NUMERICAL AND EXPERIMENTAL INVESTIGATION OF A WING MODEL WITH RGV WINGLET

Presented by,

SIVARAJ A/L GOPAL KRISHNAN

IC: 850304-08-5287

Date : 29th March 2017

Supervisor : Dr.Farzad Bin Ismail

Co-supervisor 1 : Dr.Norizham Bin Abdul Razak

Co-supervisor 2 : Dr.Noorfazreena Mohammad Kamaruddin

Doctoral of Philosophy (Aerospace Engineering)

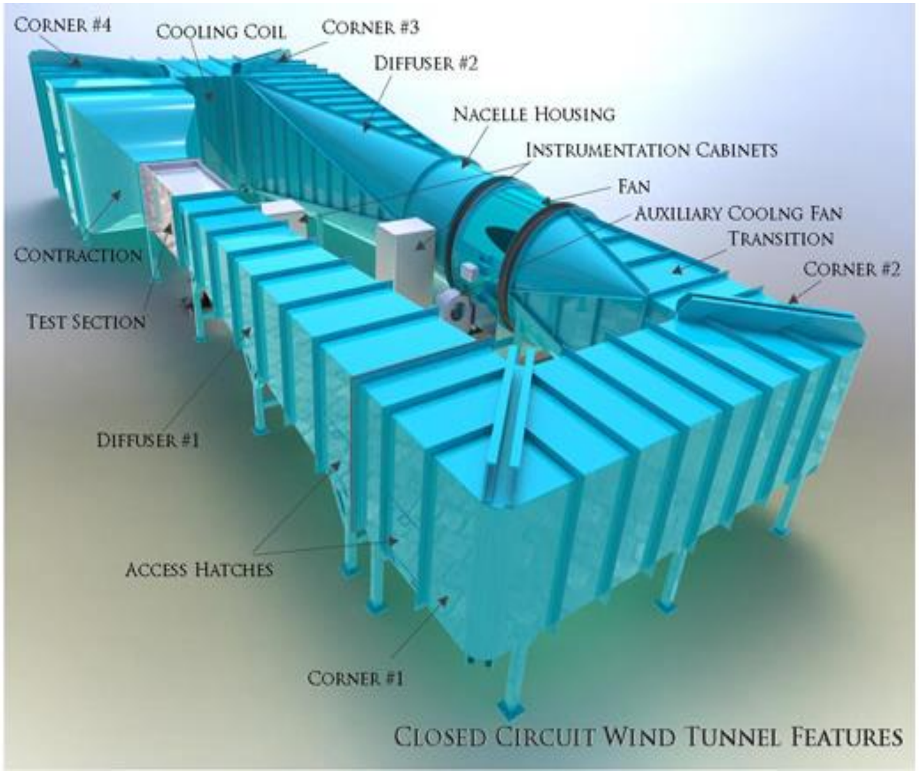
UNIVERSITI SAINS MALAYSIA

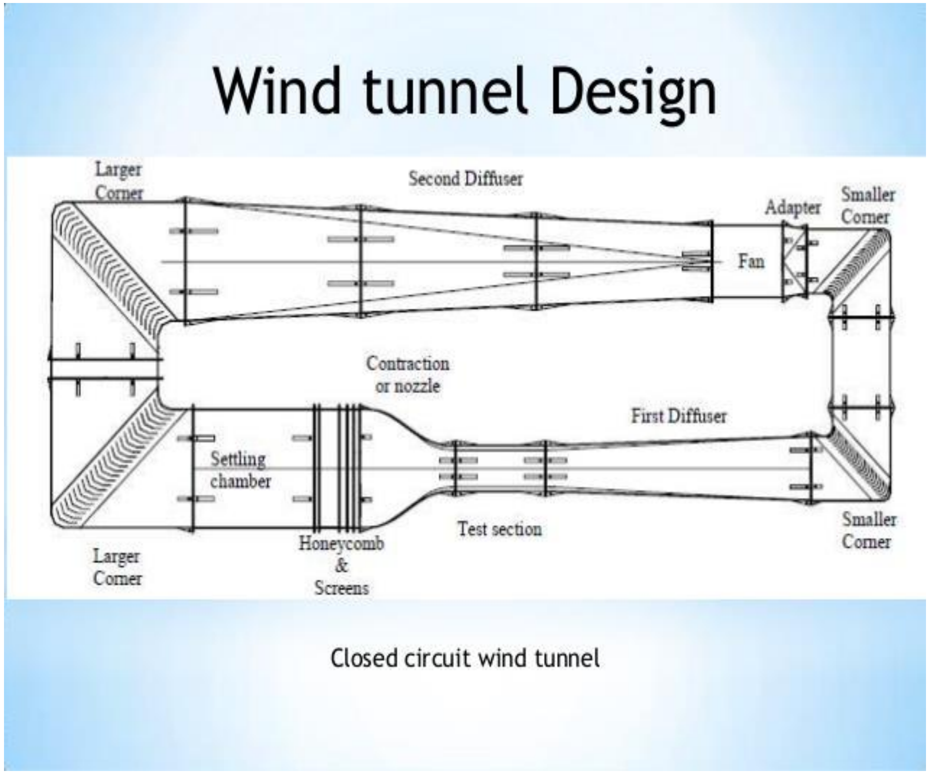
UNIVERSITI SAINS MALAYSIA

OUTLINE OF PRESENTATION

Smoke visualizations and aerodynamic coefficient output for several configurations of RGV winglet with wing is the main focus in this research.

