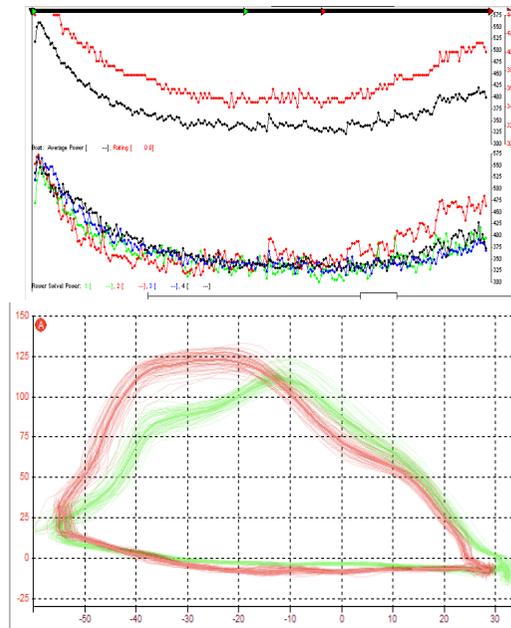
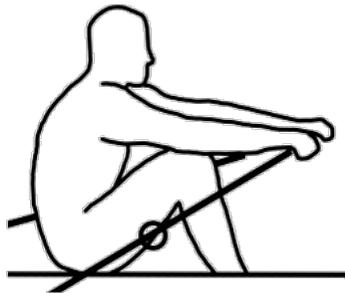


2017 World Rowing Coaches Conference, London, GB, 7<sup>th</sup> December 2017

## Capturing Data and Using Technology

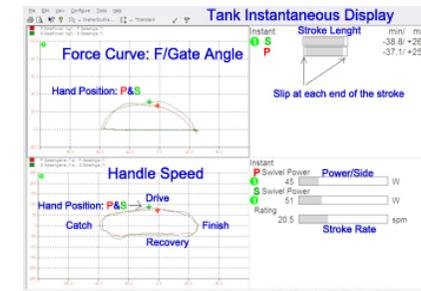


Conny Draper, PhD

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Consultant

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# Coaching & objective Assessment during Training

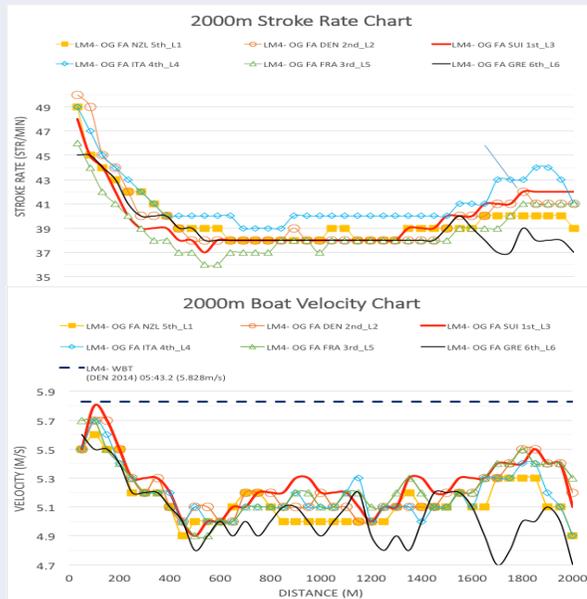


Ergometer	On-water	Rowing tank
Load regulation	Technique & performance assessment	Movement regulation
Conditioning training	On-water technique training	Additional technique training

# Biomechanical On-water Analysis & Feedback

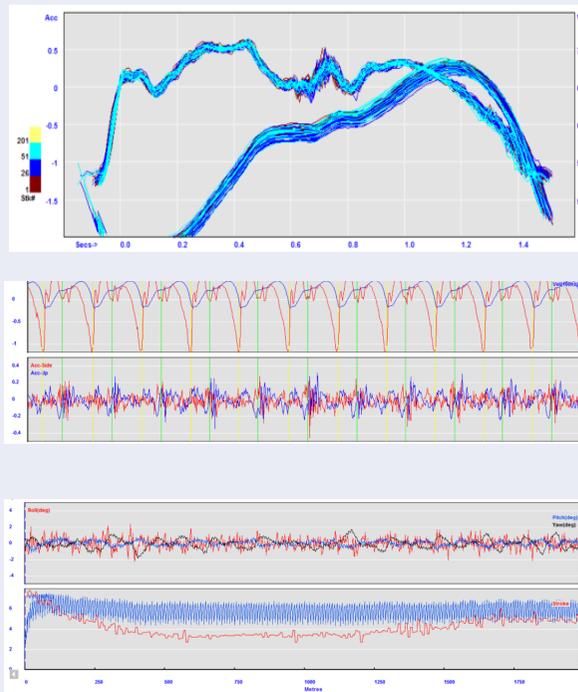
## FISA GPS Racing System (Swiss Timing)

Public Racing information of up to 6 crews/ race  
 - Stroke rate & Boat speed/ 50m



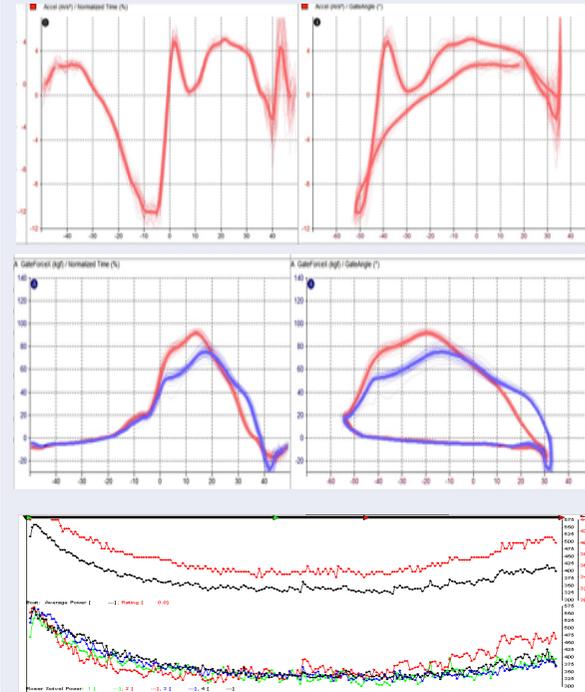
## GPS Monitoring System (i.e. Catapult 'MinimaxX')

Training monitoring/ racing tool to assess boat-specific performance & boat motion information



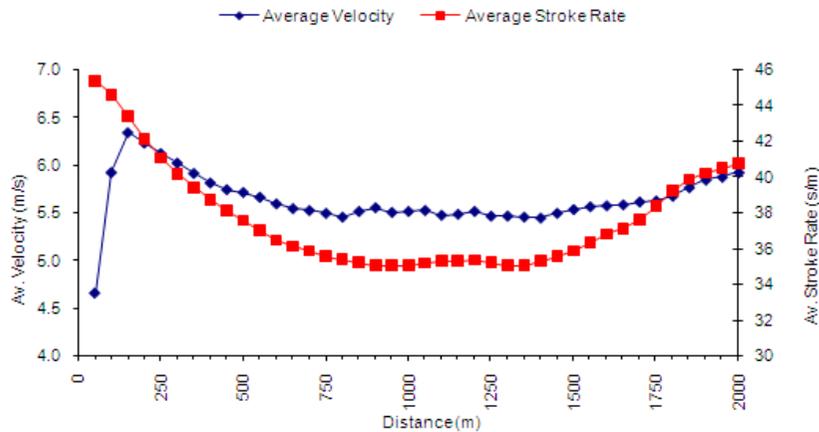
## On-water Rowing Instrumentation System (i.e. Peach Innovation)

Training monitoring/ racing tool to assess athlete & boat specific performance & boat motion information



# Race Analysis (2000m)

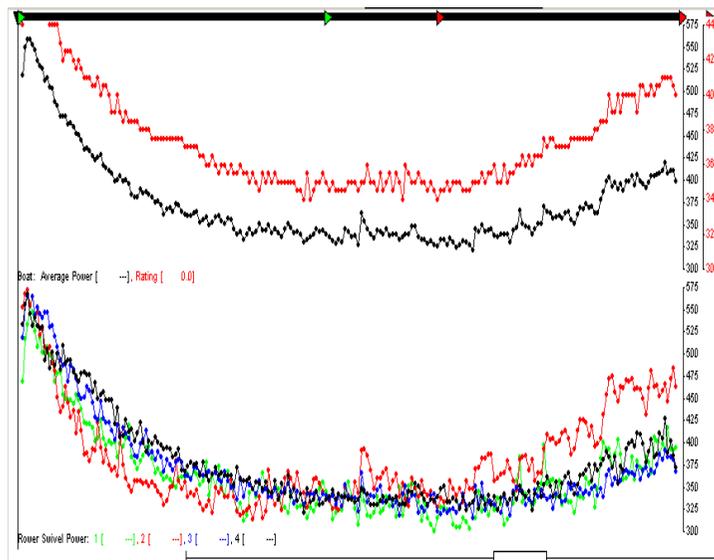
## Boat & individual Athlete's Performance during racing



Race Analysis (analysed with Catapult)  
(i.e. Catapult GPS system (MinimaxX); boat information)

Stroke rate/ 50m

Boat velocity/ 50m



Race Analysis (analysed with Peach)  
(i.e. Peach system; boat & athlete information)

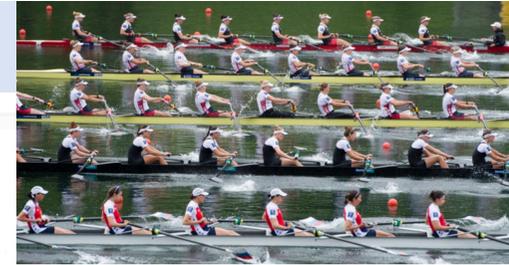
Stroke Rate/ stroke

Average Crew Power/ stroke

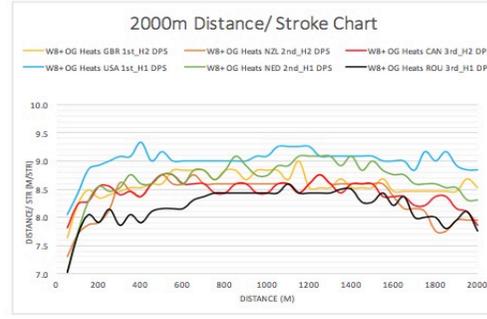
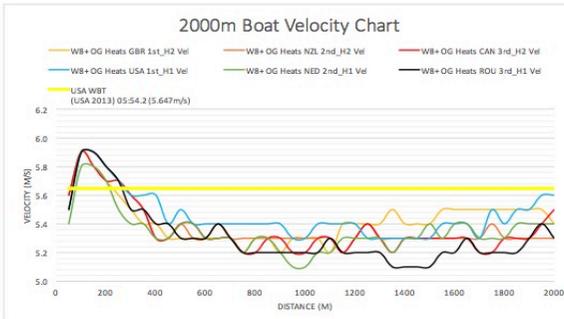
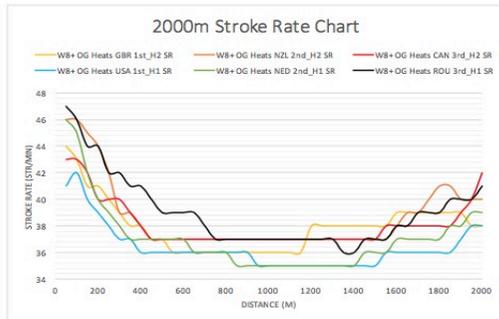
4 individual handle power output/ stroke/ rower  
(Seat 4-3-2-1)

