump caused by the removal of the blade from the water. We show the approximate drive proportion of the stroke in the boat acceleration graph below as blue, and recovery as green.

We divide the acceleration data into stroke sized chunks from each acceleration minimum to the next. A stroke starts at the MoMA which may be slightly before, after, or exactly at the moment when the rower(s) change the direction of their oars at the catch. As long as the acceleration is negative the boat continues to slow down until the blades have locked on to the water before the drive starts. The boat is at its slowest when the acceleration reaches zero after the catch. Then the boat starts to increase in speed during the drive phase. What follows after the drive is of course the recovery phase where typically the acceleration is zero but can also be negative or positive for a while depending on how the rowers move their bodies. As the crew prepare for the next catch the boat starts slowing down (decelerating again) and the next cycle begins soon after that (at the MoMA).

The boat acceleration varies rhythmically as a function of the phase of the stroke cycle, with the boat reaching positive acceleration (=velocity increasing) during drive, and with deep deceleration when the oars enter the water during catch. The boat acceleration is directly proportional to the force that is acting on the boat at any time (Newton’s second law F=ma). A detailed explanation on the forces at work on a boat during rowing can be found in the book The Biomechanics of Rowing by Dr. Valery Kleshnev. The shape of the acceleration curve during the period of one stroke depends on the rowing technique of the rowers as well as on the type of boat. The acceleration graph is very useful to gain more understanding on whether the boat is being rowed powerfully and efficiently. The quality of how power is applied via the blade after catch can be seen in the gradient of the acceleration after the MoMA. The best crews have a very narrow period of time when the acceleration is negative, and it doesn’t matter how deep the deceleration as long as the timespan of deceleration is short.

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2 Dr. Valery Kleshnev: The Biomechanics of Rowing
It is however also really useful to have a look at the boat acceleration during recovery. Some people say that in fact many rowing races are won with an efficient recovery. The best rowers do have similar power they can output during the drive but there are bigger differences in how they can perform during the recovery.

Adding an external sensor to measure the technique of individual rowers
When we add a separate sensor, the Quiske pod, into the mix the measured data gets more exciting. Then we can use the boat acceleration measured with the phone and combine that with the equally highly detailed data from the pod. The pod can be used to measure either the angular movement of the oar, or acceleration of the seat. When placed on the oar the pod uses its gyroscope to measure angular velocity in all three rotational directions, at 100Hz. When placed at the seat the pod uses its accelerometer to measure changes in seat speed, also at 100Hz. At the moment the Quiske App can only connect to one pod at a time, so to measure two oars or the seat and an oar at the same time requires two phones as shown in Figure 6.

Figure 6 The Quiske pod is multifunctional in that it can be placed on either the oar or the seat. Each pod needs one phone since it sends data at high bandwidth. Here we illustrate a pod on the oar (red) sending data to a phone by the footstretcher (red) and a pod on the seat (blue) sending data to another phone by the footstretcher (blue).
Let's start by placing the pod on the oar and see what we can learn from there.

**How to attach the pod to the oar**

Pull the pod onto the oar, with the pointy side of the pod facing towards the rower and place it on the same side as the backside of the blade (the exception to this is boats where oars do not feather, in those boats the pod should go on the top of the oar shaft). Side note: Our algorithms do not yet support analyzing rowing squared, they only understand feathered rowing. When the pod is on the oar we get two new graphs to choose from. You can swipe to access the angular oar velocity graph or the blade flight path graph. In addition to the graphs you also can see your full stroke angle as a number. Let's start with the stroke angle metric.

![Figure 7 The pod should be placed next to the oar lock on the same side as the back of the blade. The narrow end of the pod should point towards the rower](image)

**Measuring the horizontal stroke angle, the stroke length**

You need to focus on getting the right stroke length, not too much nor too little. Full body angle by half slide and compacting up to shins vertical at catch. When rowing hard and focusing on power the strokes can become too short. Seeing the stroke angle in real time helps focus on lengthening out to reach the right catch position. If you want to concentrate on stroke angle only, you can swipe to a numerical view and get rid of the graphs entirely. In the App settings you can limit the number of metrics to four which means you can really the concentrate on just the few most critical metrics, such as perhaps SPM, split, angle, and distance.

You might ask what the right stroke angle should be. It depends on many things, such as on the size of the rower, the rigging, and the type of the boat. We’ve however noticed that it is useful for any rower to know what their typical stroke angle is, and then they can strive to keep it constant, also when getting tired.

