Summary of Comments on Practical Work Report

Student Name.. Markers Initials________________

	Ranking			
Structure of the Report (compliance issue) All instruction about format have been followed, and all the prescribed sections are present	5	4	3	2 OR 1
Quality of the Report Grammar and spelling are good. The language is fluent, and flows well, no proof reading errors.	5	4	3 OR 2	1
Presentation of the Report The report is well focussed, balanced, interesting and contains an appropriate amount of detail. Illustrations are useful.	5	4 OR ~~3~~	2	1
Scope of Report Well-chosen and relevant to a Practical Work Report	3	2	1	0
TOTAL VALUE OF MARKS	3	12	–	–

$\boxed{15}$

OVERALL Grade for this Report

Total Marks greater than 14	A
Total Marks greater than 10	B
Total marks greater than 6	C
You are required to resubmit this report.	D It is recommended that you contact the Student Learning Unit for advice on the writing of this report

THE UNIVERSITY OF AUCKLAND
FACULTY OF ENGINEERING

CERTIFICATE OF PRACTICAL WORK

Student Family Name		First Name	
Student ID Number		Specialisation	Engineering Science
Part Completed	☐ II ☐ ☐		
Full Company Name	High Performance Sport New Zealand		
Company Physical Address	Avantidrome, 15 Hanlin Road, Cambridge, 3450		
Company Postal Address	PO Box 302 563, North Harbour Auckland 0751		
Company Website Address	hpsnz.org.nz		
Company Phone Number	07 849 7462	Company Fax Number	09 479 1486 (Auckland branch)
Supervisor Name and Designation		Supervisor e mail address	
Period Worked	From 2/12/15	To	22/02/16

Nature of Work (To be classified showing the hours for each classification)	Hours	
	General	Sub Prof
Data gathering and analysis and	10	
Assistance in software development	42	
Total Hours Worked	52	

Report of Engineer in Charge

Signature		Date	4/8/2016
Student Progress	As she got a better understanding of the project and some new features of MATLAB, she was ready to go the extra mile	Student Diligence	extremely motivated and competent.
Student Attendance	2hr each week then worked independently	Remarks	Report right on the deadline

FOR OFFICE USE

Name of Marker				
Reports Approved	General Hours		Sub Professional Hours	
Hours Credited	General Hours		Sub Professional Hours	
Grade ☐	Signature		Date	

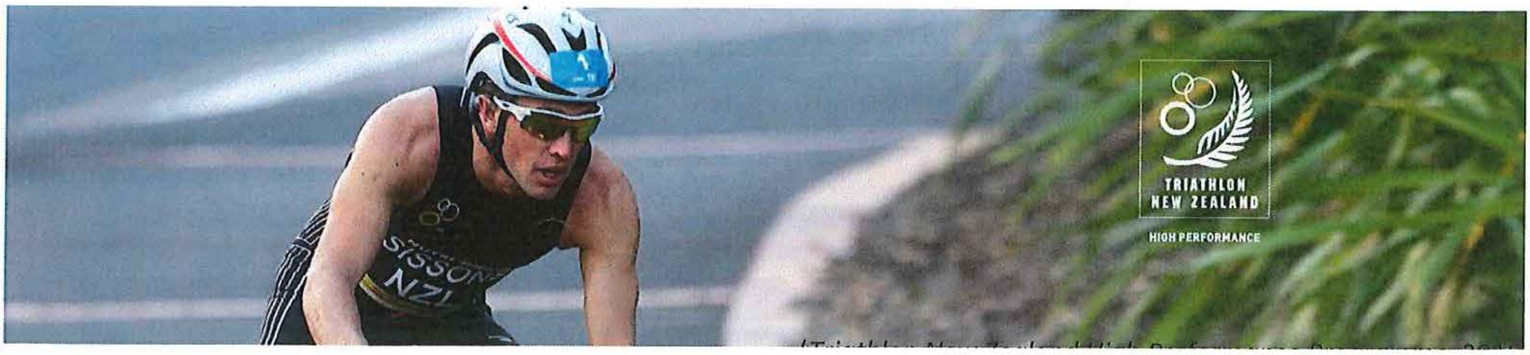
High Performance Sport New Zealand
Avantidrome
15 Hanlin Rd
Cambridge 3450
Waikato