# FISA GPS Racing System (Swiss Timing)

2016 Olympic Games  
Rio, BRASIL: 6-14th August 2016



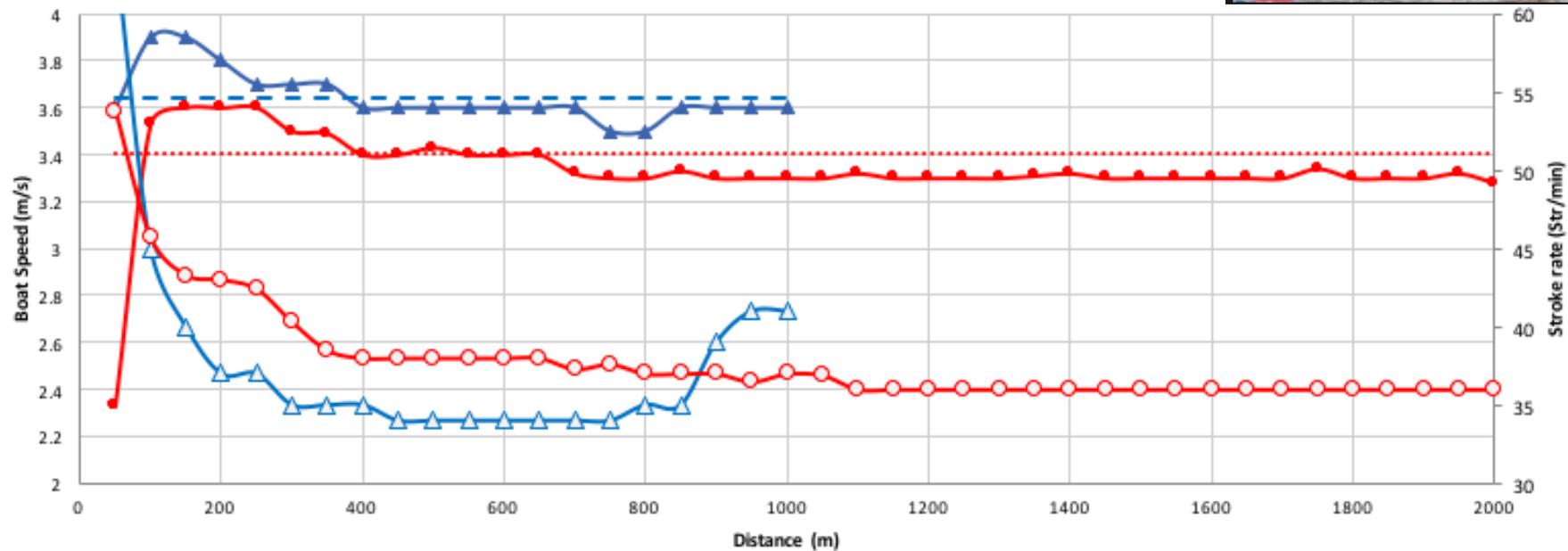
Event County Place	USA WBT (USA 2013) 05:54.2 (5.647m/s)	W8+ OG Heats GBR		W8+ OG Heats NZL		W8+ OG Heats CAN		W8+ OG Heats USA		W8+ OG Heats NED		W8+ OG Heats ROU		W8+ OG Heats GBR		W8+ OG Heats NZL		W8+ OG Heats CAN		W8+ OG Heats USA		W8+ OG Heats NED		W8+ OG Heats ROU	
		1st_H2	SR	1st_H2	SR	1st_H2	SR	1st_H1	SR	1st_H1	SR	1st_H1	SR	1st_H1	SR	1st_H2	SR	1st_H2	SR	1st_H1	SR	1st_H1	SR	1st_H1	SR
		Vel	SR	Vel	SR	DPS	SR																		
50	5.647	5.6	44	5.6	46	5.6	43	5.5	41	5.4	46	5.5	47.0	7.6	7.3	7.8	8.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
100	5.647	5.9	43	5.9	46	5.9	43	5.9	42	5.8	45	5.9	46.0	8.2	7.7	8.2	8.4	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
150	5.647	5.8	41	5.9	45	5.8	42	5.9	40	5.8	42	5.9	44.0	8.5	7.9	8.3	8.9	8.3	8.0	8.3	8.0	8.3	8.0	8.3	8.0
200	5.647	5.7	41	5.8	44	5.7	40	5.8	39	5.7	40	5.8	44.0	8.3	7.9	8.6	8.9	8.6	7.9	8.6	7.9	8.6	7.9	8.6	7.9
250	5.647	5.6	40	5.7	42	5.6	40	5.7	38	5.5	39	5.7	42.0	8.4	8.1	8.6	9.0	8.5	8.1	8.6	8.1	8.6	8.1	8.6	8.1
300	5.647	5.5	39	5.6	39	5.6	40	5.6	37	5.4	38	5.5	42.0	8.5	8.6	8.4	9.1	8.5	7.9	8.6	7.9	8.6	7.9	8.6	7.9
350	5.647	5.4	38	5.5	39	5.5	39	5.6	37	5.4	37	5.5	41.0	8.5	8.5	8.5	9.1	8.8	8.0	8.6	8.1	8.6	8.1	8.6	8.1
400	5.647	5.4	38	5.3	38	5.3	38	5.6	36	5.3	37	5.4	41.0	8.5	8.4	8.4	9.3	8.6	7.9	8.6	7.9	8.6	7.9	8.6	7.9
450	5.647	5.3	37	5.3	37	5.3	37	5.4	36	5.3	37	5.4	40.0	8.6	8.6	8.6	9.0	8.6	8.1	8.6	8.1	8.6	8.1	8.6	8.1
500	5.647	5.3	37	5.4	37	5.4	37	5.5	36	5.4	37	5.3	39.0	8.6	8.8	8.8	9.2	8.8	8.2	8.6	8.1	8.6	8.1	8.6	8.1
550	5.647	5.3	36	5.3	37	5.4	37	5.4	36	5.4	37	5.3	39.0	8.8	8.6	8.8	9.0	8.8	8.2	8.6	8.1	8.6	8.1	8.6	8.1
600	5.647	5.3	36	5.3	37	5.3	37	5.4	36	5.3	37	5.3	39.0	8.8	8.6	8.6	9.0	8.6	8.2	8.6	8.1	8.6	8.1	8.6	8.1
650	5.647	5.3	36	5.4	37	5.3	37	5.4	36	5.3	36	5.4	39.0	8.8	8.8	8.6	9.0	8.8	8.3	8.6	8.1	8.6	8.1	8.6	8.1
700	5.647	5.3	36	5.3	37	5.3	37	5.4	36	5.3	36	5.3	38.0	8.8	8.6	8.6	9.0	8.8	8.4	8.6	8.1	8.6	8.1	8.6	8.1
750	5.647	5.2	36	5.3	37	5.2	37	5.4	36	5.2	36	5.2	37.0	8.7	8.6	8.4	9.0	8.7	8.4	8.6	8.1	8.6	8.1	8.6	8.1
800	5.647	5.3	36	5.3	37	5.2	37	5.4	36	5.3	36	5.2	37.0	8.8	8.6	8.4	9.0	8.8	8.4	8.6	8.1	8.6	8.1	8.6	8.1
850	5.647	5.3	36	5.3	37	5.3	37	5.4	36	5.3	35	5.2	37.0	8.8	8.6	8.6	9.0	9.1	8.4	8.6	8.1	8.6	8.1	8.6	8.1
900	5.647	5.2	36	5.3	37	5.3	37	5.4	36	5.2	35	5.2	37.0	8.7	8.6	8.6	9.0	8.9	8.4	8.6	8.1	8.6	8.1	8.6	8.1
950	5.647	5.3	36	5.3	37	5.2	37	5.3	35	5.2	35	5.1	37.0	8.8	8.6	8.4	9.1	8.7	8.4	8.6	8.1	8.6	8.1	8.6	8.1
1000	5.647	5.3	36	5.3	37	5.2	37	5.3	35	5.2	35	5.2	37.0	8.8	8.6	8.4	9.1	8.7	8.4	8.6	8.1	8.6	8.1	8.6	8.1
1050	5.647	5.3	36	5.3	37	5.3	37	5.4	35	5.2	35	5.2	37.0	8.8	8.6	8.6	9.3	8.9	8.4	8.6	8.1	8.6	8.1	8.6	8.1
1100	5.647	5.2	36	5.3	37	5.3	37	5.4	35	5.2	35	5.3	37.0	8.7	8.6	8.6	9.3	8.9	8.6	8.6	8.1	8.6	8.1	8.6	8.1
1150	5.647	5.4	36	5.2	37	5.2	37	5.4	35	5.3	35	5.2	37.0	9.0	8.4	8.4	9.3	9.1	8.4	8.6	8.1	8.6	8.1	8.6	8.1
1200	5.647	5.4	38	5.3	37	5.3	37	5.4	35	5.3	35	5.2	37.0	8.5	8.6	8.6	9.3	9.1	8.4	8.6	8.1	8.6	8.1	8.6	8.1
1250	5.647	5.4	38	5.4	37	5.4	37	5.3	35	5.3	35	5.2	37.0	8.5	8.8	8.8	9.1	9.1	8.4	8.6	8.1	8.6	8.1	8.6	8.1
1300	5.647	5.4	38	5.3	37	5.3	37	5.3	35	5.3	35	5.2	37.0	8.5	8.6	8.6	9.1	9.1	8.4	8.6	8.1	8.6	8.1	8.6	8.1
1350	5.647	5.5	38	5.3	37	5.2	37	5.3	35	5.2	35	5.1	36.0	8.7	8.6	8.4	9.1	8.9	8.5	8.6	8.1	8.6	8.1	8.6	8.1
1400	5.647	5.4	38	5.3	37	5.3	37	5.3	35	5.3	35	5.1	36.0	8.5	8.6	8.6	9.1	9.1	8.5	8.6	8.1	8.6	8.1	8.6	8.1
1450	5.647	5.4	38	5.3	37	5.3	37	5.3	35	5.3	36	5.1	37.0	8.5	8.6	8.6	9.1	8.8	8.3	8.6	8.1	8.6	8.1	8.6	8.1
1500	5.647	5.4	38	5.3	37	5.3	37	5.3	35	5.4	36	5.1	37.0	8.5	8.6	8.6	9.1	9.0	8.3	8.6	8.1	8.6	8.1	8.6	8.1
1550	5.647	5.5	38	5.3	37	5.3	38	5.4	36	5.3	36	5.2	37.0	8.7	8.6	8.4	9.0	8.8	8.4	8.6	8.1	8.6	8.1	8.6	8.1
1600	5.647	5.5	39	5.3	38	5.3	38	5.4	36	5.4	37	5.2	38.0	8.5	8.4	8.4	9.0	8.8	8.2	8.6	8.1	8.6	8.1	8.6	8.1
1650	5.647	5.5	39	5.3	39	5.3	38	5.4	36	5.4	37	5.3	38.0	8.5	8.2	8.4	9.0	8.8	8.4	8.6	8.1	8.6	8.1	8.6	8.1
1700	5.647	5.5	39	5.3	39	5.2	38	5.3	36	5.3	37	5.2	39.0	8.5	8.2	8.2	8.8	8.6	8.0	8.6	8.1	8.6	8.1	8.6	8.1
1750	5.647	5.5	39	5.4	40	5.2	38	5.5	36	5.3	37	5.2	39.0	8.5	8.1	8.2	9.2	8.6	8.0	8.6	8.1	8.6	8.1	8.6	8.1
1800	5.647	5.5	39	5.3	41	5.3	38	5.4	36	5.3	37	5.2	39.0	8.5	7.8	8.4	9.0	8.6	8.0	8.6	8.1	8.6	8.1	8.6	8.1
1850	5.647	5.5	39	5.3	41	5.3	38	5.5	36	5.4	38	5.2	40.0	8.5	7.8	8.4	9.2	8.5	7.8	8.6	8.1	8.6	8.1	8.6	8.1
1900	5.647	5.5	39	5.3	40	5.3	39	5.5	37	5.4	38	5.3	40.0	8.5	8.0	8.2	8.9	8.5	8.0	8.6	8.1	8.6	8.1	8.6	8.1
1950	5.647	5.5	38	5.3	40	5.4	40	5.6	38	5.4	39	5.4	40.0	8.7	8.0	8.1	8.8	8.3	8.1	8.6	8.1	8.6	8.1	8.6	8.1
2000	5.647	5.4	38	5.3	40	5.5	42	5.6	38	5.4	39	5.3	41.0	8.5	8.0	7.9	8.8	8.3	7.8	8.6	8.1	8.6	8.1	8.6	8.1



# FISA GPS Racing System (Swiss Timing)



**PR1 MIX: RACE ANALYSIS COMPARISON: WBT 1000 VS. 2000M**



- ▲ Speed WBT 1000m UKR 2016 WC3 FA
- Speed WBT 2000m UKR 2017 WC2 FA
- WBT (04:34.7)-UKR 2016 WC3 Poznan
- WBT (09:47.1)-UKR 2017 WC2 Poznan
- ▲ SR WBT 1000m UKR 2016 WC3 FA
- SR WBT 2000m UKR 2017 WC2 FA

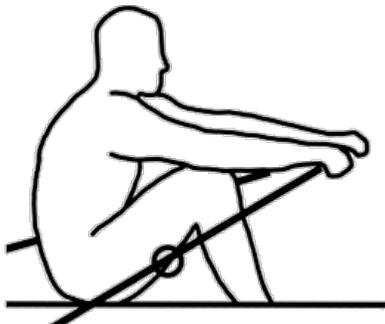
# Information Feedback

External appearance of rowing technique:  
“Coach’s eye”:

can be **observed** & so coached.

