Wind Turbine Project

FINAL REPORT

Group: 1

Members: 陳麒友 楊筌鈞

Dep./School: ESOE/NTU

Advisor: 趙修武教授

May 2018

Project Name	風機組期末報告
Description	總結本學期力學實驗完成事項
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Date	May 29, 2018

Project Successes

List and describe the highlights and key success factors of the project.

Name	Description
成功自行設計葉片	葉片是使用潛艦 Fin 拉伸、旋轉而成，在模擬與實測上結果皆不錯
認識軟體	學會 RHINO、STAR-CCM+等軟體的基本操作
CFD 殘值收斂	運用 STAR-CCM+做的 CFD 模擬殘值收斂
成功 3D 列印	選擇直立列印葉片後一次即成功，且葉片也可與 hub 順利組裝
功率測試實驗成功	雖然葉片因調錯大小使得受風面積較小，在功率測試上效果依舊不錯

Unexpected Events

List and describe any unexpected events that occurred during the project (including approved change requests), the impact that those events may have had on the project and the action(s) taken to address them.

Description	Impact	Actions Taken
葉片 3D 列印失敗	葉片躺著印會因為收縮導致成品粗糙	換成直立列印
FEM 模擬失敗	因網格與結構等問題一直無法使殘值收斂	仍在嘗試，然而還是無法成功

Lessons Learned

List and describe any lessons learned from this project and provide recommendations that can be used to improve the delivery of future information systems projects.

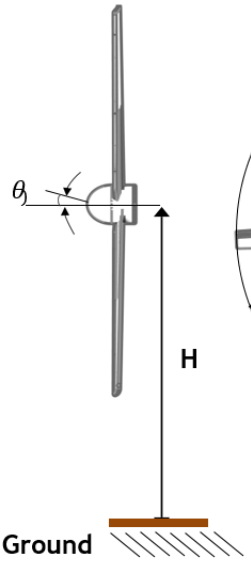
Description	Recommendation
3D 列印時會有收縮的問題，且收縮會與該層面積及列印高度有關	列印面積越大收縮越大，故直立列印葉片比躺印成品效果較佳

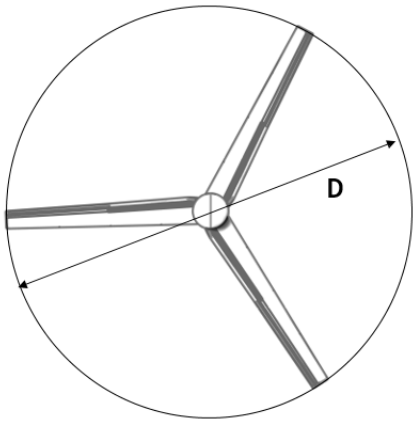
Content

PART 1 MODEL DESIGN – 7U's blade

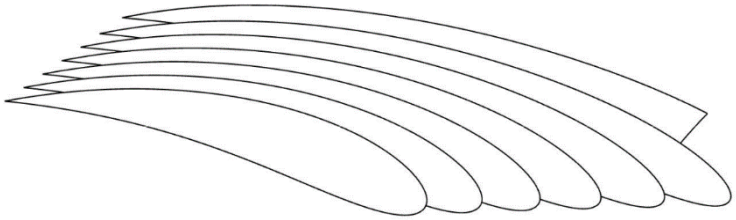
Wind turbine condition

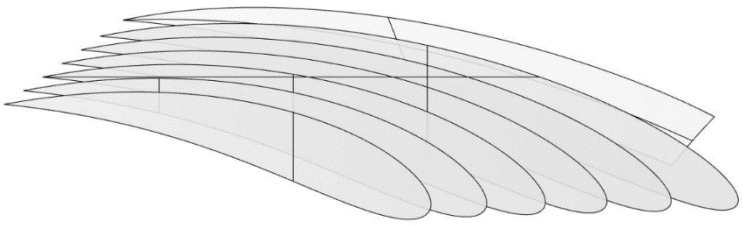
Rotor Diameter (D)	80 m
Hub Height (H)	120 m (1.5D)
Tilt Angle ($\theta_)$)	0°

