Preparation of the Elite Junior Middle Distance Runner

Scott Christensen
January 2011
Part 1: Athlete and event profiling for the middle distance events.

Part 2: Training modalities for the 800 and 1600 meter events.

Part 3: The multi-paced training scheme for the 800 and 1600 meter events.

Part 4: Key workouts for each pace of the multi-paced training scheme.
Scott Christensen

- Stillwater, Minnesota, head coach for 30 years.
- Seven different Minnesota State Champions in the 800 and 1600 since 1996.
- Four Stillwater alumni have broken 4:00 in the mile since 2003.
- Fourteen year USATF Level 2 Lead Instructor in Endurance.
Part 1

Athlete and event profiling for the middle distance events.
“The 800 and 1500 meter events are physiologically very close, but very distant psychologically” Peter Coe.
Combined Zone Races

All races from the 800 meters and longer have a significant aerobic and anaerobic component of energy contribution, and are called combined zone races.

Combined zone races have a comfort zone and a critical zone. The critical zone is where the race is won or lost.
Successful racing in the fast end of the combined zone (800 and 1600) relies on managing oxygen and........
The toleration of disassociated Lactic Acid \((\text{C}_3\text{H}_5\text{O}_3 + \text{H})\)
## Anaerobic and Aerobic Energy Contributions

<table>
<thead>
<tr>
<th>Event</th>
<th>Aerobic</th>
<th>Anaerobic Glycolytic</th>
<th>Anaerobic Alactic</th>
</tr>
</thead>
<tbody>
<tr>
<td>800 meters</td>
<td>40%</td>
<td>55%</td>
<td>5%</td>
</tr>
<tr>
<td>1600 meters</td>
<td>50%</td>
<td>48%</td>
<td>2%</td>
</tr>
<tr>
<td>3200 meters</td>
<td>70%</td>
<td>30%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>5000 meters</td>
<td>80%</td>
<td>20%</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>
Physiological Definition of “Elite” in Endurance Events

• A genetic/trained physiological shift in an athlete to a greater contribution by the aerobic energy system at a combined zone race distance.

• Example: 3000 meter race.
  • General Population = 70% aerobic/30% anaerobic
  • Paula Ratcliffe = 85% aerobic/15% anaerobic
It Is All About Preparation

“If given 8 hours to cut down an oak tree, I would spend the first 6 hours sharpening my axe.”

Abraham Lincoln
Training Issues for the Coach

- Chronological age
- Training age
- Volume vs. Intensity
- Overtraining
- Climatic Concerns
- Injury Prevention
General Physiological Goals

- Improve the aerobic energy system.
- Improve the two anaerobic energy systems.
- Strengthen the muscular system.
Considerations During the Training Periods of the Elite Miler

- Determining goals, objectives, and physiological parameters.
- Sequencing workouts
- Easy days are well thought out.
- Psychological needs of the athlete are prioritized.
## Goals and Objectives

<table>
<thead>
<tr>
<th>Months</th>
<th>800 Meters</th>
<th>1600 Meters</th>
<th>vVO2</th>
<th>5000 Meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>December</td>
<td>2:05.30</td>
<td>4:27.00</td>
<td>4:56.00</td>
<td>15:37.00</td>
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<tr>
<td>January</td>
<td>2:04.05</td>
<td>4:25.00</td>
<td>4:53.00</td>
<td>15:31.00</td>
</tr>
<tr>
<td>February</td>
<td>2:02.81</td>
<td>4:23.00</td>
<td>4:51.00</td>
<td>15:24.00</td>
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<td>March</td>
<td>2:01.58</td>
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<td>15:11.50</td>
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<tr>
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<td>1:57.34</td>
<td>4:14.00</td>
<td>4:42.30</td>
<td>14:51.35</td>
</tr>
<tr>
<td>May</td>
<td>1:54.87</td>
<td>4:09.78</td>
<td>4:34.50</td>
<td>14:37.50</td>
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<tr>
<td>State Meet</td>
<td>1:53.52</td>
<td>4:06.23</td>
<td>4:31.80</td>
<td>14:26.32</td>
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<tr>
<td>Junior Nats</td>
<td>1:51.78</td>
<td>4:04.36</td>
<td>4:28.30</td>
<td>14:23.30</td>
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</tbody>
</table>
## Physiological Parameters

