KRAM System Components

The Kinematic Running Assessment Method is a set of individual components that indicate specific biomechanical behaviors which have been shown to be associated with running efficiency. The system was generated from (a) common assessment practice (e.g. stride frequency), (b) various authorities in the track and field community including Olympic development programs individual distance running coaches, (c) personal revelation gleaned from competition experience, training experience and coaching experience, and (d) meta-analysis of current running science research.

The construction of the six-component kinematic running assessment method (KRAM) was predicated on idea that a diagnostic kinematic efficiency assessment tool can also be used as a formative assessment tool to improve running mechanical efficiency in adults as well as children as young as nine (Snowman and Biehler, 2003, explain that at the fourth grade level, children show evidence of increased fine motor control).

Three of the six components were key areas of interest in a study (Nunan, 2007) which linked specific neural/motor patterns to running efficiency; these components were stride frequency, angle of foot-strike and relative ground-contact time. The other three components of the KRAM system, *recovery-leg swing height*, *knee-compliance* and *foot-strike pattern*, have been well documented in earlier studies to be strong determinants of running biomechanical efficiency.

The components of this method are either measured by categorical qualification (e.g. foot above the knee vs. foot below the knee of recovery leg swing) or measured quantitatively in either degrees of freedom (e.g. degrees to the nearest tenth of a degree or decimal to nearest one-hundredth) or decimal fraction of a proportional value, as in GS.

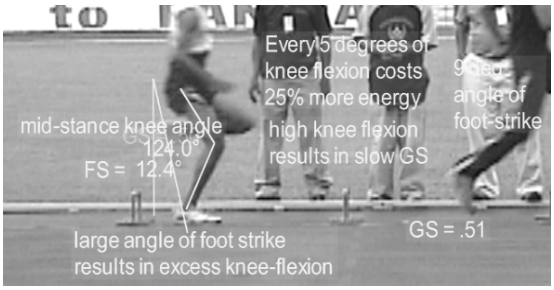


***Figure 1*. Sample video clip (Dartfish still image) from a 2007 formative-assessment running clinic in the Philippines (using mini-hurdles).**

The KRAM system has been used as an analysis tool in various clinics held from June of 2007 until present in numerous locations including multiple clinics in Bacolod City/Cadiz City/Kabankalan on Negros Island, Philippines (see figure 1), The High Altitude Running Camp at Grouse Ridge in the Sierra Nevada Mountains, the Simplot Track and Field Clinic at Idaho State University in Pocatello, as well as numerous clinics held at public and private schools and universities in the western United States.

The measurement of these components in individual runners provides substantial information for assessing their competencies in relation to running efficiency. Table VIII shows the diagnostic assessment of male college cross country runners; these values were extracted from video analysis taken during a training run. This type of diagnostic analysis can be used

for any age runner; formative, “in training” assessment would be recommended for ages eight years and older.

These components were also designed for use in research in athletics such as a longitudinal study proposed by the American Association of Health, Physical Education and Dance (AAHPERD); a call has been submitted to researchers who might provide empirical solutions to the dilemma facing our nation’s communities. An area of need is for evidence that shows “the relationship between physical competence (motor skills), learned in school physical education classes, and physical activity participation throughout the lifespan”. A longitudinal investigating of the association of physical skill acquisition and academic performance would also be a useful study in concert with the study conducted by the California Department of Education (2005) which showed a strong link between fitness and academic performance.

The KRAM components are identified and functionally defined in table I. Figure 2 illustrates the categorical and quantitative data elements pertaining to the six KRAM components. Table II describes how quantitative data elements (taken from the examples in figure 2) are used to compute the non-categorical component assessment values. Table III shows a KRAM assessment score for 12 different male college aged cross country runners.