High Performance Sport New Zealand

Practical Work Report

ENGGEN499

7 August 2016
Prepared by:
Work Duration: 2 December 2015 – 22 February 2016
Department of Engineering Science



Summary

This report summarizes the 13 week part-time internship I undertook with High Performance Sport New Zealand (HPSNZ) under the guidance of Rita Performance and Technique Analyst.

HPSNZ invests in National Sporting Organisations, helping to fund their high performance programmes as well as individual athlete campaigns. My role while working there was to design a computer program that uses a triathlete's cycling data to determine their speed and power into and out of turns in order to learn more about their turning efficiency. The programming was designed to aid Triathlon New Zealand and was completed in MATLAB.

Over the 13 weeks of work I used my previous problem solving and software skills, developed from my studies, as well as my extensive experience of cycling, to build the computer program 'Analysing Turn Data' (ATD). I further advanced my skill set, in particular my knowledge of MATLAB and its Graphical User Interface (GUI).

I enjoyed the nature of the work I undertook especially the flexibility and freedom I was given in the development of ATD. Learning the dynamics of an open plan office and how an organisation like HPSNZ is run was also very beneficial and I hope to be able to have more to do with the organisation in the future.

Acknowledgements

First of all I would like to acknowledge my supervisor who always answered my questions and guided me when I was stuck. Without her and her knowledge of MATLAB I would not have been able to go as far with the project as I did in the time frame I had.

Thank you to Triathlon New Zealand for sharing their office space with me over the 13 weeks I was working and to HPSNZ for entrusting me with the responsibility of working under their organisation.

Contents

Table of Figures

1.0 Introduction

High Performance Sport New Zealand is the governmental organisation for elite sport in New Zealand. HPSNZ invests in national sporting organisations helping athletes with performance support (rehabilitation, nutrition, performance/technique analysis, physiology etc.), athlete life, Prime Minister's Athlete Scholarships to support study and grants. HPSNZ also supports the development of world class coaches through coaching programmes and scholarships.

Over summer 2015/16 I worked part time for Rita Malcata, a Performance and Technique analyst for HPSNZ. Rita assigned me a project that, once completed, would aid her analysis of a triathlete's technical ability in the cycling leg of a race. The project involved building a program in MATLAB that determined a cyclist's speed into a U-turn and their power and speed out of the turn.

From my experience working for Rita I enhanced my MATLAB skills, in particular I learnt how to use MATLAB's Graphical User Interface. I also developed my problem solving skills, learning that it is important not to spend too long on any one problem but to move forwards and come back to it later on. I also experienced what it is like to work in an open plan office environment and found I can easily lose focus in such an environment and therefore it is beneficial for me to have strategies in place like working from home or taking small breaks every hour to keep myself focused.

2.0 High Performance Sport New Zealand

2.1 Building Layout

HPSNZ has their main office located in Auckland at the Millennium Institute of Sport and Health (MISH), but also has offices and training facilities in Cambridge, Wellington, Christchurch, Dunedin and Wanaka. I was working as part of the HPSNZ Performance and Technique Analysis Unit and because my work involved primarily triathlon related analysis I was based out of the Triathlon New Zealand office in the newly built Avantidrome, National Cycling Centre of Excellence, Cambridge.