1.0 Wind tunnel setup



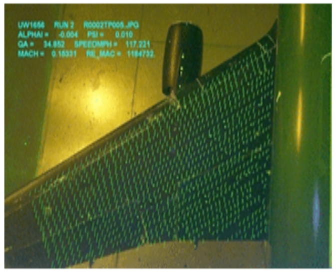


Quantitative method – 6 internal balance to get aerodynamic load results

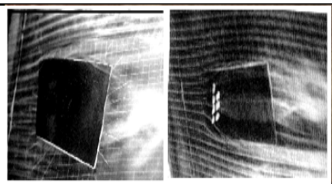
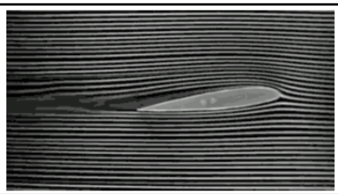
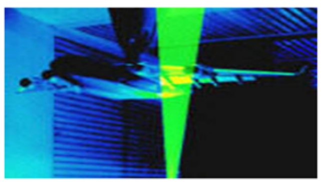
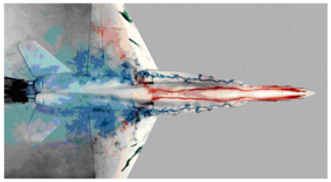
Qualitative method – smoke wire flow visualization to get streamlines flow over an wing with or without RGV.

