Science for Armwrestling

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(Graphics by Justin Kim)

Abstract
In the sport of Armwrestling, there exist many techniques that allow competitors to take advantage of their body and knowledge of Mechanics Physics to take down their opponent. This study addresses techniques and moves to most effectively Armwrestle. From the pushing movement, the press, to the pulling technique, the top roll, the physics of Armwrestling range from Static equilibrium and torque to effective use of gravitation and movement locks, joints, space.
This research is dedicated to

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Basic Notations and definitions

Scalar: something with magnitude; multiplied with something else to scale it.

Vector: an object in space that has both magnitude and direction and does not change with a change in coordinate systems.

\[ I = \text{The moment of inertia} \]
\[ \lambda = \text{linear mass density} \]

\[ \alpha = \text{the angular acceleration vector} \]
\[ \theta = \text{an angle} \]

F=force

T=torque
Table of Contents

Introduction

The Basic Techniques

The More Advanced Techniques

How to Finage Wins (illegally)

Training for armwrestling

Static Equilibrium Introduction

Static Equilibrium Application

Torque

Pushing vs Pulling

Gravity and Curling
Introduction

This paper is going to address:

The science of armwrestling in the form of visual representations and mathematical formulas

The effects of various techniques

The strengths of techniques
The Basic techniques

1. The Top Roll
   Another obvious way to increase the chances of victory is to use more muscle strength. When pushing the opponent’s arm, the forearm and bicep muscles are used greatly while the shoulder and back muscles, two of the bigger muscles of the body, are neglected. A great move to use is the Top Roll technique. To use this technique, begin with your hand completely stretched and high. Then, pull back all the while bending your wrist to make the opponent’s hand easier to pull. Less muscle usage of the opponent means easier victory for you!

2. The Hook
   The hook technique is the best technique for those with shorter arms because it will give you more leverage and take away leverage from your opponent. Simply bend and curl your wrist and pull. Those with no experience of dealing with this technique will have a hard time. This technique is heavily muscle based; however, being used to using the muscles required for this technique will give you a great advantage.

3. The Press
   Just like the name, this technique is very simple. Get your shoulder behind your arm and press. The press requires some powerful tendons connecting your forearm and bicep, but if you do it correctly, it is very difficult to stop you. The shoulders are used greatly when using this, so shoulder exercises make your press much more powerful.
More Advanced Techniques and Variations

4. Defensive hook
   This technique is great for those with good muscle endurance. It makes your opponent use more energy than you without producing as much torque as they would have been able to without this barrier. It is an ensured hook and hand control by giving up some ground. This is tricky yet rewarding. The hand control is obtained as a bonus when done correctly. To use this technique, give up space and curl your wrist. Then, pull towards the opposite shoulder. Normally, no one will be able to move until some time has passed, but once the time comes, the movement will be towards the opponent’s doom.

5. Dead Wrist press
   A press relies heavily on the shoulder—and this one does exactly that. With a floppy wrist, it would be just like doing a push up using your opponent’s arm as the ground. Remember to get behind your arm to produce the maximum amount of force. Once the match starts, go straight into a push up position, and push with all your might, remembering that you are using 3 major muscle groups, The chest, back, and legs, while your opponent is using minor muscles, the forearm and bicep.

6. The Hit
   The Hit is not per say, a technique. It is more of a natural skill which can be improved. In simple terms, the Hit is just anticipating the “go” from the referee and starting a little earlier than the opponent, catching him off guard. Once done correctly, nobody is able to tell.

How to finagle wins (illegally)
The professional Arm Wrestling League has its own set of rules; however, we are in high school. That means there are ways to cheat without really cheating, and without anyone knowing about it. I have given these strategies some witty names, so please enjoy.

1. The wait
The game plan for this strategy is to place your arm on the table, and wait for your opponent to grab your arm. Then, refuse to advance, stretching your opponent’s arm more than you. This will give a great amount of impact on the victory and defeat of this match.

2. The leg leg
Setting is important, especially for Arm Wrestling. Find a nice table with the table legs on one side only (the tables in ALHS work fine) and sit on the side that has the table leg on the opposite side of the direction you will be pushing. When the match begins, place your leg where the table leg is, and lock on. This will give you a power boost without the opponent having the same amount of boost.

3. The “Go easy on me”
This trick works best against a football or baseball player, especially if you are not one. Simply tell them that you are weak and to “go easy” on you. Then, get them with the Hit technique into a Top Roll. Easy Money. There are two possibilities after being told this—one being they go all out on you to end it right away thinking you’re weak, and the second being to actually plan on toying with you a little bit as they boast their strength to the varsity cheerleader spectators. Either way, you will either make your opponent waste more of their energy by going into a defensive hook, or catch your opponent off guard.