The video clip in Figure 1.1 may be viewed in Adobe Acrobat Reader 9.0 or later; access this link to download and install a version of this software on your computer: http://www.adobe.com/products/acrobat/readstep2.html

Figure 1.1 **Sample video clip (Dartfish rendered image) of runner analysis using all 6 KRAM components.**

Table I
KRAM components description and unit of measurement

Component	Abbreviation	Function / Description	Unit of measure
Angle of Foot-strike	FS	Hamstring performance and kinematic efficiency (Kibler, Press and Sciascia, 2006)	Degrees to the nearest tenth
Foot-strike Pattern	SP	Assessment of Passive energy potential and determinant of performance.(Williams, 1985)	Category: Heel-striker, Midfoot striker, and forefoot-striker.
Stride Frequency	SF	Neuromuscular control of Kinetic distribution and Calculation of Ground-speed (Slawinski and Ballat, 2002).	Revolutions (full right-left cycle) per minute (RPM)

Table I ***(continued)***

Component	Abbreviation	Function / Description	Unit of measure
Ground-speed	GS	Indicant of running efficiency (Hunt, 2004); associated with vertical compliance (Cavanagh, 1990) and ground-speed (Williams and Cavanagh, 1987, and current study).	Ground-contact time of both feet divided by one revolution.
Recovery-Leg Swing-Height	SX	Potential energy at foot-strike (Hunt, personal communication); affects foot-strike pattern (Scholten et al, 2002).	Category: Over the knee, at knee-height, below the knee.
Knee compliance	KC	Measurement of vertical compliance, indicant of efficiency and assessment of knee-stiffness (Cavanagh, 1990); affected by FS.	Knee-angle (in degrees) at foot-strike minus knee angle at mid-stance.

Figure 2. **KRAM assessment elements**

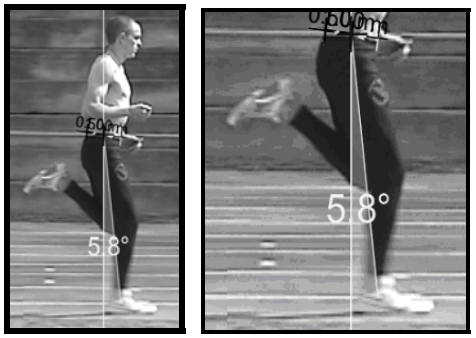
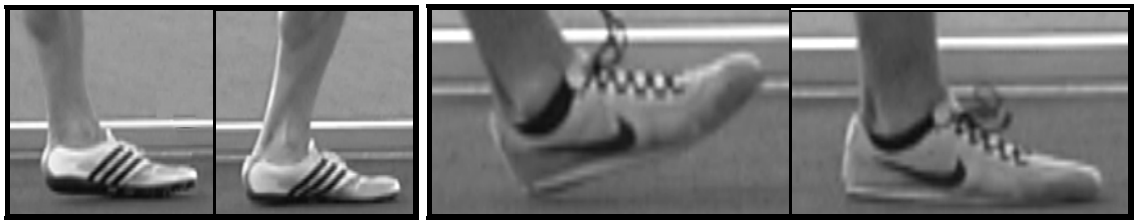
Component Name	Abbrev.	Assessment Element
Angle of foot-strike	**FS**	 Degrees to the nearest tenth
Foot-strike Pattern	**SP**	 *Midfoot-strike* *Heel-strike*
Stride frequency	**SF**	 foot-strikes time one stride (opposite limb) One revolution