**advantage** of **quick information** feedback (instantaneous)

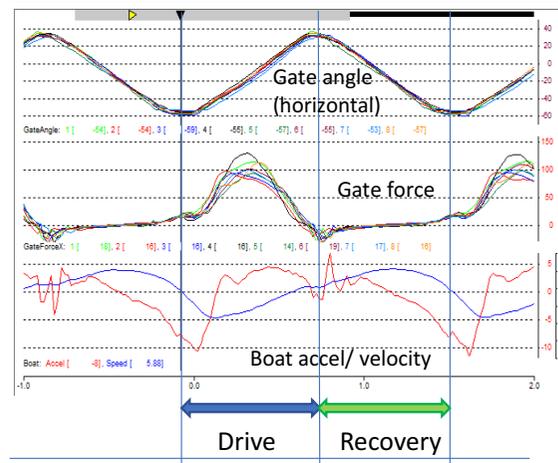
Behaviour model  
for the rower & the coach



**Utilisation of Technology**  
‘objective coach’s eye’ –  
**advantages of precision**

data is measurable – but needs to be  
**applicable – coachable – trainable**

Biomechanical explanation  
model



**Implementation of Real-Time Feedback**  
e.g. **video/ audio** sequences

instantaneous objective feedback  
(but **precision is crucial**)

**to examine** technique & performance,  
**to recognise** technical faults &  
**to provide** ideal vs. current  
technique & performance

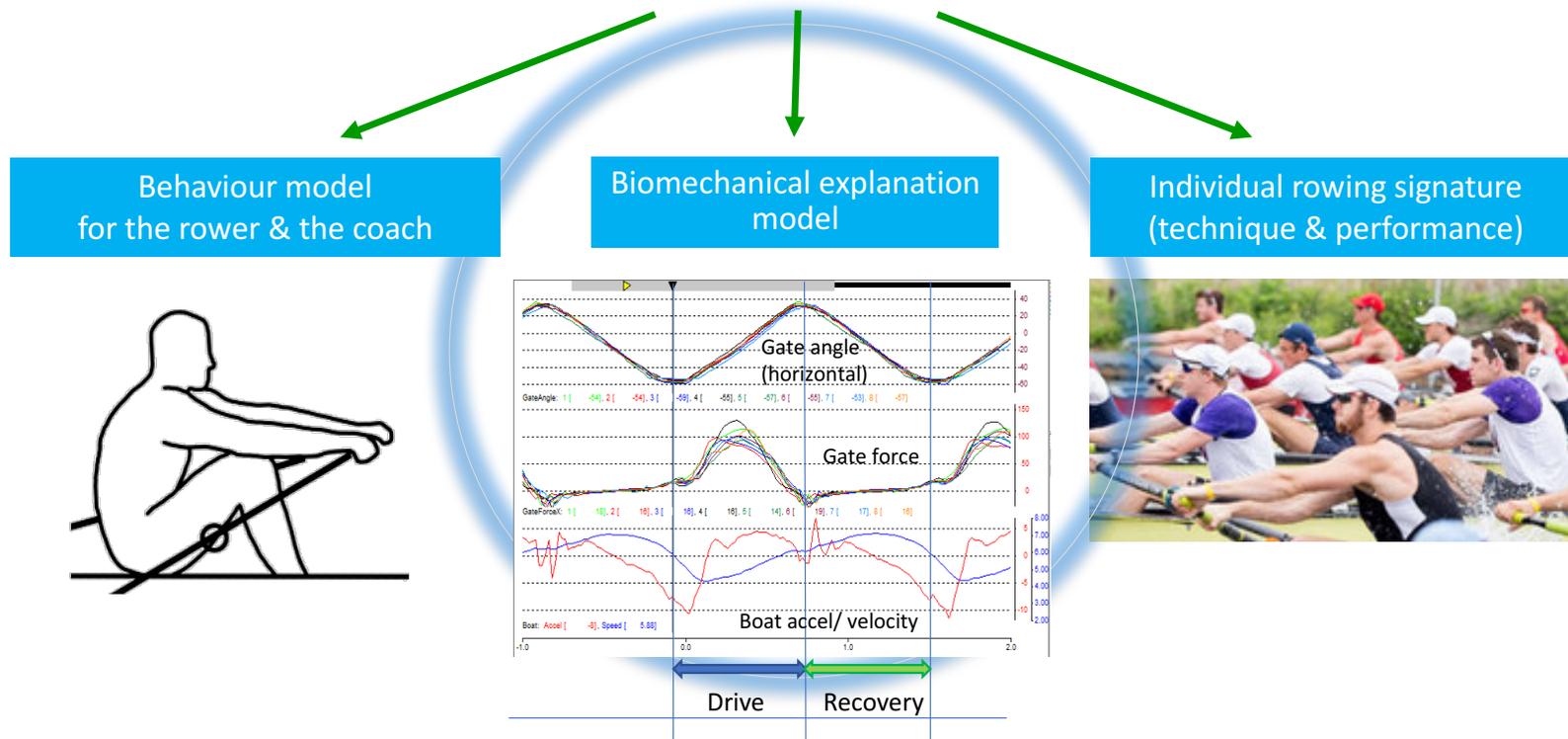
Individual rowing signature  
(technique & performance)



# Optimising Technique within a Crew Environment

## IDEAL TECHNIQUE

...as an Orientation for Diagnostics & Technique Training



## IDENTIFY TECHNIQUE & PERFORMANCE

...APPEARANCE – CAUSE - CORRECTION



# From Equipment to Technology

Equipment setup – Calibration - Data Analysis - Data management

The 'Data Analysis' & the 'Feedback' can only be as accurate as the:

Accuracy  
Reliability  
Repeatability

Equipment & hardware instrumentation:

Calibration

Software

- What does the system/ the sensors measure?
- Pay attention to precise setup & positioning of measuring tools & sensor devices
- Check if the sensors have not moved before the next monitoring session
- some sensors require regular calibration to perform accurately & reliably before the monitoring sessions
- ensure correct & crucial data handling & management of technical info
- **Training/ Performance assessment – Racing - Monitoring**
  - How to download & data process?
  - What training/ racing pieces to mark & how to analyse?
  - Which variables?

## Sensor Setup

(instrumented gate i.e. Force & angle sensor)

## Calibration

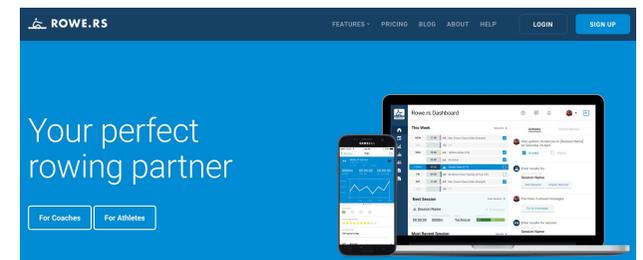
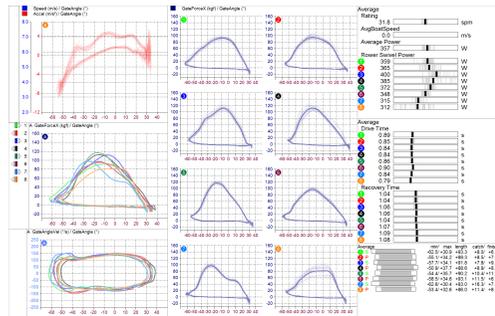
(i.e. angle sensors)

## Data analysis

(Session analysis (i.e. Peach))

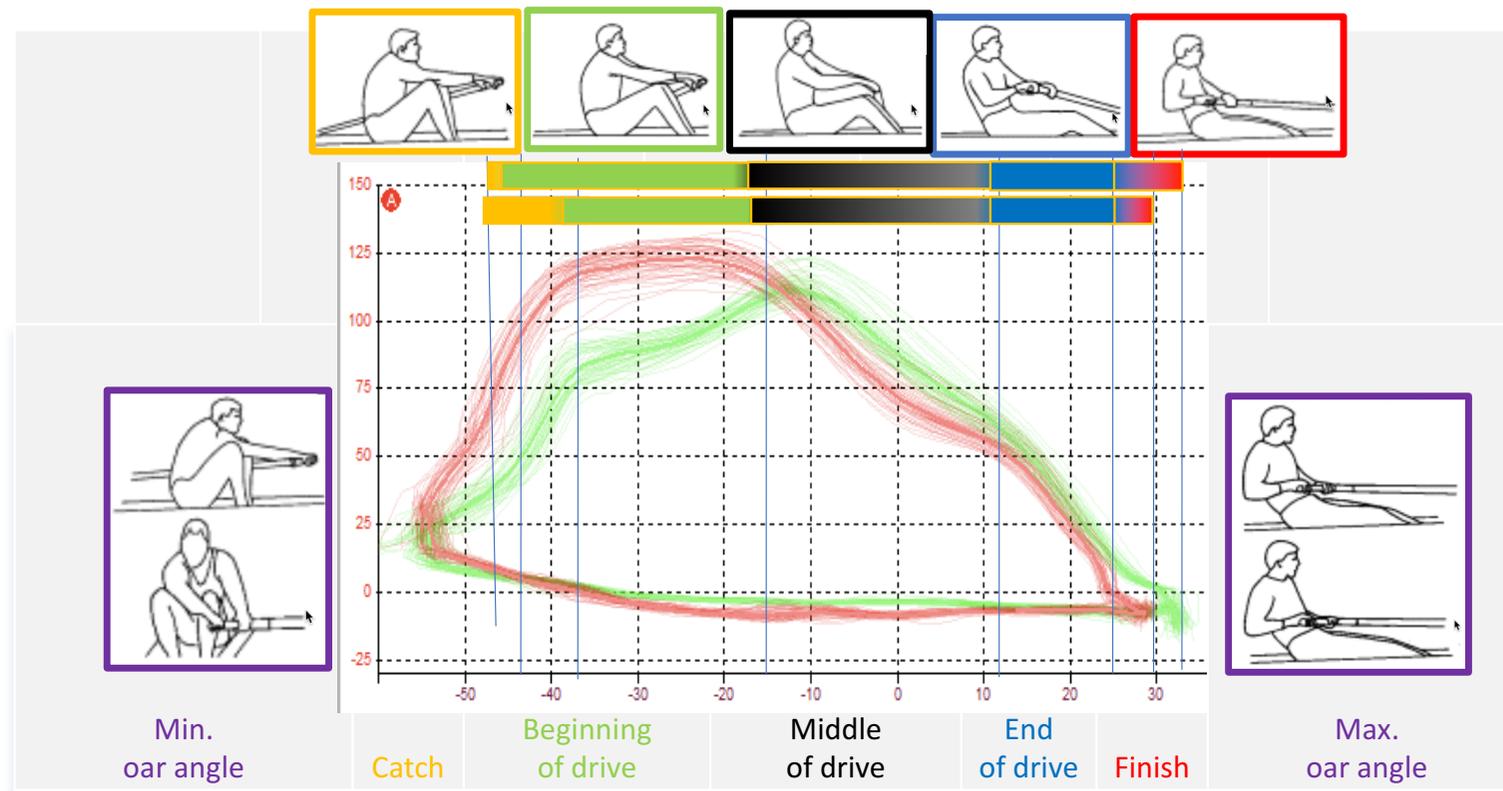
## Data Management

longitudinal Data storage & comparison (i.e. rowe.rs)



# Rowing stroke: Movement phase vs. gate force & angle curve characteristics

M4- Example: 2 athletes (same boat) with different rowing technique profiles @ SR36