Figure 1: Avantidrome Velodrome Cambridge ("Avantidrome | velodrome, indoor cycling track", 2016)

The Avantidrome is a three level building that incorporates a cycling velodrome stadium with seating for up to 4000 spectators shown in Figure 1. On the lower level is a reception area, café, small bike shop, bathrooms and the High Performance training facilities which include a gym, rehabilitation room, recovery pools and more bathrooms/changing areas. The TriNZ, HPSNZ and Para-Cycling offices are located on the second level along with a staff kitchen, a University of Waikato research lab, meeting rooms and an athlete lounge. On the 3rd level of the Avantidrome is the Cycling New Zealand office and two large conference rooms that can be hired out for functions.

The TriNZ office where I was working consists of a small meeting room, two individual desks for the High Performance Director and his Personal Assistant and another grouping of desks. Each desk has a large monitor which staff can plug-in to their laptops.

Access to the High Performance facilities and the 2nd and 3rd level offices is permitted by key card only which means there is a comfortable degree of privacy for staff members. The adjoining offices of HPSNZ and TriNZ is appropriate as it allows for easy communication between the staff who work closely together on a day to day basis regarding athlete nutrition, sports psychology and wellbeing.

2 2 Staff Organisation Structure

HPSNZ STRUCTURE CHART

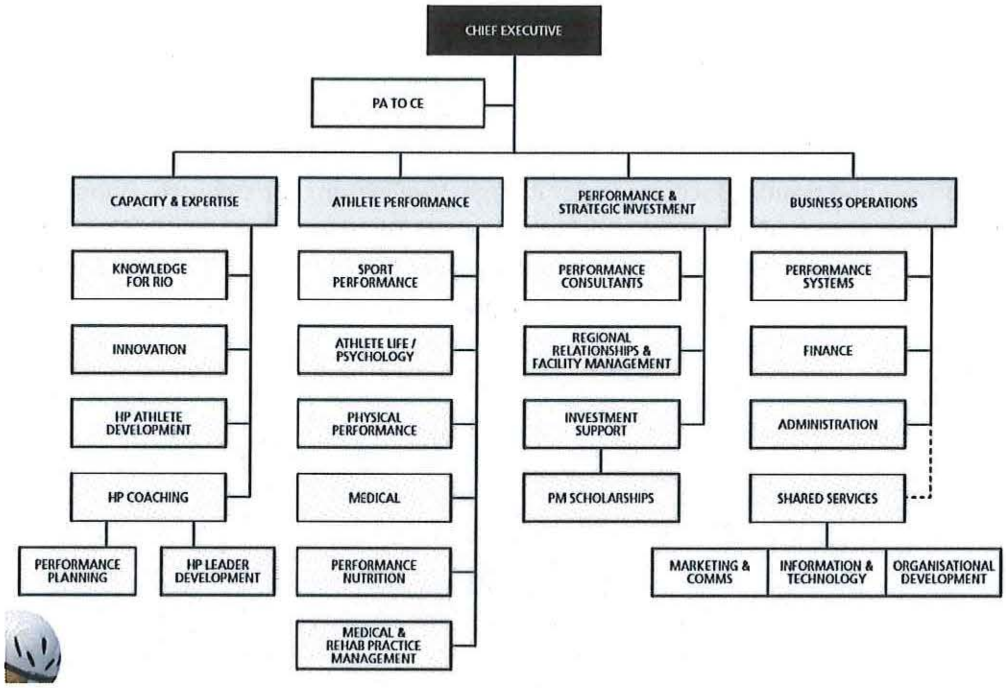


Figure 2: Staff Organisation Structure for HPSNZ ("High Performance Sport New Zealand", 2016)

HPSNZ has 120 staff working across the four main areas shown in grey in the figure above. Rita works in the Performance and Technique Analysis Unit which is under the umbrella of Athlete Performance Sport. Rita reports to Simon Briscoe who is the lead Performance Analyst.