**Blade flight path**

The horizontal stroke angle which we discussed above is important, but so is the vertical angle, which tells about how deep the oar goes in the water, or how high it flies during recovery. The blade flight path shows the shape of the path that the oar is making through the full stroke cycle. Since we don’t calibrate the pod it is only the shape of the flight path that matters, not the absolute values, nor the tilt. A typical blade flight path of a sweep rower is shown in Figure 8. The catch is at the left, the oar is driving during the bottom part of the path and finish is at the right. Recovery happens on the upper part of the graph from right to left.
Figure 8 The blade flight path of a sweep rower. The location of the MoMa is shown as a red to show the timing of the position of the oar with respect to the stroke cycle start. The positions of the catch and the finish are shown and the directions of the drive and the recovery are shown with arrows.

The shape of the flight path reveals many things about rowing technique. You can spot skying at the catch, washing out at the finish and also you can easily see differences in blade depth during drive between different rowers in a crew.

One important side note: The current implementation of our algorithms allow analyzing only rowing while feathering the blades. The App is not able to analyze squared blade rowing except in the case of traditional wooden boats where feathered rowing isn’t an option (see the User Guide online for more details).

Oar angular velocity graph

This graph shows the angular velocity of the oar during the drive and recovery. The angular velocity is positive during drive and negative during recovery and the magnitude tells how fast the oar is moving. This graph is also interesting because it visualizes the timing of the catch with respect to the MoMA. The catch is defined as the moment when the oar changes direction, which can be seen as when the graph crosses the y=0 axis. If the angular velocity crosses the y=0 axis after the MoMA it means that the catch happens after deceleration has started decreasing whereas if the crossing happens before the MoMA that means that the oar changes to the driving direction while the boat is still approaching its maximum deceleration.
Figure 9 The oar angular velocity during the time of one full stroke cycle from one MoMA to the next. The angular velocity is positive during the drive and negative during recovery.

It is interesting to see whether the catch happens before or after the MoMA. Especially useful is also to overlay the oar angular velocities of different rowers in the same crew, to spot minute differences in timing of the catch or in how the oar is moving during drive and recovery (see page 20).

Figure 10 You can read the timing of the catch with respect to the moment of minimum boat acceleration from the graph, and all see the catch slip visually in the graph.

Catch slip is something which we know interests many rowers and in the RowP system the catch slip can be seen as a change in the gradient of the oar angular velocity curve during the drive. The catch slip is the time between the catch and the time that the blade is fully immersed and driving, both of these instances are shown with blue arrows in the picture below. We don’t yet produce a number (time from catch) on this but it is something which we could do if there is enough interest.
Lots of technique related aspects are visualized in the graph showing the oar angular velocity:

- the rhythm: the ratio of drive vs recovery
- the peak angular speed of the oar during the drive phase, as well as the location of the peak
- the speed of hands away at finish (the gradient of the curve when it crosses zero)
- the timing of the catch (change of direction of the oars) with respect to the MoMA

Rowing technique is not only about oar motion though. Most of the power comes from the legs and legwork is interesting to measure by placing the pod on the seat. More on that next.

Seat measurement: Do you push hard with your legs? Every stroke?
The Quiske pod can also be used to measure seat speed. You can tape the pod underneath the seat, sometimes on the side of the seat, or on top of the seat, or inside the ProW seat pad.

When attached to the seat the pod measures the speed of the seat back and forth on the stretcher: when the speed is positive the seat is moving towards the bow and when negative it moves towards the foot stretcher. When the seat speed is zero it means that the seat is stationary (normally at the backstop).

Tired legs tend to go soft and then the push off the stretcher loses its sharpness. This is why instant feedback on seat speed is useful, it helps focus on the legs so they don’t go soft during longer sessions.

Focus on legs, legs, legs. Every stroke. Figure 12 shows a typical seat speed curve during the period of one stroke cycle from one MoMA to the next. In this example case the seat starts the leg drive (=crosses the y0= axis) slightly after the MoMA.
Figure 12. The seat speed over the period of one stroke. The seat speed is positive during the leg drive, zero when at backstops, and negative during leg recovery.

The graph shows the speed of the seat both during drive (positive speed), backstop (the speed is 0 m/s = a flat line) and during recovery (negative speed). You can also learn about the timing of the seat from the graph by seeing where the drive starts with respect to the MoMA. In the RowP App the maximum seat speed during the drive is also displayed as a single number in m/s for every stroke. Check this video showing what the instant feedback on seat speed looks like: [https://youtu.be/8CWSjDr7Ajo](https://youtu.be/8CWSjDr7Ajo)

Getting instant feedback on your rowing technique helps determine if you’re developing in the right direction as a rower. The measured data can easily be compared with other rowers which hopefully motivates improving as a rower. Next, we’ll have a look at what you can do with your measured data after your rowing session.