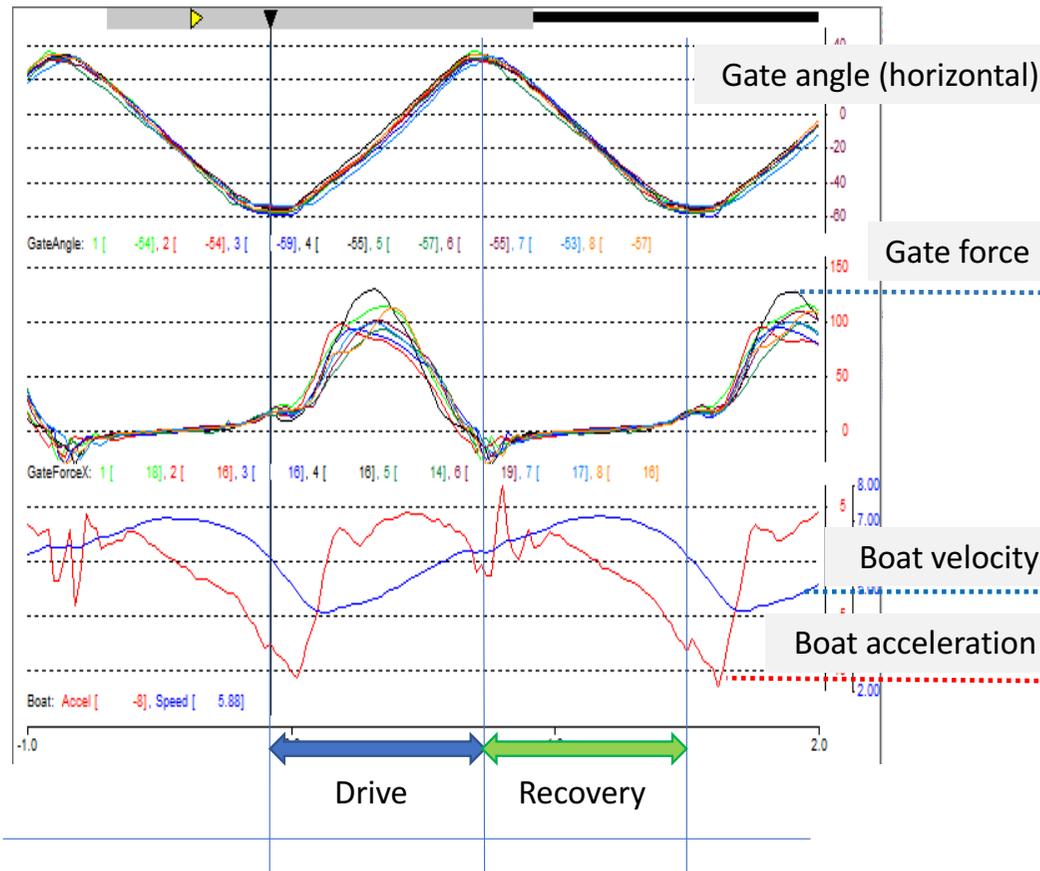


(‘Images of drive phase’ Mattes, K. 2012)

# Graphical description of Rowing technique

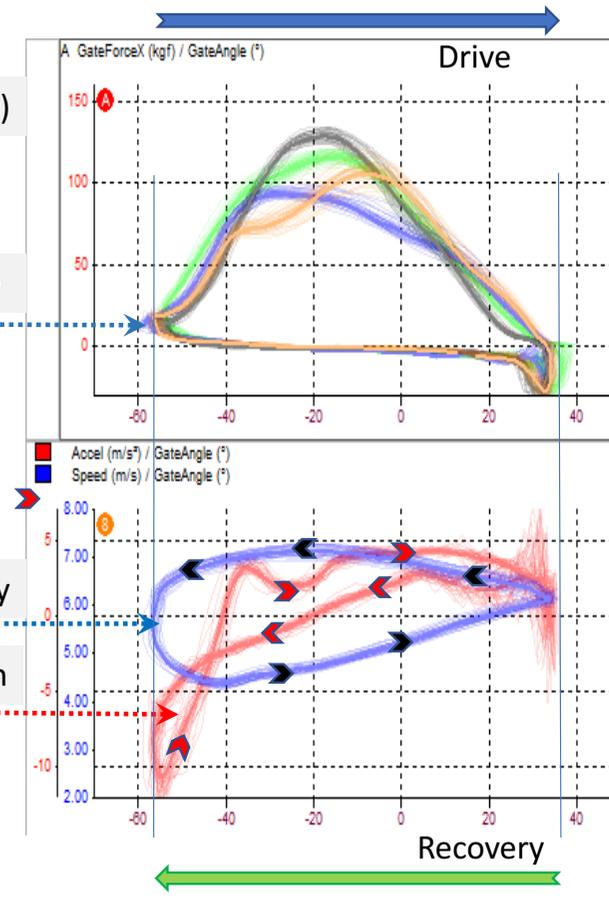
Characteristic 'rowing' curve patterns (same data set – different display)

1. 'Time' Scale (cont. stroke by stroke)



X-axis: Time (s) – continuous time scale

'Gate angle' Scale (cont. sbs)

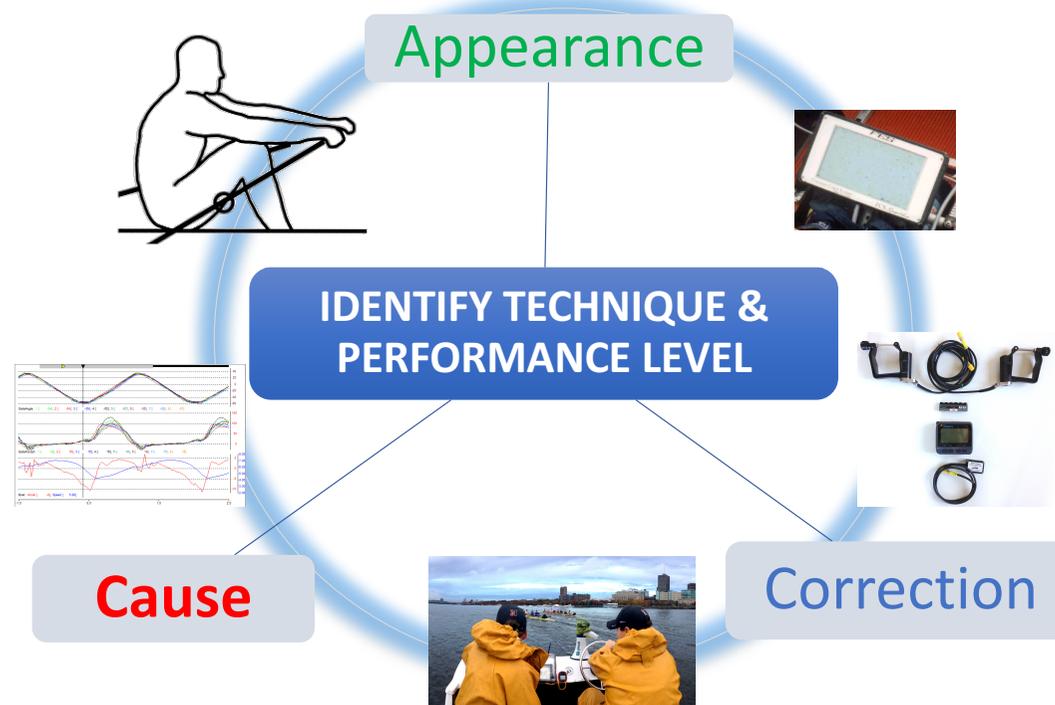


X-axis: Gate angle (horizontal) (deg)

## Identify strength & weaknesses – Correct & minimise faults

**Fault images** = divergences in rowing technique, which exceed the acceptable boundaries of an ideal technique & considerably reduce power output in rowing.

(Mattes, K. 2012)



# Identify & correct faults: Appearance

## Interaction between

Athlete

Equipment

Environment

Rower's anthropometry

Rower's boat rigging

Boat hull design  
Fluid dynamics

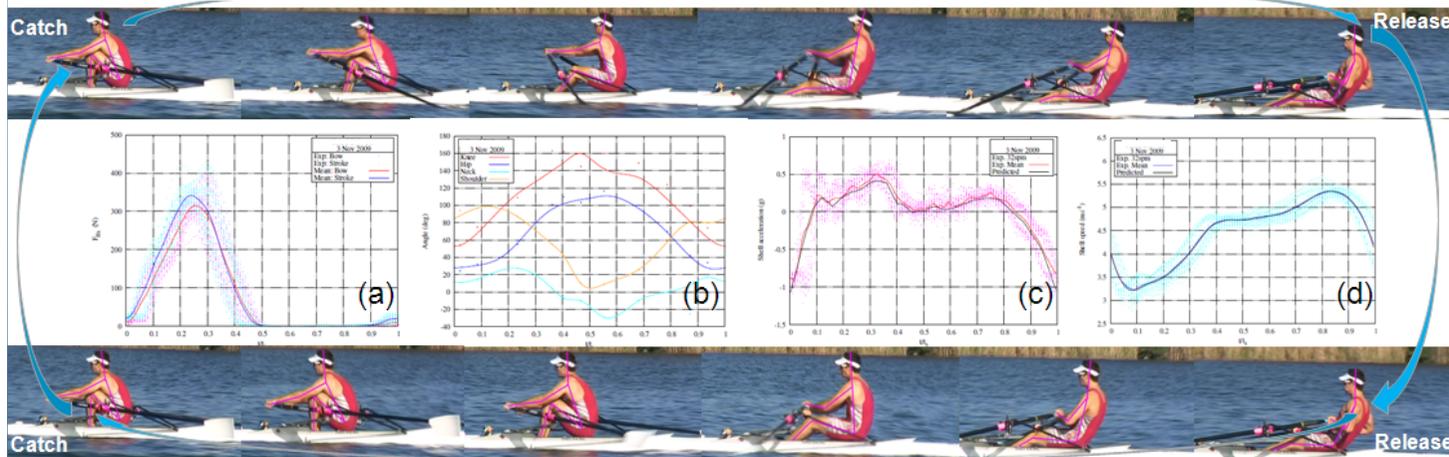
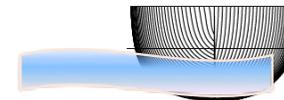
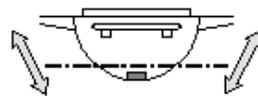
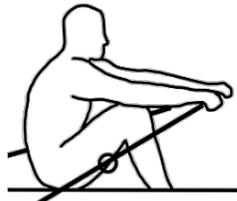


Figure 3: Video stills of an entire rowing stroke (@ SR 32Str/min); drive (top)/ recovery phase (bottom); Webb data (normal handle force) of 10 continuous (dotted line) and average (full line) stroke for bow/ stroke side (a), body angle regimes Catch, hip, neck, shoulderjoint (video: b) Minimax data of 10 continuous strokes (dotted red lines) versus model prediction (black line) of propulsive boat acceleration (c), boat velocity (d) during a rowing stroke; (Mens single scull, 2009).

## Identify & correct faults: Cause

### Skill Acquisition Principles to Enhance Skill in Rowing

#### 1. Identify the problem

- What is the main issue that is applying the handbrake to performance?
- e.g., Poor angle on the catch

#### 2. Identify the **core** problem

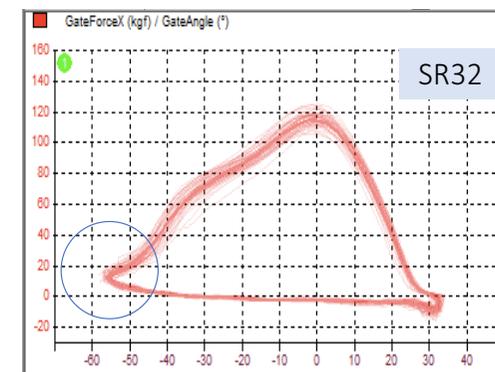
- Which particular issue is the primary cause of the main problem?  
i.e., poor timing of leg drive & handle/ upper body movement during the last 1/3 of recovery towards catch (catch preparation)

#### 3. Design drills/activities to address the issue

- Catch prep drills

#### 4. Promote transfer and encourage adaptation

- Partly – fully executed rowing sequence
- 2-4-6-8
- On- off water



(Gorman, A. 2012)

# Assessment Tools - Intervention Tools (for real-time feedback)



## ...for Technique/ Performance Improvement

- Technical drills
- Telemetry measurement with appropriate feedback
- Video filming in conjunction with telemetry or separately
- Visual Immediate Feedback System (Virtual Realty Goggles)
- Sensory-Mechanical Feedback
- Sonification (Online acoustic information)

