

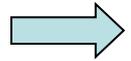
Strokes and Maneuvers:

Sea Kayaking 101

Tim Mattson, tgmattso@gmail.com



Outline:



- Paddling Jargon
- Evaluating Stokes
- Photo Gallery

Padding Jargon

Everything should be as simple as possible, but not simpler.

Albert Einstein

Eschew Obfuscation.

Jesse Buck.

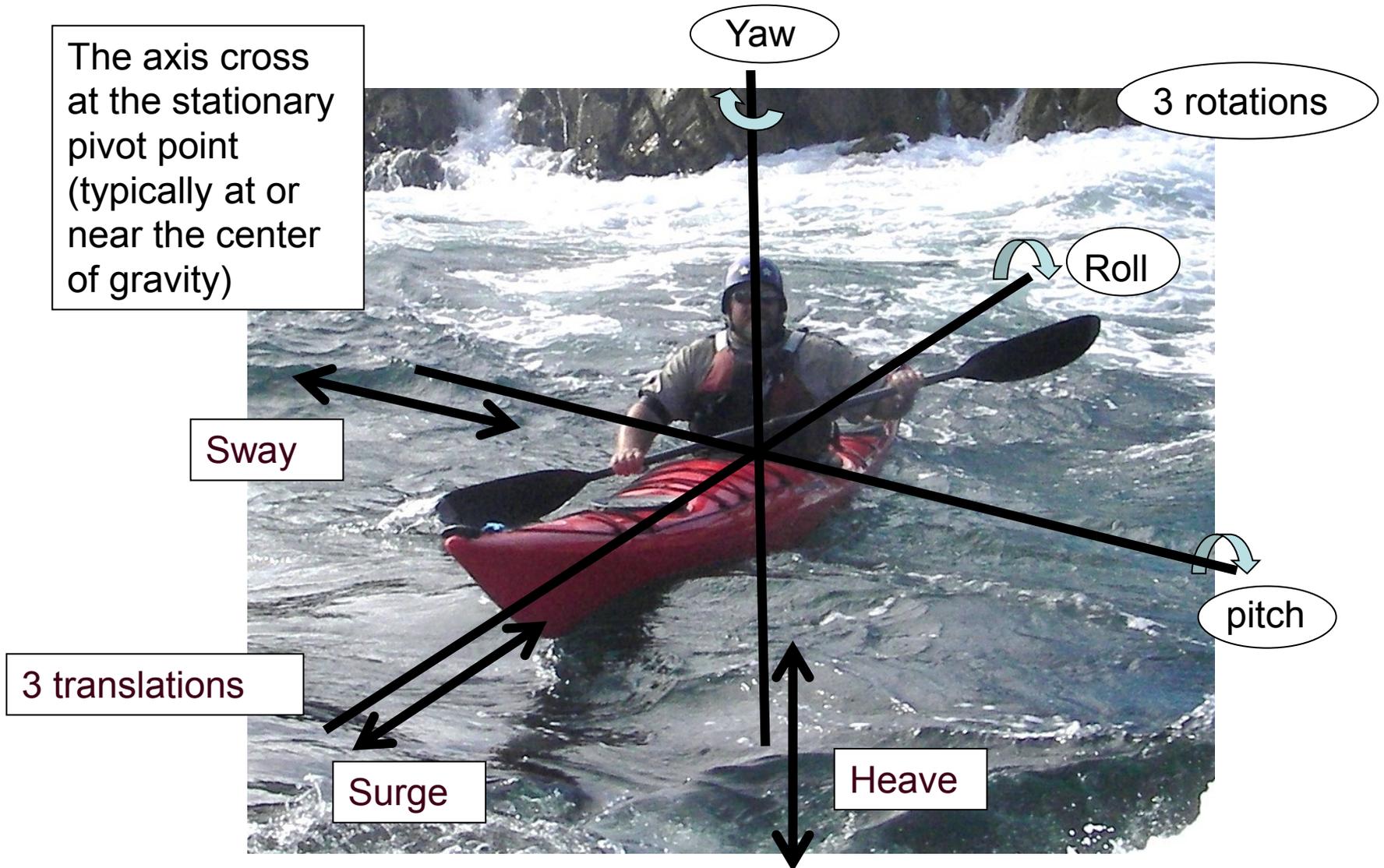
Basic Concepts:

Describing the Motion of Kayaks in Space

- Degrees of freedom; the number of distinct motions required to fully describe the motion of an object
 - In three Dimensional space, there are three translations and three rotations ... 6 degrees of freedom:
 - Rotations: rotation about an axis
 - Pitch – rocking forward and backwards
 - Roll – edging the kayak from side to side
 - Yaw – rotating the direction the bow and stern are pointing.
 - Translations: displacements along an axis
 - Sway – sliding sideways
 - Surge – bursting forwards or backwards
 - Heave – bouncing up and down in the swell

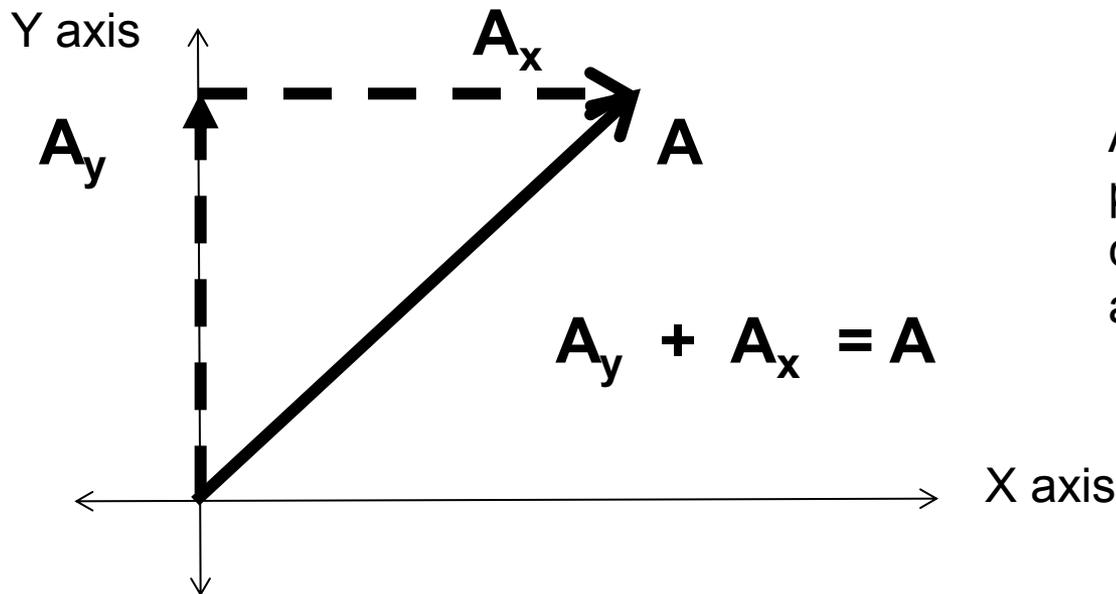
These are the standard terms used in Naval architecture. It is important to use existing terminology when possible rather than create new words just for kayaking.

Basic Concepts: A kayak's degrees of freedom



Basic concepts: Decomposing Forces

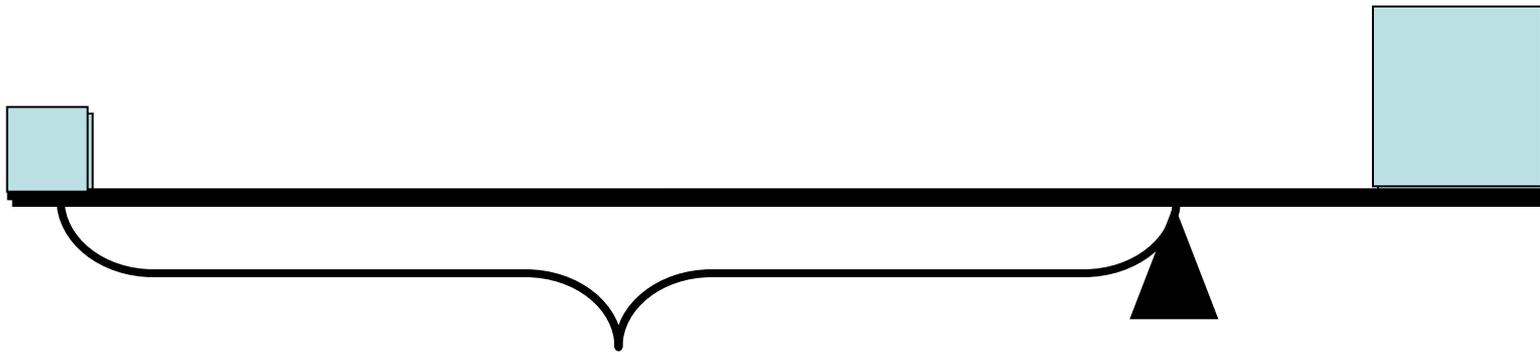
- Forces (and other Vector quantities) can be broken down in to component parts.
- For example, we can project the force A onto two reference axis to consider its components



A pure vertical stroke or a pure horizontal stroke concentrates force onto one axis.

