MECHANICS AND THRUST PRODUCTION OF MAMMALIAN SWIMMERS

By

Paul Francis Legac

An Abstract of a Thesis Submitted to the Graduate

Faculty of Rensselaer Polytechnic Institute

in Partial Fulfillment of the

Requirements for the Degree of

MASTER OF SCIENCE

Major Subject: AEROSPACE ENGINEERING

The original of the complete thesis is on file
in the Rensselaer Polytechnic Institute Library

Approved:

Timothy Wei
Thesis Adviser

Rensselaer Polytechnic Institute
Troy, New York

April 2008
(For Graduation May 2008)

ABSTRACT

Two different experiments were performed on dolphins and swimmers to elucidate the fluid dynamics involved with mammalian thrust production. The first experiment examined the swimming mechanics and forces of elite human swimmers. A two-dimensional dynamic force balance was constructed to provide real-time thrust measurements. The force balance was designed to be easily transported, assembled and used at any pool. An underwater video camera synchronized with the force output allowed for direct comparison of forces with swimming motions. The maximum and minimum forces where then correlated with their respective body positions. Of the three main kicks examined, breaststroke kick was found to be the strongest followed by butterfly and then freestyle. Observations like this made the force balance a tool for technique improvement as well. By implementing an underwater monitor the swimmers could view the changes to their force output due to minor changes in their stroke mechanics. Measurements were made with the King Aquatics swim club which included Megan Jendrick (2000 Olympic gold medalist) and Ariana Kukors (4x US National Champion).

The second experiment examined the thrust production due to the motion of a dolphin's tail while performing various swimming behaviors. Digital Particle Image Velocimetry (DPIV) was modified to be safely used on dolphins. With the use of DPIV the vortices generated by the dolphins tail were used to obtain estimates of thrust production. The values of thrust calculated were on the same order previous research of dolphins swimming against a load cell. A correlation between steady swimming speeds and thrust was found to be consistent in shape with theoretical results but showed greater thrust generation at given speeds. Also thrust coefficients were seen to be on the order of 10 times greater than the values previously used for dolphins.