Universiti Sains Malaysia

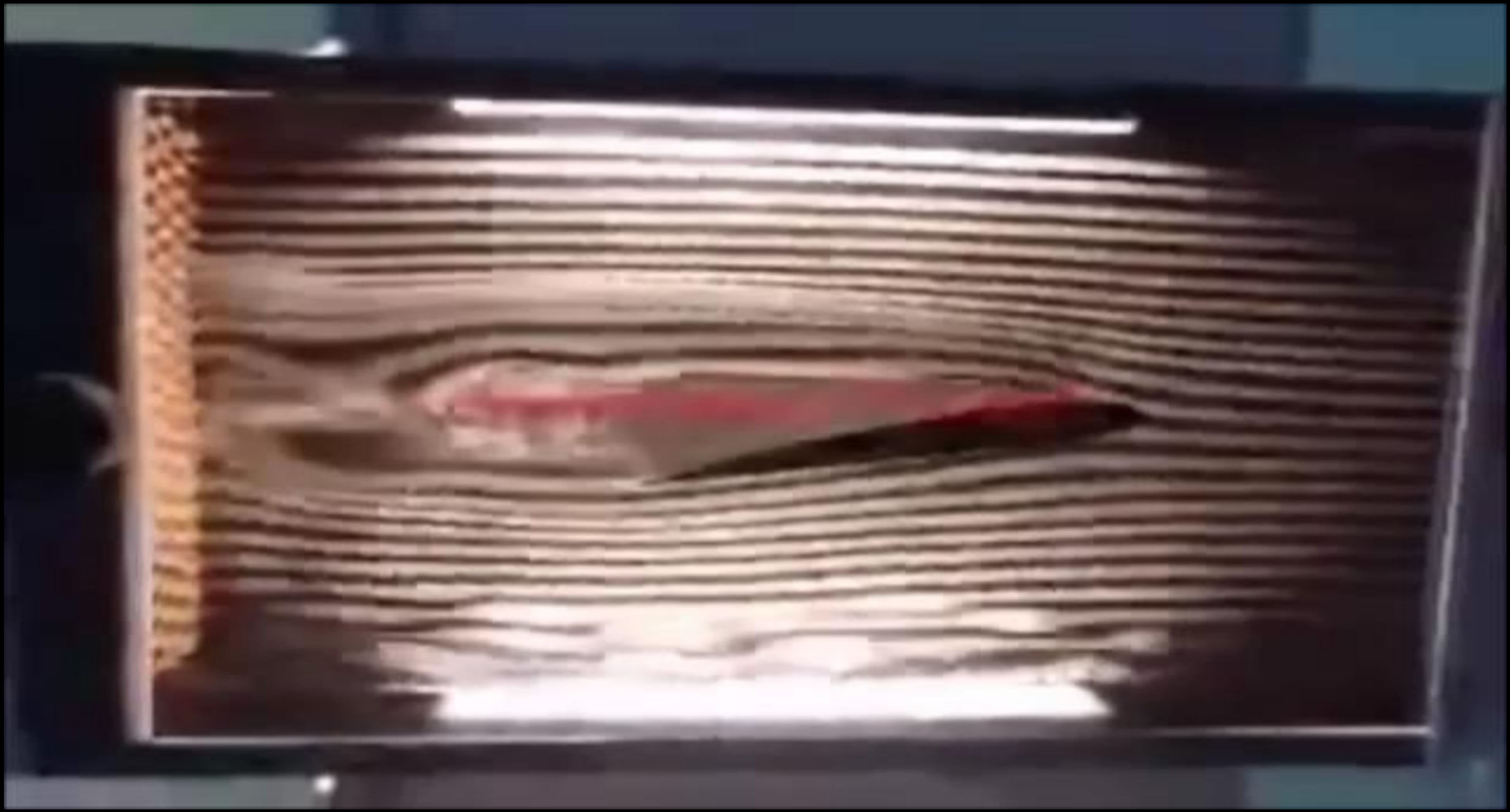
2.0 Flow visualization

No	Methods	Image	Description	Advantages	Disadvantages
1	Tufts		Fluorescent Minitufts Thread Tufts Tuft Probe Tuft attached around in grid pattern	1.0 Allows flow visualization at any model position 2.0 Yarn tufts are easy to install. 3.0 A tuft grid provides a view of the flow pattern over a large area. 4.0 Sewing thread makes a good tuft due to its clear visibility in UV or normal light.	1.0 Does not provide a detailed flow pattern since they are constantly moving with the air flow. 2.0 Minitufts require more time to install but can be left on the model.
2	Oil		A mixture of oil and dye The oil and dye particles slowly move in the direction of the local flow	1.0 Lasting air flow pattern on the model for photos when the wind is off. 2.0 Gravity will slowly change the oil pattern 3.0 Clearly shows flow pattern, especially the transition between turbulent and laminar flow as well as separation. 4.0 UV oil is the most photogenic of the flow visualization methods	1.0 After time, all of the oil will run off the model. 2.0 Model must be a dark color, preferably flat black, 3.0 Pressure taps must be protected to prevent clogging.
3	China clay		Kerosene, clay powder, and DayGlo Kerosene to evaporate, leaving streaks of clay powder in the form of the flow pattern.	1.0 Easiest method to setup and apply. 2.0 Provides lasting flow pattern on the model for photos when the wind is off 3.0 Clearly shows flow pattern 4.0 Shows flow separation well.	1.0 Cannot vary model position during flow visualization. 2.0 Model must be a dark color, preferably flat black. 3.0 Pressure taps must be protected to prevent clogging.

2.0 Flow visualization

No	Methods	Image	Description	Advantages	Disadavantages
4	Smoke		Custom-made smoke generator and probe A stream of white smoke can be inserted anywhere	1.0 Easy setup and quick repositioning of the probe allows for viewing flow patterns around any portion of the model.	1.0 Extended use fills the tunnel with smoke. 2.0 The tunnel must be vented to remove the smoke before further flow visualization can be used. 3.0 An oily residue is left on whatever the smoke touches. 4.0 Pressure taps must be protected to prevent clogging.
5	Smoke wire		Nichrome wire, safex oil, DC power supply, camera Heating of wire that vaporises the oil droplets to produce fine streak lines.	1.0 Simplest and most economical way to see flow analysis	1.0 Short duration of smoke lines
6	Particle image velocimetry (PIV)		Camera, a strobe or laser with an optical arrangement, seeding particles	1.0 Instantaneous velocity measurements and related properties in fluids 2.0 Particles is used to calculate speed and direction (the velocity field) 3.0 Most of researcher use this method since quantitative	1.0 Not available in USM
7	Water tunnel		The dye tracer, dye, water tunnel	1.0 Very clear picture of flow visualization 2.0 Can be considered effective as PIV	1.0 Not available in USM

2.0 Smoke Wire Flow visualization



3.0 Calibration Method

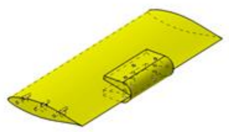
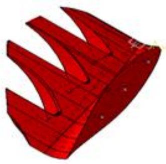
The wind tunnel measurement system need to calibrated to ensure accurate and reliable experimental results. The following are purposes for calibration :-

a) to proof load the balance
b) to determine balance coefficient
c) to determine deflections as a function of load
d) to check repeatability over short time intervals
e) to check stability over long time intervals
f) to determine sensitivity or minimum load for response

Internal balances generally calibrated outside the tunnel.