Basic Concepts: Torque and pivot points

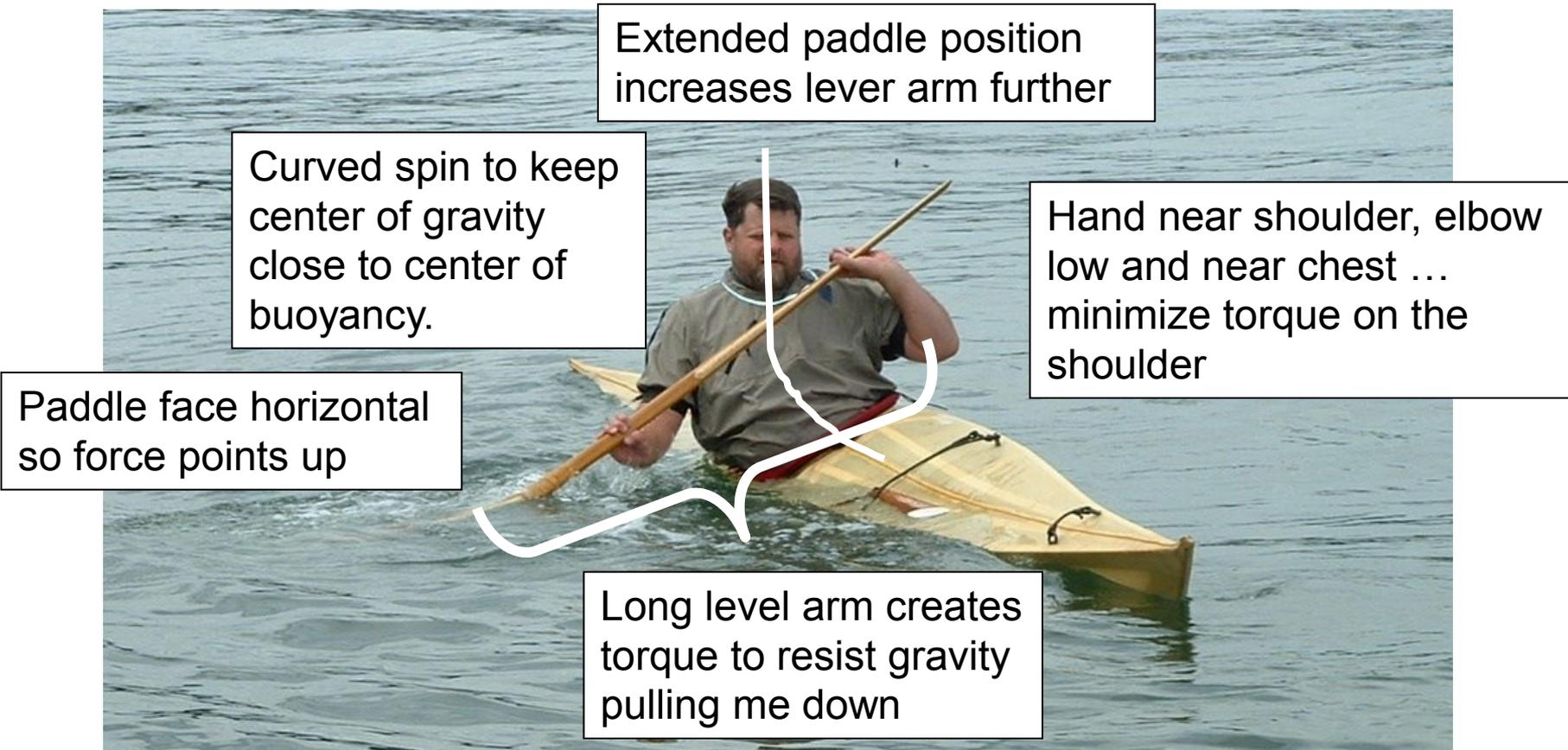
- Consider rotation about a fixed pivot point.
- The rotational force (torque) is the force times the distance from the pivot point.



The distance from where a force is applied to the pivot point is called the lever arm.