The web portal: analyzing rowing technique after the workout

The Quiske system includes a web portal where data can be analyzed in detail. It also allows individual rowers to drill into their technique data in great detail and coaches to compare the technique of rowers within their crew. In order to use the web portal you need to have some recorded data to analyze. To record data, you need to create a Quiske account for yourself, to upgrade your subscription to either rower or coach level, and to record some data and upload it.

Record your rowing by pressing Start in the Quiske App. Once you’re finished press the back button and go back to the main screen and press the folder icon. From there you can upload your session to the web portal for closer analysis. Here’s the summary overview of a workout as it looks like in the web portal:
Next is a graph which shows the strokerate and boatspeed over the full workout. From here you can choose different regions for closer analysis by painting over the area with your mouse.

The areas you choose are analyzed in closer detail and you can choose to either see each individual stroke or to look at the calculated average stroke from within each region. As an example below the boat acceleration graph from the above two regions: The blue region contains 11 strokes at SPM 35 and the green region roughly the same number of strokes at SPM 22, both regions are translated into one average curve for each region:
The boat acceleration depends not only on the stroke rate but also on the crew and the boat type. In this guide we won’t go through how to use the web portal in detail (there’s a video here http://tiny.cc/4wvxry) but we’ll next dive into how you can compare the technique of different rowers within a crew.

Synchronizing crew technique
To maximize the speed of your boat you need not only a committed and fit crew but you need to align the rowing technique between crew members. With detailed post-training analysis, you can find differences in the timing of the main sequences that the stroke consists of: the catch, the drive, the finish, and the recovery. When differences in timings between crew members come to light the instant feedback of the RowP App can be used to help rowers align their technique with that of the rest of the crew stroke by stroke while training on water.

We think the biggest benefit of our system is for people rowing in crew and their coaches. The data from each individual rower can be uploaded to our cloud and overlaid and compared with all the other rowers within the crew, to help the coach spot differences in rowing technique and help synchronize crew technique. To row a boat in the most efficient way the strokes of rowers in the same crew need to be synchronized. More specifically the timings of catch and finish, drive and recovery and the seat movements of individual rowers in the same boat need to match. The rowers need to row with the same rhythm and by overlaying the graphs from different rowers we can spot differences.

As an example, let’s look at the phases of the rowing stroke measured at the same time from the right oars of two rowers in a double.
The angular velocity is positive when the blade of the oar is moving in the drive direction and it is negative during recovery. The catch is defined as when the direction of the oar changes and as you can see from the above graph catch in this case happens not exactly at the boat acceleration minimum but slightly before it. The oars are already moving in the driving direction at the MoMA, but the blade catches water properly only after this, as can be seen from the change in the gradient of the oar angular velocity during the early drive, at that point the angular velocity continues increasing but is doing so slower. At finish the oar angular velocity decreases quickly and changes direction to go into recovery (during recovery the sign of the oar angular velocity is negative, i.e. it is moving in a direction opposite to the drive direction).

When overlaying the oar curves of the rowers in a crew you can see whether the motion of their oars is synchronized and if they row with the same technique.

You can also look at how synchronized a crew is by comparing the seat data from different rowers in a crew.

The below shows the seat speed graph measured from the same M4- at SPM 21 (however only three rowers were measured). You can see that one of the rowers (red) accelerates the seat all the way to the end whereas others have a more frontloaded leg drive. The green rower starts hit leg recovery a bit later that the others. The timing is pretty synchronized and all of the rowers keep the seat very stationary for a long period of time during backstop:
Figure 17 The seat speed graphs of three rowers in the same 4- shows quite nice synchrony in timing.

What can you learn from the seat speed graph?

- The maximum speed of different rowers. Note that the length of the legs of the rowers influences this: tall rowers have a longer distance to cover with the seat
- The timing of the seat at catch
- Whether the rowers speed up during the recovery
- Whether the rowers keep the seats at backstop for the same amount of time
Summary: benefits in measuring rowing technique on water

As food for thought we leave you with just some of the things that Quiske can help with: the boat acceleration and the seat motion graphs help rowers ensure they’re letting the boats slide under them during recovery so that they won’t upset the flow of the boat. By looking at the timing of the seat the crew can get help with rowing in synchrony. The seat data also helps rowers focus on accelerating their legs through the full drive and making a fast and strong synchronized push with their legs. The oar graphs help synchronize the handling of the oar, the speed of hands away and the full shape of the oar flight path (horizontal and vertical angles). It is also interesting to compare the full angle that each rower is able to maintain at different stroke rates during a session. Should the rower move their hands quickly away or pause the oar for a small moment after extraction? This is a matter of taste but crucial is that everyone in the crew row the same way.