<table>
<thead>
<tr>
<th></th>
<th>200-400</th>
<th>400-600</th>
<th>600-800</th>
<th>1000-1600</th>
<th>20-40 Min.</th>
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</thead>
<tbody>
<tr>
<td>Dec</td>
<td>120% VO2</td>
<td>114% VO2</td>
<td>105% VO2</td>
<td>100% VO2</td>
<td>LT 85% VO2</td>
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<tr>
<td>Jan</td>
<td>62.02</td>
<td>66.78</td>
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<td>4:53.98</td>
<td>5:42.20</td>
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<tr>
<td>Feb</td>
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<td>65.66</td>
<td>4:47.00</td>
<td>4:51.04</td>
<td>5:40.23</td>
</tr>
<tr>
<td>March</td>
<td>60.79</td>
<td>64.83</td>
<td>4:43.50</td>
<td>4:48.13</td>
<td>5:36.30</td>
</tr>
<tr>
<td>April</td>
<td>58.36</td>
<td>63.00</td>
<td>4:37.30</td>
<td>4:42.63</td>
<td>5:28.30</td>
</tr>
<tr>
<td>May</td>
<td>57.85</td>
<td>62.02</td>
<td>4:30.50</td>
<td>4:34.30</td>
<td>5:23.89</td>
</tr>
<tr>
<td>State</td>
<td>57.21</td>
<td>61.20</td>
<td>4:28.80</td>
<td>4:31.20</td>
<td>5:18.32</td>
</tr>
<tr>
<td>Junior Nat</td>
<td>55.93</td>
<td>61.08</td>
<td>4:25.30</td>
<td>4:28.33</td>
<td>5:15.10</td>
</tr>
</tbody>
</table>
Designing the elements of the macrocycle so that the best performances are at the end of the season should be the number one objective.
Specific Periods Within the 800 and 1600 Meter Macrocycle

- The **Preparation Period** focuses on the athlete as an endurance runner.
- The **Competition Period** focuses on the athlete as a miler.
- The **Transition Period** allows the athlete to prepare for the next stage of development.
Biomotor Fatigue

- Weakness or weariness resulting from exertion or prolonged stress.
- Can be short-term or chronic.
- A limiter of athletic performance.
Sources of Fatigue

• The *accumulation* of by-products; e.g., hydrogen ions in the muscle cells & blood.

• The *depletion* of substances; e.g., depletion of glycogen in the muscle cell.

• *Changes* in metabolic function from acidity or changes in core body temperature; e.g., enzyme disturbances.

• A *limitation* at the neuromuscular junctions of the nervous system, e.g., sodium-potassium pump.

• *Disturbed* coordination regulation through over-demands on the neuro-hormonal system.
Part 2

Training modalities for the 800 and 1600 meter runs.
Training Modalities for Middle Distance Runners

• The Long Run  IMPORTANT
• Tempo Run  IMPORTANT
• Strength Run  IMPORTANT
• Recovery Run  CRITICAL

• VO2 max Run  CRITICAL
• Interval Run  CRITICAL
• Repetition Run  CRITICAL
Long Run

• Outer reach of fitness level is the goal.
• Fat rather than carbohydrate is the primary energy source.
• Done at the aerobic threshold, 65% VO$_2$ max pace.
• Pace consideration when done in a group.
• Extent is 20% of weekly mileage throughout the macrocycle.
Fuel Depletions and Limits

Glycogen Utilization in Working Muscle

![Graph showing glycogen utilization during exercise](image)

Tempo Run

- Extent of work is beyond 1600 race distance.
- Intensity is done closer to the anaerobic threshold.
- Duration dictates pace.
- 6K-7K at 90% of VO$_2$ max.
Anaerobic/Lactate Threshold

• The speed at which H+ ions begin accumulating.
• Measured by lactate concentrations.
• About 15K pace (4.2 m/s) is the training mark, or 85% of VO₂ max velocity.
• Tempo runs are done as a percentage of VO₂ max velocity.
Strength Run

• Greater resistance to force is the goal.
• Any running is strength work.

• Hills are the main target workout.
• Hills are done in 4 microcycle blocks of time.
• 35-45 second bouts of work.
• 4 minute jog of incomplete recovery.
• Sets of 6-8.
Recovery Run

• Recovery has many aspects and may simply be adding base mileage at the aerobic threshold pace. Shorter in distance than the long run.

• Energy system recovery and muscle repair are the biggest concerns.