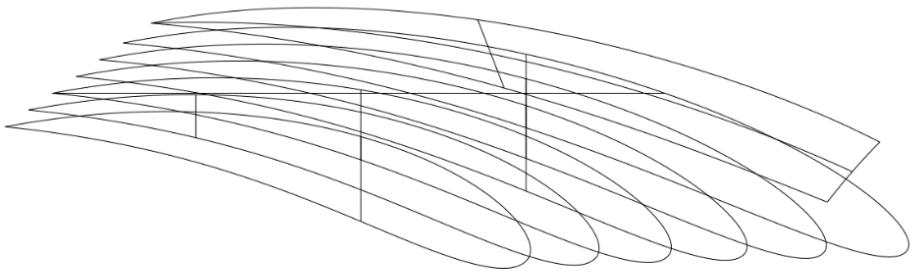




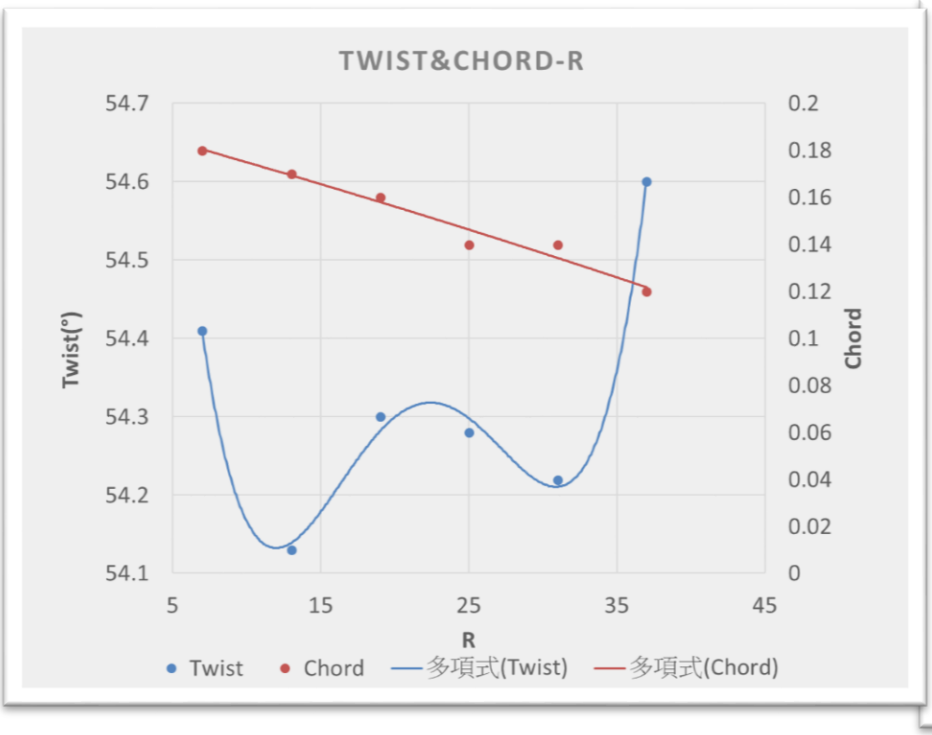
Blade sections







Blade sections along radius

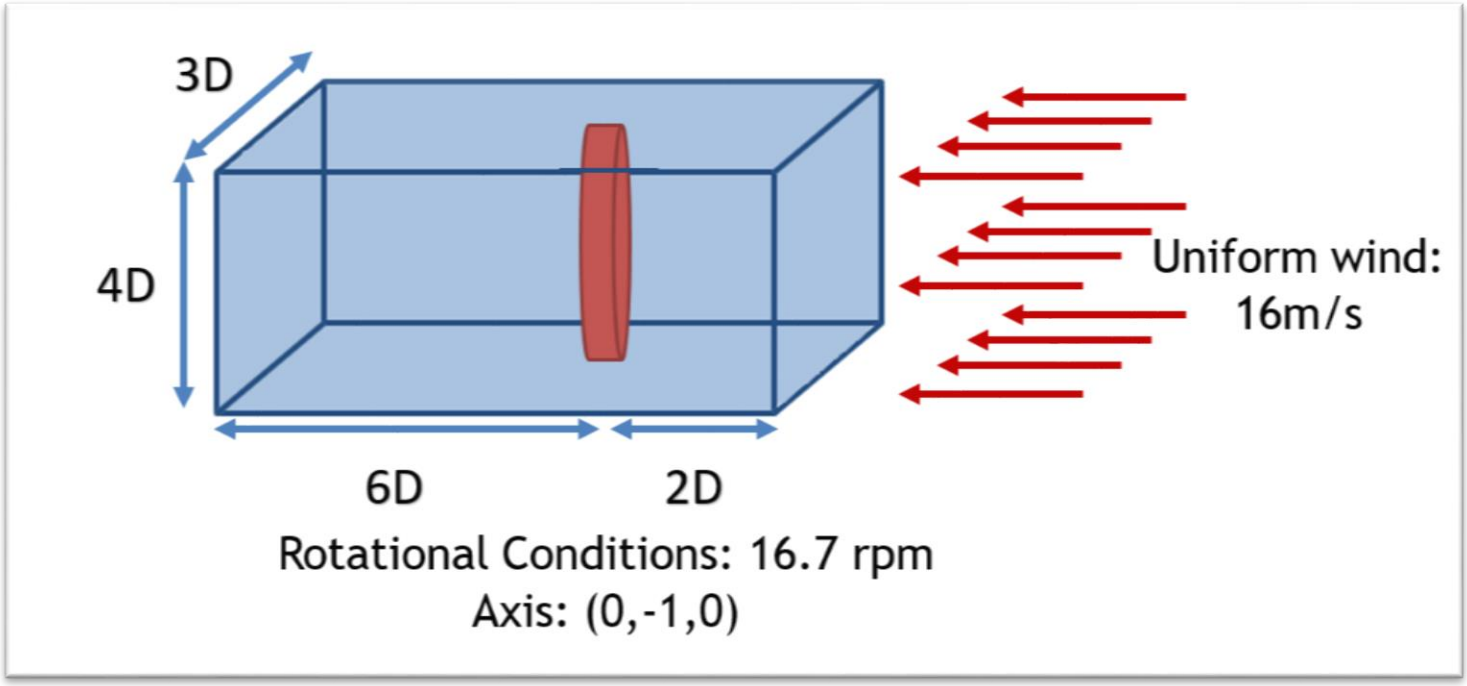


R(m)	Twist(°)	Chord
7	54.41	0.18
13	54.13	0.17
19	54.30	0.16
25	54.28	0.14
31	54.22	0.14
37	54.60	0.12