The comparison of rowers is done after the training session in the web portal. However, rowers and coaches can use the web portal to decide on the right targets. Afterwards the instant feedback of the App can be put into use to help rowers nail those targets, every stroke. The rower can choose to see graphs of oar angles or seat speed or to see simple numerical metrics which might be easier to digest while concentrating on rowing. For example, the instant feedback on the stroke angle can help the rower make long strong strokes, consistently. The App can also show the maximum seat speed during each drive, helping the rower focus on pushing hard with the legs, every stroke, even on long sessions.

Finally, a summary of the main graphs:

- The boat acceleration and the boat speed as a function of the time of one stroke
- The oar angular velocity as a function of the time of one stroke
- The blade flight path, the full horizontal and vertical movement over the period of one stroke
- The seat speed graph as a function of the time of one stroke

All of the graphs visualize rowing performance during the period of one stroke cycle. The stroke cycle runs from the negative acceleration peak to the next and all graphs measured from the same crew at the same time can be compared with each other since the data is synchronized according the same boat acceleration. Even when comparing rowers from different crews it is insightful to compare data from different boats measured at the same strokerate.

Figure 18 shows how the boat acceleration, boat speed, oar angular velocity and seat speed can be placed on top of each other to see how the timing of the phases of the oar or the seat correspond to a particular boat acceleration or speed. All these examples were measured from the same rower in a W4- crew at 35 SPM.
Figure 18 The boat acceleration graph (boat speed graph also in same picture), the oar angular velocity graph and the seat speed graph measured from a W4- at SPM 35. The red lines show the MoMA, which is the synchronization point of all data. This is how you can see e.g. what the boat acceleration looks like during a particular moment of the seat speed.
Measuring rowing technique indoors

First a brief summary on indoor rowing technique before diving into how to measure and analyze it.

Indoor Rowing: the basics

Indoor rowing consists of continuously repeating strokes which in turn can be broken down into a series of alternating drives and recoveries. The drive must be powerful and firm whereas the recovery needs to be controlled and relaxed. Hold the handle with your fingertips in order not to tense your shoulders. The drive should consist of three segments that seamlessly flow into each other: legs, body and arms. Start the drive with your legs by hanging off the handle with straight arms. Pull the lever low enough to enable a sharp, fast push with the legs. Engage your torso, that is your back, after the legs. Only after the legs are fully extended and you’re leaning suitably backwards (depends on your length!) should you pull with your arms. If you pull with your arms too early there’s no strength left in them left for the finish and then your stroke ends up too short.

On recovery the sequence is the opposite, first the hands, then the torso and finally the legs. Hands away should be quick but relaxed. Body rocks over with a fluid motion and with good posture. Recovery of the legs starts partially at the same time with the body rocking over. Recovery should be relaxed in order to gather energy for the next drive phase.

Indoor rowing can feel like dancing when you get into the right flow. Rowing consists of accelerations, decelerations, and pauses, that should happen at exactly the right time, just like dancing. It's about doing the right moves at the right time with the right rhythm.
Quiske helps with finding the right rhythm, and so make indoor rowing more enjoyable. The App and the seat pod that goes with it helps rowers find the right technique by measuring and giving feedback on the rhythm of the different sequences that the full stroke consists of.

Measuring rowing technique on the Concept2 indoor rowing machine

On the traditional static indoor rowing machine, the phone with the Quiske App needs to be attached to the handle and the sensor pod needs to be on the seat with the pointy part of the pod facing forwards.

![Figure 20 On the static indoor rowing machine the phone needs to be firmly attached to the handle and the pod to the seat.](image)

The system works on any rowing machine but first in the below examples and pictures we’re using the Concept2 (C2). The pod can be on the side of the C2 seat or you can also put it inside the ProW seat, it happens to fit perfectly.

![Figure 21 On the C2 the RowP pod goes on top or on the side of the seat and the phone goes on the handle](image)
The Virtual Coach
The RowP App comes with a Virtual Coach when rowing indoors. The coach is relentlessly observing your every stroke and gives guidance on your rowing rhythm. Whenever you are getting there in any of the particular metrics the coach colors the corresponding area yellow, and when you get it perfect the coach lets you know with green color, pushing you to make as much as possible green every single stroke.