• 20 min run at minimum.
A Critical Understanding of VO$_2$ max is Necessary for the 800/1600

- Aerobic power improves due to cardiovascular development.
- Cardiac Output (Q) = HR x SV.
- VO$_2$ max = HR x SV x A-vO$_2$ diff.
- HR$_{max}$ = 207 – 0.7 x age.
- VO$_2$ max pace HR is ~85% of HR$_{max}$.
Percentage of VO$_2$ max as a Function of Race Velocity

<table>
<thead>
<tr>
<th>Event</th>
<th>% of VO$_2$ max</th>
</tr>
</thead>
<tbody>
<tr>
<td>800 Meters</td>
<td>120%</td>
</tr>
<tr>
<td>1500-1600 Meters</td>
<td>110%</td>
</tr>
<tr>
<td>3000-3200 Meters</td>
<td>102-100%</td>
</tr>
<tr>
<td>5000 Meters</td>
<td>97%</td>
</tr>
</tbody>
</table>
**VO₂ max Training Study**
**12 week Training Period**
*(Helgerud et al, 2007)*

- LSD: CR for 45 min @70% VO₂ max
- LT: CR for 25 min @85% VO₂ max
- 15/15: 47 reps @90% HR max, 15 s rest
- 4*4 min: 4 min repeats @ VO₂ max

Workout repeated twice per week, 40 mile weeks.
% Change VO$_2$ max & Stroke Volume
(12 Weeks)
Helgerud et al, 2007, MSSE
### Pre/Post Physiological Changes

<table>
<thead>
<tr>
<th></th>
<th>Pre LSD</th>
<th>Post LSD</th>
<th>Pre LT</th>
<th>Post LT</th>
<th>Pre 15/15</th>
<th>Post 15/15</th>
<th>Pre 4*4</th>
<th>Post 4*4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VO₂ max</strong></td>
<td>55.8</td>
<td>53.8</td>
<td>59.6</td>
<td>60.8</td>
<td>60.5</td>
<td>64.4</td>
<td>55.5</td>
<td>61.4</td>
</tr>
<tr>
<td><strong>VE O₂</strong></td>
<td>150.6</td>
<td>153.3</td>
<td>148.8</td>
<td>153.6</td>
<td>147.5</td>
<td>160.3</td>
<td>150.7</td>
<td>164.8</td>
</tr>
</tbody>
</table>
Deena Kastor’s $\text{vVO}_{2}\text{ max}$ Development

• **Tested VO$_2$ max:**
  - Age 22 (1995) $\text{VO}_2\text{ max: } 77.5$ ml/kg/min
  - Age 27 (2000) $\text{VO}_2\text{ max: } 80.5$ ml/kg/min
  - Age 32 (2005) $\text{VO}_2\text{ max: } 81.1$ ml/kg/min

• **Tested VO$_2$ max at Lactate Threshold:**
  - Age 22 (1995) : $61.8$ ml/kg/min
  - Age 27 (2000) : $62.2$ ml/kg/min
  - Age 32 (2005) : $67.3$ ml/kg/min
**VO₂ max Run**

- A lab value and a field value.
- Each bout of work is 400-3200 meters.
- Total volume is 3200-8000 meters.
- Done as an interval style workout.
- *Pace is date specific.*
- *Rest equal to work.*
Interval and Repetition Runs

- Used mainly for anaerobic and VO$_2$ max development.
- 30 meters to race distance.
- Barefoot grass runs.
- Rest dictates training effect.
- Efficiency early.
- Capacity late.
Recovery And Blood Lactate Levels

Active Recovery
Passive Recovery
Part 3

The multi-paced training scheme for the 800 and 1600 meter events.
The Multi-Paced Training Scheme

• Based on a 12 day microcycle.

• The long run, tempo run, strength run, recovery run, and races are included within the 12 days.

• The 12 day cycle also includes one day each of five distinctively varied paces that predominantly deliver ATP through the anaerobic energy system. This is the multi-paced training scheme.
The 5 Paces of the Multi-Paced Training Scheme for the 800/1600:

- $\text{VO}_2 \text{ max} \text{ Run (800-3200 meters)}$
- Special Endurance 2 (Grass Runs – 500 meters)
- Special Endurance 1 (300-500 meters)
- Speed Endurance (150 meters)
- Speed (30-60 meters)

- Adapted from: Frank Horwill, Peter Coe, and Sebastian Coe
Sprinters vs. Distance Runners
[Rate vs. Economy]