A long pivot arm lets a small weight lift a heavy weight

Edging with a support stroke



Extended paddle position increases lever arm further

Curved spin to keep center of gravity close to center of buoyancy.

Hand near shoulder, elbow low and near chest ... minimize torque on the shoulder

Paddle face horizontal so force points up

Long level arm creates torque to resist gravity pulling me down

Add up gravitational force on each chunk of kayak/body. From a distance, it averages to a point. This is the center of gravity.

Add up force due to displaced water (buoyancy) on each chunk of the boat. From a distance, it averages to a point. This is the center of buoyancy.

Basic actions

- **Maneuver:** a specific motion of a kayak in the water or an action carried out with the kayak.
- **Stroke:** a process in which a paddle is used to affect the motion, stability or attitude of a kayak.
- **Leaning:** Shifting the center of gravity by moving the torso to rotate the kayak along the roll axis (or sometimes the pitch axis). In an extreme lean, the center of gravity may move beyond the center of buoyancy creating a situation where a support stroke is required to prevent capsize.
 - **A leaned turn:** a turning stroke in which the body is leaned into the turn moving the center of gravity beyond the center of buoyancy to create a stronger pivot point for the turn.
- **Edging:** rotating the kayak along the roll axis but with the spine/hips rotated so the center of gravity remains inside the center of buoyancy.

A Maneuver consists of a sequence of one or more strokes combined with leans and/or edging interacting with the environment to move the kayak a particular way.

Orientations, positions, and arms

- **Vertical stroke:** A stroke for which the paddle shaft is located in a plane perpendicular to the water and parallel to the long axis of the kayak (the roll axis).
- **Paddle Positions:** 3 basic positions:
 - bow, amidships (hip) and stern.
- **Arm positions** during a stroke
 - Standard position: the arm on the side of the stroke is close to the blade in the water.
 - Cross position: the arm opposite to the side of the stroke is close to the water.
- **Edges:** refer to which edge is involved in a maneuver relative to the circle associated with the path of the kayak through the water ...
 - **Inside edge** points to the center of the circle,
 - **Outside edge** points away from the center of the circle

Blade motion/orientation during a stroke

- **Dynamic stroke:** a stroke in which the paddle's position changes relative to the kayak during the stroke. Examples: forward stroke, sweep stroke.
- **Static Stroke:** a Stroke in which the paddle position is fixed relative to the kayak. Any force arising from this stroke arises from the interaction of the paddle blade with water moving relative to the kayak. Rudder strokes are the classic static strokes.
- **Blade Pitch:** The orientation of a paddle blade relative to moving water. Also known as **blade articulation**. Three basic pitch positions:
 - **Neutral:** the blade is placed in the water parallel to the flow of the water and slices through the water generating a minimum of force.
 - **Open:** the leading edge of the paddle is pointing away from the kayak creating a force on the paddle directed away from the kayak.
 - **Closed:** the leading edge of the paddle is pointing towards the kayak creating a force on the paddle directed towards the kayak.
- **Sculling:** Moving a blade back and forth in the water adjusting the blade's pitch to maintain a given leading edge (open or closed) relative to the motion of the blade.

Types of Strokes

- **Draw stroke:** a dynamic stroke in which the force pulls the kayak towards the paddle. Example: a draw to the hip or sculling draw stroke.
- **Pry Stroke:** a dynamic stroke in which the force pushes the kayak away from the paddle.
- **Rudder stroke:** a static stroke applied on-the-move to create a force pushing towards or away from the kayak depending on the blade pitch.
- **Propulsion stroke:** A stroke used to move the kayak forwards or backwards (i.e. a surge translation). Examples include forward and reverse strokes.
- **Turning stroke:** A stroke used to rotate the kayak along the yaw axis. Examples include seep strokes, bow rudders, and low brace turns.
- **Support strokes:** Strokes that counteract rotations about the roll axis. An example of a pure support stroke is a low brace. Note that most strokes can provide support by using blade pitch to create force in the vertical (heave) direction.

The Core strokes

- **Brace stroke:** a stroke generating a rotational force in the roll plane. Used to prevent capsizing or provide support during an aggressive lean.
- **Forward stroke:** a dynamic stroke in which the principle component of the force is along the longitudinal axis of the kayak and directed aft.
- **Reverse stroke:** a dynamic stroke in which the principle component of the force is along the longitudinal axis of the kayak and directed fore.
- **Sweep Stroke:** a “low and wide” dynamic stroke that converts the energy of the stroke primarily into a rotational force in the yaw plane.