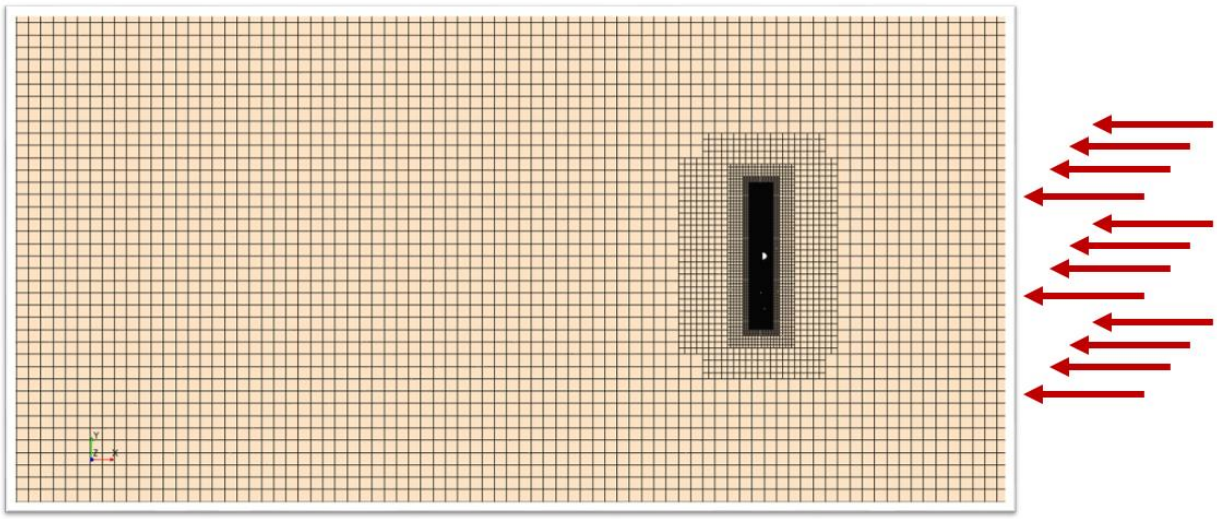
Discussion: 憑著流力的知識，按照規範設計出 7U 號葉片。

PART 2 CFD ANALYSIS

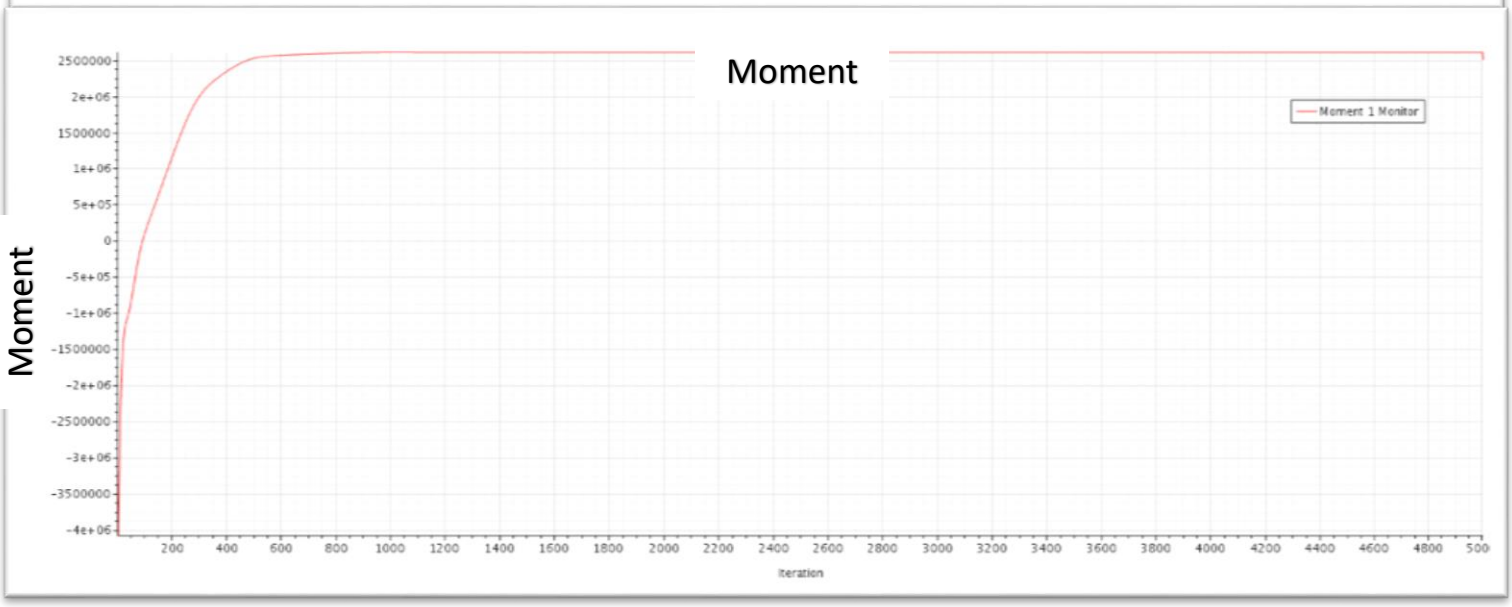
Computational domain



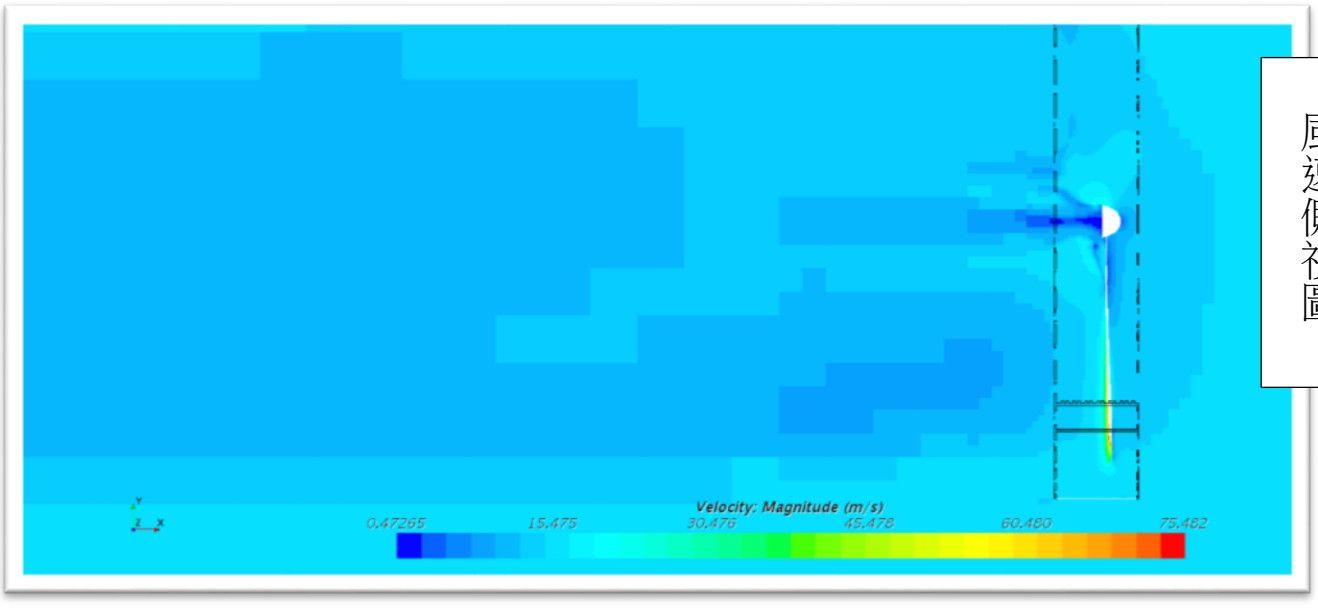
Mesh Distribution (total mesh: 2,884,571**)**