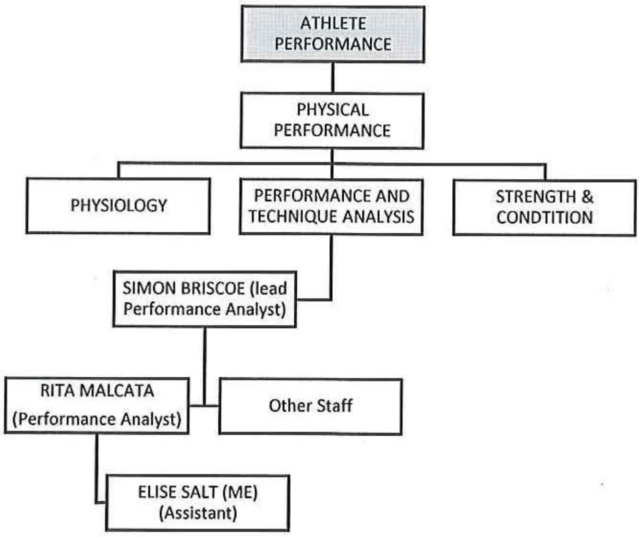


Figure 3: Snapshot of Performance and Technique Analysis Unit Structure

3.0 Work Undertaken

3.1 Overview

On a technical bike course in a triathlon i.e. one with lots of sharp turns and/or U-turns, extra energy can be expended due to slowing down too much before a turn. If an athlete slows down unnecessarily or performs a turn inefficiently they can lose contact from riders in front and have to accelerate hard to catch up to them again using up valuable energy. My work consisted of building a program using MATLAB that could read in a cyclist's racing data (their power, speed, time, cadence), use this data to identify when an athlete is turning (around both 90 and 180 degrees) and filter the data to give the power and speed into and out of a turn and display this to the user for further analysis. The purpose behind this project was to give a means of comparison for coaches to see how different athletes expend their energy out of turns and potentially explain why some triathletes drop from bike bunches or suffer on the run leg of a triathlon due to an increased energy expenditure during the bike discipline of the race. Furthermore, quantifying how an athlete is executing the turns over multiple races provides a measure for coaches to evaluate if there have been changes as result of training interventions.

3.2 Approach

Over the course of 13 weeks, I worked on this project under the guidance of Rita Malcata. Rita works in Cambridge on Monday's and Tuesday's and in Auckland during the rest of the week. Every Tuesday I would spend up to 2hours at the TriNZ offices. This time was spent either consulting with Rita about progress I had made since the previous week or working on the project itself. During the remainder of the week I worked from home, working on the project between my own training sessions. There were several steps I undertook to complete the project;

1. Import data file to MATLAB
2. Use the data file to identify when an athlete is turning
3. Create a way to correct turns identified wrongly and turns not identified
4. Extract the power and speed before and after the turns
5. Create a user friendly interface
6. Export the data from MATLAB into a useable format e.g. csv.
7. Write instructions for users of the programme

3.2.1 Importing Data

Using Training Peaks WKO an athlete's cycling data file can be exported into csv format. The data file consists of speed (kph), power (watts), distance (km), cadence (rpm) and heartrate (bpm) for each second of the ride. With this data in csv format it was a simple case of importing the data using MATLAB's inbuilt functions.

3.2.2 Identifying Turns

In order to single out when an athlete is turning from their data file alone, it was necessary to find a condition that was true when an athlete was turning and false otherwise. This posed more of a problem than I initially thought as there was no blanket condition that identified all 90 and 180 degree turns for all athletes without also identifying other instances in an athlete's ride. In the end I set default options for a condition and created a user input form enabling a user to change the default options if necessary. The default conditions that identify when an athlete is turning are:

- The athlete's speed is less than 25kph
- The athlete's power is less than 5 Watts

To identify when the athlete is no longer turning but accelerating out of a turn:

- The athlete's power must be greater than 50 Watts
- The sum of next two seconds of power (after the first second that is > 50 Watts) must be greater than 0.7 x the athlete's maximum power (the largest output power for the whole ride)

For example, Figure 4 shows an athlete's data file for the bike leg of a triathlon in csv format. When Analysing Turn Data (ATD) is run in MATLAB for this file the athlete will be identified as turning at 05:20 minutes (highlighted in blue in Figure 4) as the athlete's speed is less than 25kph and their power is less than 5 watts. At 05:26 minutes MATLAB will identify that the athlete is no longer turning as their power is greater than 50 watts and the sum of the next two seconds of power (highlighted in yellow in figure 4) is greater than 0.7 times the athlete's maximum power, which in this particular case was 540watts.

