Artificial Soccer Turf – What Shoes to Wear?

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Development of Artificial Soccer Turf (AT)

1st Generation
1960
concrete layer
no infill

2nd Generation
1980
elastic layer
sand infill

3rd Generation
1990
elastic layer
sand/rubber infill

Introduction  Methods  Results and Discussion  Conclusion

U 17 World Cup
Peru 2005

U 20 World Cup
Canada 2007

Young Boys Bern
Switzerland

Red Bull Salzburg
Austria
# FIFA 1-Star and 2-Star Installations

<table>
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<tr>
<th>Continent</th>
<th>1-Star</th>
<th>2-Star</th>
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<td>OFC</td>
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Game Characteristics

- Only slight changes depending on playing level
- Discrepancy of objective and subjective data

- FIFA 2007
- Anderson et al. 2008
- Müller et al. 2009

Exception: Sliding Tacking
Injury Observations

- No major differences in injury incidences

Prospective Studies

Critical Improvement compared to 1\textsuperscript{st} and 2\textsuperscript{nd} Generations of Artificial Turf

- Ekstrand et al. 2006
- Fuller et al. 2007\textsuperscript{a}
- Fuller et al. 2007\textsuperscript{b}
- Steffen et al. 2007
Purpose:

Development of an AT Soccer Shoe Outsole
- A Three Phases Project -
Project Chronology

Phase I 2007: Status Quo Evaluation

Phase II 2008: Prototype Modification

Phase III 2009: Market Comparison

Introduction, Methods, Results and Discussion, Conclusion
Comprehensive Evaluation of Athletic Footwear


Performance

Biomechanical

Perception

Performance – Slalom Parcours

- 3 repetitive runs per shoe condition
- 2 minutes rest between runs
- Shoe change between each run

- Variables
  - Running time
  - Running time perception

Perception – Traction

• Several rapid cutting movements
• Questionnaire: 9-point perception scale
• Variable
  - Traction suitability
Biomechanical – Cutting

• 45° cutting movement, two step approach
• 5 repetitive trials
• Variable
  - Force ratio: m-l shear/vertical

• high shear forces during cutting movements in soccer (Valiant, 1987)
Testing Protocol

• subject pool of 37 experienced soccer players
  (23.0 ± 3.4 years, 177.4 cm ± 4.3, 71.4 ± 6.1 kg)

• 4 different shoe models in each phase

• Randomization of shoe models

• FIFA 2-Star *Liga Turf 240 22/4 RPU brown* (Polytan)

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**Statistics**

- Mean and standard deviation
- Repeated measures ANOVA \( (p < 0.05) \)
- Post-hoc test: Bonferroni \( (p < 0.05) \)
Phase I – Status Quo Evaluation

Natural Grass Outsole Designs

- hard ground (HG)
- firm ground (FG)
- soft ground (SG)

first prototype

innovative design (ID)

currently used on artificial turf

DuoCell technology at forefoot

Introduction  Methods  Results and Discussion  Conclusion
Perception: Slalom running time
p<0.0001

Slalom running time
p<0.0001

Biomechanical force ratio Fx/Fz
p=0.0012

Traction suitability
p<0.0001
Findings: Phase I – Status Quo Evaluation

Natural Grass Outsole Designs

- hard ground (HG)
- firm ground (FG)
- soft ground (SG)

Phase II prototypes based on the innovative design

- first prototype
- innovative design (ID)

- better suited
- less suited
- better suited

Introduction

Methods

Results and Discussion

Conclusion
Traction Concept

Availability - Mechanics

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Utilization - Biomechanics

- Interface
  - Material
  - Geometry
  - Loading

- Athlete
  - Anatomy
  - Anthropometrics
  - Body Composition
  - Motor Performance Skills
  - Training Status

Optimization of Traction for Maximization of Performance

Introduction    Methods    Results and Discussion    Conclusion
Phase II – Modified Prototypes

- **Phase I (ID)**
  - Innovative design

- **DC-FG**
  - DuoCell only at forefoot
  - FG design at rearfoot

- **DC 85**
  - DuoCell at forefoot and rearfoot
  - Slightly different TPU hardness

- **DC 90**
Slalom running time

$p = 0.04$

[Graph showing comparison of ID, DC-FG, DC 85, and DC 90]

Biomechanical force ratio $F_x/F_z$

$p = 0.70$

[Graph showing comparison of ID, DC-FG, DC 85, and DC 90]

Perception: Slalom running time

$p = 0.02$

[Bar chart showing perception of ID, DC-FG, DC 85, and DC 90]

Traction suitability

$p = 0.10$

[Bar chart showing traction suitability of ID, DC-FG, DC 85, and DC 90]
Findings: Phase II – Modified Prototypes

• no negative effect of rearfoot DuoCell compared to rearfoot FG
• no effect of TPU hardness

Phase III prototype based on DC 90 design
Introduction

Methods

Results and Discussion

Conclusion

Phase III – Market Comparison

Predator Absolion PS TRX AG (AP)
Tiempo Mystic II MG (NT)
King XL Synthetic Grass HG (PK)
final Prototype (DC 90)

commercially available artificial turf designs
**Introduction**

**Methods**

**Results and Discussion**

**Conclusion**

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**Slalom running time**

\[ p = 0.0035 \]

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**Perception: Slalom running time**

\[ p = 0.0051 \]

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**Biomechanical force ratio Fx/Fz**

\[ p < 0.0500 \]

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**Traction suitability**

\[ p = 0.0006 \]
Findings: Phase III – Market Comparison

- Final prototype outperformed three commercially available shoes.
- Relatively short and evenly distributed stud configurations were identified to provide good functional traction to players.
- Comprehensive approach was shown to be successful for the development process of an artificial soccer turf outsole.
Thank you very much for your attention!

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