Turning underway

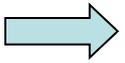
- **Bow sweep:** a quick, short sweep extending out from the bow. Used to initiate a turn. Often followed by a stroke to assist/manage the turn (e.g. low brace turn or a bow rudder).
- **Bow rudder:** a rudder placed towards the bow ... blade pitch usually neutral to slightly open. Used to create a stronger pivot point and make a sharper turn.
- **Cross bow rudder:** a rudder placed towards the bow, but the hand opposite to the side of the stroke is close to the blade in the water.
- **Stern rudder:** a rudder placed towards the stern ... often used to keep the boat moving straight in following seas:
 - Open blade and edge towards the paddle to turn the bow away from the side with the paddle.
 - Closed blade and edge away from the paddle to turn bow towards the side with the paddle.
- **Low brace turn:** a leaned turn with support from a low brace.
- **High brace turn:** a leaned turn with support from a high brace.

Moving Sideways

- **Draw to the hip:** a dynamic stroke working perpendicular to the roll axis finishing with a vertical paddle amidships. Used to move a kayak sideways.
- **Sculling Draw:** a vertical sculling stroke amidships with an open pitch blade; used to move a kayak sideways towards the paddle.
- **Sculling Pry:** A vertical sculling stroke amidships with a closed pitch blade; used to move a kayak sideways away from the paddle.
- **Side slip:** an amidships rudder with an open blade pitch to cause a sideways slip of the kayak while underway. Also known as **hip-rudder**. Often called a **hanging draw**, though this name is “wrong” as it is a static stroke and draw strokes are dynamic.

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- Photo Gallery



General principles

- Maneuvering a kayak should be efficient, ergonomically safe, and effective. The foundation of effective paddling is built on three pillars:
 - **The body:** Engage the torso
 - Upright posture and shoulder-safe arm positions.
 - Preposition the torso to support the stroke. For example, a good forward stroke is possible only if the torso is pre-wound; a good draw stroke requires that the torso is positioned to “face the work”
 - **The kayak:**
 - The kayak motion should support the maneuver. This means a still boat except when
 - Edging or leaning (rotation about the roll axis) to support a turn
 - trimming (rotation about the pitch axis) to strengthen pivots fore and aft.
 - **The Paddle:**
 - Position the paddle blade and shaft for maximum effect.
 - When you want to glide (e.g. rudders), the shaft is “in the vertical plane and parallel to the kayak’s motion”.
 - When you want propulsion, bury the blade before applying force.
 - Fine tune each maneuver by using the right blade pitch in just the right amount (e.g. start neutral on bow rudders and open the angle slowly to tighten the turning radius).

Forward stroke

- 4 phases: Plant, Power, exit, and Glide with pre-wind
 - Prepare for stroke by pre-winding your torso
 - Plant paddle just in front of your feet, lower arm straight.
 - Fully bury blade (but not the shaft) before applying power (no splashing at entry).
 - Power from the torso rotation, not the arms/shoulders (center line of PFD crosses center line of boat).
 - Upper arm slightly bent and fixed relative to chest throughout the power phase of the stroke.
 - Upper hand moves straight across the deck in a plane parallel to the water throughout the power phase of the stroke.
 - Lower arm remains straight (no collapsing elbow) so the blade goes out from the kayak during the stroke ... roughly following the bow wake.
 - Slice blade out at the hip (no splash of water on exit) bringing lower arm up to upper hand.
 - A still boat moving forward ... i.e. No rocking, pitching or side-to-side yaw.

The key is to pre-wind before the stroke starts and to fully bury the blade before applying any power. You can help do this by pausing at the end of the stroke ... using the pause to prepare for a pre-wound and aggressive plant. The stroke is in $\frac{3}{4}$ time ... i.e. a waltz (one plant, two exit, three pause).

Draw to the hip Stroke

- Torso fully rotated ... face your work.
- Clean slice outward (paddle blade does not leave the water); lower hand path moves 90° (perpendicular) from boat.
- Upper hand is stationary relative to the paddler and relaxed, held in front of your face, at or beyond the gunwales.
- Boat moves exactly sideways; bow and stern move at the same rate.

Look for a still upper arm working as a solid pivot point for the paddle shaft.