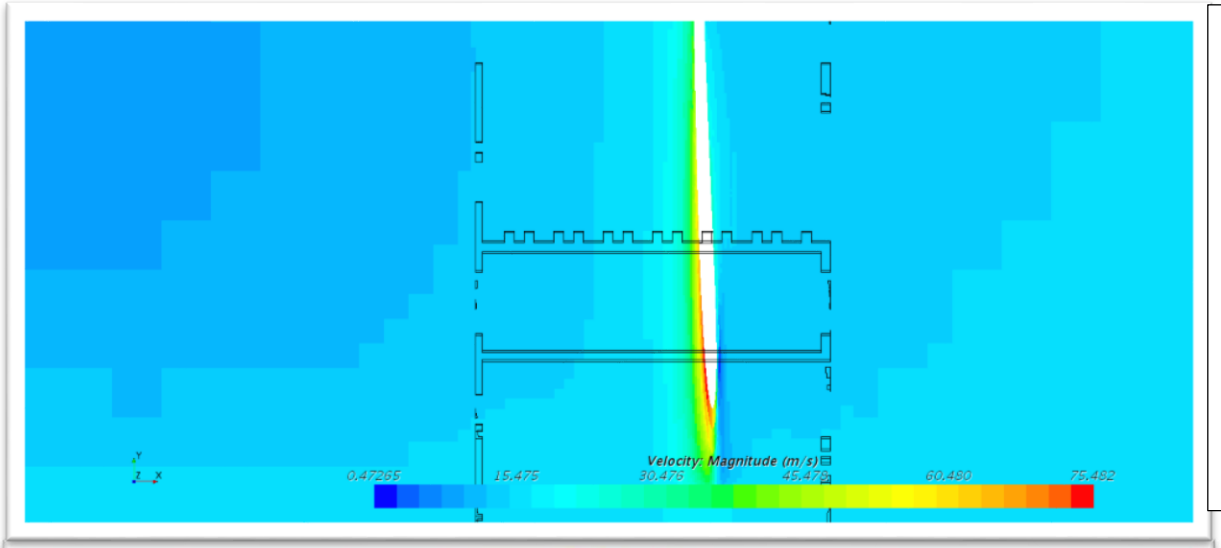
Convergence Condition



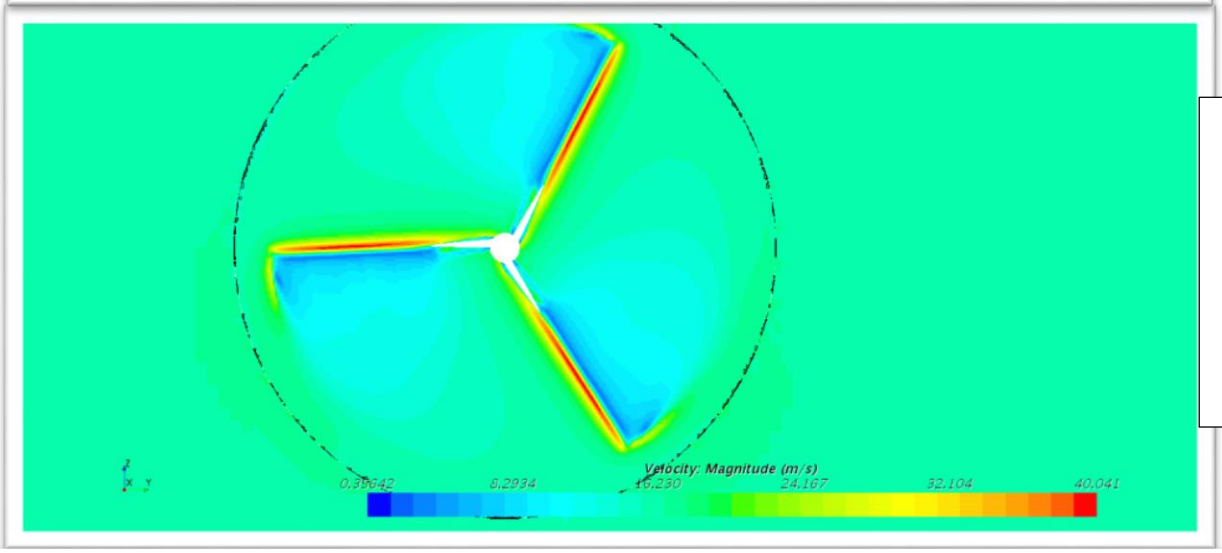
Flow Field



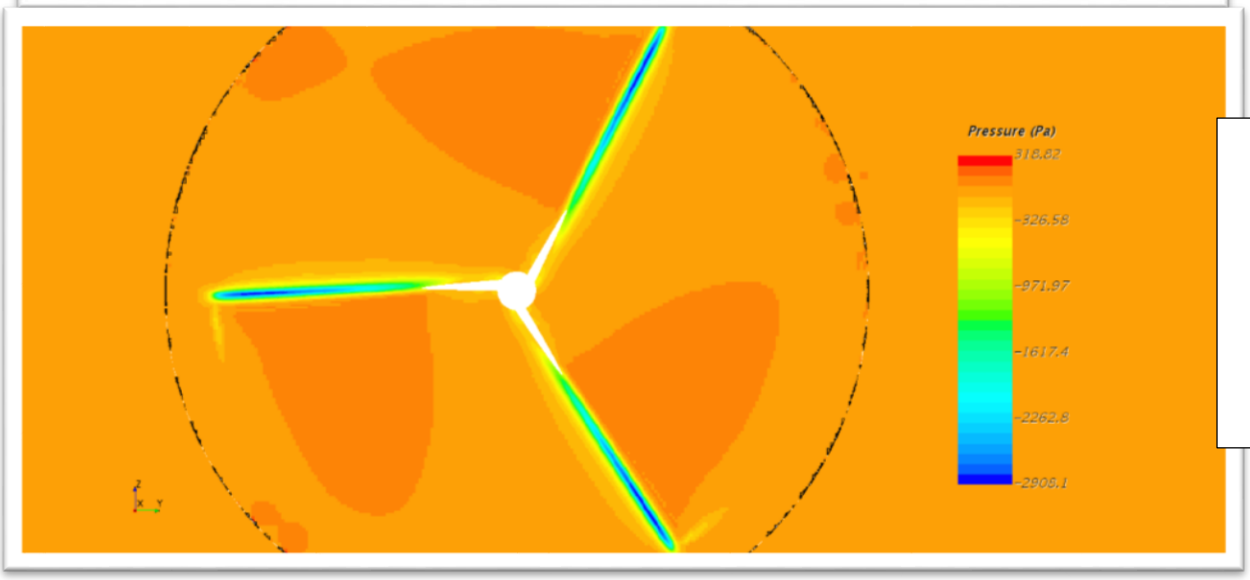