The App provides instant feedback on your technique, every stroke, with colour coded instant feedback on five basic metrics:

1. Drive rhythm
2. Legs rhythm
3. Legs speed
4. Seat stopped
5. Rowing Style

The drive rhythm (1) is the time of the drive vs the full stroke time. The ideal value depends on the rate but smaller is better.

The seat/legs rhythm (2) is the ratio of time during which the seat is moving (legs are pushing. The ideal again depends on rate but smaller is better.

The leg speed (3) indicates the speed of the leg push during the drive.

Seat stopped (4) tells how long your seat is stopped at back stop.

Style (5) measures how segmented your rowing is, i.e. how clearly the legs, the back, and the hands are segmented. The Virtual Coach prefers a segmented style with three clear phases: don’t lean back while your legs are still pushing, and keep moving the handle even when the seat has stopped.

When you’re rowing really well the Virtual Coach gives you an additional boost by giving you thumbs up and if you’re able to keep making perfect strokes for longer periods of time the Coach gives you a heart:
The Virtual Coach encourages the rower with thumbs up or a heart for particularly good achievements.

**Sharing your results**

After your session the App also provides a summary screen for sharing. The summary contains the average scores for each of the five measured points and also calculates an overall technique index. There is also an inspirational quote to keep you motivated for your next session.

*Figure 22 The Virtual Coach encourages the rower with thumbs up or a heart for particularly good achievements.*

*Figure 23 The session summary includes the overall session metrics and a total technique index.*
The Virtual Coach comes with three different levels: Easy, Moderate, or Challenging. The level determines the width of the range of acceptable values for your seat timing, your seat rhythm, rowing rhythm, and for how long you stay at backstop.

Further metrics for those of us who love detailed data
If you are interested in even more nitty gritty feedback you can switch to the graph view which shows the detailed speeds of the handle and the seat at any time. You can additionally choose to see four or eight metrics (set this in App Settings) or to alternatively see graphs showing the handle and seat speed in real time. Swipe left to see the blue handle and the red seat speed graphs. The handle speed is blue and the seat speed is red. The speed is positive during drive and negative during recovery. When the curve crosses zero the handle/seat are stationary.

The default additional metrics are the following:

- SPM= Strokes per minute
- Stroke length (m)
- Handle max (m/s)= the maximum handle speed during the drive (this is the highest point the blue curve reaches during one stroke)
- Seat max (m/s)= the maximum seat speed during the drive (the highest point the red curve reaches during one stroke)
- Seat stopped (%)= the percentage of time that the seat is stationary during one full stroke. This the period when the red curve is zero between drive and recovery
- Rhythm (%)= some people call this Ratio. It is the percentage of time of the drive time over the full stroke time
- Seat rhythm (%)= the percentage of time that the seat is moving during the drive over the full stroke. The smaller this number is the sharper your leg push is.
- Seat timing (1/100s)= the time difference between the seat and the handle drive start. If the seat starts before the handle this number is positive.

![Graph showing handle vs seat speed](image)

Figure 24 When indoor rowing the RowP App gives instant feedback on 8 different metrics as well as showing the speed of the handle and the seat, every stroke.
The ranges of metrics that the Virtual Coach finds acceptable depend on the stroke rate. As an example, when rowing at a stroke rate 20-24 SPM the rhythm metrics should follow the below in order not to trigger the red arrows of the Virtual Coach:

- Rhythm <33%
- Seat rhythm <25%
- Seat stopped >38%
- Seat timing 0-6

Figure 25 shows an example of rowing at SPM23 approved by the Virtual Coach. The figure also illustrates what proportions of the handle and seat graphs correspond to what phase of the rowing stroke.

The indoor rowing graphs reveal a lot of detail about indoor rowing technique. The ideal graphs depend on rowing rate as well as on the type of rowing machine. The Quiske system can also be used on the dynamic machines such as the RP3. Also it works on the Concept2 on slides. Just make sure to choose the right type of indoor rowing machine within the Settings inside the App. Next a short introduction on how to measure rowing technique on the RP3.
Measuring Rowing Technique on the RP3

Our latest Quiske App update added support for dynamic indoor rowing (RP3 and C2 on slides). We do not yet measure the seat of the RP3. Check this video for a quick introduction on how to measure rowing technique on the RP3: http://tiny.cc/pivxry

Static and dynamic indoor rowing differ from each other in many ways that we will not go into here. We’ve written a detailed blog post on the differences between them here: https://www.rowingperformance.com/blog/dynamic-vs-static-indoor-rowing-what-s-the-difference

As on the static machines on the RP3 you need to attach the phone to the handle, using any sturdy phone holder. The pod goes on the frame of the RP3, e.g. between your feet, with the thinner part of the pod facing towards the rower.

