MT GAMBIER TRACK
INJURY ANALYSIS AND
PRELIMINARY DESIGN
REPORT

By Prof David Eager, Ms Hasti Hayati and Mr Imam Hossain for Greyhound Racing SA

22 January 2018
# Table of contents

1. Mt Gambier injury data analysis .............................................................. 3
   - Introduction ...................................................................................... 3
   - Injury levels .................................................................................. 3
   - Mt Gambier injury data at a glance ................................................. 4
   - Mt Gambier vs NSW tracks ............................................................... 4
   - Mt Gambier injury data analysis in 2016 and 2017 ........................... 5
   - Mt Gambier injury locations plots .................................................. 8

2. Mt Gambier track design modeling and simulation .............................. 12
   - Introduction ................................................................................... 12
   - Curvature of the track path ............................................................ 12
   - Track surface grades ..................................................................... 13
   - Greyhound attack angle relative to box alignment ......................... 15
   - Greyhound heading due to lure position ........................................ 17

3. Conclusion .......................................................................................... 19
1. MT Gambier Injury Data Analysis

Introduction
This Report contains an analysis of the Mt Gambier track injury data for period 1 Jan 2016 to 31 Dec 2017. It also contains an analysis of the track configuration.

Injury Levels
The classification shown in Table 1.1 is used throughout the Report.

<table>
<thead>
<tr>
<th>Rating</th>
<th>Incapacitation period</th>
<th>Typical injury types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor injuries-1 (MINa)</td>
<td>0 days</td>
<td>Mild skin abrasion/grazes</td>
</tr>
<tr>
<td>Minor injuries-2 (MINb)</td>
<td>1-10 days</td>
<td>Grade 1 muscle injury Mild skin laceration</td>
</tr>
<tr>
<td>Medium injuries (MED)</td>
<td>11-21 days</td>
<td>Joint/ligament sprain skin laceration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grade 2 muscle injury</td>
</tr>
<tr>
<td>Major injuries (MAJ)</td>
<td>Greater than 21 days</td>
<td>Grade 3 muscle injury Bone fracture</td>
</tr>
<tr>
<td>Catastrophic (CATb)</td>
<td>Euthanased post-race</td>
<td>Euthanased post-race, unable to be retired or unable to race</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NB: may not include all data (deaths)</td>
</tr>
<tr>
<td>Catastrophic (CATa)</td>
<td>Deceased or euthanased on race day</td>
<td>Severe skull or spinal trauma complex/open/join fracture</td>
</tr>
</tbody>
</table>

Throughout the Report the following levels of injury will be used:

Level 1 = CATa + CATb

Level 2 = CATa + CATb + MAJ

Level 3 = CATa + CATb + MAJ + MED

Level 4 = CATa + CATb + MAJ + MED + MINa + MINb
**MT GAMBIER INJURY DATA AT A GLANCE**

There were 5556 races and 98 associated injuries in 2016 (total injury rate of 17.6 per 1000 starts) and 6454 races and 113 associated injuries in 2017 (total injury rate of 17.5 per 1000 starts) at the Mt Gambier track. Figure 1.1 compares injury rate in 2016 against the injury rate in 2017.

![Mt Gambier injury rate in 2016 vs 2017](image)

**Figure 1.1** Mt Gambier track normalized injury rate per 1000 starts in 2016 vs 2017

Although there were more absolute injuries in 2017 the normalised rate of injuries dropped by 1% compared to 2016 (17.64 vs 17.51). This reduction is considered statistically insignificant.

**MT GAMBIER VS NSW TRACKS**

Figure 1.2. compares the Mt Gambier track injury rate in 2016 with the injury rates at the all NSW tracks for the same reporting period.
To quantify the relative performance of the Mt Gambier track the normalised 2016 Level 1 data for Mt Gambier is presented relative to all the NSW tracks both TAB and non-TAB for the same reporting period (1 Jan to 31 Dec 2016). The total injury rate for Mt Gambier is positioned approximately in the middle of the NSW data. Mt Gambier is indicated by the red arrow in Figure 1.2. It should be noted that the Mt Gambier data does not include CATb data i.e. euthanised post-race, unable to be retired or unable to race. If the CATb data were included the Mt Gambier injury rate may well be higher than Lismore, the highest ranked NSW TAB track in 2016.

**MT GAMBIER INJURY DATA ANALYSIS IN 2016 AND 2017**

Figure 1.3 compares the 2016 and 2017 normalised Level 1 injury rate for each month at the Mt Gambier track.

As it can be seen from Figure 1.3, January 2016 has the highest normalised Level 1 injury rate for all months in 2016 while in 2017, September recorded the highest rate.