Minutes	Torque	Km/h	Watts	Km	Cadence
0:05:14	5.233	40.9	123	3.265	98
0:05:15	5.25	40.4	27	3.277	95
0:05:16	5.267	39.3	4	3.288	88
0:05:17	5.283	37.9	3	3.298	80
0:05:18	5.3	35.6	3	3.308	78
0:05:19	5.317	30.8	3	3.318	78
0:05:20	5.333	24.4	0	3.325	19
0:05:21	5.35	18.8	0	3.331	0
0:05:22	5.367	15.4	0	3.335	0
0:05:23	5.383	13.5	0	3.339	0
0:05:24	5.4	11.2	0	3.341	0
0:05:25	5.417	14	0	3.345	0
0:05:26	5.433	18.6	396	3.35	12
0:05:27	5.45	22.1	422	3.356	56
0:05:28	5.467	25	439	3.362	65
0:05:29	5.483	27.1	426	3.37	72
0:05:30	5.5	29.4	371	3.377	80
0:05:31	5.517	30.9	362	3.387	84
0:05:32	5.533	32.9	366	3.395	88

Figure 4: Sample athlete's cycling data in raw (csv) format

3.2.3 Correcting Turns

Due to the loose nature of the condition above it was necessary to implement an option for users to manually add turns that were not picked up by the condition or delete ones that were incorrectly identified. In order to do this I created a user interface where a user can see at what distances the athlete is turning and can choose to add or delete turns they would like analysed. In the figure below the red dots represent where the athlete is turning. When the user clicks 'Close' the program goes on to collect the power and speed data for 5 seconds (user defined) before and after each of the red dots. The interface in Figure 5 enables the user to add in areas to be analysed or delete areas they don't wish to be analysed. If a user decides to add a point they can do so graphically by selecting anywhere on the graph or manually by entering a distance. ADT will look for any jump in power within 10 seconds of this point and by doing so determine whether there could possibly be a turn near this point that the condition did not pick up. If there is no jump in power then an alert will pop up as shown in figure 3, which notifies the user than the area they have chosen does not correspond to a turn. The user can then choose to analyse this point anyway or forget the point.

Figure 6: MATLAB alert to notify user that the area they selected was not identified as a turn