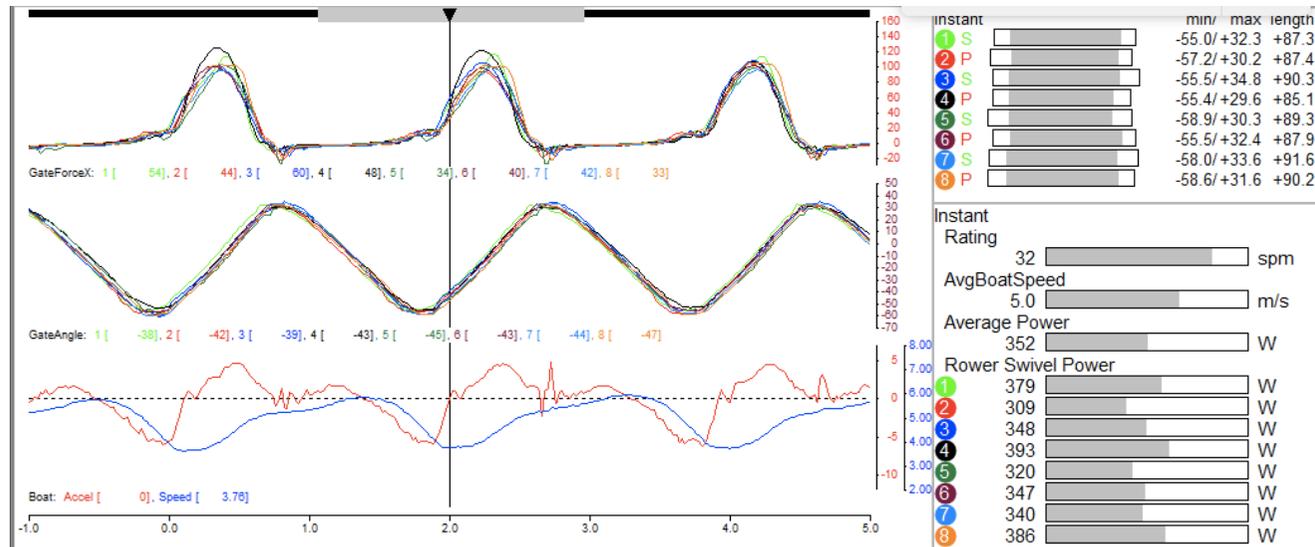


U.S. Men's Four - London 2012 Olympic Bronze Winners p. Ed Hewitt - row2k.com



# Real-time Feedback

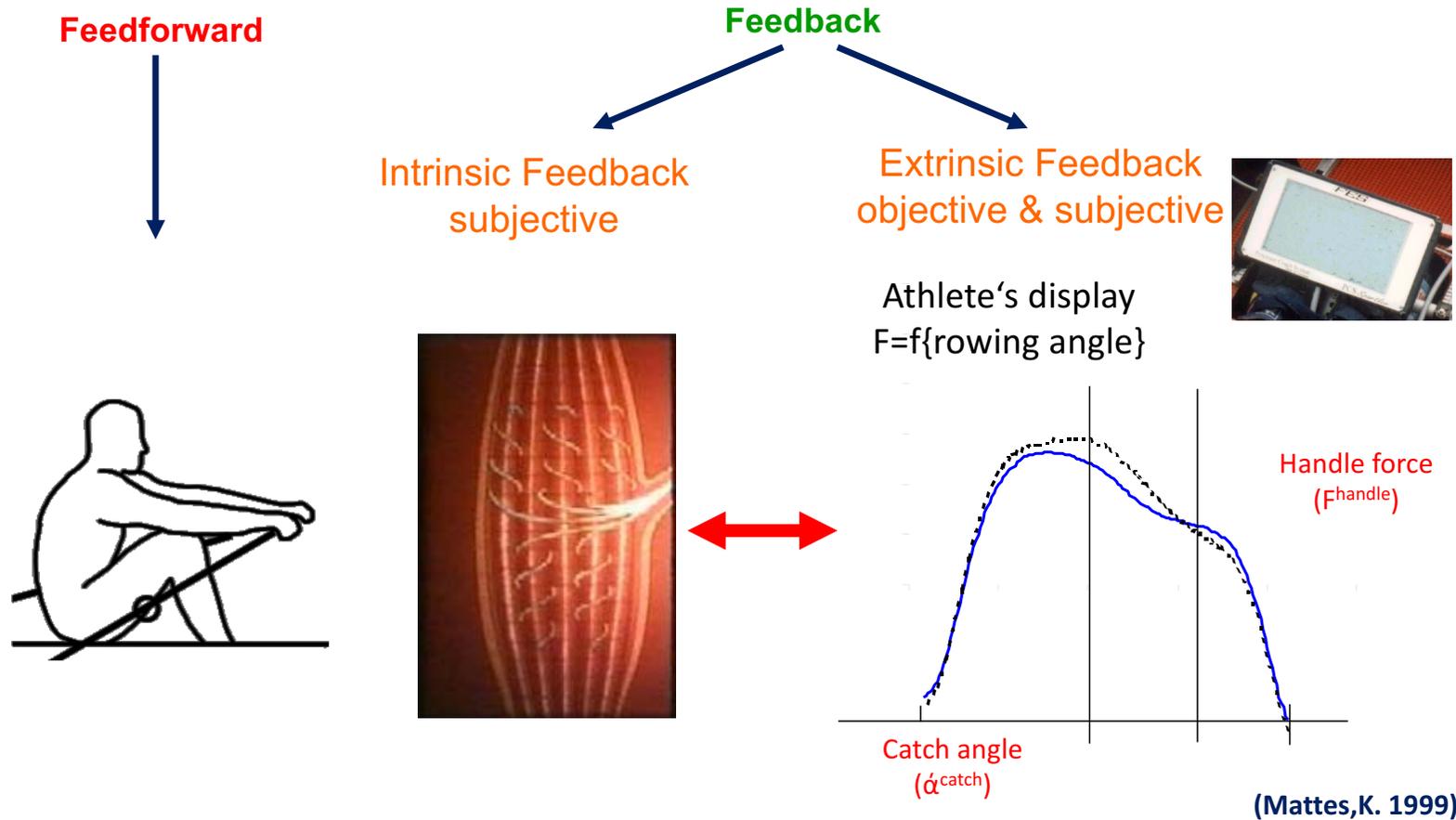
visual on-water feedback via screen (coaches'/athletes' boat)



During feedback training – choose appropriate feedback tool for athlete or coach (different demands – What are you going to work on during the training?)

# Identify & correct faults: Correction (1)

Orientation of the feedback training towards the internal processes of the athlete



## Technology as a Teaching Tool for Athletes

- **Why do we use technology?**
  - Differentiated Learning
  - Technical Improvement
  - Monitoring & Assessment
- **What do we want out of it?**
  - Value Add vs Work Add – Help not hindrance
- **How much will we actually get out of it?**
  - Know what you're looking for
  - Do what works for you, not others
- **When are we going to use it?**
  - Plan for when you'll use it
  - Don't "out-gadget" yourself

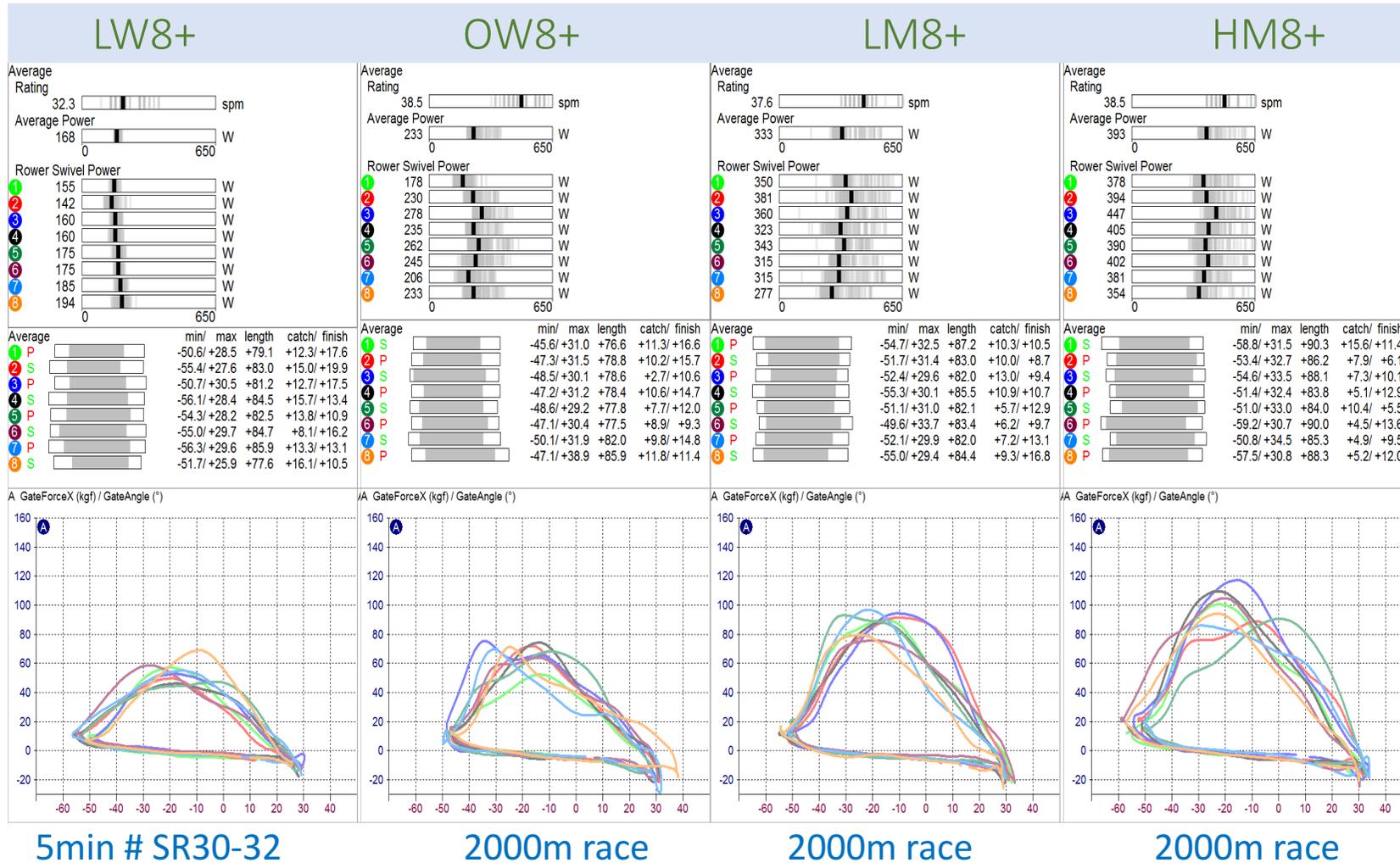
## Data collection - Data management: Monitoring - Assessment – Feedback – Implementation

The Information is depending on the purpose of the Data Gathering :

- Training Monitoring: Training Session observation
- Session/ Testing assessment: Use of a consistent testing protocol recommended (i.e. 2000m SR (18-32 piece; 500m mid race; starts)
- Training vs Racing Monitoring: Technique & boat performance consistency (i.e. Stroke length; starts consistency, crew synchronicity...)
- Short/ Long term tracking: State of athlete's technique & training (technical & physical)  
Athlete's wellbeing (Injury Prevention/ Rehab)
- Program/ Athlete Development: Open – Para rower  
Freshmen – Varsity  
Junior – Senior A/ Beginner – Elite



