Innovations and technologies for athletes’ training in Elite Sport Centers

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Program

1. Sports science and technological innovations
2. Position detection in game sports
   1. Technology and practical use
   2. Reliability and validity
3. Perspectives
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Innovation cycle in sport

1. Innovation
   new technologies new theories new knowledge
digital video talent/expertise brain organization
2. Estimation of potential for sports
3. Implementation of pilot projects
4. Implementation of routine service
Innovations

• Partly from sports science, mostly from other sciences
• Demand of keeping track with what is going on in many areas
  – Who will do that?
  – Efficient communication channels?
Estimation of potential

• „Fig leaf“ function of scientific innovations
• „Nice to have“ vs. substantial improvement of practical work
• Criterium: advantages for my athletes in international sports competitions
• Spectrum of competencies
  – Understanding of innovation
  – Understanding of training process
  – Understanding of sports organization
Implementation

Pilot study
• Funded by research funding
• Close interactions between researchers and users
• Focus on effects

Routine service
• Funded by sports organisation
• Run autonomously by users / scientific service staff
• Focus on cost-benefit relation
Innovation cycle

- Innovation
  - Estimation of potential
    - Pilot study
      - Routine service
        - Practical application

- Science
- Sports Science
- Sports Practice
Role of training centers/national sports institutes
Innovations vs. conventional training

• Two sources for winning performances:
  1. Perfectly organized conventional training system plus
  2. Innovations that give the decisive advantage

• National institutes have to care for both, but
  – Practitioners prefer investments in conventional training („homework“)
  – Scientists are interested almost exclusively in innovations
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Position detection

- 10-20 companies worldwide offer position detection in sport
- Widespread service in professional game sports, especially football (soccer)
- Germany: Association of professional football clubs provides clubs with statistics on actions and positions (and sells these statistics to other customers)
Technologies

• Radar
  – Expensive, high precision, objects need to wear active tags
  – Applications in speed scating, football (training), football (Ball), moto cross

• GPS
  – Cheap, low sample frequency, objects need to wear antennas, problems with indoor sports
  – Applications in skiing, sailing, car racing, many others

• Video based image detection
  – Only technology without tags fixed to objects
  – Potential for detecting not only positions but 3D-objects as a whole
  – Applications in football, field hockey, American football, baseball and others
Typical statistics in football match analysis

- Total distance covered
- Distance covered in speed intervals, e.g.
  - <0.2 m/s standing
  - 0.2-2 m/s walking
  - 2-4 m/s jogging
  - 4-5.5 m/s running
  - 5.5-7 m/s high-speed running
  - >7 m/s sprinting
- Frequency of speed intervals
- Heat maps
Application in football training

- Comparison of small sided games (5 vs. 5) with different intervals:
  - 5*4 min, 1 min break
  - 4*5 min, 1.5 min break
Tasks for Sports Science

• Control tasks
  – Controlling the quality of measurements
  – Controlling the acceptability of workflow
  – Compare different offers on scientific criteria
  – Test for reliability and validity of measurements

• Enhancement tasks
  – Assess validity of standard reports
  – Create new insights from data
  – Generate information of practical interest from data
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Reliability

• Different systems come to different results
  – Different filtering techniques
  – Number of cameras used ranges from 2 on the press desk to 20 mounted all over the stadium

• Some reliability studies with poor quality

• Lack of know how and knowledge!
Problems of image detection 1

Linear run, acc - stop - acc
left runner, run #3

Y-Position [m]

Difference [m]

Laser
Image processing
Difference
Problems of image detection 2
Validity

- Frequently, distance covered and distance covered in high intensity running is taken as a measure for endurance capacity.
- Frequently, the reduction of distance covered in the second half is taken as a sign of fatigue.
Distance covered per match

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Variation of time played
Validity of distance covered

Distance covered in interrupted and running match

<table>
<thead>
<tr>
<th>Role</th>
<th>Interrupted Match</th>
<th>Running Match</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goalie</td>
<td>0.83</td>
<td>0.76</td>
</tr>
<tr>
<td>Central Defender 1</td>
<td>1.28</td>
<td>0.91</td>
</tr>
<tr>
<td>Central Defender 2</td>
<td>1.20</td>
<td>0.97</td>
</tr>
<tr>
<td>Fullback 1</td>
<td>1.53</td>
<td>0.74</td>
</tr>
<tr>
<td>Fullback 2</td>
<td>1.68</td>
<td>1.13</td>
</tr>
<tr>
<td>Central Midfield</td>
<td>1.86</td>
<td>0.96</td>
</tr>
<tr>
<td>Wide Midfield</td>
<td>1.78</td>
<td>0.73</td>
</tr>
<tr>
<td>Attacker</td>
<td>1.63</td>
<td>1.29</td>
</tr>
</tbody>
</table>

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Fatigue
Distance covered and standings

- **Lead**: 106
- **Draw**: 112
- **Behind**: 116
Game standings over 90 minutes (n=306 games)
Further pitfalls

- Ball possession
  - Varies between 33% and 66%
  - Ball possession is not a good indicator of success
  - Teams in ball possession run more

- Playing position

- Quality of tactics
Resumée position detection

Achievements

- Technological innovations have made positional data available
- A wealth of information is available routinely per match

Still to solve

- Standards for data processing (filtering techniques)
- Standards for accuracy testing
- Interpretation of position and speed data
- Key aspect: capability to select different situations
  - Running game / interrupted game
  - Offence / Defense
  - Set game / fast break / position game
  - Playing position
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A glance in the future

- Technological development is a continuous process
- Many areas will be affected
  - Physiological sensors in/on athletes
  - Mechanical sensors in athletes and environment
  - Detailed video coverage and instantaneous 3D-Simulations
  - Information exchange via „Evernet“ / „Seamless network“
  - Artificial Intelligence for data analysis
- Comprehensive data on athletes’ performance will be available in near future
Role of national institutes

Innovation cycle
- Identify promising developments
- Run pilot studies
- Organize routine implementation

Innovation projects
- Collaboration with external partners (universities, companies)
- Financing, funding
- Bridge the gap to practice
That’s what it is all about!

Thanks for listening!