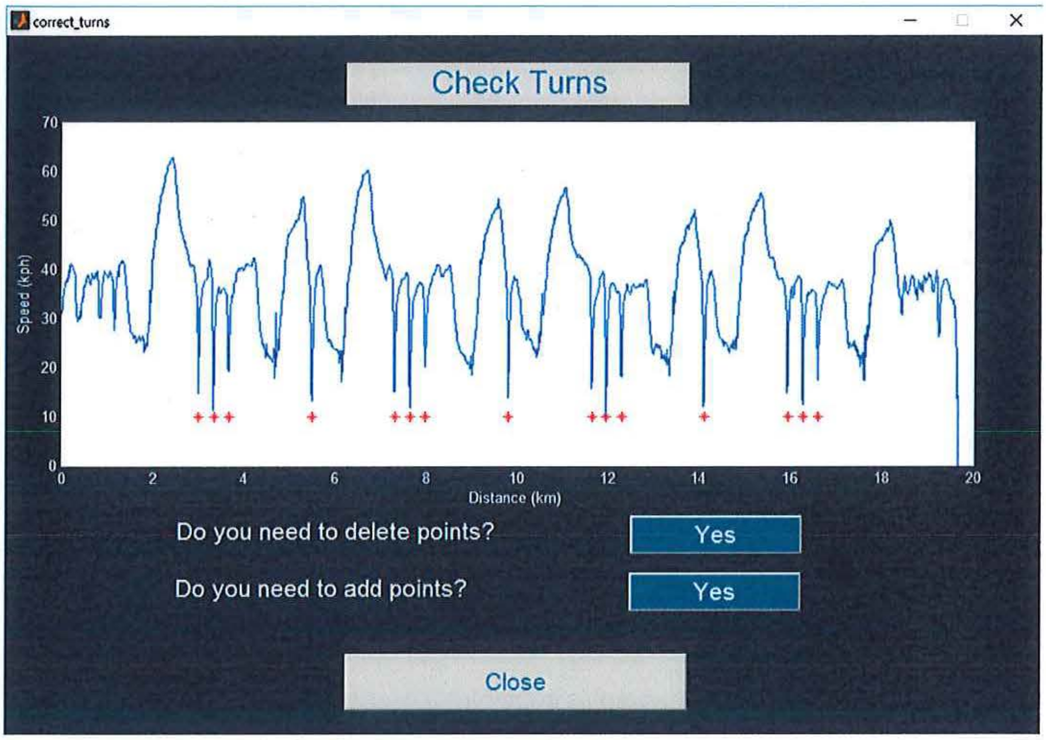
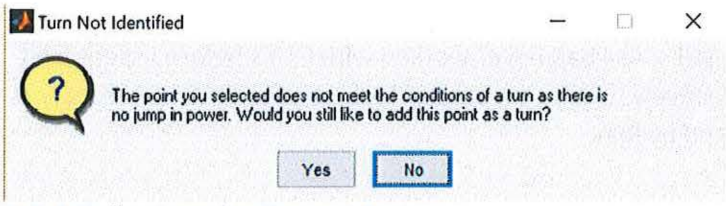


Figure 5: Graphical User Interface for checking the location of turns



3.2.4 Collecting the Correct Data

Once the user has confirmed the turns that have been identified by the program, ATD collects the power and speed data before and after the turns and uses this to calculate other values such as the average Watts/kg of the athlete and their acceleration into and out of the turns. For example referring back to Figure 4 ATD will collect the speed of the athlete going into turn i.e. from time 05:15 to 05:19 as well as the speed and power out of the turn i.e. from time 05:26 to 05:30. The final output in MATLAB is in the form shown in the figure below. A user can see a summary of the data (distance, power, speed, acceleration) for each turn in the course.

Output_Table

Data Table

Turn #	Distance	Average Power	Avg Watts/kg	Max Power	Max Watts/kg	Slowest Speed	Deceleration	Acceleration
1	3.00	446.20	8.10	540	9.80	14.70	3.60	2.70
2	3.40	410.80	7.50	439	8.00	11.20	2.50	2.20
3	3.70	407.80	7.40	430	7.80	19.80	4.20	2.30
4	5.50	392.40	7.10	495	9.00	13.20	3.40	2.60
5	7.30	387.60	7.00	530	9.60	15.00	4.60	2.70
6	7.70	375.20	6.80	442	8.00	11.70	4.50	2.30
7	8.00	349.40	6.40	382	6.90	22.70	3.60	2.00
8	9.80	436.20	7.90	530	9.60	13.80	4.50	2.50
9	11.60	384.80	7.00	434	7.90	15.70	4.20	2.10
10	12.00	458.40	8.30	522	9.50	10.30	3.40	3.00
11	12.30	376.40	6.80	458	8.30	18.60	3.40	2.20
12	14.10	428.00	7.80	445	8.10	12.00	3.90	2.70
13	15.90	407.60	7.40	486	8.80	14.70	3.90	2.60
14	16.30	354.00	6.40	428	7.80	12.50	4.40	2.30
15	16.60	296.40	5.40	319	5.80	17.30	3.50	1.70

Close

Figure 7: Summary of output data for user

3.2.5 Exporting the Data

Figure 7 shows a summary output of the data in MATLAB. My next task was to export the data to excel so that it could be saved in an editable format. To do this I used the MATLAB function xlswrite. An example of the final output in excel can be found in the Appendix. The data from ATD is written onto three sheets, the first contains a brief summary of the data, the 2nd a more detailed summary of the data and the 3rd sheet is a copy of the raw data first inputted to MATLAB but with an additional column indicating where ATD has identified the turns.

