What is endurance?

Steve Magness
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I am **NOT** a team sports coach.
I am **NOT** going to tell you how to do your job.
Thought process behind creating endurance.

Understand perspective from elite endurance side

Concepts NOT details
How do we think???

First Principles Reasoning
• Break it down to its fundamental truths
  • Build up from there.

Analogy Reasoning
• Start from-What is the most similar situation.
First principle reasoning

We always have assumptions!

Examples:

Stress:
- From 1940’s (Hans Selye) to 2000’s- taught stress reduction
  - Why? Research came from assumption that stress is bad.
- Now? Perception matters
  - Positive view of stress= lowest risk of death
  - Positive view of aging= Lived 7.6yrs longer

Keller et al. 2011, Does the perception that stress affects health matter.
Levy et al. 2002, Longevity increased by positive self perceptions of aging.
How do you see endurance?

• Perspective
  • What lens are you seeing the sport through?
    • Speed
    • Endurance
    • Mechanical

• Where’s your bias and how does it color you?
  • “Therefore, football is primarily a 'speed of actions' sport. In other words, football is an intensity sport rather than an endurance sport.” Raymond Verheijen, Soccer coach

  • “So, the philosophy of training for EVERY event is TO EXTEND THE CAPACITY TO LAST AT A FIXED SPEED, specific for the performance that you want to build.” Renato Canova, Endurance Coach
In Science...

- Vo2max
- Lactate Threshold
- Aerobic Capacity
- Running Economy
- ....
In Training...

USA Swimming:

<table>
<thead>
<tr>
<th>SEVEN ENERGY ZONE SYSTEM</th>
<th>Set Distance (m)</th>
<th>Set Duration (min)</th>
<th>HR (bpm)</th>
<th>HR (% max)</th>
<th>Work:Rest</th>
<th>Sample Set (*for Sr. Age Group swimmer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AEROBIC (RECOVERY)</td>
<td>Variable</td>
<td>Variable</td>
<td>&lt; 140</td>
<td>&lt; 70</td>
<td>N/A</td>
<td>600 Easy Swim</td>
</tr>
<tr>
<td>AEROBIC DEVELOPMENT (EN1)</td>
<td>1500 - 4000</td>
<td>≥ 15</td>
<td>140 - 160</td>
<td>70 - 80</td>
<td>:10 - :30 rest</td>
<td>6-10 x 400 Swim @ :10 rest</td>
</tr>
<tr>
<td>AEROBIC/ANAEROBIC MIX 1 (EN2)</td>
<td>800 - 2000</td>
<td>10 - 40</td>
<td>160 - 180</td>
<td>80 - 90</td>
<td>:15 - :30 rest</td>
<td>4-6 x 300 Swim @ :15 rest</td>
</tr>
<tr>
<td>AEROBIC/ANAEROBIC MIX 2 (EN3)</td>
<td>600 - 1600</td>
<td>8 - 30</td>
<td>180 - Max</td>
<td>90 - 100</td>
<td>:30 - :60 rest</td>
<td>4-8 x 150 Swim @ :30 rest</td>
</tr>
<tr>
<td>ANAEROBIC 1 (SP1)</td>
<td>200 - 600</td>
<td>2 - 15</td>
<td>Max</td>
<td>100</td>
<td>2:1 – 1:1</td>
<td>2-3 sets of 6-8x50 race tempo @ :10-:30 rest or 4 x 125 Rotate IM @ :45 rest</td>
</tr>
<tr>
<td>ANAEROBIC 2 (SP2)</td>
<td>200 - 600</td>
<td>4 - 12</td>
<td>Max</td>
<td>100</td>
<td>1:2 - 1:4</td>
<td>4 x 75 Swim @ 3:00-4:00 rest or 6 x 50 @ 2:00 rest</td>
</tr>
<tr>
<td>SPRINT (SP3)</td>
<td>25 - 100</td>
<td>1 - 2</td>
<td>Max</td>
<td>100</td>
<td>1:3 - 1:4</td>
<td>4-6 x dive 15m @ 1:00 rest or 6-8 x 12.5 Swim @ :45 rest</td>
</tr>
</tbody>
</table>
At USMNT camp, grueling fitness regimen half the battle

“The VO2 max fitness test administered by the US men’s national team training staff on Wednesday afternoon at The Home Depot Center began with a slow walk before building up, minute by minute, to a frantic 10-mile-per-hour pace. Every breath had to be carefully calculated.”
What is endurance?

- **Extension**
  - Performing a task to the same quality for a longer period of time.

- Examples:
  - Football
    - 8 plays maintaining force output instead of 6
    - Recovers to 100% in 20sec instead of 30sec between plays
  - Speed
    - Able to run 15sec/100m pace for 900m instead of 850m before breaking down.
What’s the assumption?

