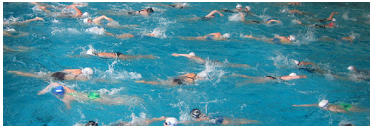


Swimming



Biomechanics

- Kinematics of swimming
 - Refractions
- Kinetics of swimming
 - electrical

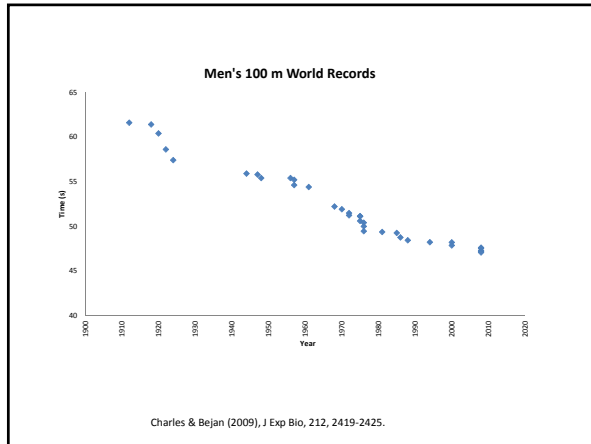


Monon: Using an electric tool, in a pool, with a metal ladder. David Monon: Standing barefoot on the ladder while using it.

Competitive Strokes

- Butterfly
- Backstroke
- Breaststroke
- Front Crawl
 - Freestyle





Factors influencing improvements

- Swimmer
 - Training
 - Nutrition
 - Technique
 - Arm
 - Kick
 - Breathing
- Equipment
 - Pool design
 - Water
 - Swim suit
 - Wet suit
 - Training equipment



Terminology

- X-beat kick
 - 2-beat kick
 - 2 kicks (one left, one right) per stroke
 - 6-beat kick
 - 6 kicks per stroke
- Early Vertical Forearm
 - aka High Elbow
 - Catch and early pull phase



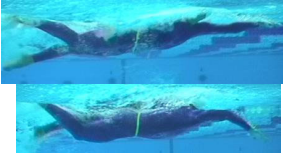
Breathing Patterns

- Bilateral
 - Being able to breath on either side
- Breathing pattern
 - Every stroke (Breath – R – Breath)
 - Every 3rd stroke (Breath - R – L – R – Breath)
 - Every 5th stroke



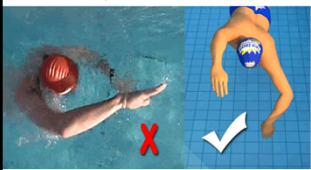
Swimming Phases

- Pull (left or right)
 - From hand entry to exit
 - Can be broken down to 'catch', 'pull', 'push' phases
- Recovery
 - From hand exit to entry
- Stroke cycle:
 - Pull + Recovery
- Stroke Rate (aka stroke index)
 - Strokes per time
- Stroke Length
 - Distance per stroke

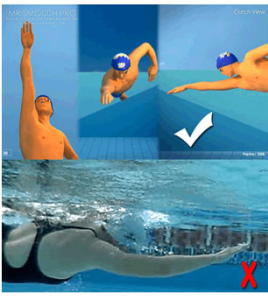
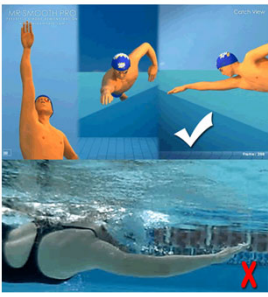


The 5 Phases of the "Catch & Pull"

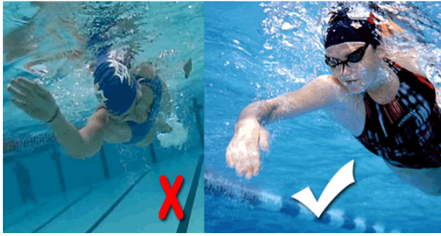
Phase 1 - Hand Entry



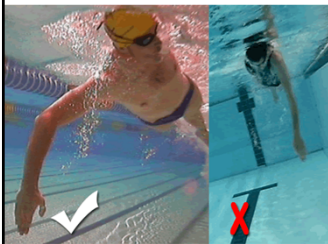
Phase 2 - Extension Forward



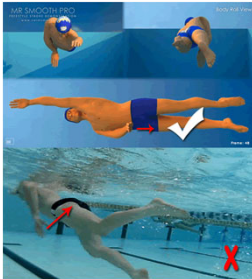
Phase 3 - Initial Catch



Phase 4 - Bent or High Elbow Catch ("vertical" forearm)



Phase 5 - Exit, Finish or Push



Swimming Kinematics

- Historical
 - Paddle-wheel motion

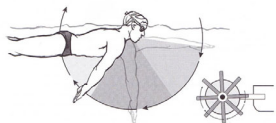


Figure 1.2 The paddle-wheel theory of propulsion.

