MINET Franck Tutor : Kobayashi-sensei	*Study of the power output depending on the cyclist's position*	
Internship report		14/06/2013

My work placement project was to study the power output of a cyclist on a Mamachari regarding the height of the bicycle's saddle. It was a wonderful introduction to biomechanics. I was in Kobayashi-sensei laboratory and worked with Fujii-san and Suzuki-san. My second task was to study the power output of the FES cycle regarding the suspension settings, for this project I worked with Komatsu-san and Himori-san. In this experiment, my task was to help setting up the powermeters, extract and analyze the data.

I. Power output on a Mamachari

a) *Equipment employed*

The aim of this study was to establish a link between the cyclist's position and his power output. A powermeter was used in order to assess the consequences on the power output. This device was introduced at the end of the 1980s in professional cycling. Nowadays, it is available to amateur cyclists as well, if they can afford it. The powermeter is composed of strain gauges which electrical resistance varies when they are stretched, and then it is transformed into a value of power. We set up our powermeter on a Mamachari. Mamachari is the name given to a typical Japanese city bike, known to be very comfortable. It carries many accessories such as a bike lock, lights, mudguards, a basket and so on. One of its drawbacks is its heavy weight, between 15kg and 20kg.

To measure the power produced by the cyclist, the powermeter used for this experiment is the Look Keo Power pedals. Each pedal is composed of eight strain gauges that measure the flexion of the axle and send the data to the Polar watch CS600X wireless. We also employed a Garmin GPS to determine the route for the experiment and a speedometer Vectra wireless. Thanks to all the sensors, we extracted many data such as the heart rate, speed, cadence, power for each leg, altitude, distance…

b) *Experiment, results and analysis*

For this experiment, Fujii and Suzuki were in charge of riding the bicycle in order to get the required data. My task was to make sure all the sensors and powermeter were paired, and to extract and analyze the data. To determine the influence of the cyclist's position on the power output, I decided to set the speed of the bicycle (at 15km/h and 20km/h) and vary the saddle height (0mm high and 100mm high). The 100mm high saddle is close to the optimum saddle height for Fujii and Suzuki.

Firstly, let's focus on Fujii's data with 0mm and 100mm high saddle:

Fuji-san

		Average values			Peak values		
Saddle height	Speed (km/h)	Heart rate (bpm)	Cadence (rpm)	Power (W)	Heart rate (bpm)	Cadence (rpm)	Power (W)
100	15	140	45	-	158	42	228
100	20	X	55	-	X	64	278
0	15	165	50	-	193	52	263
0	20	160	60	-	180	62	289

As shown in the chart, we can see that the low saddle position has a disruptive effect on the cyclist's riding: his maximum heart rate increases by 22% and his peak power by 15% in order to maintain the same speed. The low position also causes a very fast tiredness of the cyclist and an uncomfortable position on the bicycle.
We obtained the same results with Suzuki, when the saddle was low, his maximum heart rate was higher and he had to produce more power to maintain the same speed (compared to the 100mm high saddle position).
To conclude, we realized that the variation of the saddle's height has a great influence on the power output: if the saddle is too low, the cyclist will have to produce more power to maintain the same speed, and he will be tired very early. Nevertheless, the results are a little bit skewed by a few varying factors (wind, cyclist's tiredness…) as the experiment is performed in the field. This experiment will be reiterated by Mr. Kobayashi in his laboratory with cameras focused on the cyclist's position, in order to suppress these external factors and to obtain more accurate results.

II. Power output on a FES cycle

a) Equipment

Functional Electrical Stimulation cycling is a therapy treatment for spinal cord injury patients. The FES cycle employed was designed and built in Akita National College of Technology. We used the crank based powermeter SRM DuraAce to measure the power produced by the cyclist.

b) Experiment, results and analysis

For this experiment we decided to modify two suspension parameters (two positions of the suspension and two different spring preloads) which led us to compare the power output of the cyclist according to the four different settings. We found the following average power values: 79W, 72W, 74W, 86W. As the variations between these values are not significant enough, we cannot draw any conclusion about the effect on the power output (moreover, the wind skewed a little bit the trials). We can just notice that the driver's comfort increased when the spring preload was low.
As the Look Keo Power pedals were also set up on the FES cycle we compared the average value of the power output with the SRM data: the Look Keo Power data are 9% lower than the SRM. As we cannot pair the two powermeters and they record one value every second, they do not record the same values of power. For example, the SRM powermeter measured several peaks of power that the Polar did not record. One solution could be to increase the frequency of values recording.

To conclude, this project was an extremely positive experience. I have a passion for motorcycle and in general for motorcycle and bicycle racing, therefore it was really interesting to be able to use some very advanced related equipment. In addition to carrying out my project, my internship at Akita National College of Technology was an amazing immersion into a multicultural working group, in which communication and cross-cultural skills were required in order to achieve the project.