風速側視圖



風速側視圖(單一葉片)



風速正視圖



壓力正視圖

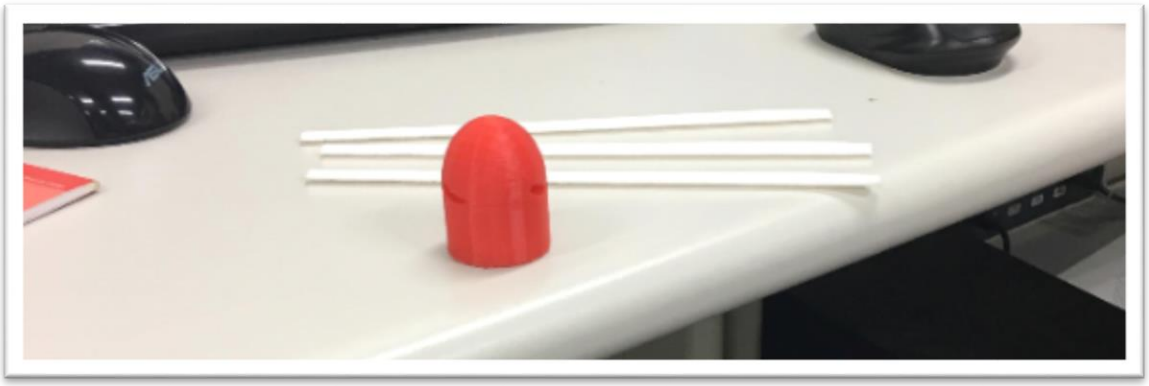
Discussion: CFD 模擬成功，殘值收斂。從 Flow field 中可看出，葉片後風速較快、壓力較低，但因我們葉片頂端並非尖形，所以 tip vortex 不明顯。