WR Mean Time per 100 m vs. Distance

mean time/100 m (s) vs. distance (m)
Anaerobic Energy Zones

- Anaerobic alactic using PCr to ATP fuel shuttle.
- Anaerobic glycolytic using carbohydrate to ATP as the fuel shuttle.
## Glycolytic Workloads

<table>
<thead>
<tr>
<th>Speed Endurance</th>
<th>60 meters to 150 meters @ 97% max effort</th>
<th>[Ex.] 2 sets of 5 reps of 110 meters.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special Endurance 1</td>
<td>150 meters to 300 meters @ 95% max effort</td>
<td>[Ex.] 2 sets of 3 reps of 300 meters</td>
</tr>
<tr>
<td>Special Endurance 2</td>
<td>300 meters to 600 meters @ 92% max effort</td>
<td>[Ex.] 1 set of 4 reps of 500 meters</td>
</tr>
</tbody>
</table>
Glycolytic Training Parameters

- **Efficiency** work done first 2/3 of season.
- **Capacity** work done last 1/3 of season.
- **Efficiency** work done as interval runs.
- **Capacity** work done as repetition runs.
Glycolytic Workouts

• Choose between Speed Endurance, Special Endurance 1, or Special Endurance 2.
• Decide the extent.
• Decide the intensity.
• Decide the reps and sets.
• Decide the total volume.
Improvements in Ground Contact Time

“If a distance runner can lessen their ground contact time by .02 seconds per stride, with all else being equal, there should be a ~5 second improvement in 1600 meter performance. This can be accomplished by strengthening the muscles of the foot.”

Ralph Mann Ph.D.
Special Endurance 2 Work  
*Done on the Grass*

- Used on a **regular** basis it **will** strengthen the muscles of the foot.

- Athletic fields or grassy parks can be set up with cones to provide a 500-600 meter course.
Anaerobic Endurance Intervals and Repetition Runs

Examples:

800m and 1600m

Special Endurance 1
Cornerstone Workouts

• 8 x 400 in 58 sec with 3 min rest

• 4 x 400 in 51 sec with 14 min rest
Speed Endurance

- 60-150 meters on the track.
- The essence of “fast” running.
- For the 800/1600 concentrate on 150 meters.
- Because it is 100% effort, control of the rest interval dictates effect,
Glycolytic Capacity Work

- Repetition running is the type of work.
- Parameters of the load is near max with long recovery.
- Rest as a vital component.
- Watch out for “OVERDOING” the effort.
Alactic Energy Zone

- No hydrogen ion build up.
- 7-9 seconds in duration.
- Limited by fuel reserve.
- Fuel restored at sub-maximal velocity “on the fly”.
- Used for max speed development.
Alactic Speed Work

• Strength work -> 4x the force generation.

• 10-12 flying, 30-60 meter runs, full 3-4 min rest.

• Good videotape workout.

• Follow with a 4 mile recovery run.
Regeneration Timeframe

24 hours
• Normal long runs, strength runs, recovery runs, moderate tempo runs, alactic runs

48 hours
• Races, long runs plus, lactate threshold runs, basic glycolytic, strong tempo runs, VO₂ max

72 hours
• Long races, very strong glycolytic, very strong or long tempo runs
Training Effects

• Some physiological effects after 24 hours.
• Full physiological effects after 20 days.
• Periodize and sequence your workouts so they fit the race schedule.
• The body is very resilient when at a high fitness level.
• Watch for muscle trauma caused by too much testosterone.
12 Day Multi-Paced Microcycle

- Day 1: VO₂ max
- Day 2: Hills
- Day 3: Long Run
- Day 4: Special 1
- Day 5: Recovery Run
- Day 6: Race

- Day 7: Special 2
- Day 8: Tempo Run
- Day 9: Recovery Run
- Day 10: Speed Endur.
- Day 11: Recovery Run
- Day 12: Speed
Part 4

Key workouts for each pace of the multi-paced training scheme.
Cornerstone Workouts

- 4 * 1 mi @ VO$_2$ max pace
- 7 * 800 @ VO$_2$ max pace
- 8 * 90 sec runs on grass
- 8 * 400 with 3 min rest
- 6 * 150 with 4 min rest
- 8 * 400 with 45 sec rest
- 15 * flying 30 meters
- 4 * 500 with 15 min rest
- 8 * 200 with 8 min rest
- 2 * 3 * 300 with 3 min rest