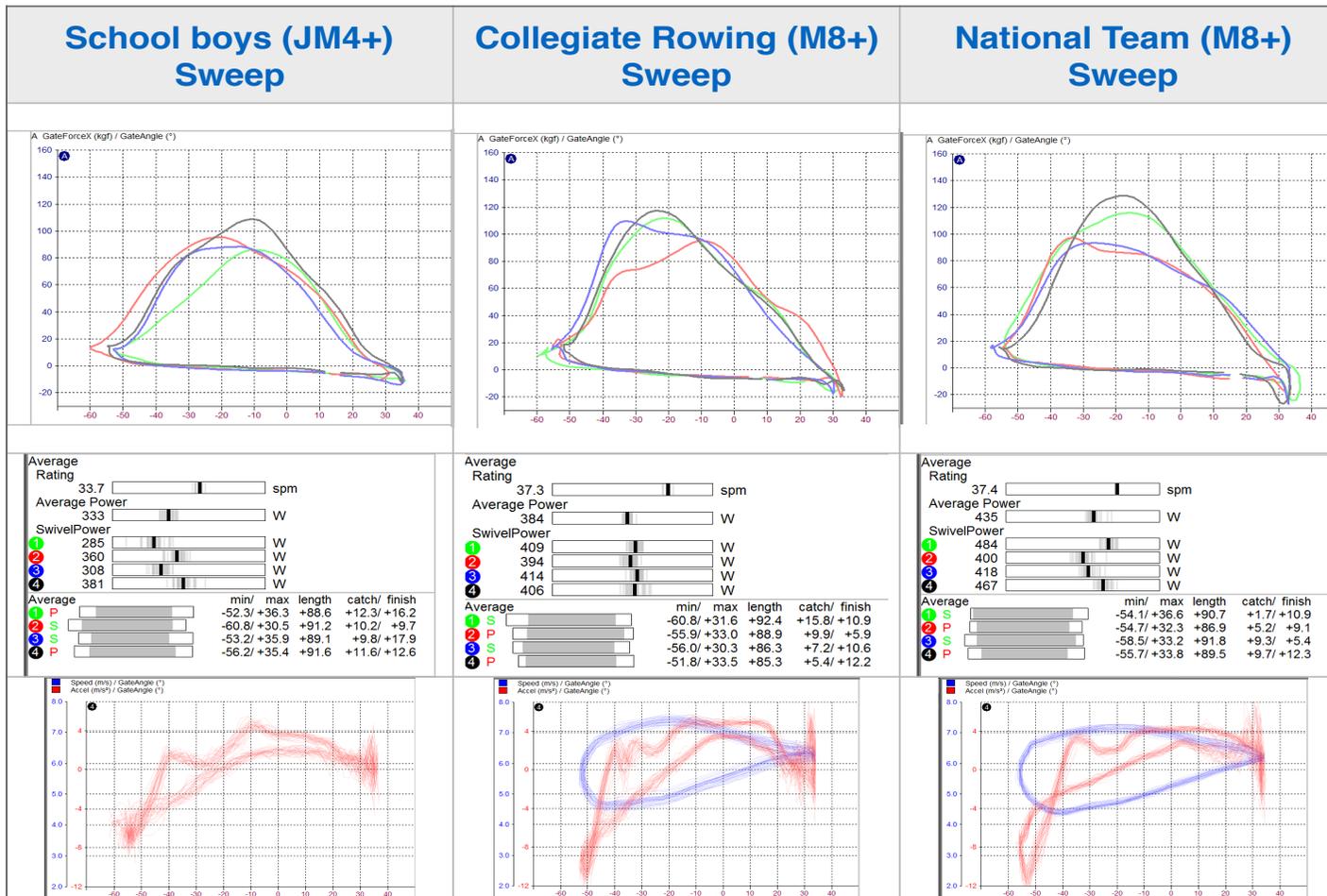
# Peach: College Boat class comparison



# Peach: Rowing Technique - skill level comparison

## School – Collegiate - Elite

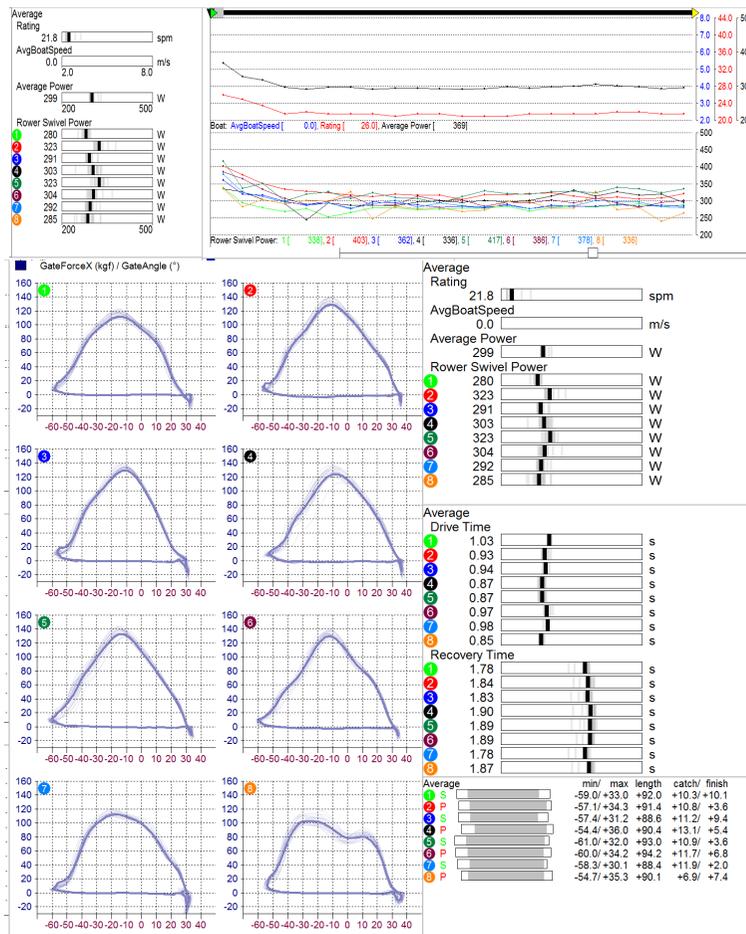
### Men's Sweep Comparison: 5min SRRP pieces



