ABettorEdge in association with **Punting Form**

Affordable, Accurate and Informative Sectional Timing

A Discussion Paper and Blueprint

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Sectional Pro Form …. The first electronic form guide for thoroughbred racing to feature a fully integrated coverage of sectional times in Australia.

1 Introduction

The first electronic form guide for thoroughbred racing to feature a fully integrated coverage of sectional times in Australia was introduced in January of 2013 by Punting Form (in association with ABettorEdge). This was born out of a desire to have accurate sectional times available for 'informed' wagering decisions. Whilst some racing jurisdications (both domestically and internationally) have attempted to produce sectional time data, the lack of broad takeup can be attributed to the use of unsuitable technology which has often resulted in an inconsistent outcome considering the associated infrastructure and running costs.

Punting Form and ABettorEdge have produced a prototype of an affordable and accurate sectional time solution with automated 'real-time' race pace versus benchmark information displayed at each distance marker.

Testing conducted using this prototype (assembled using off the shelf technolgy) has shown it would be possible to produce accurate sectional times on a consistent basis, for metropolitan and non-metropoltan race meetings in Australia or New Zealand.

2 Why Have Sectional Timing?

There would be very few sports involving a racing contest which do not consider 'elapsed time' as an important component. Whether it be during training or post-race performance evaluation, time is considered a critical and measurable factor.

Horse Racing as a wagering medium is uniquely placed alongside 'other' sports. Through careful consideration and 'form analysis', it is at least theoretically possible to enjoy a long term profit from wagering activities. This is not the case with the likes of Poker Machines, yet they experience a high participation rate and deliver significant financial returns to management. Promotion of Horse Racing as a fair and intelligent wagering alternative should have considerable merit. Stewards would also no doubt find 200m increment sectional timing of benefit in their decision making regarding 'running and handling' inquiries.

Sports coverage continues to evolve, with audience engagement being encouraged through the use of emerging technology (AFL Champion Data, spider cam, hot-spot, real time snicko, point of view cameras etc). Horse racing needs to keep pace with these developments if it is to maintain or improve its standing / presence in the community.

3 Infotainment, Useful Data for Punters … Which is It?

Presentation 'style' probably determines the answer to this question when it comes to sectional times. For those wanting 'infotainment' (information presented in an entertaining way), a more graphical and

real time emphasis may be required. To be useful, time data needs to be accurate or at least fit for the purpose of being used for intelligent wagering. User individual-preference will dictate whether the presentation should be graphical in nature, tabular or just 'raw' time data in an electronic format. There is less likely to be a 'real-time' requirement amongst data-consumers, with complete and accurate coverage along with ease of use, being higher on the list of desirable attributes.

4 Review of Current Technology

4.1 Radio Transmitter / Receiver combined with Photocell

Usually used for 'race' timing. The start signal is transmitted wirelessly for synchronization of timing equipment including photo cells which record when an infrared light beam is broken by the leading horse.

Pros:

- Can be used to display fit-for-purpose real time 'race' splits.
- Mature and relatively cost effective technology.

Cons:

- False triggering by birds etc.
- No guarantee as to which part of the horse breaks the beam.
- Cannot be utilized to time and display individual runner performances.

4.2 Radio Transmitter / Receiver combined with High Speed Photo Finish

Photo Finish … high speed line scan camera; the blue ribbon standard in terms of accuracy.

Primarily used for 'race' timing and determination of Finishing Order. The start signal is transmitted wirelessly for synchronization of timing equipment including a photo cell and high speed line scan camera which records time and position data by frame count across the finish line.

Pros:

- Providing the start signal is accurately transmitted and received, this methodology is highly accurate.
- Any timing system used to determine finishing order must have either a photographic or video record as part of its basic methodology (as this one has).
- Networking a series of photo finish cameras at various marker locations can also give accurate 200m increment sectional times for each runner, providing the cameras are located based on accurate distance measurements and horse identification is correctly undertaken.

Cons:

- Individual runner information has to undergo manual post-race processing and does not typically yield xy position data.
- High speed line cameras (while a mature technology) are expensive and therefore not really cost effective for use at 'multiple' distance markers.

4.3 Transponder and Inductive Loop

Involves burying a loop of powered cable beneath the track surface, over which horses carrying a transponder pass.

