

# (Towards) Making A Brick Fly using Machine Learning

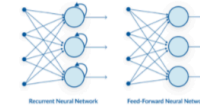
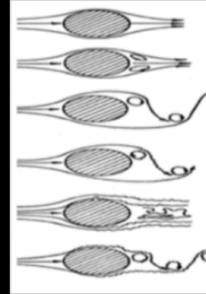


## Goal:

- To Control external forces around a Bluff Body
- Forces: flow, lift, drag, and turbulence
- Bluff Body: a cylinder or **Brick!**
- Models a Plasma Actuator with rotating cylinders

## Solution:

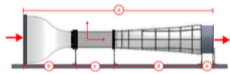
- Implement a Machine Learning algorithm
- Hypothesis: Data-Driven solution is best controller



## What is Machine Learning?

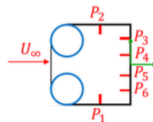
- Computer structure learns from data
- No explicit programming
- Makes predictions based on large datasets
- Different types
  - MLP vs. RNN vs. CNN

	MLP	RNN	CNN
Data	Tabular data	Sequential data	Image data
Input/Output	Yes	Yes	Yes
Processing	Yes	Yes	Yes
Storage	Yes	Yes	Yes
Learning	Yes	Yes	Yes
Deployment	Yes	Yes	Yes



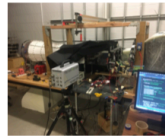
## Placed the Bluff Body in a Wind Tunnel

- Past Experiments: Supported theory
- Brick in the middle of the airflow
- Electronic system devised to gather data
- Input Pressure Data
- Output cylinder RPM



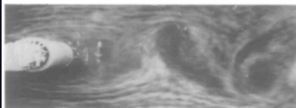
## Trials with the Wind Tunnel

- Good initial results
- Algorithm Created by Calin Ghioaga
- Single Layer Neural Network
- Affected flow significantly

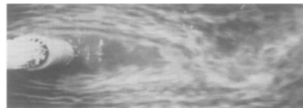


Visualisation of Flow:

Without Control:



With Control:



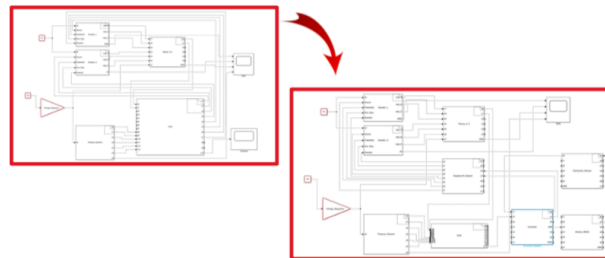
## Major Setback!

- DAQ was non-functional (August)
  - Critical to every part of operation
  - Repair deemed impossible (January)
- Too expensive to replace
  - Must replace with same functionality
  - Needed creative solution that leads to same outcome



## Solution

- Replace and improve all functionality with materials on hand
- Took months and majority of capstone project to fix



## New Direction: Rebuilding DAQ

Cheaper Solution with Same Functions  
 Est. 46% Savings

- Split Input and Output
- Lost DAQ ( -- ~\$3800CAD)
- Microcontrollers ( + \$268CAD)
- Input DAQ ( + ~\$1800CAD)

**Pros:** Cheaper, Faster Sampling rate

**Cons:** Less Reliable, Longer setup Time, More points of failure, individual components make it bulkier and messier

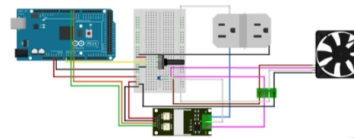
## Other Implementations

- Fan Control – Improves on original design
- Code Storage & Documentation
- Pedagogical Value
  - Appreciate the engineering behind DAQs
  - Worked within budget



## Conclusion:

- Wanted to use Machine Learning to solve problem.
- Wound up fixing a lower level issue that will enable the next group to use machine learning



## Future Direction:

- Train and Test multilayered neural networks
- Develop method to find best control
  - Ensure algorithm has learned from wide range of data