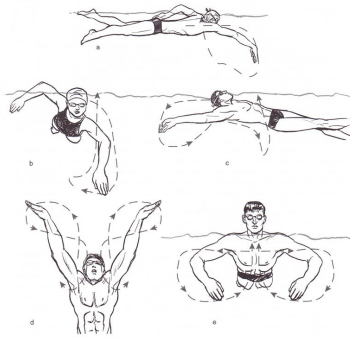
Maglischo, E.W. (2003). Swimming Fastest. Human Kinetics.

Swimming Kinematics

- 'S-shape' curve
 - Complex, 3-D
 - General motion
 - Reference frame



Maglischo, E.W. (2003). Swimming Fastest. Human Kinetics.



Maglischo, E.W. (2003). Swimming Fastest. Human Kinetics.

Swimming Kinematics

- Basic kinematic descriptors:
 - Stroke Rate
 - Stroke Length
 - Velocity

Stroke Rate, Length, and Velocity

- Velocity = SR x SL
 - SR units: Strokes per sec (Hz)
 - SL units: m per stroke
 - Velocity units = (strokes/s) x (m/stroke) = m/s

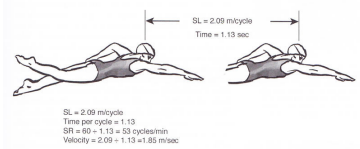
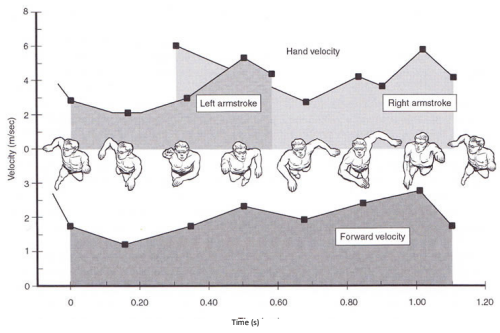


Figure 20.1 Swimming velocity can be calculated from a swimmer's stroke length and stroke rate.

Maglischo, E.W. (2003). Swimming Fastest. Human Kinetics.



Maglischo, E.W. (2003). Swimming Fastest. Human Kinetics.

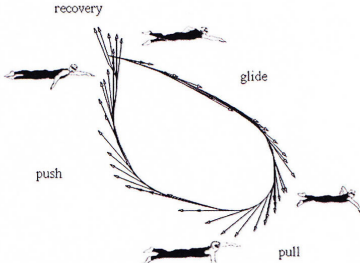
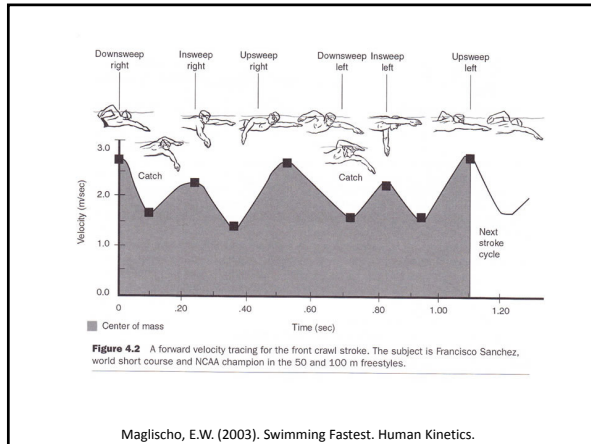
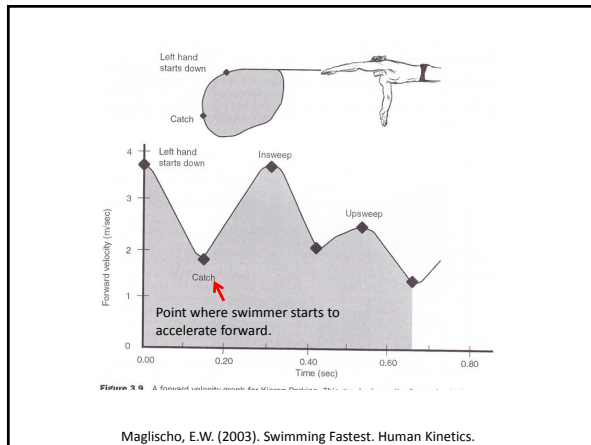