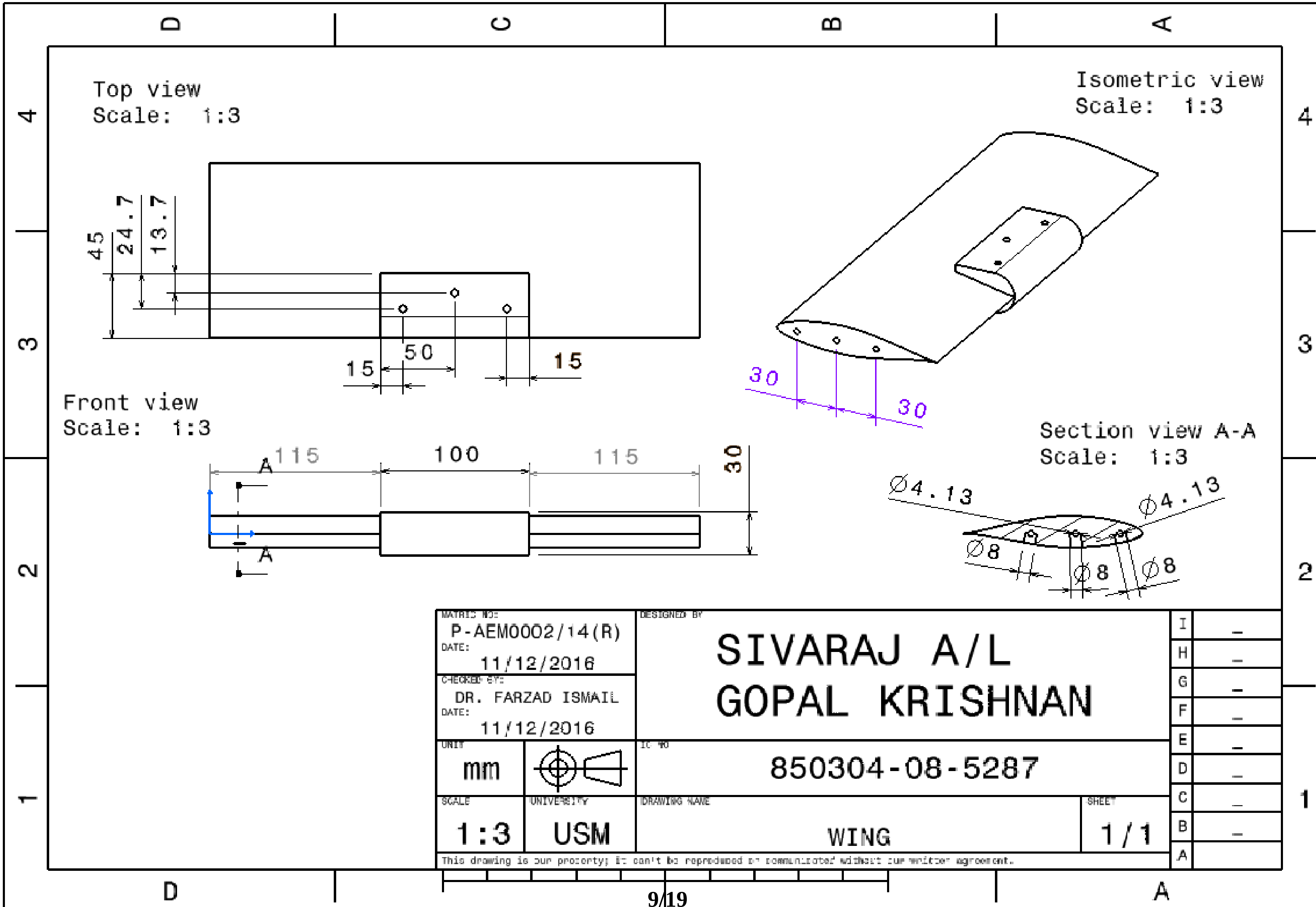
Pitot-static tube is used to determine the air speed.

4.0 Design Configuration

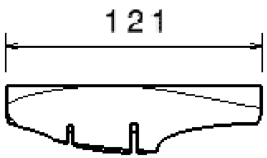
Name	Model
Wing	
RGV 1	
RGV 2	
RGV 3	
RGV 4	
RGV 5	
RGV 6	

Following are RGV design details:-
Airfoil - NACA 65(3)-218, Chord – 121mm,
Wing Length – 330mm, AR – 2.73
Material – Aluminum,
Method of fabrication – CNC machine used to cut aluminum according RGV designs.

