

THE KINEMATIC SEQUENCE

The *Handoff*

Hips, then chest, then arm, then hand. Each one peaking later and faster than the last, and each one slowing down to pass its speed forward. It is a handoff rather than a sum, which is why a segment that refuses to slow down breaks the whole thing.

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Speed is not added up along the chain. It is **handed forward**, and the handing requires each segment to give up what it had.

That is the part that gets missed. Everyone knows the order. Fewer people build training around the fact that a segment has to decelerate for the next one to accelerate, which means the ability to *stop* is as much a part of throwing hard as the ability to go. A pitcher who can produce force but not absorb it will show a broken sequence no matter how strong he is, and no amount of additional strength will fix the order.

The order, and the speeds

Hips

FIRST TO PEAK

Start the rotation from the ground and get out of the way. The timing of the hip peak trends toward lower elbow load when it happens earlier, though that particular parameter did not separate high and low torque groups significantly, so treat it as a weaker signal than the arm positions.

Chest

ACCELERATED AGAINST THE HIPS

Turns faster than the hips did, because it is being accelerated against a decelerating pelvis. This is where the

front leg block does its work: braking the pelvis is what spikes chest rotation speed.

Arm

LEFT BEHIND, THEN CARRIED

Does not act. Gets acted upon. The arm is heavy and relaxed and the chest turns underneath it, which is what produces layback. When this link fails the arm starts generating instead, which is the pushing pattern.

Hand

FASTEST, LAST

Internal rotation reported between roughly **6,000 and 7,000 degrees per second** depending on the study, which is somewhere around seventeen to nineteen full turns per second. The fastest motion the human body produces, and it is almost entirely inherited rather than generated.

Two ways it breaks

ORDER

A segment peaks out of turn

The chest peaks before the hips, or the arm before the chest. Whatever comes next has nothing handed to it and has to supply its own acceleration.

The signature is **high elbow load with unremarkable velocity**. The arm is doing work that should have been done for it, and getting paid at the elbow rather than on the gun.

TIMING

The order is right and the gaps are wrong

Everything peaks in sequence but too close together, or too far apart. A handoff that happens after the previous segment has already stopped transfers nothing.

Harder to see and more common. This is what a late block, a late pelvis, or a late arm each produce, and each has its own document.

Both failures are absorption problems as often as production problems

A segment that cannot decelerate cannot hand off. The glutes, side abs, lat and cuff are all braking the segment behind them at the same time as they drive the one in front. Which means **the sequence is limited by the weakest brake, not the strongest engine** — and that is why eccentric and isometric work matters more for a thrower than raw pushing strength.

The finding that changes how you coach repeatability

Skilled pitching is not less variability. It is better organised variability.

An analysis of joint coordination through the delivery found that better pitchers do not move more identically. They vary in **structured** ways: the chest and hips settle down before foot contact, while the shoulder does not reach its minimum variability until peak layback. The base is highly repeatable and the arm chain carries the adjustments that preserve the release.

Higher velocity pitchers showed *better coordination* at release rather than less movement. And separately, variability in the arm near peak layback and in how the hand turns at release has been associated with **better** command, not worse — because that late adjustability is the mechanism by which a pitch that started wrong gets saved.

So the instruction is not "be more repeatable." It is **be repeatable in the base and adjustable in the arm**, and drilling the second one out in pursuit of a consistent release removes the thing that rescues bad pitches.

Efficiency and output are different axes

Harder throwers score worse on efficiency, and that is expected

In Driveline's sample of 182 captures, harder throwers showed lower overall mechanical efficiency than slower ones despite the higher velocity. The harder you throw, the messier the mechanics tend to score.

Which means an efficiency number in isolation cannot tell you whether there is a problem. Judge on **stress per mph** instead. Inefficient at 96 and inefficient at 84 are different situations, and only one of them is worth risking a mechanical change over.

Training it

Sequencing responds badly to instruction and well to changed tasks. This is the clearest case in the library for constraints over cues.

APPROACH

Change the task so the right order is the easy one

Driveline's position is that weighted implements act as their own pitching coach, and that outward focused cues beat body part cues for full body movements. Both apply here more than anywhere.

- **Step back and rocker patterns**, which move hip initiation earlier without anyone mentioning hips
- **Plyo wall work** at proper distance, so rotation is the only way to complete the task
- **Tempo and rhythm drills**, which work on the gaps rather than the order
- **Outward cues** — drive through the ground, throw through the catcher's glove — rather than load your back leg

SUPPORT

Train the brakes, not just the engines

Since the weakest brake caps the sequence, absorption work is sequencing work.

- **Eccentric and isometric blocks** before explosive ones
- **Drop and stick landings** for the front leg, which is the biggest brake in the chain
- **Slow lowering cuff work** for the last one
- **Med ball throws in the actual sequence**, low reps and full rest, since rate collapses under fatigue

MEASURE

Judge it on order and gaps, not on smoothness

A delivery can look ugly and sequence correctly. Several very hard throwers do exactly that.

- Peak angular velocity **order**, then the **timing gaps** between peaks
- Med ball throw speed against vertical jump, which separates production from transfer
- Variability at foot contact against variability at release. They should differ

Where this sits in the library

Every other document is one link in this chain

False Load is the hips not being loaded. *Swing or Rotate* and *The Long Way Back* are the block failing to convert momentum into rotation. *Nothing Left to Turn* is the chest spending its rotation early. *Allowed, Not Made* is the arm not being left behind. *Push or Whip* is the arm generating what it should have received. *Stopping It* is the last handoff, to nothing.

Which makes this the document to read first if you want the map, and last if you want the detail.

Sources

- Skilled pitching is not less joint variability but better structured joint variability, SportRxiv
- Driveline — Biomechanics Rewind: A Look at the Numbers, efficiency above 87 mph
- Driveline — The Interaction of Biomechanics and Command
- Driveline — A Different Model for Cueing Pitching Mechanics

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- [Fleisig et al. — Kinematic Parameters Associated With Elbow Varus Torque in Elite Adult Baseball Pitchers](#)
 - [Comparison of Kinematic Sequences During Curveball and Fastball Baseball Pitches](#)
 - [ASMI — The Clinician's Guide to Baseball Pitching Biomechanics](#)
 - [American Baseball Biomechanics Society — Standardisation mission](#)
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Repeatable in the base, adjustable in the arm. The variability you drill out is the variability that saves pitches.