Figure 1.4 compares the 2016 and 2017 normalised Level 2 injury rate for each month at the Mt Gambier track.
Figure 1.3  Mt Gambier track normalized Level 1 injury rate for each month (2016 and 2017)

As can be seen from Figure 1.4 January recorded the highest Level 2 injury rate in 2016 while September recorded the highest rate in 2017.

Figure 1.4 compares the 2016 and 2017 normalised Level 3 injury rate for each month at the Mt Gambier track.
February recorded the highest normalised rate of Level 3 injuries in 2016 while both February and September 2017 recorded the highest Level 3 injury rate in 2017.

Figure 1.6 compares the 2016 and 2017 normalised Level 4 injury rate for each month at the Mt Gambier track.
March 2016 recorded the highest Level 4 injury rate in 2016 while September recorded the highest rate of Level 4 in 2017.

**MT GAMBIER INJURY LOCATIONS PLOTS**

The location of injuries in 2016 and 2017 for all three distances (400 m, 512 m and 600 m) are plotted and reported.

Figure 1.7 shows injury locations for 400 m distance in 2016 (top) and 2017 (bottom).

Most of the injuries occurred at the first turn (Eastern Turn) and some shortly after the start and at the beginning of the second turn (Western Turn). The injury location pattern is consistent for both 2016 and 2017.
Figure 1.7 Mt Gambier track location of injuries for the 400 m distance - 2016 (top) vs 2017 (bottom)
Figure 1.8 shows injury locations for 512 m distance in 2016 and 2017.

As it can be seen, most of the injuries occurred at the beginning of the first turn (Eastern Turn) and some at the exit. The injury location pattern is consistent for both 2016 and 2017.
Figure 1.9 shows injury locations for 600 m distance in 2016 and 2017.

The data are not sufficient to determine the hazardous locations for this distance. Nevertheless, it would appear that the first turn is over represented in the injury data.
2. MT GAMBIER TRACK DESIGN MODELING AND SIMULATION

INTRODUCTION

This section presents findings of the Mt Gambier track design as analysed using the GRSA survey data provided. The following aspects were considered in the report: centrifugal acceleration; centrifugal acceleration jerk relative to the track’s rail path curvature; track’s cross-fall; and greyhounds’ attacked angle relative to starting box alignment.

CURVATURE OF THE TRACK PATH

Centrifugal acceleration on the track is proportional to the track’s curvature. All transitions between straights and bends are potential regions for centrifugal acceleration jerk. The geometry of the track consists of semicircles and straights. The track can be divided into two sections corresponding to two turns as shown in Figure 2.1. As can be seen, the track has an average bend radius of 52.4 m and this is equivalent to a peak centrifugal acceleration of 6.5 m/s² at the rail.

![Figure 2.1 Mt Gambier track geometry as retrieved from GRSA provided survey data](image_url)
No horizontal transition\(^1\) is observed for the track path, instead a bend of a larger radius is used for facilitating conjunction between straights and bends. A horizontal transition significantly decreases centrifugal jerks. If the track is reconfigured with a horizontal transition as shown in Figure 2.2 the centrifugal jerks would be decreased by 70\% as shown in Table 2.1.

![Diagram of Mt Gambier track improved rail path design by adding horizontal transition](image)

**Table 2.1** Peak average jerk magnitude comparison for race distances from worst to best

<table>
<thead>
<tr>
<th>Track design</th>
<th>Jerk magnitude (m/s(^3))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mt Gambier</td>
<td>13.5</td>
</tr>
<tr>
<td>Mt Gambier with a horizontal transition</td>
<td>4.1</td>
</tr>
</tbody>
</table>

**TRACK SURFACE GRADES**

As can be seen from Figure 2.3, the track has an average 5.9\% cross-fall on the bends and an average 1.9\% cross-fall on the straights. Moreover, the surface grade along the turns is variable which will cause undesirable vertical acceleration and transients for greyhounds on the bends. It was noted that there is a drop in the land from one end of the track to the other end.

\(^1\) A horizontal transition allows gradual change of track path from straight to the bend and vice versa.
Figure 2.3  Mt Gambier track cross-falls percentage as retrieved from GRSA provided survey data

Figure 2.4 shows an improved cross-fall configuration for Mt Gambier track by taking the theoretical optimum values as well as cross-fall gradient into consideration. Since Mt Gambier track has a constant turn radius a constant surface grade is preferable for the entire bend as it would minimise vertical acceleration and the resulting forces on the greyhounds. Furthermore, the gradual cross-fall gradient starting from midway along the straight would facilitate a softer transition into the constant 13.2% bend surface grade. The effect of increased cross-fall on a straights is as yet unknown and it is recommended that this concept be tested before implementing at the Mt Gambier track.
The minimum bend radius and cross-fall of the track will limit the maximum achievable speed to 17.1 m/s for galloping greyhounds. This is based on the assumption that the track would provide a constant static friction coefficient of about 0.5 (averaged) between track’s surface and greyhounds paw.