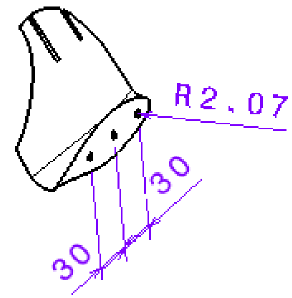
4.0 Design Configuration



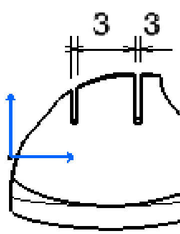
Top view
Scale: 1:3



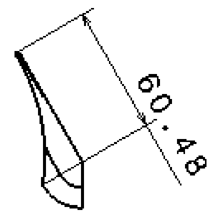
Isometric view
Scale: 1:3



Front view
Scale: 1:3



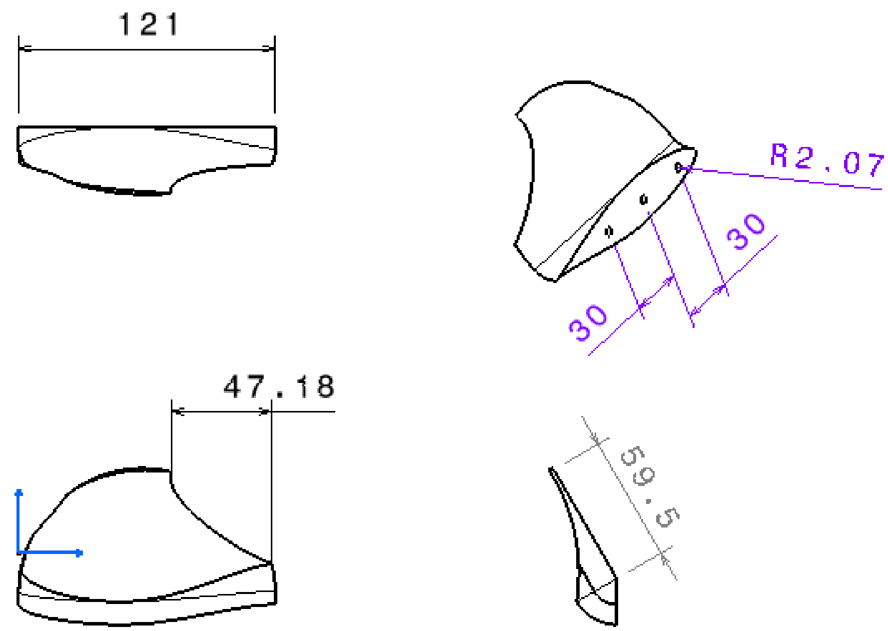
Right view
Scale: 1:3



MATRIC NO: P-AEM0002/14(R) DATE: 11/12/2016		DESIGNED BY SIVARAJ A/L GOPAL KRISHNAN		I _
CHECKED BY: DR. FARZAD ISMAIL DATE: 11/12/2016				H _ / G _ / F _
UNIT mm		IC NO 850304-08-5287		E _ / D _
SCALE 1:3	UNIVERSITY USM	DRAWING NAME RGV 1	SHEET 1/1	C / B _ / A _

Top view
Scale: 1:3

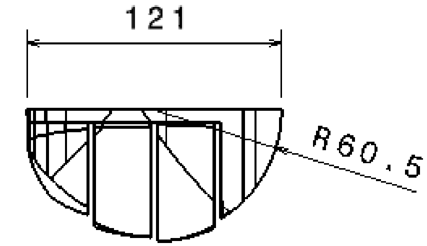
Isometric view
Scale: 1:3



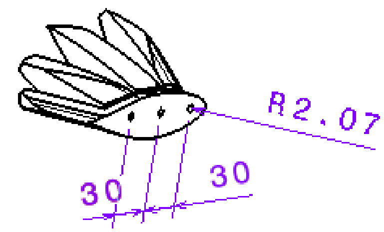
Front view
Scale: 1:3

Right view
Scale: 1:3

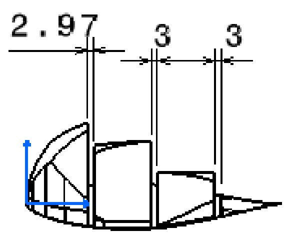
MATRIC NO: P-AEM0002/14(R) DATE: 11/12/2016	DESIGNED BY SIVARAJ A/L GOPAL KRISHNAN		I	_
			H	_
CHECKED BY: DR. FARZAD ISMAIL DATE: 11/12/2016			G	_
			F	_
UNIT mm		IC NO 850304-08-5287	E	_
			D	_
SCALE 1:3	UNIVERSITY USM	DRAWING NAME RGV 2	SHEET 1/1	C	_
			B	_
			A	