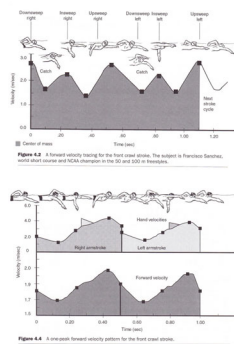
Figure 1. Phases of the stroke (the vectors represent the hand's velocity).

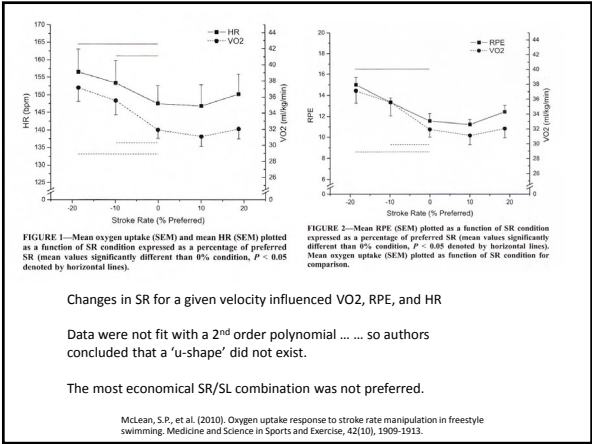
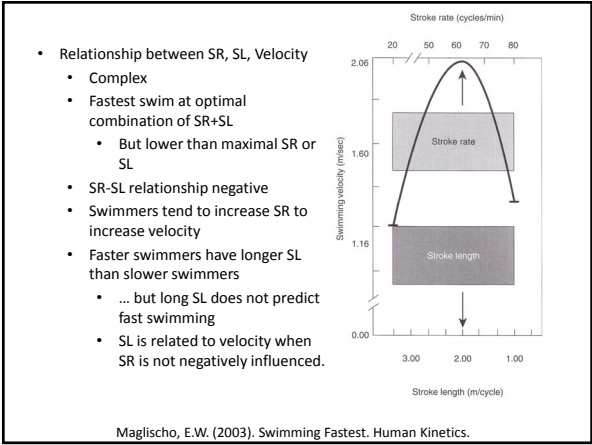
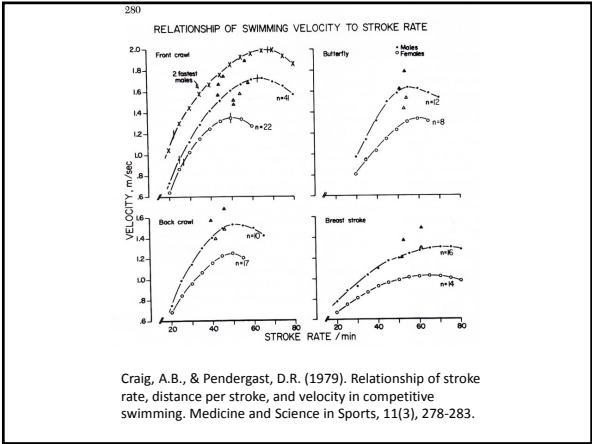
Gourgoulis, V., et al. (2010). Kinematic characteristics of the stroke and orientation of the hand during front crawl resisted swimming. Journal of Sports Sciences, 28(11), 1165-1173.





- One peak vs. Two peaks
- # of increases in velocity
- Advantage of one peak:
 - Less fluctuations in velocity
- Disadvantages
 - Shorter length of insweep
 - Characteristic of one-peak
- Style dependent on body type, kicking rhythm, how swimmers were taught.
- Best style ... both are effective.





Summary Swimming Kinematics

- Phases
- Pattern
- SR, SL, Velocity
 - economy
- Fastest swim at optimal combination of SR+SL
 - But lower than maximal SR or SL
- Swimmers tend to increase SR to increase velocity
- Limitation:
 - Work done in a pool vs. open water