- VO$_2$ max
- VO$_2$ max
- Special Endurance 2
- Special Endurance 2
- Speed Endurance
- Special Endurance 2
- Speed
- Special Endurance 2
- Special Endurance 1
- Special Endurance 1
**VO₂ max Workout #1**

- Active 3 mile warm-up run.
- Extent is 4 * 1 mile.
- **Pace is** *PRESENT DAY* 3200 max effort.
- Use a conversion table or a \(V_{\text{dot}}\) (Jack Daniels) value to determine work effort from another race value.
- **Rest is equal to work.**
- 2 mile jog.
VO_{2 max} Workout #2

• Active 3 mile warm-up run.
• Extent is 7 * 800 meters.
• Pace is \textit{PRESENT DAY} 3200 max effort.
• Use a conversion table or a V_{dot} (Jack Daniels) value to determine work effort from another race value.
• \textit{Rest is equal to work}.
• 2 mile jog.
Special Endurance 2 Workout #1

- 2 mile active warm-up.
- Using 5 cones set up a 500-600 meter course on the grass of several side by side soccer fields or a park.
- Have the runners barefoot during the repeats.
- Extent of run is $8 \times 600$ with near max effort.
- Vary the rest so that the athletes run all 8 at about the same time. Start with 3 minutes rest and gradually move to 5 minutes rest between.
- 2 mile jog.
Special Endurance 2 Workout #2

- 2 mile active warm-up.
- Several very fast strides.
- Extent of work is 8 * 400 meters at near max effort on the track.
- Rest is 3 minutes.
- Time goal is (at least) 5 seconds faster than PRESENT DAY 1600 pace.
- 2 mile jog.
Speed Endurance Workout

- With a measuring wheel and can of spray paint, mark a dot on the track exactly 150 meters from the finish line.
- 2 mile very active warm-up.
- Extent of work is 6 * 150 meters on the track at max effort. Use a starting device.
- Rest is 4 minutes.
- Time goal is their PRESENT DAY 400 meter time multiplied by .35.
- 3 mile easy run.
Special Endurance 2 Workout #3

- 3 mile active warm-up.
- Several active strides.
- Extent of work is 8 * 400 meters on the track at seasonal 3200 goal paced effort.
- Rest is a 45 second jog to the next starting point. Athletes rotate around the track.
- Time goal is their 3200 meter seasonal goal. The 8th 400 is absolutely max effort.
- 2 mile jog.
Speed Workout

• 2 mile active warm-up.
• Several active strides.
• Flying 30 meter repeats on the track.
• Work is max effort.
• 4 minutes jog rest between repeats.
• Do up to 12 reps.
• 4 mile easy run.
Special Endurance 2 Workout #4

• Capacity work done as repetition running.
• 2 mile active warm-up.
• Several active strides.
• Extent of work is 4 * 500 at max effort.
• Rest is near complete at 15 minutes.
• Time goal is *PRESENT DAY* 800 pace multiplied by .59.
• 1 mile jog.
Special Endurance 1 Workout #1

- 2 mile active warm-up.
- Several very active strides.
- Extent of work is 8 * 200 at near max effort on the track.
- Rest is extensive at 8 minutes between repeats.
- Time goal is *PRESENT DAY* 400 meter pace multiplied by .47.
- 2 mile jog.
Special Endurance 1 Workout #2

- 2 mile active warm-up.
- Several very active strides.
- Extent of work is 2 sets of 3 repeats of 300 meters on the track.
- Rest is incomplete at 3 min between repeats and 5 minutes between the sets.
- Time goal is seasonal 800 goal pace multiplied by .35.
- 2 mile jog.
Dealing with Mid-Week Duals

- One race per week is preferable.
- Many duals are mandatory.
- Smaller teams have a greater challenge than bigger teams.
Ups and Downs of Dual Meets

- Using smaller meets for developing young athletes and emphasizing split time awareness is a plus.

- Too many meets may lead to injuries, fatigue, chronic poor race performances and psychological stress, all minuses.
The Peak is Many Things

- Fitness is at a peak.
- Strength is at a peak.
- Hormones are at a peak.
- Rest is at a peak.
- Enzymes are at a peak.

- Aerobic system needs strong stimulus every 4 days.
- Anaerobic system needs strong stimulus every 3 days.
More Endurance Information Available in the Following Book:

The Complete Guide to Track and Field Conditioning for Endurance Events.

By Scott Christensen

Athletesacceleration.com/trackandfieldendurance.html