![Figure 26 The phone is attached to the handle and the pod to the frame of the RP3 with the thinner end of the pod pointing towards the rower](image)

Make sure you choose the RP3 as the boat type inside the settings, that the sensor option is switched on, and finally choose a virtual coach of the level you prefer. Then you’re ready to connect to the pod and start rowing.

On the RP3 you have a choice of two kinds of instant feedback. The default screen is the virtual coach which gives instant feedback on rowing technique in a very easy to understand way, via colored balls in different areas. If you prefer to see the actual measured data you can swipe left, to see the detailed measured handle and seat speeds together with a large number of numerical metrics. Let’s start with the Virtual Coach view:
The Virtual Coach gives instant feedback on rowing technique every stroke.

The ratio e.g. the drive rhythm (1) is the time of the drive vs the full stroke time. The ideal value depends on the rate but smaller is better.

The legs rhythm (2) is the ratio of time during which the legs are pushing. The ideal again depends on rate but smaller is better.

The leg speed (3) indicates the speed of the leg push during the drive. Higher is generally better (but you should not do bum shooting!)

Seat stopped (4) tells how long your seat is stopped at back stop and also gives an indication on how segmented your rowing style is, i.e. how clearly the legs, the back, and the hands are following each other in sequence: don’t lean back while your legs are still pushing, and keep moving the handle even when the seat has stopped.

Style (5) gives and indication on how front loaded your drive is. The Virtual Coach prefers strong fast legs. When you’re rowing really well the Virtual Coach gives you an additional boost by giving you thumbs up.
By swiping left you get access to more detailed metrics and graphs. The graph shows the actual measured handle and seat speeds overlaid on each other during every stroke. The metrics show your SPM, stroke length, maximum handle and seat speeds in m/s, as well as information on rhythm and timing:

- **SPM=** Strokes per minute
- **Stroke length (m)**
- **Handle max (m/s)=** the maximum handle speed during the drive (this is the highest point the blue curve reaches during one stroke)
- **Legs max (m/s)=** the maximum speed for the RP3 body during the drive (the highest point the red curve reaches during one stroke)
- **Legs stopped (’%)=** the percentage of time at backstrokes during one full stroke. This the period when the red curve is zero between drive and recovery.
- **Rhythm (%)=** some people call this Ratio. It is the percentage of time of the drive time over the full stroke time
- **Legs rhythm (%)=** the percentage of time of leg drive over the full stroke. The smaller this number is the sharper your leg push is.
- **Seat timing (1/100s) =** the time difference between the seat and the handle drive start. If the seat starts before the handle this number is positive.

*Figure 28 The graph view of RP3 technique gives detailed data on rowing technique*
By recording the data and uploading it to the cloud you can do detailed analysis of rowing technique and comparisons with other rowers. This can help when trying to synchronize crew technique.

**Figure 29** shows examples of good rowing (graphs as well as their corresponding grades by the Virtual Coach) at rates 20-22 on the C2, C2 on slides and the RP3, showing quite big difference in between the machines.

**Figure 29** Ideal handle and seat speeds at rates 20-22 for the C2, the C2 on slides, and the RP3. The shape of the ideal graph depends not on the rowing machine but also on the rowing rate.

Getting into the right rhythm may not be so easy. It is quite normal for beginners and gym rowers to rush on recovery or to pull with their hands before fully pushing with their legs. The most common beginner’s mistakes are perhaps the back opening too early, bum shooting (the seat starts moving much before the handle) and rushing on recovery. We made a video showing these common mistakes and how the RowP Virtual Coach can highlight these to help improve: [http://tiny.cc/67uxry](http://tiny.cc/67uxry)

**Recording and analyzing indoor rowing**

You can record your rowing on the erg by pressing Start. Once you're finished press the back button and go back to the main screen and press the folder icon. From there you can upload your session to the web portal for closer analysis.
Comparing the indoor rowing technique of different rowers

It is interesting and useful to compare the indoor rowing technique of different rowers. As a coach you can work on synchronizing crew technique indoors in order to later make the boat move more efficiently on water.