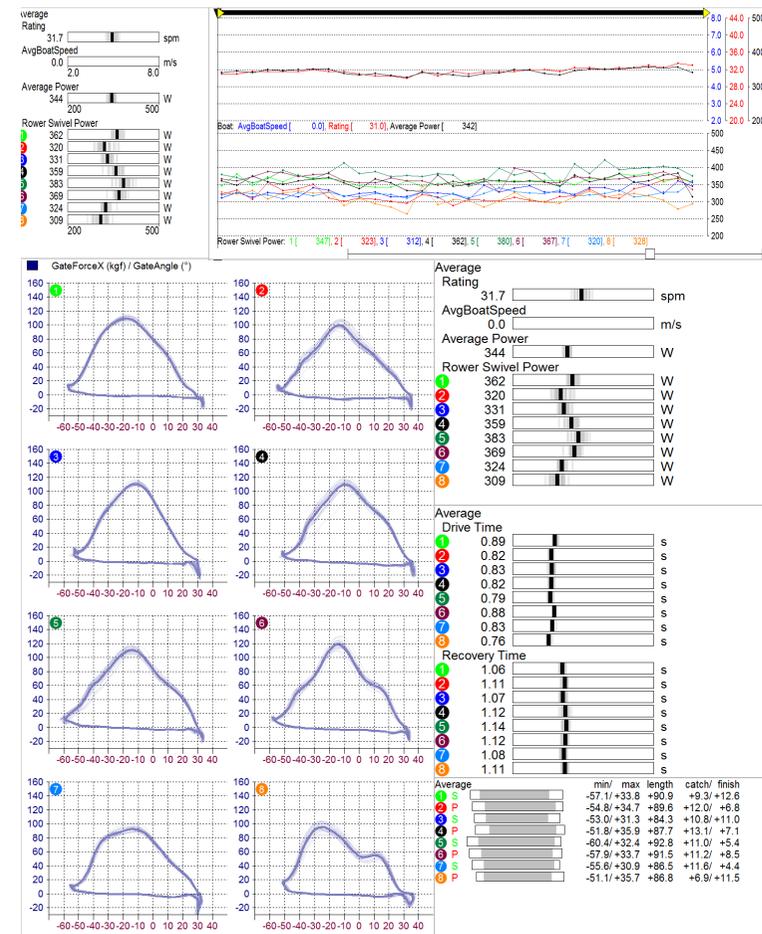


# Example #2: Ind. Athlete Technique/ Performance Level @ different Stroke Rates

2000m Step rate piece: (500m @ SR20-24-28-32)  
SR20



SR32

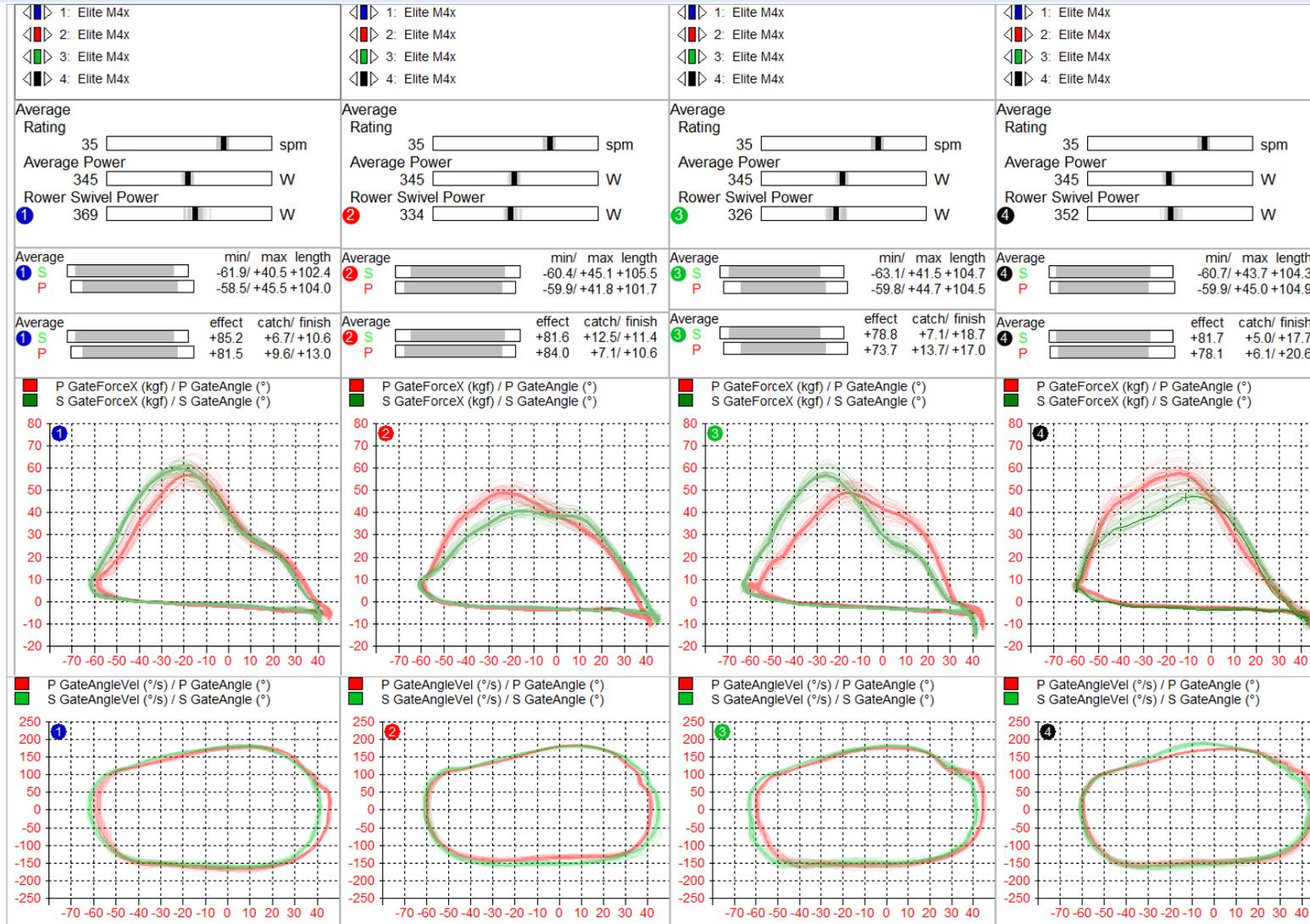


Data gathered & analysed with the Peach system

# Sculling: Elite M4x

## 2000m race (3<sup>rd</sup> min)

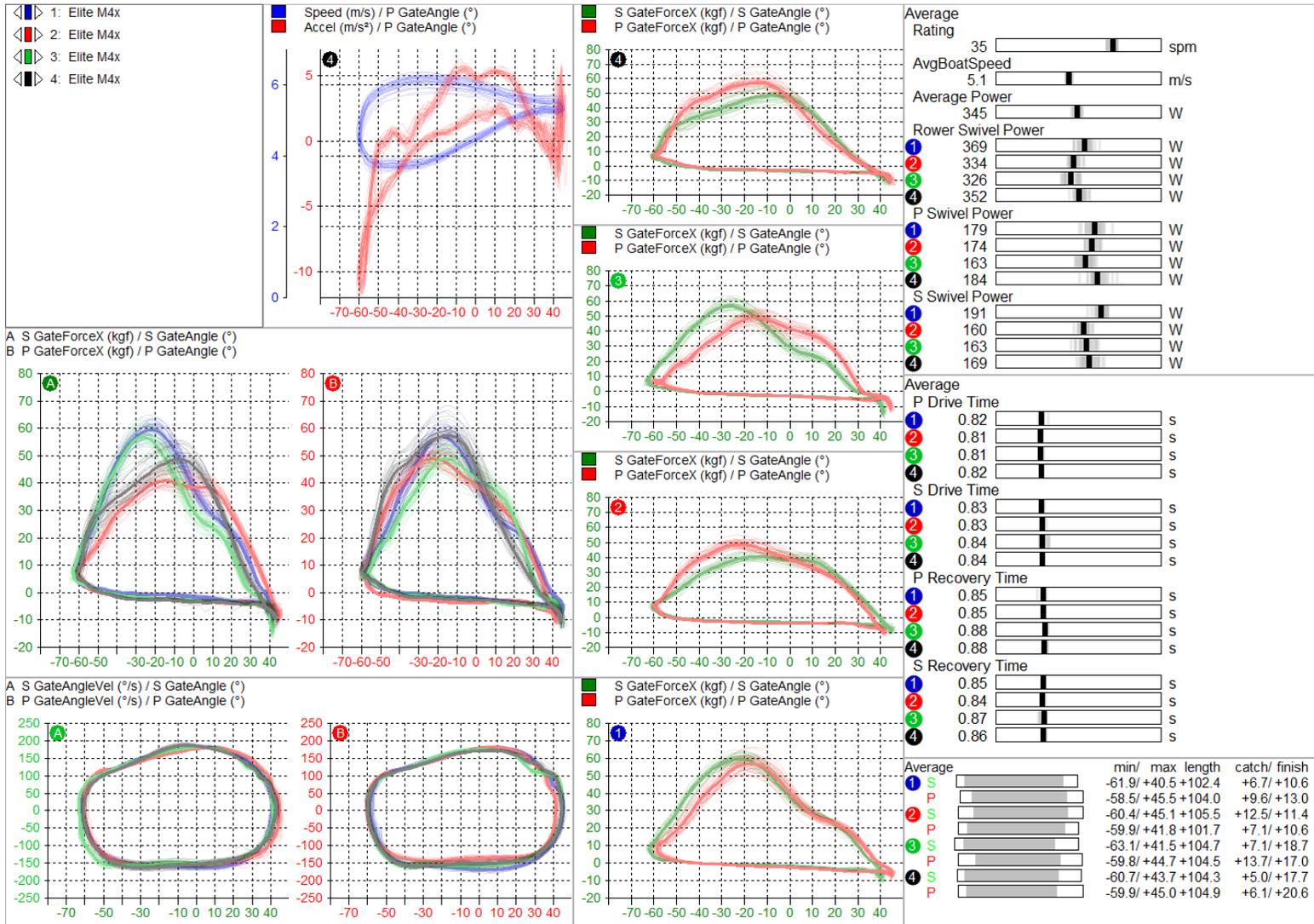
## Template: Scull\_T#4 Ind. Feedback



# Sculling: Elite M4x

2000m race (3<sup>rd</sup> min)

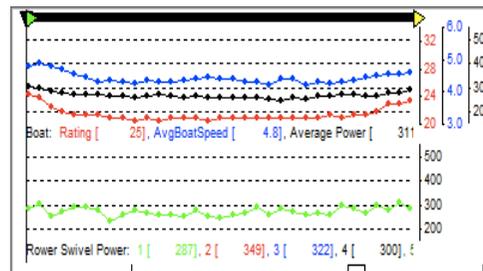
## Template: Scull T#6 Technique analysis\_Team



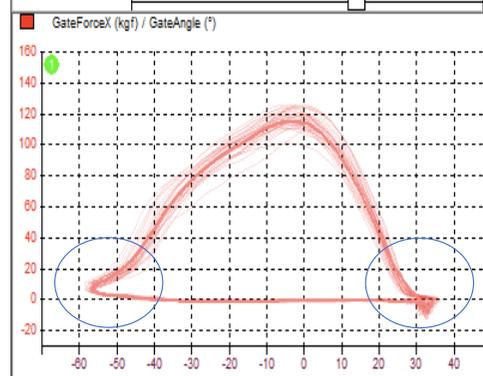
# Example 3: Influence of increasing Stroke Rate on ind. Technique

## Rowing Technique & Performance Analysis

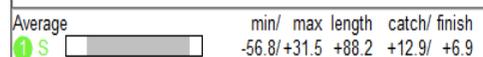
Performance Profile:  
(stroke by stroke values)



Technique Profile:  
Gate force – gate angle graph



Arc Profile:  
(average values; bar graph)



Stats Profile:  
(average values; bar graph)



Str/str variable Display

Stroke rate  
Boat speed  
Boat power

Individual rower power

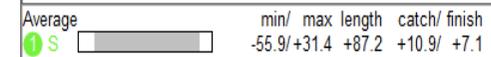
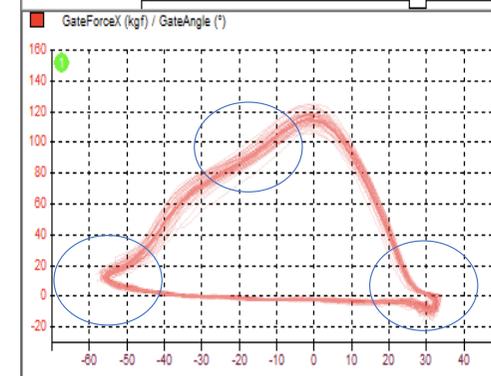
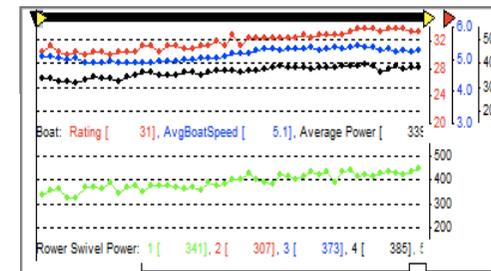
Str/str graphical Display

X-axis: gate angle  
Y-axis: gate force

Average value/ selected #  
Display (i.e.):

Stroke length/  
catch/ finish angle & slip

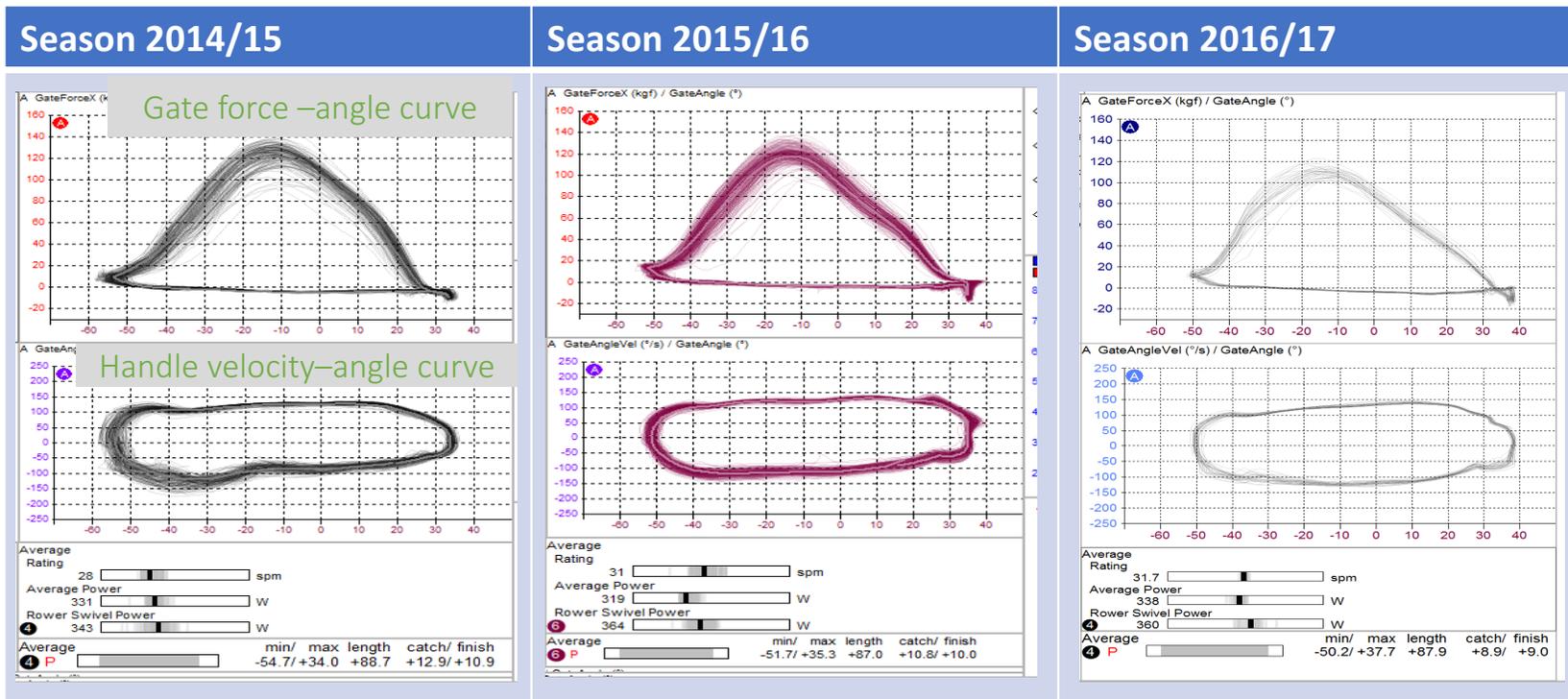
Stroke rate  
Boat speed  
Power....



Data gathered & analysed with the Peach system

## Example 4: Technique Review & Progress over 3 Seasons

Target stroke rate: SR32 (slightly different distances betw. the 3 #)



Assessment of quality of the stroke profiles/ SR:

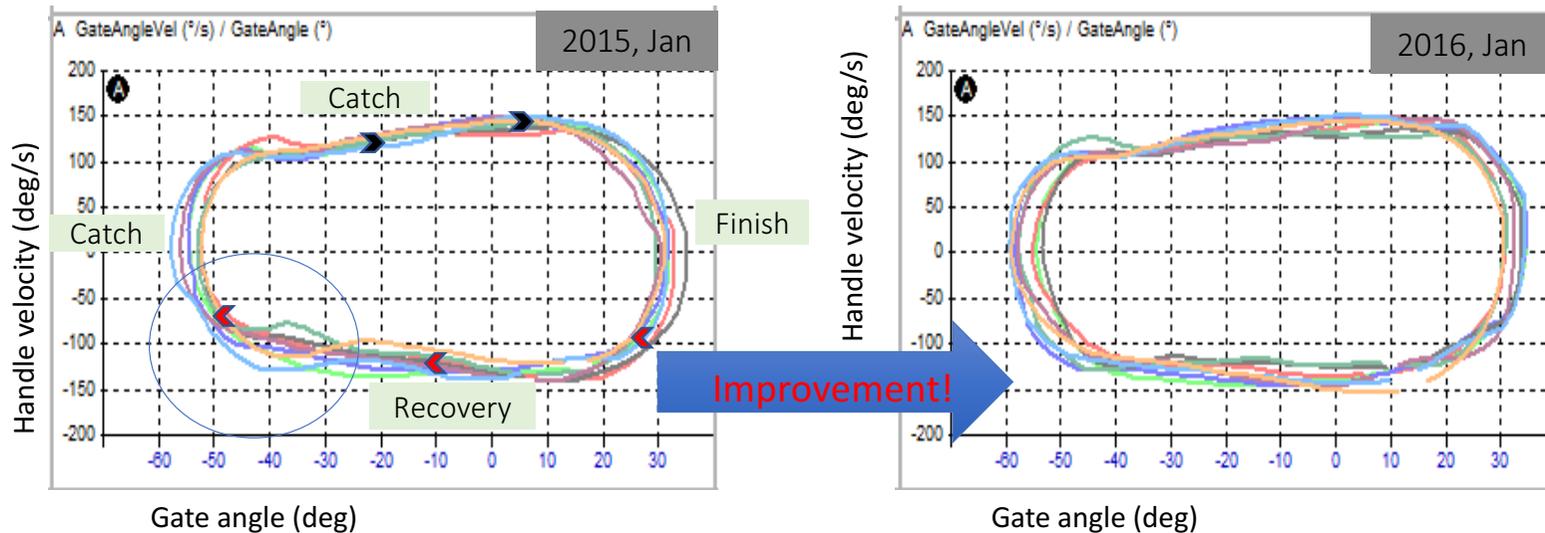
- shape & stroke by stroke consistency of force & handle velocity curve signature

Quant. assessment of rowing-related variables

- Discrete values/ SR: handle power, work, average/ peak force, stroke length; catch/ finish angles; catch/ finish slip drive/ recovery time etc.