3.2.6 Creating a User Friendly Interface

A good user interface is key to any usable program as it enables a user to easily navigate the program from start to finish without requiring specific knowledge of how the program works or how it has been coded. In order to interact with the user (get inputs, verify or correct the turns identified and show summary data) I used MATLAB's Graphical User Interface (GUI) as well as message boxes. Both figures 5 and 7 were created using GUI's. As I had never worked with GUI's before I spent a bit of time researching how to use them effectively which consisted of looking at MathWorks resources and also studying previous work completed by Rita.

4.0 Reflective Appraisal

4.1 Work Environment

I enjoyed working in the Triathlon New Zealand Offices at the Avantidrome in Cambridge. The staff were friendly and it was a relaxed environment to work in. Rita was very approachable and was usually free to help with any questions I had. If I was to criticize anything about my working experience it would be that the open plan office nature often meant that I had difficulty concentrating. I find I am most efficient at working when there is complete silence around me and so with the radio playing in the background and other staff members talking I sometimes lost concentration and was not as efficient as I could have been.

Rita was very understanding of my sporting commitments and didn't put any pressure on me to meet deadlines or come into the office for any particular time. It was up to me when I worked on the project and when I had my weekly meetings. Although this meant that I could be flexible with my hours and fit the work around my daily training sessions, this approach was probably not a good representation of work in the real world where time pressure and deadlines are a reality.

4.2 Skills Developed

The project description itself was kept quite brief. I was given rough guidelines of what Rita wanted to get out of the program and suggestions of how to approach it but no set tasks. This enabled me to experiment with MATLAB's many functions and play around with the user interface which I found very beneficial to my learning.

Despite having used MATLAB for numerous assignments and projects in my Engineering Science papers I had never before used the Graphical User Interface option. With GUI's one can design a program that interacts with the user through buttons, checkboxes, graphs, tables and other ActiveX controls (similar to those in Microsoft Excel's VBA). Although the overall result does not look as polished as the VBA equivalent, the MATLAB GUI's were sufficient enough to step a user through my program.

Other skills I developed in MATLAB were:

- How to import and export data between Excel and MATLAB
- Using question dialogue boxes to interact with a user

I also brushed up on my basic MATLAB coding. It was refreshing to see that MATLAB is used by organisations outside of university.

4.3 Lessons Learnt

This was my first time working outside of the University on a project for an organisation and so I learnt a lot about out not only MATLAB which I was coding on, but also about the processes of program development.

A key lesson I will take with me onto future jobs is to not spend too much time on any one specific project task especially when under a time constraint. I spent a lot of time trying to find a condition that would be met for all cyclists when they are turning around both 90 and 180 degree turns. I became so preoccupied with finding a condition that I lost sight of the end functionality of the project. Although this was an important aspect of the project, my time was better used settling for a sub-optimal condition and then creating a way for a user of the program to change the condition themselves or to add in or delete segments in a ride where a turn has or has not been correctly identified. My key lesson here was that it is often not possible to reach perfection and it is just as important to recognise the limitations of my work and create mechanics to overcome them.

5.0 Conclusions

- 60 general hours completed in HPSNZ Performance and Technique Analysis Unit
- Knowledge of MATLAB from my university papers was utilised and progressed
- Understanding of program development furthered
- Strategies to aid program development gained such as asking for help and not lingering on specific tasks for too long
- Experience of working in an open plan office and the associated distractions was gained

Generally well-written & edited, with a good description of work done and good reflective content. Overall, well done (if a little on the short side!).