Figure 2 **(continued)**

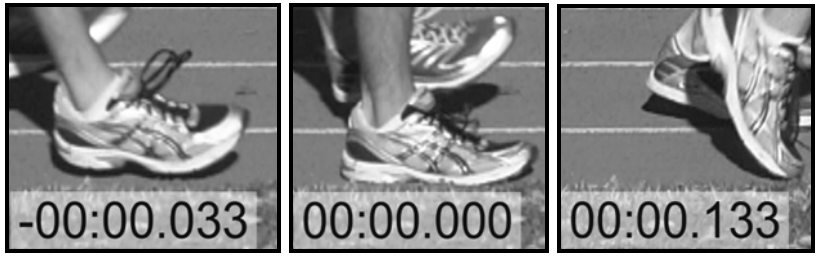
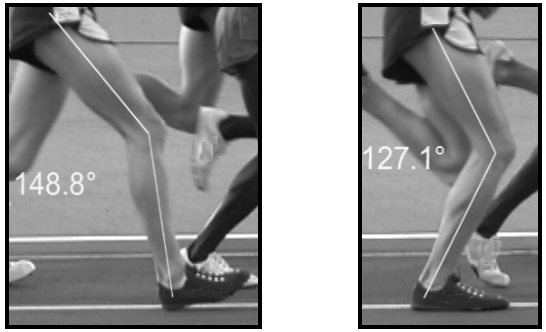
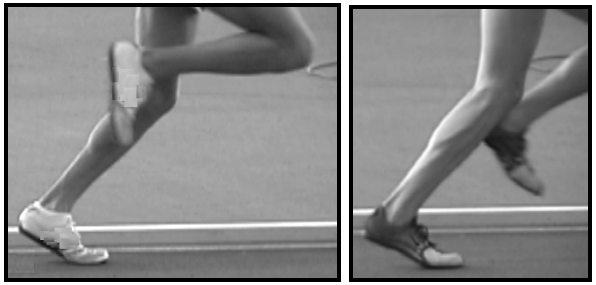
Component Name	**Abbrev.**	Assessment Element
Ground-speed	**GS**	 Pre ground-contact Foot-strike (time) Toe-off (time)
Knee compliance	**KC**	 Pre ground contact knee-angle Mid-stance knee-angle
Recovery leg swing-height	**SX**	 Ankle: *above the knee* Ankle: *below the knee*

Table II

Formulas for computing the quantitative KRAM component values

Angle of foot-strike	FS is assessed using video analysis tools; Dartfish Pro-Suite 4.08 was used in the sample shown in figure 26.
Stride frequency	$SF = \frac{1\text{rev}}{.667\text{s}}\left(\frac{60\text{s}}{1min.}\right) = 90$ rpm
Ground-speed	$GS = \frac{\text{ground} - \text{contact}}{\text{Stride}} = .\frac{.133\text{s}}{.333\text{s}} = .40$ or 40% of stride
Knee compliance	KC = (pre ground-contact knee angle) **–** **(**mid-stance knee angle) = 148.8° - 127.1° = 21.7°

Note. Sample stride frequency, ground-contact time, and knee angle element values were taken from figure 26.

1 stride = ½ revolution (one revolution is the period of time marked by two consecutive foot-strikes of the same foot).

Table III
Diagnostic KRAM Values observed in male distance runners

	SP[a]	SX[b]	FS[c]	KC[d]	SF[e]	GS[f]
John A	M	0	13	20	90	0.52
John B	RM	(+)	10	*25*	90	0.50
John C	RM	0	13	19	91	0.55
John D	RM	0	12	24	92	0.49
John E	M	0	9	16	95	0.47
John F	RM	0	13	20	90	0.60
John G	RM	0	10	*18*	88	0.58
John H	H	(+)	15	28	84	0.60
John I	M	0	8	19	84	0.51
John J	M	(+)	8	20	88	0.44
John K	M	(-)	10	*24*	95	0.55
John L	H	0	10	22	90	0.60

Note. 1 Stride = ½ revolution
[a]SP: Foot-strike pattern: F = forefoot, M = midfoot, RM = rear midfoot, H = heel
[b]SX: Recovery leg swing height: (+) = above the knee, 0 = knee-height, (-) = below the knee
[c]FS: Angle of foot-strike
[d]KC: Knee-compliance: the number of degrees the knee collapses during the stance phase
[e]SF: Stride frequency: 60 seconds ÷ revolution period = revolutions per minute
[f]GS: Ground-speed: decimal fraction of stride of that foot is on the ground (e.g. 0.50 = 50%)