EFFECTS OF AN ANGLED STARTING BLOCK ON SPRINT START KINEMATICS

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INTRODUCTION: The sprint start mechanics have changed over the years with the invention of the starting blocks. The most recent modification of the starting block developed by Gill Athletics was to create an outward angle of the foot position in the block in order to match the .28 rad. (16 deg.) oblique axis of the ankle. This study examined the effects of an outward angled foot position in a starting block prototype on the first four steps during sprinting kinematics.

METHODS: Six female sprinters in the middle of their outdoor season volunteered from the Indiana State University Track team read and signed an informed consent before they performed sprint starts from a standard block and a Gill angled starting block prototype. The subjects' mean age, height, and weight were 20.0 ± 0.9 yrs, 1.65 ± .08 m, and 59.9 ± 5.0 kg. The prototype starting blocks were made with an outward, .28 rad. angle of the foot pad in order to permit full foot force to be applied perpendicularly to the block pad. From the height, the blocks were adjusted such that the lead knee was placed at a 1.75 rad angle and the subjects were permitted to practice using the new blocks for a one hour period over one week. Prior to testing, subjects jogged 400 m, and then performed their regular sprinter stretches. Each subject performed 3 maximal sprint starts for 30 meters using either the standard block or the angled block followed by the other block shown in Figure 1.

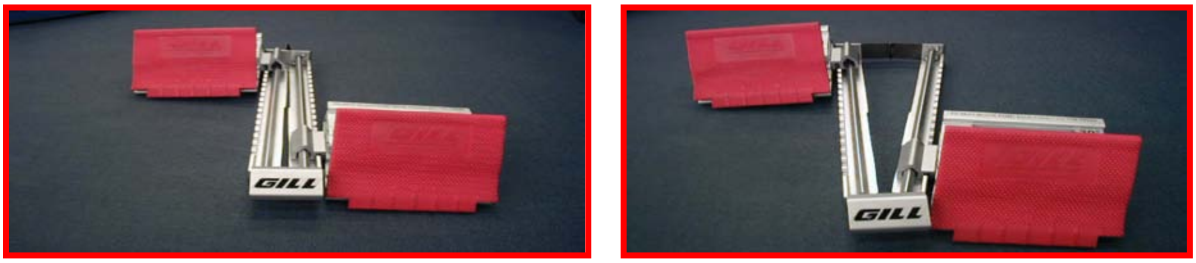
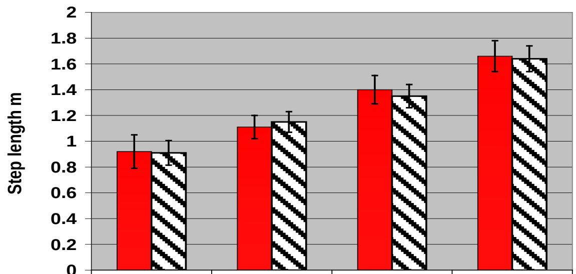


Figure 1. Traditional starting block & Gill angled starting block prototype

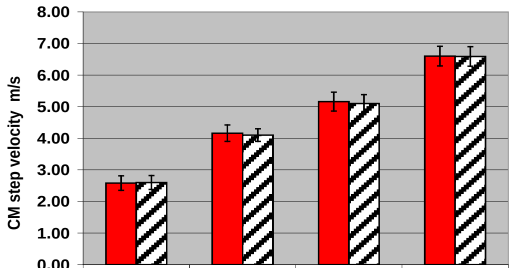
All sprint starts were recorded at 60 Hz with a .001 s shutter from side, right rear, and front views, 16 body markers were identified, and a calibration cube was placed in the middle of the 4 step field of view. Markers were digitized, transformed using the 3D direct linear transformation (DLT), and digitally filtered at 10 Hz using the Ariel APAS 2008. Kinematic variables of step length, total body CM horizontal velocity, and the block clearance times were calculated and analyzed with an ANOVA with repeated measures.

RESULTS AND DISCUSSION: The analysis found significant differences ($p<.001$) between the first four running step lengths but not between the type of block, which is shown in Figure 2. Also, the body's CM velocities were significantly different for the step factor where the 4th step was fastest, which is illustrated in Figure 3. Research conducted by Guissard (1992) found that by adjusting the block's medial/lateral angle to replicate the oblique ankle angle on the starting block significantly resulted in sprint start velocities that were .03 m/s faster in the first 4 steps. Their study found the angled blocks elicited a slightly higher non-significant average linear velocity of 4.63 m/s as compared to 4.60 m/s for the standard block. In the present study, the block clearance time was measured when the back foot passed the front part of the block. Non-significant ($p=.334$) mean block clearance times were .482 ± .050 s for the angled block and .470 ± .038 s for the standard starting block, shown in Figure 4. It was reported by Ozolin (1988) that sprinters take 0.3 to 0.4 seconds to react to the starting gun and clear the blocks. The longer time for force being applied against the angled block provided could produce a larger impulse even with similar forces, and may be responsible for the slightly higher CM velocities seen in the accelerative phase (2nd, 3rd, and 4th steps).



	Step1	Step2	Step3	Step4
Angled	0.92	1.11	1.40	1.66
Standard	0.91	1.15	1.35	1.64

Figure 2: Step lengths using blocks



	Step1	Step2	Step3	Step4
Angled	2.58	4.16	5.16	6.60
Standard	2.60	4.10	5.10	6.59

Figure 3: CM step velocity using blocks

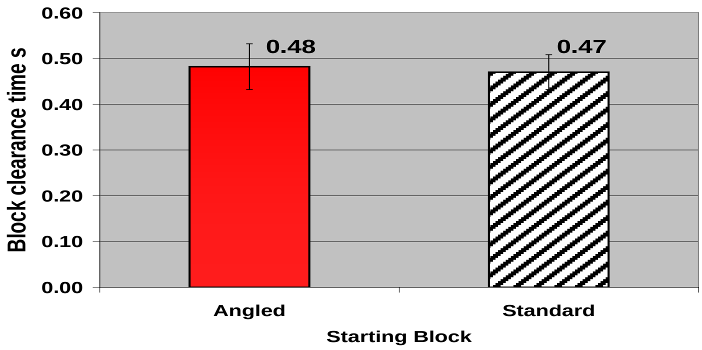


Figure 4: Block clearance time

CONCLUSIONS: A .28 radian oblique angle on the block allowed the athletes to apply their foot force perpendicularly against the block for a longer time period. An increase in the runners' explosive impulse coming out of the blocks produced longer block clearance times, and slightly higher maximal velocities during the accelerative phase (steps 2, 3, and 4). Although the angled block did not produce greater velocities during the first step, it did facilitate an effective transition to form running with slightly higher velocities which were non-significantly different in the latter steps measured. According to research conducted by Stevenson (1997), a longer stride resulted in a higher linear velocity at take-off, but hindered block clearance time. The present study found that the angled starting block produced slightly longer step lengths for 3rd and 4th steps, which resulted in higher linear velocities but slower block clearance times. Overall, the angled block was equally effective as the standard block with only slight, non-significant improvements in the runners' velocity. Our study's relatively slow .017 s frame duration may have not provided a fast enough sampling rate, to measure minor adjustments in timing and velocities which can occur in time intervals less than .001 s. Although, these slight differences may appear to be insignificant, they may be beneficial for coaches and athletes, in sprinting events where the margin of winning or losing is measured in milliseconds.

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