The above sample shows two rowers both rowing at stroke rate 18 on the Concept2. One rower is green and the other blue, the solid line shows their handle speed and the dotted line is their seat speed. The green rower starts his seat earlier than the blue rower as can be seen at the right-hand side of the graph. The blue rower has a more front-loaded drive whereas the green rower accelerates his drive towards the finish. The seat and the handle should follow a similar gradient at catch because if they follow different paths it means that either the back is opening too early or there is bum shoving. Both rowers have fast hands away. The blue rower has a more even recovery with the handle moving at almost constant speed for the majority of the recovery. The green rower moves his handle quicker at the start of the recovery, then almost pauses the handle before making a quick movement with his hands just before the catch.

Typical graphs on different types of indoor rowing machines

The measured data depends very much on the type of erg. Static and dynamic ergs behave in a very different way. In a static erg both the handle and the seat are moved in the same direction whereas in a dynamic erg they move in opposing directions. There are also differences within the dynamic ergs, e.g. the weight of the frame being pushed with the legs influences the magnitude of the handle and seat speeds. One factor common to all machines influencing the shape of the seat/legs graph is the drag-factor. The smaller the drag factor the larger the speed.

Figure 31 shows the measured handle and seat/legs speeds on three different types of indoor rowing machines overlaid using the analysis feature in the Quiske web portal. It reveals that the machines behave very differently and you cannot directly compare static and dynamic graphs with each other. The graphs in Figure 31 were all generated by the same rower. The reason for handle and legs speed being higher for the RP3 compared with the C2+slides is that the weight of the frame being pushed is considerably less as well as the flywheel itself being of different construction (the weight is 22kg for the RP3 vs 27kg for the C2+ slides).
Sidenote: What about the damper setting?
The dragfactor influences the flow of air into the flywheel. When the lever is set high there’s a lot of air entering the flywheel casing which slows the flywheel down and makes it more harder to spin. When the dragfactor is low the flywheel spins faster and easier. It is then really important to manage a fast catch, and to drive the legs down at the right time with explosive force. Rhythm and timing are crucial, you need a fast catch followed by a sharp leg drive, a front-loaded power curve and a calm recovery. All of this is easier with a lower dragfactor.

When the dragfactor is low it is easier to manage a fast leg drive, which means you can use the biggest muscles in your body in the most efficient way. That’s for example why the virtual coach keeps an eye on your seat rhythm, which measures the rhythm of your legdrive.

Hint: It is easier to satisfy the requirements of the Virtual Coach with a lower dragfactor.
Measurement gear

The Quiske system comprises an Android/iOS phone running the Quiske application and an external pod.

Android

The Quiske RowP Android App can be downloaded from Google Play Store. As a free version it supports most of the basic rowing metrics provided by other high-end commercial products.

Android requirements;

- Android 5.0 (Lollipop) or later
- minimum Bluetooth Low Energy (BLE) 4.0 support
- IP68 (water-proof) or IP67 (splash-proof) support when using outdoors
- lighter devices preferred when used indoors

When measuring and comparing crew data it is recommended to use similar phone models for all rowers within the crew because there may be small differences in how phones filter acceleration data.

Using the Quiske App does not require having a SIM-card or internet connection during the workout. However, internet connection, e.g. WiFi, is needed for the following:

- to download and update the app
- for Android and system application updates
- to upload your workouts to RowP cloud service
- to speed up getting a GPS fix. Especially when travelling to new place it can take long time for device to get GPS fix without SIM-card. It is highly recommended to connect the device to WiFi and use some map application like Google Maps to make sure that device has received GPS fix before starting the workout

The App uses GPS sensor of the phone for speed calculations and for storing the rowing route. The internal accelerometer is used for the cycle detection and for synchronizing the external pod data. Because of this the device needs to be rigidly attached in the boat. Sessions are stored in the device memory and can be uploaded afterwards to the cloud service under the rower's subscription. After the upload the session will be deleted automatically from the device memory. Sessions can be deleted manually, too.

It is recommended to shutdown most of the background applications in the device during rowing. Using Airplane/Flight mode is a recommended way to save battery, too.

iOS

The iOS version of the Quiske App will launch in November 2018. It supports any iOS phones 11.x and above.

Quiske Pods

The App supports one external Pod per device and it can be placed on the oar (left/right) or on the seat. There are two models of the pod, please, check that the placement of the pod is correct in the instructions online.

After the Pod has been connected to application it sends data at 100 Hz to the App.