- “Aerobic” = Endurance
- Cardiovascular/ Energetics model
- Specific HR’s, paces, etc. → Adaptations
Wrong Assumptions

- Endurance is task dependent
- Ground contact times lengthen
- Force into ground drops
- Stride length/rate change.
Wrong Assumptions

DEMANDS of a workout ≠ Adaptations from a workout

3 sets of 8x150m at **14.5 100m** speed with 50m jog (3min b/t sets)
OR
4x1mile at 5min pace with 2min rest (**18.75 per 100m**)

Lactate after each= Same
Exercising at same % VO2max

What is endurance?

Isolated Approach:
• metabolic, biomechanical, neural, psychological, etc

OR

Global approach
• Stress is stress, performance is what matters
MODEL TO DEVELOP ENDURANCE

“Oversimplifications...cut through the hideous complexity with a working model that is almost right, postponing the messy details until later”

Dan Dennett
How to develop endurance?

Training Stimulus $\rightarrow$ Adaptation

GIVEN adequate recovery, nutrition, etc.
Questions that Need Answering?

• 1. What is the training adaptation we are looking for?
• 2. What stimulus leads to that adaptation?
• 3. How much is enough?
Traditional Model

![Stress Adaptation Cycle Diagram]
Reverberating Stress/Recover

Stimulus (exercise bout, sympathetic stimulus)
Response to stimulus, and subsequent response to response
(perturbed from homeostasis)

Heart rate variability  Force output  RPE
EMG  Glucose
Adapting to Stress?

Opponent Process Theory of Emotions

The body “catches up”
So what?

- Stress
  - Change it!
  - We influence:
    - Type, direction, amount of “stress” applied
- How they come off stress
  - Return to baseline
Return to baseline-

- Dependent on:
  - Age/Experience
  - Resiliency/Coping
    - DHEA-s to cortisol ratios
  - Stress “sensitivity”
    - GSR or questionnaires
- Example:
  - Younger athletes- Return to baseline faster
    - 45min post “large stressful event”
  - Sleep/Debrief
    - Improved our return to norm the next day by 30%
Stress-Destress

• Processing
  • Anti-Anxiety drugs → ↑ risk of PTSD, ↓ processing of trauma

• Let natural process take place
  • NSAIDs= ↓ tendon healing
  • Antioxidants= ↓ potential mitochondria biogenesis

• Post “stress” plan- Emotional/NS NOT Physical
  • “Cool down”= debrief
  • “green” exercise
  • Ice baths?? → Negative Affective state
How much stress?

• “Trying to solve a problem before being taught the solution leads to better learning, even when errors are made in the attempt” Make it Stick by Brown

• Productive Failure vs. Winning the workout
Set Point Theory?

• Changing Happiness
  • Winning Lottery/ Death in the family?  

  VS

• Small changes in behavior?

• Short term vs. long term?
How hard?

• Most workouts= Small stress
  • CEMENT adaptations.
  • Change behavior
• Occasional BIG norm changer- “see god” workout
  • Workouts to shift psychological and physical “norms”
    • i.e. Brian- 3x1mi 4:30s→4:14
• Exploiting Psychology for Norm changing
  • Last Rep is the one people remember
    • Same with body
      • “Gene expression is specific to the last exercise stimulus”
Set Point Theory
How hard?

- Barbell Strategy (Antifragile)
• Productive vs. Non-Productive fatigue

• Non-productive
  • Sloppy foot strikes
  • Dragging, Falling apart
  • fatigue for fatigues sake.
Productive fatigue
Productive Fatigue

- Challenge
- Holding things together

- $3 \times (600-1:29, 45\text{sec rest, }200-28) \text{3min b/t sets}$
  - End with a 400m- 51sec
The Foundation of Training
• Why a foundation is needed
  • Connections!!!!!!!!

• Wider a foundation, the more connections we can make
  • Curiosity
  • Learning
  • Art
  • Music
  • Athletics
Foundation

In season
• Foundation does NOT = “Aerobic Base”
  • Neuromuscular
  • Biomechanical
  • Endurance, speed
  • Psychological
  • Strength, etc.
• Whatever you need to do to set the stage for what you’re trying to do
Where’s the sticking point?

Look above and Below.

If we have a guy who does 5mi @ 5:30, and we need him to do 5mi at 5:20 pace how do we do it?