Sculling draw

- Torso fully rotated; face your work; blade moves with rotation of torso plus lower arm.
- Paddle shaft in plane vertical to the water and parallel to the boat (to move directly sideways).
- Upper hand is stationary relative to the paddler and relaxed, held in front of your face, reaching at or beyond the gunwales.
- Vary the plane of the sculling to move sideways, diagonally forward, or diagonally backwards."

Be sure that the power in the stroke comes mostly from the torso while the paddle shaft remains in a fixed plane relative to the torso.

Sweep stroke

- Spin boat 360 degrees in place by alternating forward and reverse sweeps (on alternating sides of the boat).
- Paddle shaft low, blade out wide, near surface of water.
- Paddle blade starts and ends touching the bow and stern of the boat
- Good boat edging to the inside ... builds during beginning of sweep (0,1,2,3), reduces as you move from the mid-point to the end(3,2,1,0)
- Power from torso rotation with your shoulders parallel to the paddle shaft. You can use your arms in the stroke, but only at either end of the stroke after torso is fully rotated.

Pre-wind aggressively for forward or reverse sweep. Your eyes help you engage torso rotations ... for reverse sweep, start looking at the paddle tip. For forward sweep, start looking out from the kayak on the opposite side from the stroke (not at the paddle).

Reverse stroke

- Paddle in a straight line in reverse. Use back-face of paddle
- Use edges (smooth positive control) to aid turning.
- Power from the torso, rotate to plant behind the hips.
- Adjust paddle path to maintain control ... vertical for power, slicing in towards the knees for directional stability.

Start the stroke with your torso rotated towards the stern ... the same torso position as you used when starting the reverse sweep.

Stern Rudder

- Torso fully rotated, face your work.
- Minimize braking by keeping paddle shaft in vertical plane parallel to kayak:
 - Upper hand high (shoulder to eye level)
 - over the water on the active side
 - Blade close to boat.
- Use edges plus blade pitch to track straight or turn boat (either direction from each side)

The paddle shaft should be parallel to the gunwales ... otherwise this becomes a braking stroke. Note that if you drop your upper hand it tends to pull inwards towards the center of the kayak and turn the rudder into a brake.

Bow rudder (a turning maneuver)

- A three step stroke:
 - A strong and stable Edge (usually an outside edge ... though in surf or eddies, you may need an inside edge to “moon the current”).
 - Strong bow sweep with torso engagement to initiate the turn.
 - Bow rudder
- Shoulder-safe upper arm position with upper hand out in front (not resting on your shoulder). You must be able to look over your upper forearm.
- Paddle blade in water close to the boat located forward near the feet.
- Once you plant the rudder at the bow, the torso should be rotated to “face your work”.
- Use blade pitch to adjust the aggressiveness of the turn.

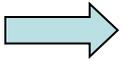
The goal is to turn with a minimum of lost speed

