

Implementation and Actuation of a Fish Replica to Study Schooling in *Danio rerio*

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Research

Title: Implementation and Actuation of a Fish Replica to Study Schooling in *Danio rerio*

The zebrafish (*Danio rerio*) is commonly used as an experimental subject due to its well understood genome and rapid embryonic development in the laboratory setting. These animals exhibit shoaling or schooling in nature, in which the follower fish are thought to maintain hydrodynamic efficiency by swimming in the wake of a leader fish. This experiment examines the response of a single live zebra fish swimming in a flow chamber behind a replica fish at varying flow rates. Replica fish are molded from silicone or lurecraft polymer, the molds for which are 3D printed. The tail of the replica fish is actuated using one of two methods with a frequency and maximum amplitude typical of wild type zebrafish. The tail may be oscillated using an Arduino controlled servomotor or by neodymium magnets embedded in the replica tail in conjunction with electromagnets positioned around the flow chamber. Video of the live fish body is taken and analyzed using MATLAB and ProAnalyst software to monitor the biomotive response in and around the wake of the replica.

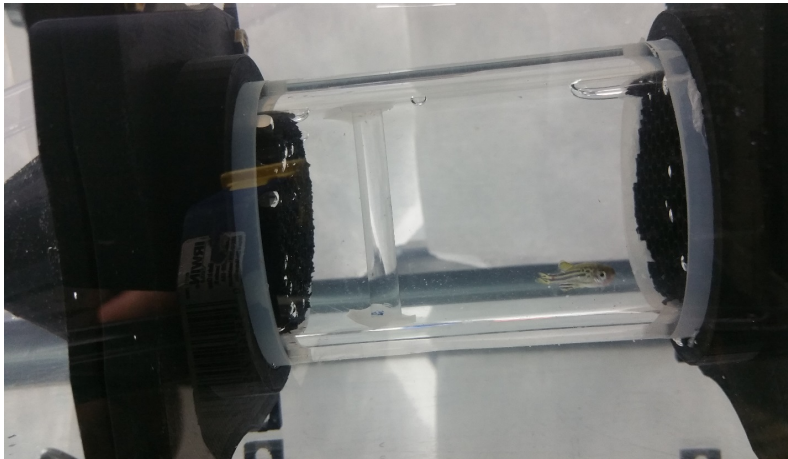


Figure: Live zebrafish resting in the flow test chamber

Lesson Plan

Title: Applications of Boyle's Law and Bernoulli's Equation in a Cartesian Diver and Blowpipe

Students will review the principles of pressure and Boyle's law to design both a cartesian diver setup and a simple blowpipe. Students will create posters with diagrams explaining the changes in pressure in their devices and how changes in pressure affect the diver and the dart in the blowpipe. Bernoulli's equation will be introduced to the students as an extension from the Regents curriculum, and a cross sectional view of an airplane wing will be used as a motivation for this section of the lesson. Drawing from both their prior knowledge of gas laws and their new understandings of Bernoulli's equation, students will predict the temperature effects of the fluid in their blowpipes and cartesian divers. Finally, thermal imaging cameras will be used to verify their predictions, and the results will be added to the posters.

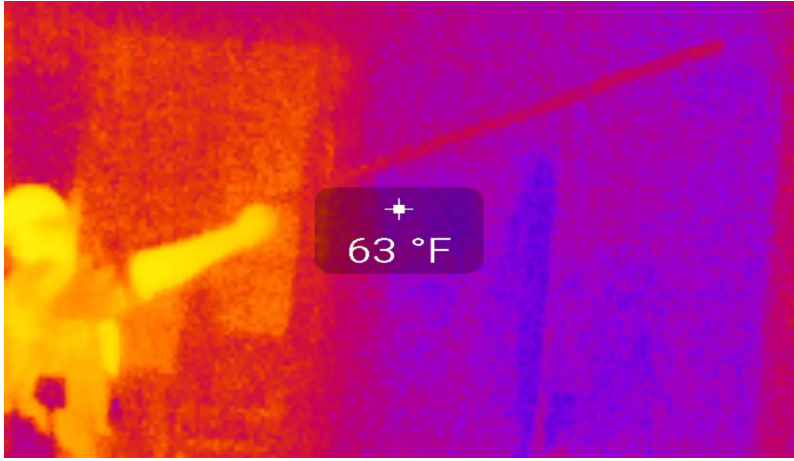


Figure: Thermal image of a blowpipe in use.