Pros:

- Is able to provide sectional times for individual runners'
- Horse identification is automatic.
- Information could be processed in real-time.

Cons:

- Distance changes due to rail movements have to be accommodated using mathematical 'estimation' techniques, as the loops cannot be moved.
- Does not provide xy position data (i.e. width in running/distance traveled data).
- Reliability and maintenance issues have proved to be 'problematic'.

4.4 GPS combined with IMU (Inertial Measurement Unit)

Each horse carries a GPS unit which logs position versus time data at a predetermined rate (typically 20 to 50 times per second). The addition of an IMU is done to try and provide a backup function for when the GPS unit loses 'lock' with the minimum number of required satellites.

Pros:

- Highly portable with little or no fixed infrastructure required.
- The data usually undergoes post-race processing, but could conceivably be done in real time as well.
- Can provide xyz position data (i.e. width in running/distance traveled and height/incline data).

Cons:

- Single frequency (L1), single constellation GPS units (those found in most smartphones and typical tracking systems) are quite affordable, but suffer from regular drop-outs, long start up 'lock' times and have an accuracy of typically no better than +/- 5m (a 4 length band) under ideal conditions.
- RTK (Real Time Kinematic) GPS units with dual frequency (L1 & L2) and multi-constellation functionality (GPS,

GLONASS etc) can have good 'lock'/response times and cm level accuracy, but would be expensive to develop and implement at present, due to a $7,000 to $10,000 per unit (i.e. per horse) price tag.

4.5 Real Time Location System (RTLS)

This technology usually measures the Time-of-Flight (ToF) of a radio signal, or the length of time it takes for the radio signal to travel between the radio nodes. The information is then used to calculate the distance between the Mobile Node (carried on the horse) and each of the Reference Nodes (infrastructure nodes fixed at known locations).

Pros:

- Provides a real-time based infotainment perspective with animations able to be overlaid on television broadcasts representing positions in running.
- Does provide xy position data (i.e. width in running/distance traveled data).

Cons:

- Location accuracy is typically on the range of 0.5m to 1.0m.
- As with all radio based communication technologies, network design is critical, with line-of-sight, bandwidth congestion and signal interference being key considerations.
- The location positional accuracy of current implementations (along with radio network communication issues) means this system should not be relied upon for 'fit-for-purpose' sectional timing.

Frame by Frame … the strength in this approach is that it has the high accuracy of a photographic or video based framework as its underlying technology.

4.6 Frame by Frame Video Analysis – Manual

The methodology utilized by ABettoredge and 'others' to compile sectional times from broadcast race videos. TV broadcast in Australia and NZ utilizes the PAL video standard where 25 frames are transmitted each second. This translates to each frame representing 0.04 seconds of time.

Pros:

- The strength in this approach is that it has the high accuracy of a photographic or video based framework as its underlying technology.
- It does not require any additional on-course timing equipment.

Cons:

- The cost of 'labour' content involved in manual runner identification combined with frame by frame timing analysis.
- A high reliance on good side-on camera angles and accuracy of rail markings (with compensation for rail movements).
- Does not typically provide xy position data (i.e. width in running/distance traveled data).
- Cannot be performed in real time.

5 Affordable, Accurate and Informative Sectional Timing … Achievable?

The Australian racing industry is not dissimilar to many racing jurisdictions, in that there is a high cost to adopt best practice across a large quantity and geographic spread of race tracks. Hong Kong is perhaps best placed in this regard, due to a limited number of race tracks confined to a small area. They utilize photographic/video methods for sectional timing and have recently implemented a real time location system as well. The real time location system implementation was not without technical issues and a statement from the CEO of the HKJC has been reported as saying they will continue to use their existing methods for timing purposes, as the implemented RTLS is not accurate enough for this purpose.

It is our belief that there are three distinct areas which can be addressed by any 'new' developments in race timing systems;

5.1 Finish Position and Time / Margin for Each Runner

This can only be the domain of either a high speed line scan camera (photo finish) or a high speed video camera. Permanent visual evidence and the ability to differentiate margins (taken at the nose tip) to a sub-cm level are key requirements. Due to its critical nature, all tracks should currently be well served in this area. We say 'should', because inaccurate official overall race times are still frequently published (presumably because of synchronization issues between the starting pulse and finish equipment). High speed line scan cameras are expensive and the only technology currently in use at the finish line. There may be a cost saving in the adoption of high speed video cameras, but given most of the hardware/software is already in place, the case for this may not be compelling.