Furthermore, for the current track configuration the theoretical optimum cross-fall for the track bends is 13.2% or 7.5 deg. This assumes greyhounds would gallop with an average speed of 18.5 m/s and the track would provide a constant static friction coefficient of about 0.5 (averaged).

**GREYHOUND ATTACK ANGLE RELATIVE TO BOX ALIGNMENT**
Currently the Mt Gambier starting box are aligned with the tangent of the turning apex as shown in Figure 2.5, for example the alignment of 512 m starting box with the immediate bend tangent.
When the current 512 m box alignment was dynamically simulated this modeling predicted that changing the box alignment to a head clearance of approximately 40 m was optimum when the box opening was tripped as the lure passed a line perpendicular to the box as depicted in Figure 2.6.

Starting box alignments were investigated with the angle of attack (rate of rotation) of greyhounds. Angle of attack measures how quickly a greyhound is changing its running direction or rotation around its centre of gravity during a race. A higher rate of rotation indicates a higher lateral force acting on the greyhounds. As a greyhound navigates from starting box to the track it experiences significant changes in its angle of attack. Table 2.2 shows a maximum rate of rotation of a greyhound while moving from starting box to the track. The existing 512 m distance start starting box alignment exposes greyhounds a higher rate of rotation than the other starting box
alignment (400 m and 600 m distances starts). The alignment shown in Figure 2.6 produced approximately a 34% decrease in the rate of rotation.²

<table>
<thead>
<tr>
<th>Starting box alignment (m)</th>
<th>Rate of rotation (rad/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing 400¹</td>
<td>1.59</td>
</tr>
<tr>
<td>Existing 512</td>
<td>2.63</td>
</tr>
<tr>
<td>Existing 600²</td>
<td>1.53</td>
</tr>
<tr>
<td>Improved 512</td>
<td>1.73</td>
</tr>
</tbody>
</table>

³ It is highly recommended that any changes to the starting box position be checked to confirm they have not introduced any bias that has made a particular box more favourable than another.

³ Since the 400 m and 600 m distances are on the bend the rate of rotation of greyhounds cannot be improved by adjusting box alignment.

**GREYHOUND HEADING DUE TO LURE POSITION**

Currently the lure positioning along the track after the opening of the starting box gate promotes congestions and sharp turning of greyhounds as they exit the box. Positioning the lure adequately ahead of starting box as the gate opens (Figure 2.8) would led to a clearer vision of the lure for greyhounds as well as providing the greyhounds with a clearer navigation path. This can be achieved by the moving starting box opening gate sensor ahead along the lure running rail from its current configuration on the track as shown in Figure 2.7. For approximately 15 m ahead lure placement (Figure 2.8) after the starting box gate opening significantly improves greyhounds’ rate of rotation like shown in Table 2.3 when compared to Table 2.2. As can be seen from Table 2.3 with this lure positioning configuration the rate of rotation is 73%, 37%, and 65% less for the 400 m, 512 m and 600 m starting boxes respectively.
Figure 2.7  Mt Gambier 512 m current starting box opening sensor placement

Figure 2.8  Mt Gambier 512 m improved lure positioning

Table 2.3 Improved transition rate of rotation for different starting box due to lure positioning on the track

<table>
<thead>
<tr>
<th>Starting box (m)</th>
<th>Rate of rotation (rad/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>400</td>
<td>0.43</td>
</tr>
<tr>
<td>512</td>
<td>1.65</td>
</tr>
<tr>
<td>600</td>
<td>0.53</td>
</tr>
</tbody>
</table>
3. CONCLUSION

Analyzing the Mt Gambier track injury data from 2016 and 2017 shows that the injury rate has not significantly varied in these two years. If the Mt Gambier injury rate is compared with that of NSW tracks and adjusted for missing CATb injuries it could be worse than the worst NSW TAB track.

Injury location plots for all three distances are plotted and analysed in this Report. It is seen that most of the injuries for 400 m distance are occurring at the first turn after the start. For 512 m the majority of injuries are also occurring at the first turn after the start. Data for 600 m is insufficient to make a statement.

The Mt Gambier track design is very similar to many other sister tracks such as Gosford and Wentworth Park tracks and also carries design limitations which would require redesign and greyhounds' dynamic consideration. Variables such as horizontal and vertical alignments of the track as well as clear lure vision for the entire race period influence the injury rates. This report presents some preliminary track design optimisation strategies that would theoretically improve the dynamic racing conditions for greyhounds.

Whatever the chosen design it is strongly recommended that this is modeled to confirm the interaction of the various parameters and variables within this design.