The Quiske Pod has a 100mA battery and needs to be charged on average every second week. The charging level of the Pod can be checked within the App when connected. Please, make sure that the
charging level is over 70% before starting your session. The pod can be charged using a USB-charger in 10 minutes to over 90% but requires about 1 hour charging time to be fully charged.

Remember to exit the App after rowing to close the connection to the pod.

Customer Feedback

The first customer feedback has been excellent. We’re in a new market, where anyone can analyze and improve their own rowing, empowering coaches with modern tools and rowers to coach themselves. We would like to partner with rowing clubs and vendors across the world and indeed Quiske have our first customers from 14 different countries around the world.

Olympic Medalist Eskild Ebbesen put it very nicely when talking about the Quiske RowP system “You really need the numbers!”.

Read Coach Bergenroth’s thoughts on Why the Quiske Pod could be the Next Big Thing in Rowing.

The English coach Edward Boileau used two RowP pods to synchronize the seat motion of his pair boat, and said the Quiske data was the reason the pair went on to win a narrow Gold medal at their next race.

The Decamillis Rowing Academy is actively using the Quiske system to measure their young athletes.

Our customers value the web portal and the innovative solution where a synchronization algorithm is used to allow easy comparison of the technique and timing of different rowers.

Charlie Wemyss, Head Coach of crew at the US Berwick Academy began discussions with Quiske already a year and a half ago and started using the RowP system first in his single and later with his crew. Charlie feels that measuring rowing performance is the way forward to improved times and for higher personal and team success. Also, Charlie comments that Quiske is the easiest system to implement, with no hard wiring, easy placement on the seat and oars, instant feedback, and cloud analysis.
Comparison to competitors

This section gives an overview on how we see the Quiske RowP system compares with competing solutions. We’ve tried to make the comparison objective, and if you see flaws we’d like to hear from you.

<table>
<thead>
<tr>
<th>Key benefits</th>
<th>Quiske RowP</th>
<th>Coxmate GPS</th>
<th>Rowing in Motion</th>
<th>Peach / BioRowTel on water</th>
<th>BioRowTec for ergo</th>
<th>NK SpeedCoach with Empower Oarlock</th>
<th>Concept 2 PM5</th>
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<tr>
<td>Easy to install</td>
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*Figure 34 Comparing the key benefits available in different competing products*

The biggest difference to established competitors is that our system works not only on water but also indoors. Additionally, the RowP pods are multifunctional in that they can be used to measure either oars or the seat. Most competitors also lack a modern cloud where data can be analyzed in detail and where the technique of different rowers can be compared.

The Quiske RowP system does not measure force or power like the Peach, the BioRow, and the NK Empower Oarlock products do. The focus of the Quiske system is on technique, measuring the seat and oar handling in detail and analyzing the rhythm and timing of all phases within the rowing stroke.
Meet the Team

Quiske is owned by Dr. Kristina Björknäs and Pentti Soini, both physicists with long careers in global business and both still competing in rowing on water and indoors. Kristina learned to row when finishing her PhD at Oxford University and brought her love for the sport back to Finland some 15 years ago. Pentti has been coaching and developing the rowing culture in Finland all his adult life. Last year the team was strengthened by Dr. Caspar Ockeloen who is responsible for the algorithm development.

Dr. Kristina Björknäs

Kristina is a Physicist turned into a marketeer with >15 years of global business experience and a solid academical background in Physics, a PhD in Engineering Science from Oxford University, and many years of experience in R&D, sourcing, marketing, and managing of cross-functional teams. Kristina was responsible for the launching of new camera technologies to global markets at Microsoft and Nokia. Earlier she managed the display and touch component roadmap, supplier portfolio and supply chains in the Nokia sourcing organization. Kristina is a competitive rower and represented Finland in indoor rowing at the World Games in 2017.

Pentti Soini

Pentti studied Technical Physics at Helsinki University of Technology and has since worked as a technology expert at Nokia, IBM, Cisco, Microsoft and Fujitsu. His strengths are in customer orientation and the ability to manage challenging projects to completion and indeed he steered the successful launching of our RowP App. Pentti has been rowing competitively for 30 years and coaches junior rowers too. Pentti is the organizer of the world’s largest indoor ErgoMarathon already for 16 years in a row.

Dr. Caspar Ockeloen

Caspar is the third Physicist in our team. Caspar is of Dutch nationality and has a PhD in particle physics and is currently doing his Academy Postdoctoral research at Aalto University in Espoo, Finland. Caspar is responsible for the Quiske algorithms and the visualization of the data.