6.0 References

Avantidrome | velodrome, indoor cycling track. (2016). *Avantidrome / Home of Cycling*. Retrieved 2 August 2016, from http://www.avantidrome.co.nz/facilities/velodrome

High Performance Sport New Zealand. (2016). *High Performance Sport New Zealand*. Retrieved 2 August 2016, from http://hpsnz.org.nz/

Triathlon New Zealand High Performance Programme. (2016). Retrieved from https://triathlon.kiwi/high-performance/about-hp/

Appendix

Turn	Distance	Average Power	Average Watts/kg	Max Power	Max Watts/kg	Slowest Speed	Deceleration	Acceleration
1	3	446.2	8.1	540	9.8	14.7	3.6	2.7
2	3.4	410.8	7.5	439	8	11.2	2.5	2.2
3	3.7	407.8	7.4	430	7.8	19.8	4.2	2.3
4	5.5	392.4	7.1	495	9	13.2	3.4	2.6
5	7.3	387.6	7	530	9.6	15	4.6	2.7
6	7.7	375.2	6.8	442	8	11.7	4.5	2.3
7	8	349.4	6.4	382	6.9	22.7	3.6	2
8	9.8	436.2	7.9	530	9.6	13.8	4.5	2.5
9	11.6	384.8	7	434	7.9	15.7	4.2	2.1
10	12	458.4	8.3	522	9.5	10.3	3.4	3
11	12.3	376.4	6.8	458	8.3	18.6	3.4	2.2
12	14.1	428	7.8	445	8.1	12	3.9	2.7
13	15.9	407.6	7.4	486	8.8	14.7	3.9	2.6
14	16.3	354	6.4	428	7.8	12.5	4.4	2.3
15	16.6	296.4	5.4	319	5.8	17.3	3.5	1.7

Figure 8: Summary output written to excel

Turn	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Distance	3	3.4	3.7	5.5	7.3	7.7	8	9.8	11.6	12	12.3	14.1	15.9	16.3	16.6
Power Out	236	396	410	322	149	301	309	398	336	416	287	382	272	329	266
	442	422	391	495	332	382	343	530	396	502	352	440	411	428	304
	540	439	430	481	443	442	356	498	434	522	373	445	486	365	279
	538	426	410	369	530	404	382	410	398	446	458	436	483	345	314
	475	371	398	295	484	347	357	345	360	406	412	437	386	303	319
Speed In	29.2	18.8	32.4	23.3	33.5	25.1	33.4	27.4	32.6	23.7	32.4	23.7	30.4	25.6	31.1
	25.1	15.4	29.2	19.2	29.2	17.9	30.3	22.2	27.7	16.6	29.2	18.8	24.7	19.3	27.4
	20.2	13.5	24.4	15.9	24.9	14.6	25.7	16.7	22	12.5	25.3	15.7	19.4	14.4	23.9
	15.1	11.2	19.8	13.2	19.3	11.7	22.7	13.8	16.7	11.5	21.4	12	16.6	12.5	23.9
	14.7	14	19.8	14.2	15	11.7	22.7	13.8	15.7	10.3	18.6	13.5	14.7	14.1	17.3
Speed Out	17.2	18.6	19.2	17.4	15	16.8	20.1	18	18.3	13.7	18	15.9	17.4	17.4	18.6
	19.8	22.1	23.7	20.3	18.8	20	22.9	19.4	20.7	18.6	20.3	20.3	20.7	21.5	21
	24.4	25	25.5	20.3	21.3	23.2	24.8	24.4	24.4	22.8	23.3	23.9	24.6	25	23.5
	28	27.1	27.9	27.1	25.6	23.2	27.4	28.4	26.6	26.5	25.9	27.1	28	27.2	24.9
	30.8	29.4	30.6	30.3	28.6	28.3	30.1	30.3	28.9	28.6	29.2	29.6	30.3	28.7	27.3

Figure 9: Detailed summary output written to excel