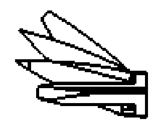
Top view
Scale: 1:3



Isometric view
Scale: 1:3

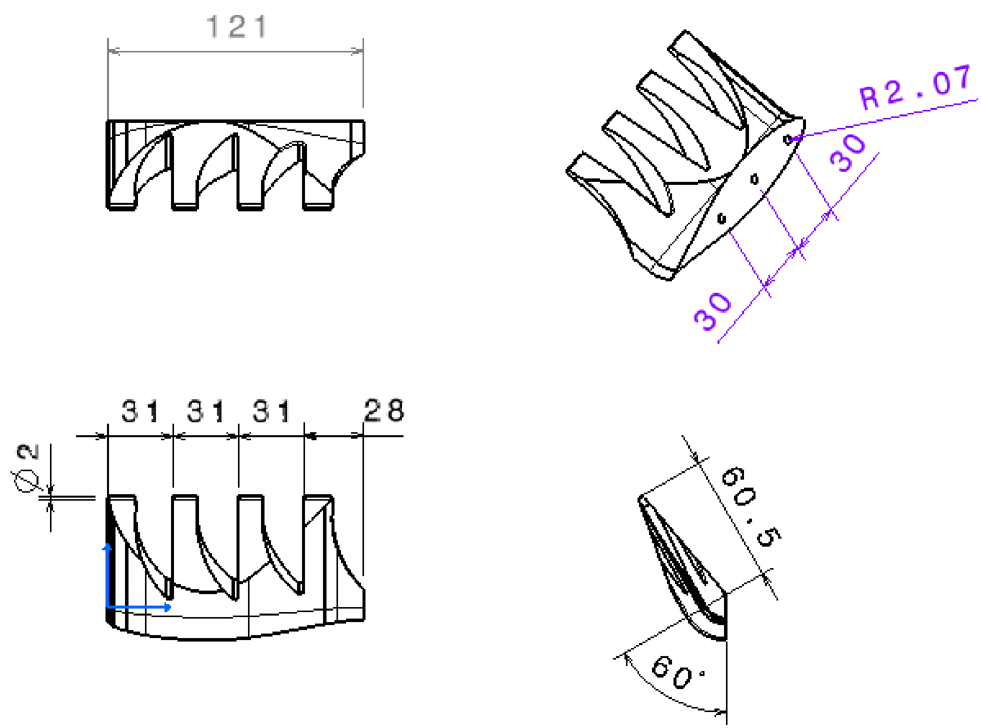


Front view
Scale: 1:3



Right view
Scale: 1:3

MATRIC NO: P-AEM0002/14(R) DATE: 11/12/2016	DESIGNED BY	SIVARAJ A/L GOPAL KRISHNAN
CHECKED BY: DR. FARZAD ISMAIL DATE: 11/12/2016		
UNIT: mm	IC NO	850304-08-5287
SCALE: 1:3	UNIVERSITY: USM	DRAWING NAME: RGV 3 — SHEET: 1/1



Top view
Scale: 1:3

Isometric view
Scale: 1:3

Front view
Scale: 1:3

Right view
Scale: 1:3

MATRIC NO: P-AEM0002/14(R)
DATE: 18/03/2016

DESIGNED BY: SIVARAJ A/L GOPAL KRISHNAN

CHECKED BY: DR. FARZAD ISMAIL
DATE: 18/03/2016

UNIT: mm

IC NO: 850304-08-5287

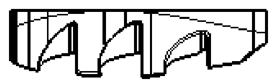
SCALE: 1:3

UNIVERSITY: USM

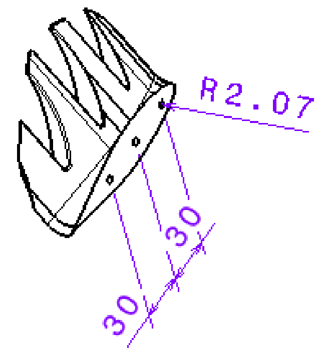
DRAWING NAME: RGV 4

SHEET: 1/1

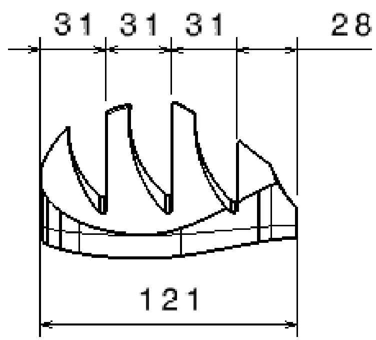
I _
H _
G _
F _
E _
D _
C _
B _
A _



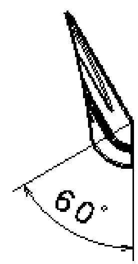
Top view
Scale: 1:3



Isometric view
Scale: 1:3



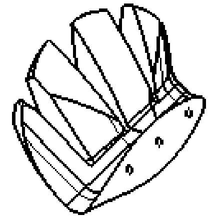
Front view
Scale: 1:3



Right view
Scale: 1:3

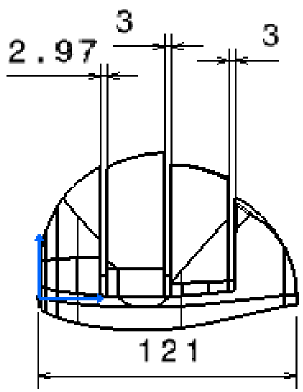
MATRIC NO: P-AEM0002/14(R) DATE: 18/03/2016	DESIGNED BY: SIVARAJ A/L GOPAL KRISHNAN		
CHECKED BY: DR. FARZAD ISMAIL DATE: 18/03/2016			
UNIT: mm		IC NO: 850304-08-5287	
SCALE: 1:3	UNIVERSITY: USM	DRAWING NAME: RGV 5	SHEET: 1/1