4. The Wait Out
The Wait Out technique is the cheapest way to win an arm wrestling round. The logic of this strategy is to send a buddy to arm wrestle your next opponent to “warm him up”. This will waste the energy of the opponent if he ever agrees. If he declines, simply tell your opponent that he is too scared to face your buddy. He will come running back, insisting on a match.

Training for armwrestling
In order to use some of these techniques, training is necessary. Techniques will only get you so far. In this page, we will go over what parts of your body to train, and how to train.

1. Stay On The Table
   The best way to get better at arm wrestling is to practice and practice. Just like how a football player spends hours per week practicing to get better, arm wrestling is similar to that. Armwrestling itself will train your muscles used for the sport (obviously).

2. Forearms
   This muscle directly controls your wrist, which is extremely crucial to your victory. Instead of doing compound exercises, target your forearms directly by doing wrist curls. This will strengthen your tendons as a bonus.

3. Everything else
   While the forearms provide the most considerable amount of force and support, you cannot win a game of chess with just the strongest piece. Compound movements such as deadlifts, squats, rows, bench press, and pull ups are the best choice for muscle building. The bigger, the better after all.

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Static Equilibrium Introduction

Static equilibrium is a state in which there is no movement whatsoever; the acceleration is zero and so is the velocity. Most of the time, an armwrestling match will portray this scenario.
For instance, at the start of the match, both players will apply force until one is overpowered. A table fixed onto the ground will provide some normal force that will be beneficial to wrap a leg around or to hold onto when pushing or pulling.

Static Equilibrium Application

When using the hook technique or the toproll technique, which are pulling related movements, the leg is usually supported by a table leg. This is because the table produces both a vertical and a horizontal normal force perpendicular to the point of contact. Similar to walking, the normal force pushes the body and stabilizes the puller.

Torque
What is torque you ask? Torque is angular force. It depends on whether you win or lose in an armwrestling match. When you pull a lever, it is almost impossible to make it move when pulled from the very bottom, closest to the point of rotation. The formula for torque is given by the cross product between the position vector and the force vector, or the distance times the perpendicular force.

Pushing vs Pulling

So the main question asked is: which is better, pushing or pulling? Both pulling and pushing has its benefits when done correctly. The fulcrum effect is used by pullers with longer arms as they can produce a much greater torque. Simply pushing down with their shoulders will create the desired force. Pushers aim to get the opponent off balance and attack their joints by moving them to an uncomfortable position. With the flop wrist press, there is less muscle control required, so it is used by players with a stronger tricep though it does put the tendons of the hand at risk.
Gravity and Curling

It is known that gravity acts on everything on Earth. Does it do work here too? Yes. The gravity will pull from the center of mass with a magnitude of about 9.81 times the mass, exerting a torque. Normal force does exist here too; however, since the normal force acts on a different point, it too produces a torque. When an arm is above another, the gravity will be in favor of the winning side. It is because of all these forces that this sport is hard to master. Curling the wrist gets rid of many things to control like the wrist and slipping, that can be caused by too much force in opposite directions.
Additional resources

(used in between sections during presentations)
\( F_A \) = force applied by the left
\( F_R \) = force applied by the right
Torque in movement

\[ \tau = \vec{r} \times \vec{F} = I\alpha \]

Assume end of match when one gives up

\[ I = \frac{mL^2}{3} \left(1 + \frac{1}{12}\right) \]

\[ \alpha = \frac{A}{L} = \frac{2A}{L} \]

\[ \tau = \frac{2}{3} mL \left(\frac{13}{12}\right) = \frac{13}{18} mL \]

Length inc. = \( \tau \) inc.

Effects on other arm? (just forearm)

\[ \tau_A = \frac{2}{3} FL \]

\[ \tau_B = FL \]

Longer L = greater \( \tau \)
Friction between hands

\[ \mu = \text{coefficient of friction} = 0.62 \pm 0.22 \]

*when players generate F in different directions -> slip.*

Use: A strap, chalk at first
The Fulcrum

\( \phi < \phi < 90 \)
\( \sin \phi < \sin \phi \)
given property above

(Not drawn to scale)

\[ \sum \tau_A = F_A \sin \phi \frac{2L}{3} \]
\[ \sum \tau_B = F_B \sin \phi \frac{2L}{3} \]
\[ \therefore \sum \tau_A < \sum \tau_B \]

Competitors with longer arms show use of the Fulcrum effect by leaning back and downwards
Less muscle required to push with a flip wrist

\[ \sum \tau_p = F_B \cdot B \]
\[ (A + B)F_A \sin \theta \]

results in large torque on "P", an elbow tendon

great risk of injury:
not recommended
\[ F_n = \text{normal force by the table} \]
\[ F_A = \text{pushing/pulling force} \]