## Example 5: Influence of crew dynamics analysed with the individual Handle velocity

### Comparison of Handle velocity applications (W8+)



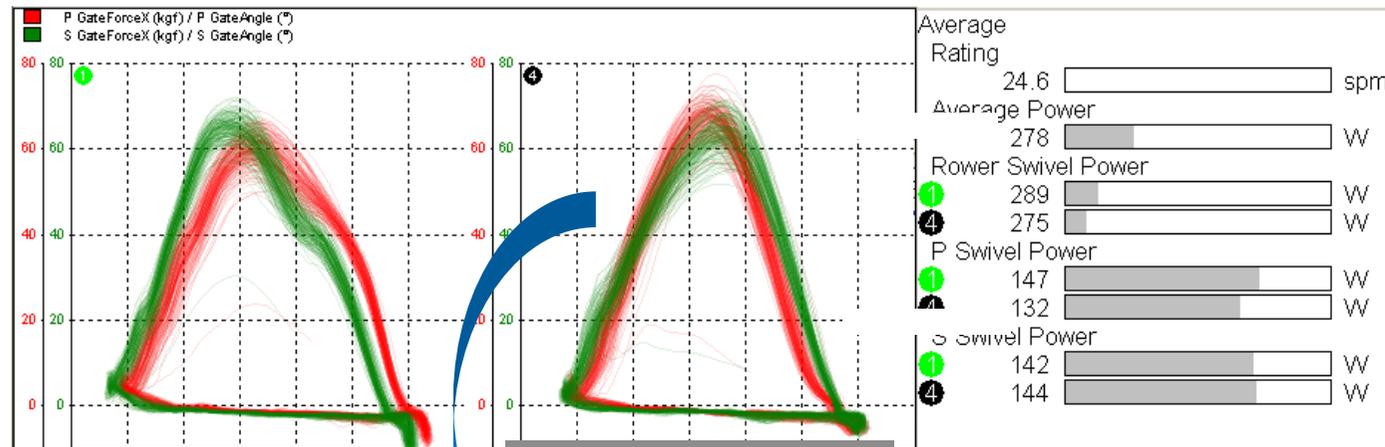
...during the recovery - different handle velocities towards the next catch

# 5c. Post-Training Analysis

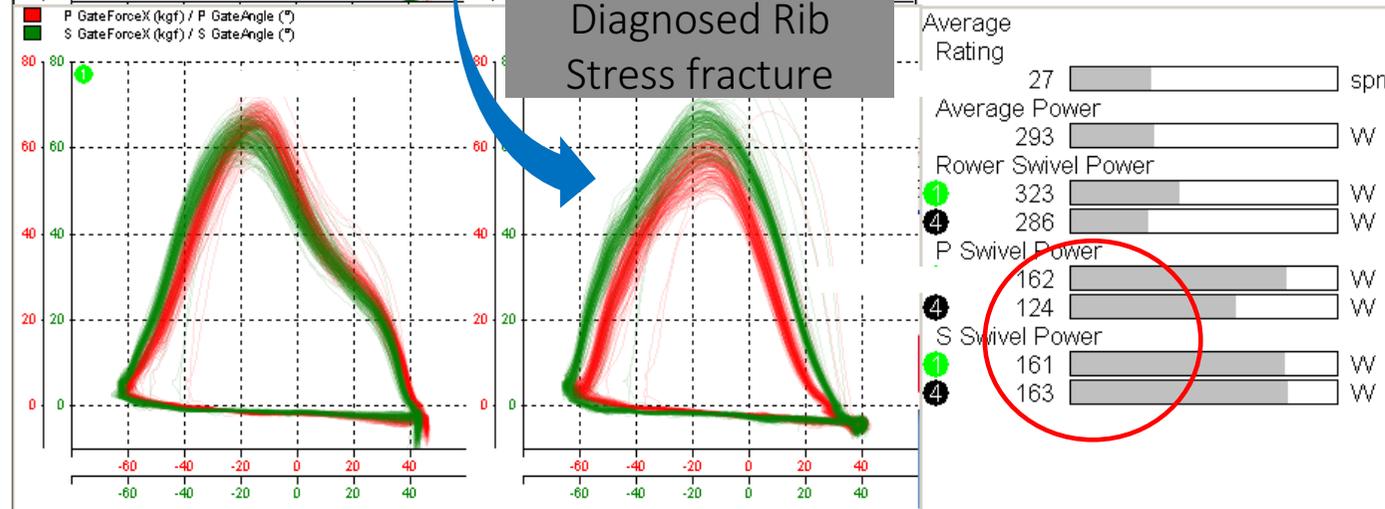
Example 3: Mens' Sculling: international medallist

Diagnosis: Rib stress fracture

January –  
olympic  
year



May -  
olympic  
year



Conny Draper, PhD

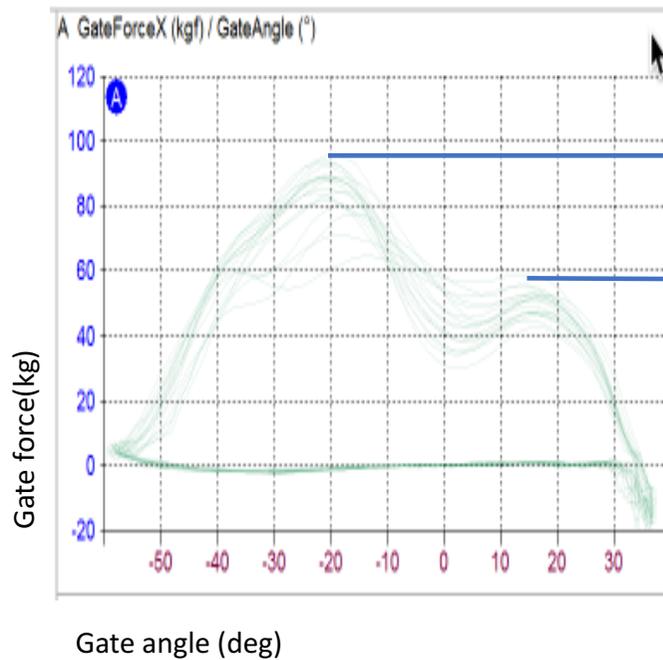
## Example #6: Change of technique during a training session (Female Freshman)

Intercollegiate W8+; inexperienced female rower

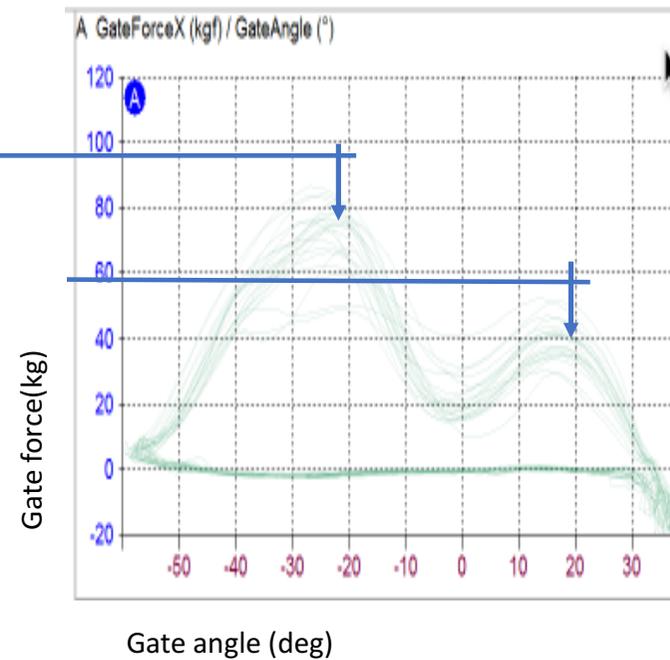
Rowing technique of inexperienced athlete can change dramatically during a hard training session

Comparison of change in rowing technique & performance during a 70min on-water rowing session:

after warm-up (30+min)



after 60mins



# Technology in a High Performance Environment

- is an integrative tool to assess training – selection – performance
- Athletes' centered – Coach driven
- building a support team is based on trust



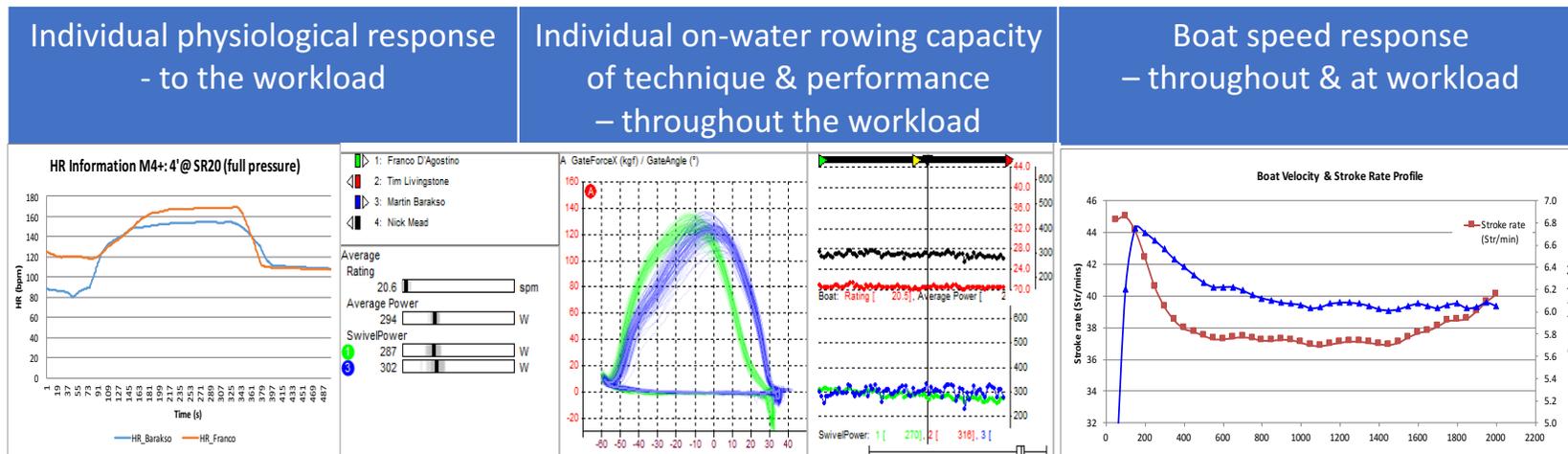
# Future Vision: Combining Athlete-Boat Information

- towards Optimizing Racing Performance -



Exp. M4+: 4min # SR20 (full pressure)

HR profile - ind. performance/ technique – Boat speed response



## Summary: Does Technology advance rowing?

### **Program approach: Athlete centered – Coach driven**

- objective assessment tools - great 'Messaging tools' between coaches & athletes to evaluate session, crews, rower/s, coxwains
- Detailed information enhance knowledge of athletes' & crew progress - & quantify our coaching & the training response

### **Technology can only assist NOT replace the Art of Coaching!**

- Consider WHY, WHEN & HOW you utilize technology in training & racing

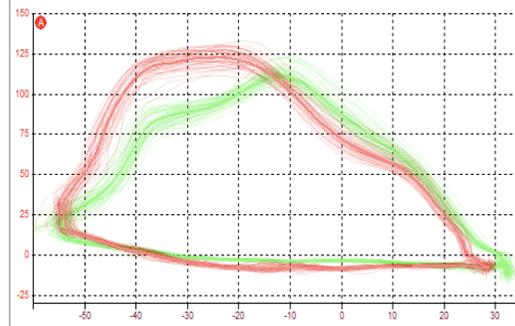
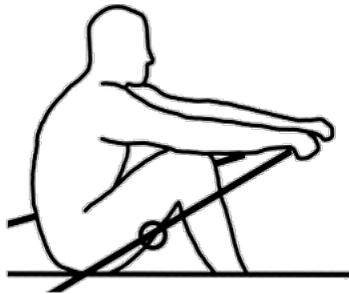
### **Collaborate with Professionals!**

Seek advice about:

- technology implementation into your Rowing program – What suits your coaching style and your belief?
- technology management – avoid to create data you cannot manage to assess during coaching hours ('post training' data processing can take a lot of time)

2017 World Rowing Coaches Conference, London, GB, 7<sup>th</sup> December 2017

## Capturing Data and Using Technology



Thank you for your attention!

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Consultant  
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