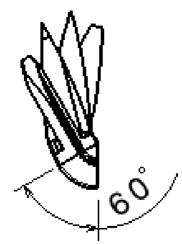
Top view
Scale: 1:3



Isometric view
Scale: 1:3

Front view
Scale: 1:3



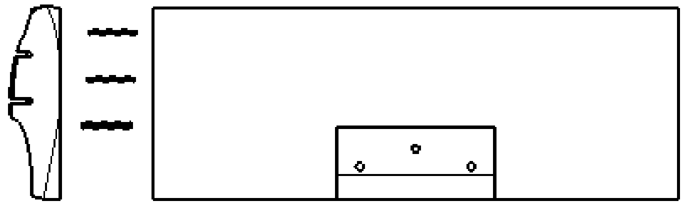


Right view
Scale: 1:3

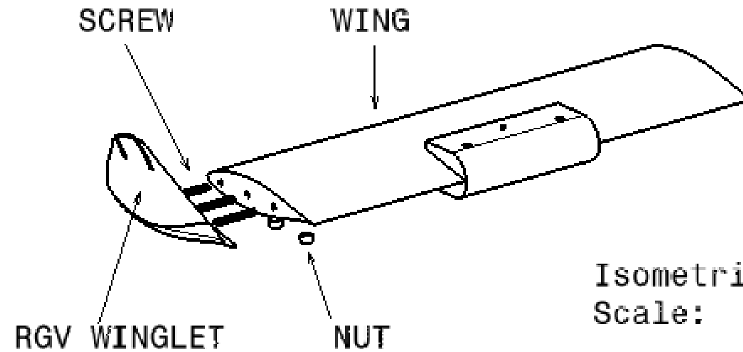
MATRIC NO: P-AEM0002/14(R) DATE: 11/12/2016	DESIGNED BY: SIVARAJ A/L GOPAL KRISHNAN		
CHECKED BY: DR. FARZAD ISMAIL DATE: 11/12/2016			
UNIT: mm		IC NO: 850304-08-5287	
SCALE: 1:3	UNIVERSITY: USM	DRAWING NAME: RGV 6	SHEET: 1/1

This drawing is our property; it can't be reproduced or communicated without our written agreement.

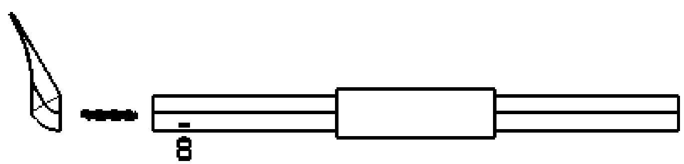
I	_
H	_
G	_
F	_
E	_
D	_
C	_
B	_
A	



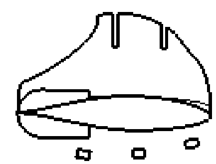
Top view
Scale: 1:4



Isometric view
Scale: 1:4

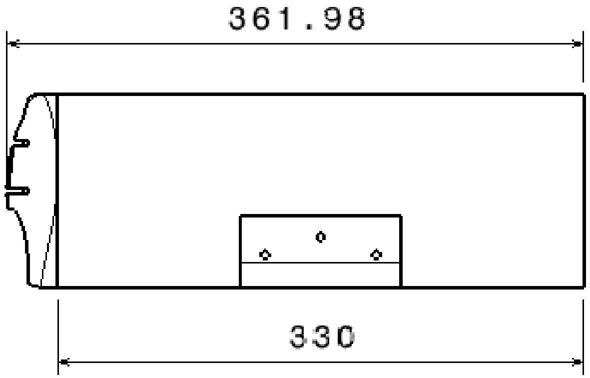


Front view
Scale: 1:4

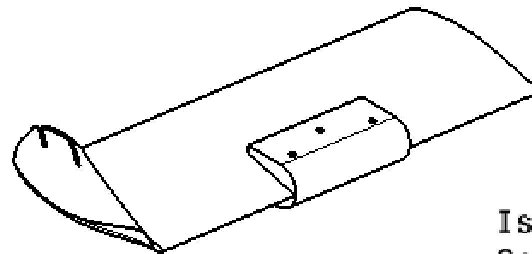


Right view
Scale: 1:4

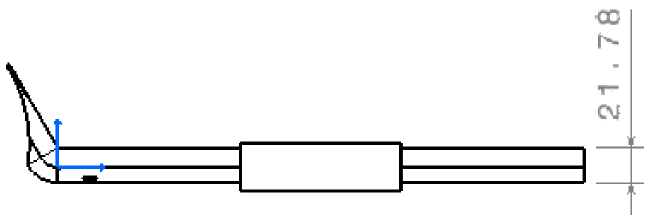
MATRIC NO: P-AEM0002/14(R) DATE: 12/03/2016		DESIGNED BY: SIVARAJ A/L GOPAL KRISHNAN		I _
CHECKED BY: DR. FARZAD ISMAIL DATE: 12/03/2016				H _ G _ F _
UNIT: mm		IC NO: 850304-08-5287		E _ D _
SCALE: 1:4	UNIVERSITY: USM	DRAWING NAME: EXPLODED VIEW OF RGV	SHEET: 1/1	C _ B _ A _