PART 3 FEM ANALYSIS

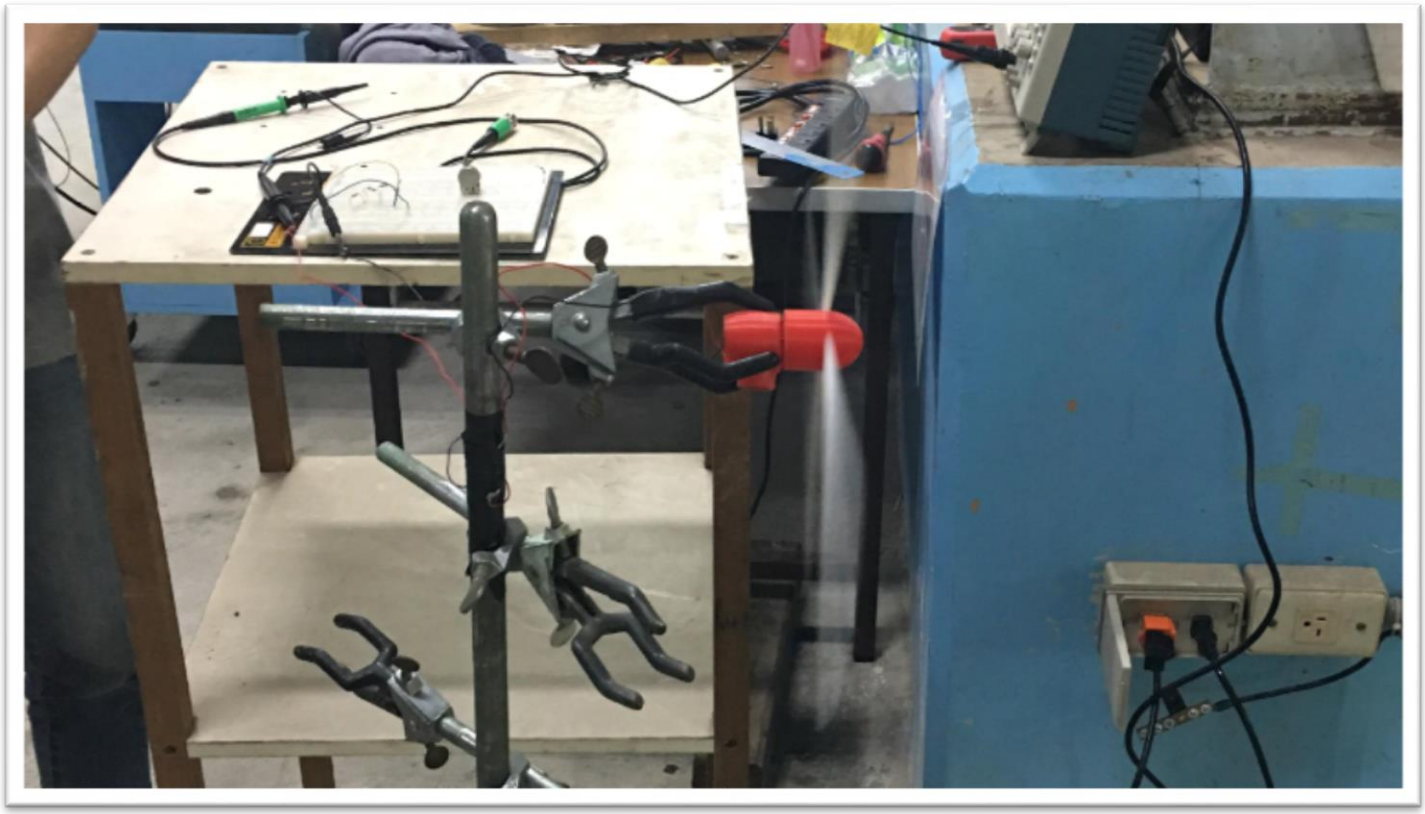
Failed: Residuals do not converge.