5.2 Sectional Time and Position / Margin Determination for Each Runner

There is currently no accurate and cost effective off-the-shelf solution implemented (or available for implementation) within Australian or overseas racing which serves this purpose. Ideally, any 'solution' should be portable (able to be shared amongst nearby tracks) and

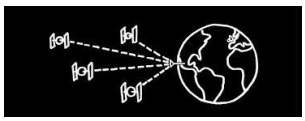
The fact that hardware and software is improving at an exponential rate whilst actually becoming more affordable, presents racing with an opportunity to develop and implement an affordable industry wide solution.

produce time/position data which is fit-for-purpose. Our definition of fit-for-purpose is correct position in running data and times accurate to +/- 0.04 secs (or within a 0.08 secs band = approx. 0.5 lengths). This data should be made available in 200m increments from the 600m mark as a minimum and preferably from the 1200m mark.

The fact that hardware and software is improving at an exponential rate whilst actually becoming more affordable, presents racing with an opportunity to develop and implement an affordable industry wide solution. There is no need to apply typical hi-tech timing solutions borrowed from elite sports at a premium price point. Recent technological breakthroughs in batteries, wireless communication networks, video software and video cameras etc means we can achieve a fit-for-purpose outcome which is both portable and relatively low cost. The key idea is to use commonly available technologies combined in such a way as to achieve the desired results where possible.

5.3 Real Time Infotainment for the Race and / or Each Runner

A basic implementation of this can consist of only real time 'race-splits'. Segments of the harness and greyhound industry have such a system available to race callers and on-course participants (split times displayed on large LED scoreboard apparatus). This functionality has not been extended to television coverage and does not contain any live benchmarking to 'describe' what the various splits mean with regard to race pace and performance. Australian thoroughbred racing has no real time coverage of race sectionals. Real Time Location Systems are available from overseas suppliers as an off-the-shelf solution but are relatively expensive, usually include significant fixed infrastructure and do not also satisfy item 5.1 and 5.2 requirements (for reasons already noted). The most promising technology which could cover item 5.2 and item 5.3 objectives is RTK (Real Time Kinematic), multi frequency, multi constellation GPS units with cm level position accuracy. This would require very little fixed track infrastructure and could be completely portable. Only the 'cost barrier' remains to be overcome for this to be part of a feasible RTLS solution.



Hand held RTK (Real Time Kinematic) GPS units with cm level position accuracy should be used for accurate rail measurement and placement of distance markers.

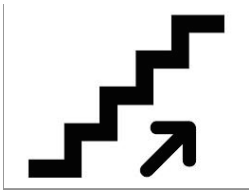
It is possible to compile fit-for-purpose data from 'on-horse' modules carried in the saddle cloth provided an adequate positional update period could be maintained and extrapolated from (a device mounted on the tip of the nose is not required, apart from satisfying item 5.1 requirements).

It should be noted that a major weakness with any existing timing system is inaccurate measurement and placement of starting barriers and distance markers (particularly with account taken for rail movements). This is where the use of a hand-held RTK GPS unit with custom software for rail measurement should be investigated.

6 A Blueprint for Moving Forward

ABettorEdge and Punting Form are comprised of individuals with professional qualifications and experience in Engineering and

Information Technology. We are well resourced and funded to prototype and test sectional timing systems to the stage of full on-course implementation and have a large database of historical sectional times and proprietary benchmark data. The information presented in this document has been introductory and 'conceptual' in nature, but we are already well underway with an internally funded project. Equipment and software has been specified, purchased, and initial 'proof-of-concept' testing successfully undertaken. As a result, we can be confident that the most fundamental requirements covered in this discussion paper, are possible. Considering all of the preceding discussion covering financial viability, technology cycles and lessons learnt from previous implementations, we believe a 'graduated' or 'stepped' approach may best serve the thoroughbred racing industry:



6.1 Basic-Level Sectional Timing

The minimum requirement for basic-level sectional timing would require that 'fit-for-purpose' broadcast race video be made available for manually conducted frame-by-frame video analysis. Accurate race leader sectional times (race pace) would then be available before the commencement of the next race with detailed sectional times for each runner available within 48 hours.