<table>
<thead>
<tr>
<th>Speed side</th>
<th>Endurance side</th>
</tr>
</thead>
<tbody>
<tr>
<td>5x1mi @ 5:15</td>
<td>7mi at 5:40</td>
</tr>
<tr>
<td>6x800 @ 2:30</td>
<td>10mi @ 6:00</td>
</tr>
<tr>
<td>10x400 @ 68...etc</td>
<td>15mi long run....etc</td>
</tr>
</tbody>
</table>
Seamless transitions

• "Next logical step...”
• What direction? Athlete “tells” you...each workout is a “test”

Specific work for female 5k runner:
16wk out- 8mi run with 8x1min on/off at 5k effort

12wk out- 4 sets of (5x400) at 75sec with 40sec Rest (3 b/t sets)

8wk out- 2 sets of 4x800 with 90sec rest, (3 b/t) @ 2:30

4wk out- 4x1mile with 3min rest @ 5:00

2wk out- 3xmile w/ 3:30 rest- 5:00, 4:55, 4:50
Workouts= a test?

![Graph showing athlete and coach RPE over time.](image-url)
Individual Workouts=
Manipulating Constraints

• Adaptation in the direction you want.

• Creating the endurance you need
  • Event Demands + athlete characteristics
  • Creativity
Workouts = Manipulating constraints

- faster?
- Rest?
- Rep length longer?
- Volume?
- Density?
- Add extra work (strength, exercises, etc)
- Environment? (Hills, sand, heat, boredom)
- WAY it is run (surges, tactics)
- Feedback! (splits, auditory, visual)
Psychological constraints

- Time
- Space
- Uncertainty
EXAMPLES
“Threshold” development

**Lea Wallace** - 800m- 2:00.30 & 1500m- 4:09

- Threshold work = 4miles @ 6min pace
  - OR
  - 4x1mi w/ 45-60sec jog - averages 5:40

- Physiologic strain vs. Mental Effort?

- **WHY** the discrepancy? Focus
  - Is FOCUS for (20min+) a necessity for 800m race that lasts ~2min?
Misunderstanding “Jogging”

• “easy” running for us
  • Still maintains good mechanics
  • Accelerates adaptations
  • When running 60-100+ miles per week, done in pre-fatigued state
  • Cements adaptations
  • Recovers “willpower”

• Does running make you slow?
  • If they get slow, it is YOUR fault, not the endurance work
    • You messed up the balance.
Periodization = Modulation

- Density/Space
- Intensity- How “hard”
- “Type”
What kind of wave are you creating?

- **Carly Seymour**
  - (Oly Trials MarathonQualifier)
  - 1 workout a week

- **Lea Wallace**
  - Volume and intensity shifts

- **Sara Hall**
  - 20th world XC champs
  - Density changes
### Carly Seymour

<table>
<thead>
<tr>
<th>Two runs 9mi and 6mi</th>
<th>2mi w/up 3x2mi with 3min rest between 1st- 5:35, 2nd- 5:30, 3rd- 5:25</th>
<th>12mi</th>
<th>9mi and 6mi</th>
<th>Easy run with 8x100m strides</th>
<th>10 miles</th>
<th>Long run-20mi</th>
</tr>
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### Sara Hall

| 16 hour recovery 4-5x60m sprints. Full rest | 2mi warm-up Fartlek-16x1min on/1min off (looking at around 5:00 pace effort) 2mi cool down | Single run- 9-10miles | Two runs of 5miles or similarly even split double Feel free to work down | 2mi warm up 8mile tempo (good strong rhythm, start around 5:45 and gradually work down) 2mi cool down | 14mile long run, start more relaxed, | 6-7miles recovery |
What assumptions are you making?

- “Problem” athletes = opportunity to rethink your own norms
  - Drevan- 1:49
    - 3 runs + 3 swim sessions
  - Natosha Rogers- 2\textsuperscript{nd} at Olympic Trials in the 10k
    - Easy/recovery days- “Run until you don’t enjoy it”
  - Chris Ibarra- 1:49
    - No base
    - So... built “specific aerobic”... lots of 100s, 150s, 200s, with VERY short rest
Team Sports

• Break down demands of your support
  • Where does fatigue happen?

• Start from the extremes- supporting a foundation
Team sports example

• Football
  • Demands-
    • 5-8sec very fast burst plays with short (35sec) and long (minutes+) recoveries
    • ~35 drives, 240 plays
    • Work: rest- 1:6
    • Gives where to go (specificity)...need to support with wide base of foundation

• Foundation
  • Speed side- 20m accels→
    • Extended (25-30-35-40m)
    • In different positions, etc.
More examples:

• Endurance side
  • Long or short?
    • How long can they run with good mechanics/foot contacts- **START THERE**
    • Learn how to actually run slow!!!
      • Tom Tellez example.
  • Short “tempo” intervals- split into sets
    • ~4 sets of 6-8x100m w/ 30sec rest, 3-5min rest between sets of “stuff”
  • Interspersed circuits
    • Run until mechanics break down, then shift demand (core, med ball work, etc.) then return to specific

• Psych constraints:
  • “Aerobic” work interspersed with 5-10+min of mental/attention demands
    • Why?---Focus, Attention
    • Brain controls endurance
Thanks!

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