PART 4 3D PRINTING

組裝前



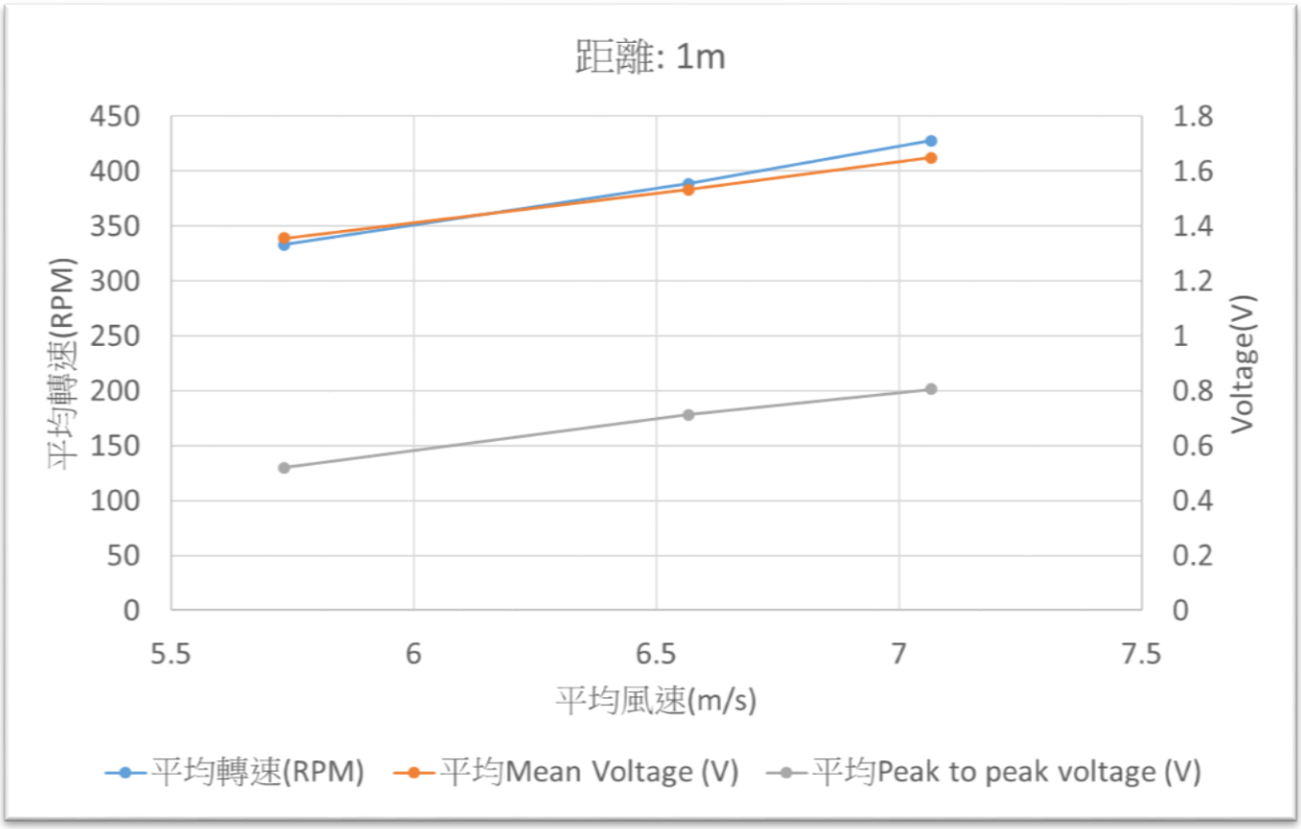
組裝後實測

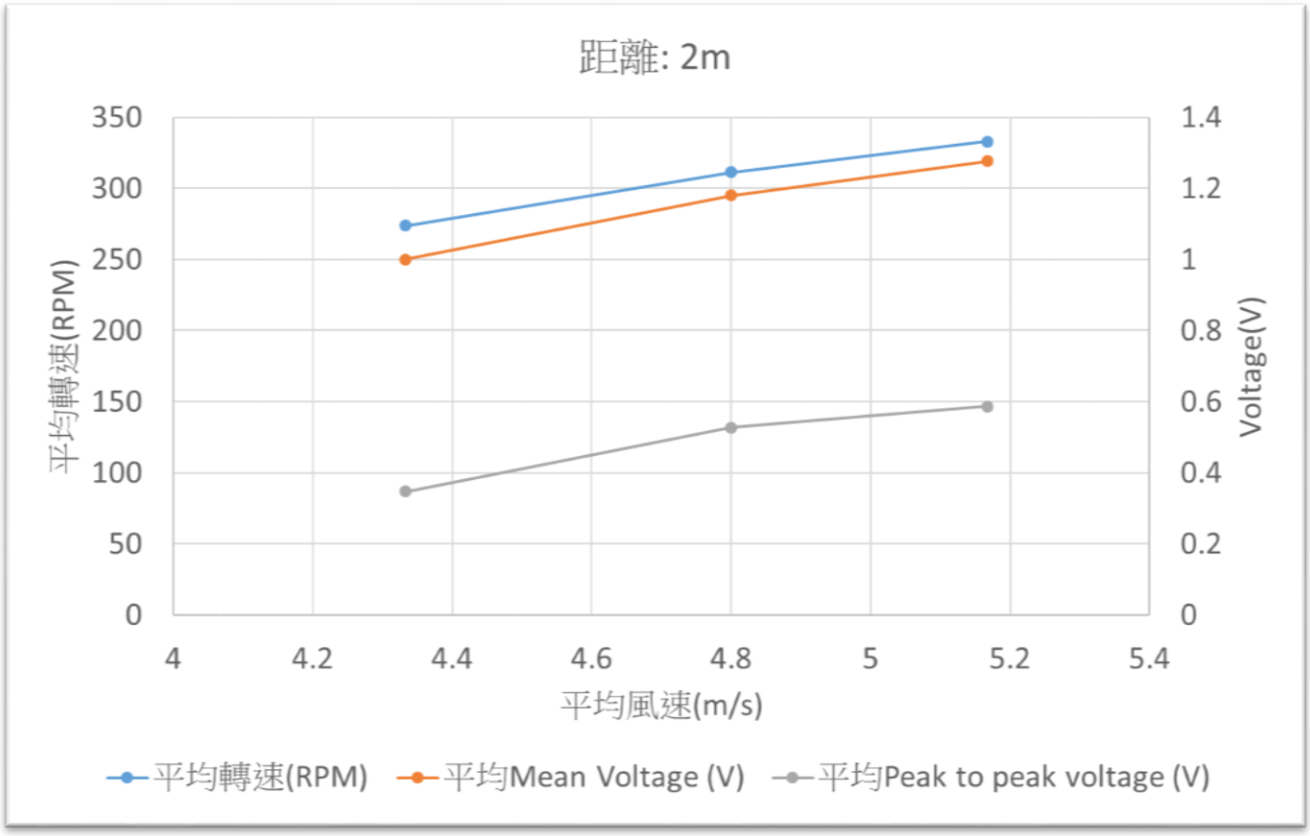


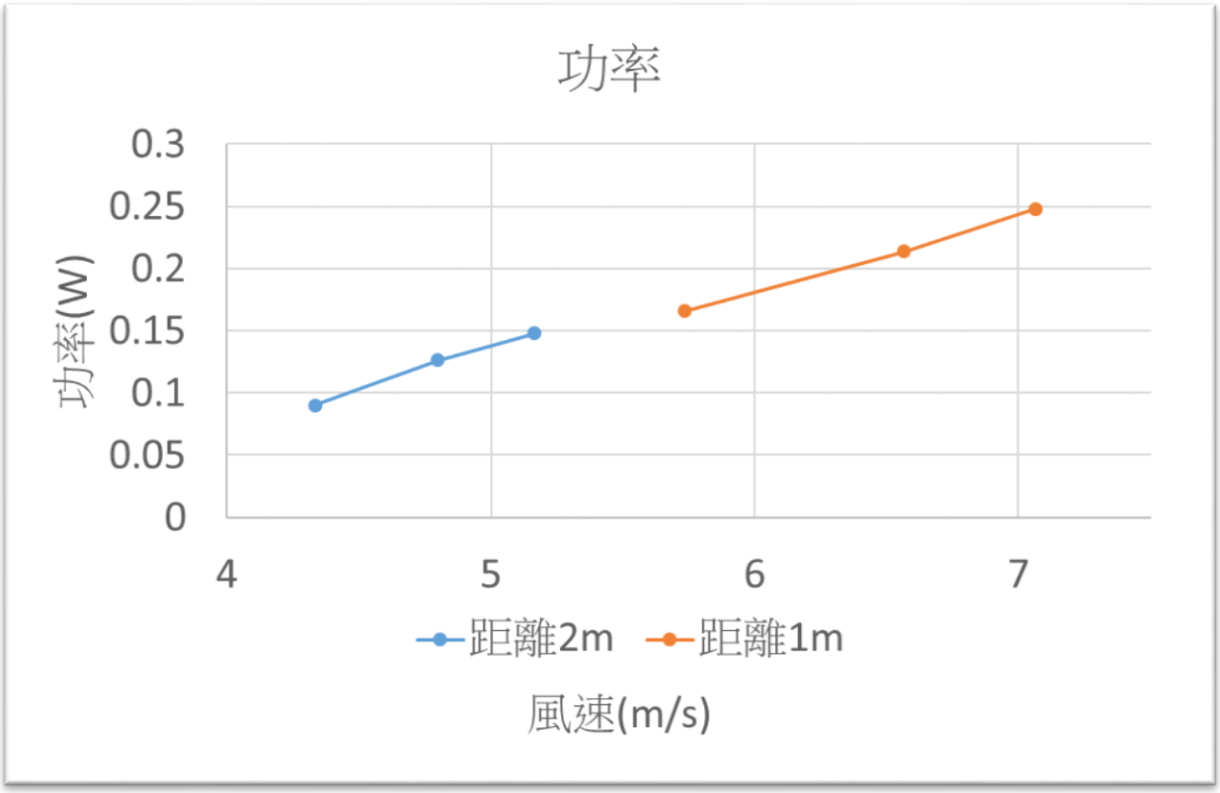
Discussion: 3D 列印選擇直立列印後相當成功，列印時 hub 上的孔 blade 與 hub 接合得十分緊密，不需黏著劑。

PART 5 POWER MEASUREMENT

距離 (m)	風扇強度	風速 (m/s)	轉速(RPM)	Mean Voltage (V)	Peak to peak voltage (V)	平均風速(m/s)	平均轉速 (RPM)	平均Mean Voltage (V)	平均 Peak to peak voltage (V)	平均功率 (W)
1.00	弱	5.6	339.00	1.36	0.50					
		5.7	329.33	1.37	0.56	5.73	333.11	1.36	0.52	0.17
		5.9	331.00	1.34	0.50					
	中	6.4	389.33	1.54	0.76					
		6.5	387.33	1.53	0.72	6.57	388.44	1.53	0.71	0.21
		6.8	388.67	1.53	0.66					
	強	7.1	433.00	1.65	0.82					
		7.2	427.67	1.66	0.72	7.07	428.00	1.65	0.81	0.25
		6.9	423.33	1.64	0.88					
2.00	弱	4.5	276.00	1.05	0.30					
		4.2	263.33	1.04	0.34	4.33	273.67	1.00	0.35	0.09
		4.3	281.67	0.91	0.40					
	中	4.8	316.67	1.15	0.52					
		4.7	313.00	1.20	0.58	4.80	311.11	1.18	0.53	0.13
		4.9	303.67	1.19	0.48					
	強	5.0	338.67	1.24	0.56					
		5.2	325.33	1.36	0.58	5.17	332.89	1.28	0.59	0.15
		5.3	334.67	1.23	0.62					







Discussion: 量測到的風速在距離 1、2 公尺皆與 V_{mean}、V_{p-p}、及 RPM 成線性關係。

PART 6 Contribution of each group member

陳麒友: 模型設計(60%)、CFD(60%)、FEM(70%)、3D 列印(30%)、功率量測(50%)、口頭報告(40%)、書面報告(40%)

楊筌鈞: 模型設計(40%)、CFD(40%)、FEM(30%)、3D 列印(70%)、功率量測(50%)、口頭報告(60%)、書面報告(60%)