Roll

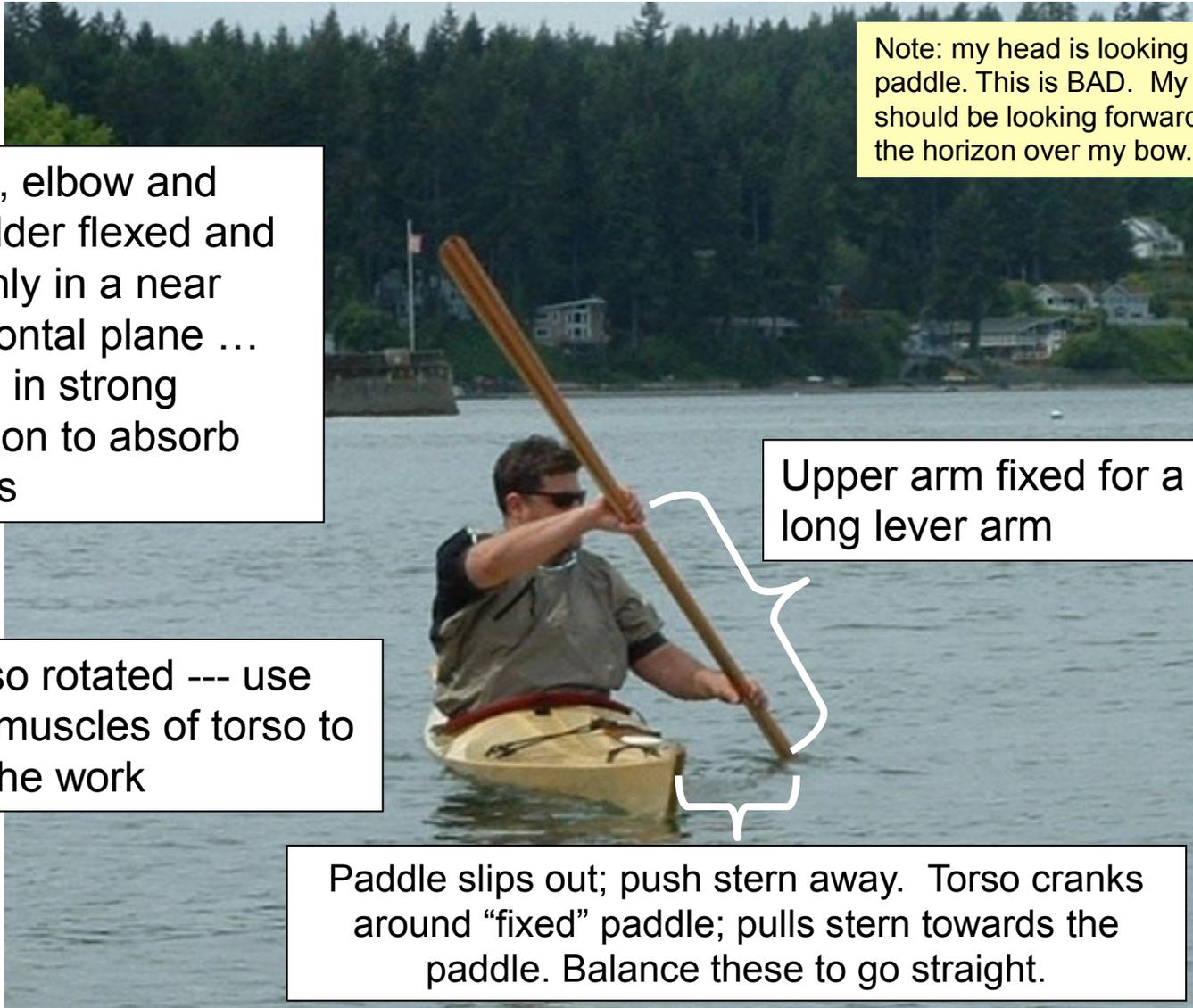
- Take your time ... setup underwater.
- Smooth and clean motion. If you “own the roll” then you can do it in slow motion ... make it look easy.
- Boat mostly up before torso leaves water.
- Low pressure on arms/paddle
- Fluid follow-through
- Safe arm position (elbows in close to torso).

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Forces during a forward stroke



Note: my head is looking at the paddle. This is BAD. My head should be looking forward out at the horizon over my bow.

Wrist, elbow and shoulder flexed and roughly in a near horizontal plane ... joints in strong position to absorb forces

Upper arm fixed for a long lever arm

Torso rotated --- use big muscles of torso to do the work

Paddle slips out; push stern away. Torso cranks around "fixed" paddle; pulls stern towards the paddle. Balance these to go straight.

The paddle as a lever



Note: this is an old style “push-pull” stroke. Don’t do the stroke this way.

I include this picture to show that in a powerful forward stroke, the paddle doesn’t move backwards much in the water. You really need to visualize the stroke as planting the blade in a fixed position and then cranking your body around that fixed blade.

Note: paddle slices out but not back (or not by much). It provides a fixed point to pivot around.

low brace turn – a leaned turn

- A low brace turn (palms down): used to turn a kayak underway ... hopefully without losing too much speed.



This is about as good as it gets:

- Torso is “facing the work”
- Shoulders square to the paddle.
- Body leaning out to create a strong pivot point.
- Minimum paddle drag ... the body position and edge does the work.
- Facing the turn
- Smiling