Considering all of the discussion covering financial viability, technology cycles and lessons learnt from previous implementations, we believe a 'graduated' or 'stepped' approach may best serve the thoroughbred racing industry.

Brief requirements / description of proposed basic-level sectional timing:

- Racing bodies and race video broadcasters would need to ensure guidelines are set and maintained regarding 'fit-for-purpose' race video broadcasting.
- Such fit-for-purpose race video would typically require the use of more than one camera, such that the video frame/s encompass the full race field passing clearly visible 200m running rail markers, from a predominantly side-on perspective. Fewer cameras may be able to be utilized if 'virtual' 200m increment track lines form part of the broadcast for any oblique or front-on camera perspectives.
- 200m increment running rail markers (working backwards from the finish line) must be accurately positioned before the meeting is conducted (to take account of rail movements). The use of a hand-held RTK GPS unit with custom software for accurate rail measurement would meet such accuracy requirements.
- Starting positions must be accurately measured and positioned, to reflect published race distances.

6.2 Intermediate-level Sect Timing & Infotainment

As per the basic-level description with the addition of a real-time race pace component.

Brief requirements / description of proposed intermediate-level sectional timing and infotainment:

- Fit-for-purpose race video broadcast as per Basic-Level requirements OR alternatively, have synchronised POV (point of view) video cameras located at the starting barrier, each 200m position and the finish. These cameras would be

activated to only record while horses are in 'view'. Small video files would then be transferred wirelessly from each camera to an on-course PC and ultimately transferred to the 'cloud' for complete post processing. This would yield 'final' 200m increment sectional times for each individual runner.

- Radio transmitters and receivers combined with photocells at each camera location would serve the dual purpose of triggering cameras to start recording (if suitable race video broadcast was not made available as the alternative) and also provide real time, 'preliminary' race/leader sectional time data. This race time data would be transferred wirelessly to an on-course server, compared to ABE/PF benchmarks, with the split times and 'race pace' at each marker (eg 3 lengths fast, moderate, 4 lengths slow etc) shown on LED display boards in real time. Ultimately a race clock, split times and 'race pace' could potentially be overlaid on TV broadcasts as well.

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6.3 Advanced-Level Sect Timing & Infotainment

As per the basic-level description with the addition of a real-time, individual runner location and time/pace animation component RTLS).

Brief requirements / description of proposed advanced-level sectional timing and infotainment:

- Fit-for-purpose race video broadcast as per Basic-Level requirements (should an RTLS system be developed with a demonstrated 95% location accuracy of +/- 15cm at a minimum update rate of 25 Hz per horse tag, then this video for manual frame by frame post-race analysis, would no longer be required).
- A Real Time Location System capable of transmitting x-y-z location Vs Time data (to 95% +/- 50cm) for each runner (carrying a transponder tag) to a server located on course. Suitable equipment and software would then display broadcast quality race animations and 'preliminary' sectional time and race pace data (as well as providing real time data/animations for phone apps etc). As previously stated, should an RTLS system be developed with a demonstrated 95% location accuracy of +/- 15cm at 25 Hz, then further manual video post processing would not be required and sectional times generated by the RTLS (photo finish timing for overall race time from start to finish would still be required under all scenarios) could be regarded as 'official' as opposed to 'preliminary'.

7 Conclusion

It is our belief that an affordable, accurate and informative sectional timing solution could be deployed across all segments of the thoroughbred racing industry. A 'graduated' or 'stepped' approach as outlined in this discussion paper, would serve the industry well. Financial considerations may see a different level of service be

provided for different locations or meetings, but it is important that a ‘piecemeal’ approach to ‘basic’ sectional data provision not be undertaken.

Rapid technological advances which are likely to take place over the next 5 to 10 years should also form a key component in any decision making. The fundamental building blocks of any sectional timing system will comprise x-y-z position data updated at a certain frequency (rate per second). A basic level offering may only have ‘x’ position and time data, but any ‘back-end’ data processing and storage systems could be ‘future-proofed’ to some extent by allowing for all of these fundamental building blocks. In this manner, a technology shift in the type of equipment which provides the basic data, could be more readily accommodated by pre-existing investments in infrastructure.