Top view
Scale: 1:4



Isometric view
Scale: 1:4

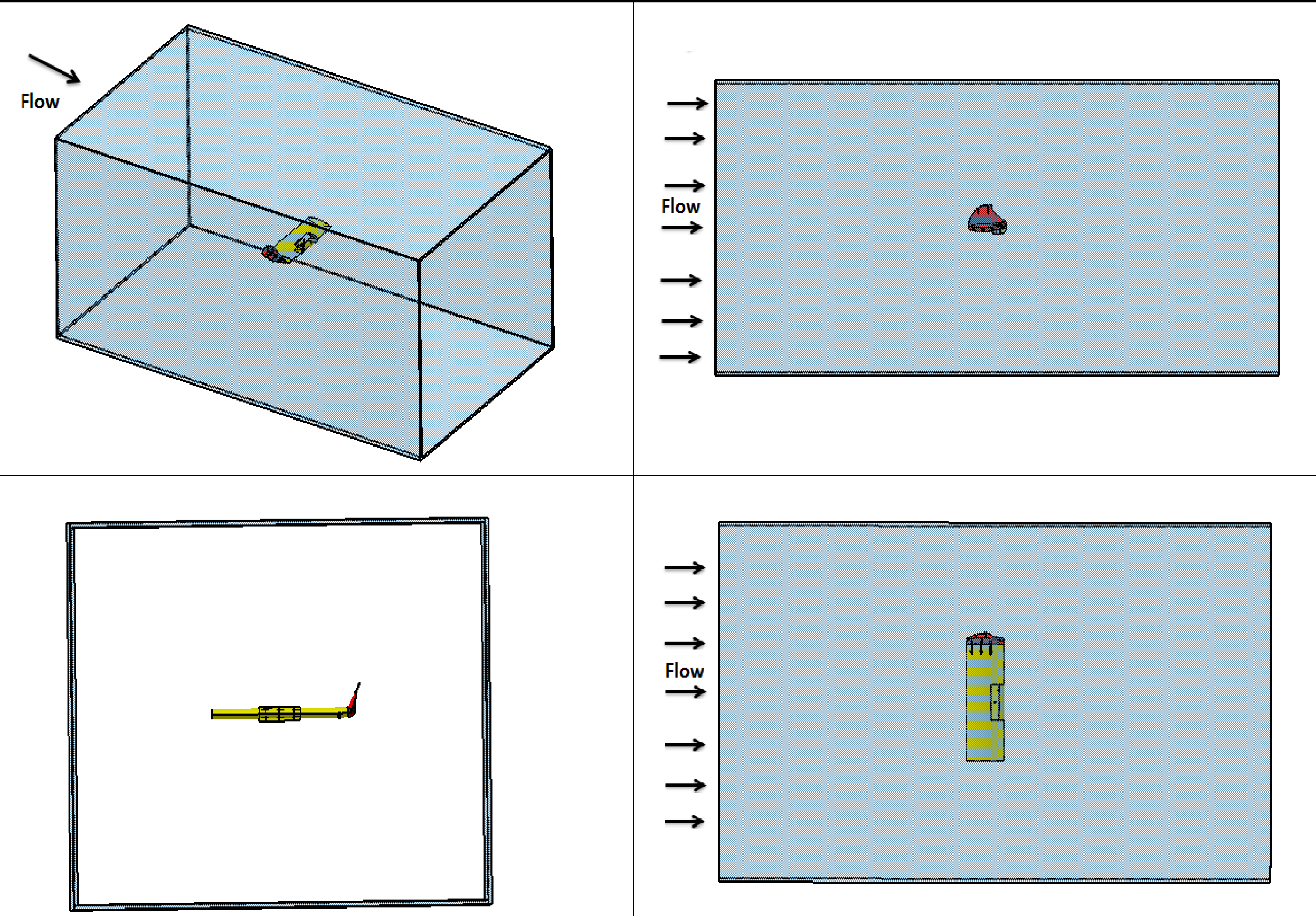


Front view
Scale: 1:4

Right view
Scale: 1:4

MATRIC NO: P-AEM0002/14(R) DATE: 12/03/2016	DESIGNED BY SIVARAJ A/L GOPAL KRISHNAN		
CHECKED BY: DR. FARZAD ISMAIL DATE: 12/03/2016			
UNIT mm		IC NO 850304-08-5287	
SCALE 1:4	UNIVERSITY USM	DRAWING NAME WING WITH RGV	SHEET 1/1

I	_
H	_
G	_
F	_
E	_
D	
C	_
B	_
A	_


Flow
Flow
Flow


THANK YOU
Q & A
UNIVERSITI SAINS MALAYSIA