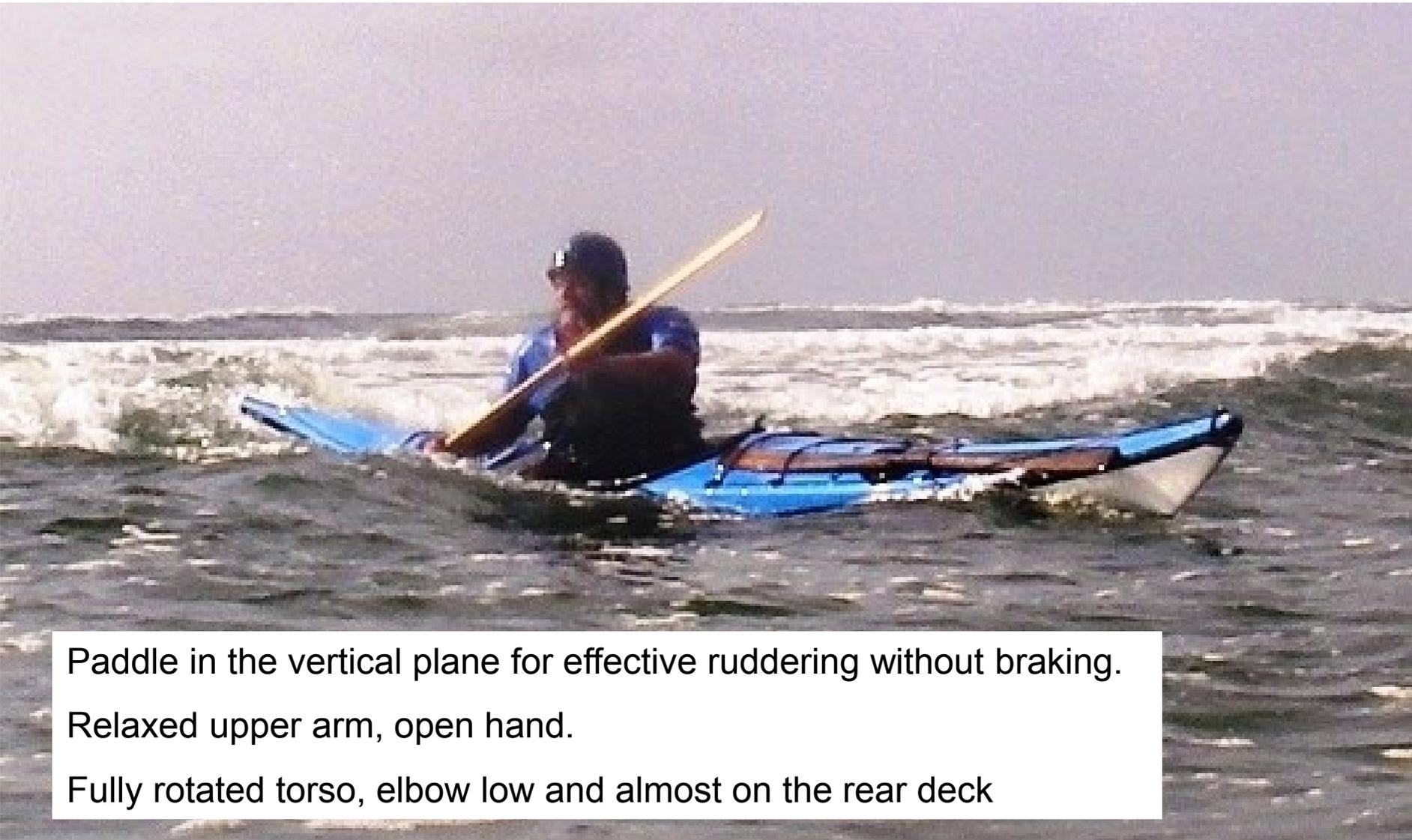
High brace

- Waves on this beach were building and dumping.
- I knew a violent broach was coming.
- I prepared with a high brace position.
- Notice my elbows are below my shoulders and close to my trunk



Tim Mattson, LaPush WA, Aug 2010, photo by Pat Welle.

Stern Rudder



Paddle in the vertical plane for effective ruddering without braking.

Relaxed upper arm, open hand.

Fully rotated torso, elbow low and almost on the rear deck

Tim Mattson holding straight course on a small wave ... Long Beach WA, May 2009. Photo by Pat Welle.

Peel-out (high brace turn)

- Rotate torso to face into turn
- Elbows low
- Moon the current



Tim Mattson at Deception pass (7 knot current) Jan 2010, photo by Pat Welle

Forward stroke - prewind



This is what you want to look like just before the plant on a forward stroke

Key points to note

- Torso rotation from the hips
 - As seen by belly button pointing to the side
- Lower arm from previous stroke raised to upper arm
 - As seen by the horizontal paddle shaft position.
- Wrists in a relaxed neutral position
- Boat still and flat
 - As seen by even wake in the water
- Head facing forward, eyes looking at the horizon

Capsize maneuver



- Breath before going under
- Relax and setup under water (give your self time to match motion with water)

Tim Mattson falling into a whirlpool at canoe pass. Photo by Neil Schulman