Group work member contribution table

Section (add, remove and rename sections as needed)	**Person(s) responsible and percentage** (e.g. Person A 70% Person B 20% Person C 10% OR All members contributed equally)
Summary	Junxu Jin 100%
Statement of problem	Junxu Jin 100%
Background and literature review	Jarrod Lawson 100%
Research questions	Junxu Jin 50% Jarrod Lawson 50%
Methodology	Haoze Xia 100%
Risk assessment and ethical considerations	Haoze Xia 100%
References	Jarrod 97% Junxu Jin 3%
Formatting and editing	Jarrod 70% Junxu Jin 15% Haoze Xia 15%

SOLAR CHIMNEY EXPERIMENT

Research Proposal

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SUPERVISOR:

DR Long Shi

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Summary

This research proposal identifies all the relevant literature regarding solar chimneys. It's revealed that since this is a technology that has only begun to develop and mature in the past decade, there is not enough data and information to get the current experiment results across all climates, especially a climate such as Victoria. We propose to do the experiment to get the results of the performance of the solar chimney in a colder climate than previously researched. For the experiments, we will design an adjustable size of solar chimney and then influence the structural dimensions of the solar chimney to measure the performance of the solar chimney. Also included the timeline planning for this project, a methodology to testing, risk assessment and finally ethical considerations to predict and hopefully build a better profile of solar chimney design in the climate of Victoria.

1 Statement of problem

Solar chimney is a reliable renewable energy system which is one of the several available options for achieving natural passive ventilation in building, this is through solar-induced air movement of air [1]. The primary benefit of using solar chimney to replace the air conditioning is because buildings can consume about 42% annual energy usage of the whole world, mainly for heating, cooling, providing electricity and air conditioning. Solar chimney can also reduce the greenhouse gas emissions [2]. In an enclosed building, there is not much indoor air capacity for existing contaminants. Therefore, by using a solar chimney to increase natural ventilation, the indoor air quality is improved as cleaner outdoor air circulates into the building [3].

2 Background and literature review

With the environment becoming ever important and fossil fuels slowly diminishing, solar thermal technologies have been investigated as a sustainable alternative [4, 5]. The use of a solar chimney benefits a home's ventilation reducing the need and demand of traditional heating and cooling [6, 7] This works on the principle of solar radiation penetrating a glass wall and heating the air inside. The heat increase causes the air to rise drawing fresh air from an opening below [3]. This ventilation can be used in different ways, primarily it is to heat and cool the room the chimney is attached to [8, 9]. To cool a room, the chimney draws air from inside the room, then expels it outside at the top of the chimney. With a door or window open on the other side, fresh air can enter the room cooling the mean temperature of the room [10, 11]. Coupled with insulation in the building to reduce natural heat gains [12], this overall is proven to be an effective method to cool and ventilate a building without any electrical input [13]. Furthermore, solar chimneys can also function as a heater in two ways, drawing air from outside, heating then ventilating inside the connected room providing fresh warm air. Or alternatively, acting like a convection heater, sucking the air inside and heating it in a circular effect [14, 15].

Over the years, experimental tests have been conducted at scale, in a lab and through Computer Fluid Dynamics (CFD) [16]. It has been concluded that the primary parameters that influence a solar chimney are the dimensions of the opening and exit, the amount of solar radiation inside the chimney and the dimensions of the chimney [2]. Further factors include the room configuration and material use [17]. Experimental tests all conclude that for any sized solar chimney, there is a clear relationship that the more solar radiation inside the chimney, the greater the temperature [18]. Increasing the airflow in the chimney can be achieved through dimensional changes of the opening and exit [19-21]. Although, there is an optimal airflow amount before there isn't enough time for solar radiation to effectively occur [22]. Changing the dimensions of the chimney itself including the width of the chimney also greatly increased the chimneys performance allowing for more radiation to occur [23]. Outside of the chimney itself, there are other major influence factors that contribute to the performance of the solar chimney such as the location of the chimney within the room. It can be installed on the wall side, although research also indicates it is effective when lying along the roof incline [24, 25]. Whilst it is clear there are many factors that contribute to the performance of the solar chimney, a research gap exists that can regulate and control the performance though guidelines.

Solar chimneys perform on the sole requirement that there is enough solar radiation and its effectiveness relies on this property [26]. The practical application on this also relies on this fact and the climate needs to suit [27]. While the main source of testing has been performed in laboratory conditions, research exists to paint a map of where this solar technology can perform at its highest efficiency [28]. Climates closer to the equator still have enough year-round solar radiation enabling the use of solar chimney [29, 30]. It has been proven that even during nigh hours, hot arid climates work just as well as the need for solar chimney is reduced because of a comfortable ambient temperate night [31, 32]. In locations where it is humid such as Singapore, there is still a need for air-conditioned intervention. Although a solar chimney can reduce its use saving operational costs [33]. All this research conducted in warm climates illustrates the need for experimental testing in cooler climates. While low solar radiation tests have been performed, there is a lack of consideration to the other effects that come with a cooler climate.

3 research questions

- What effect does dimensions of the solar chimney have on airflow?
- What effect does dimensions of the solar chimney have on temperature?
- What effect does airflow have on temperature?
- How effective is the ventilation on cold (low solar radiant) days? Which is similar to the climate of Victoria

4 Methodology

4.1 Time Planning

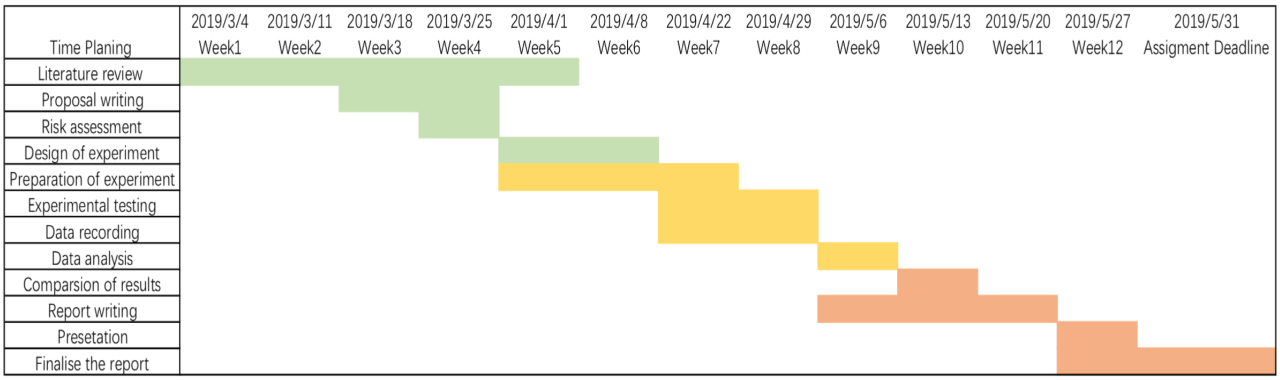

Fig.4.1 Gantt Chart

- The green colour: Design and Preparing the Experiment
- The yellow colour: Analysis and Conduct the Experiment
- The red colour: Report and Finalize the Experiment Report

4.2 Resource Planning

This project is to explore the influence of the structural dimensions of the solar chimney including length, width, height, angle and heat flux on the flow field, velocity field and temperature field of the solar chimney. This leads to the relationship between the solar chimney structure, heat flux density and natural ventilation [3].

This project selects the simplest and most commonly used rectangular chimney model. The solar chimney model consists of four walls (Fig.4.2), three of which are opaque, solar absorbing walls to absorb the energy of the sun becoming a heated wall.

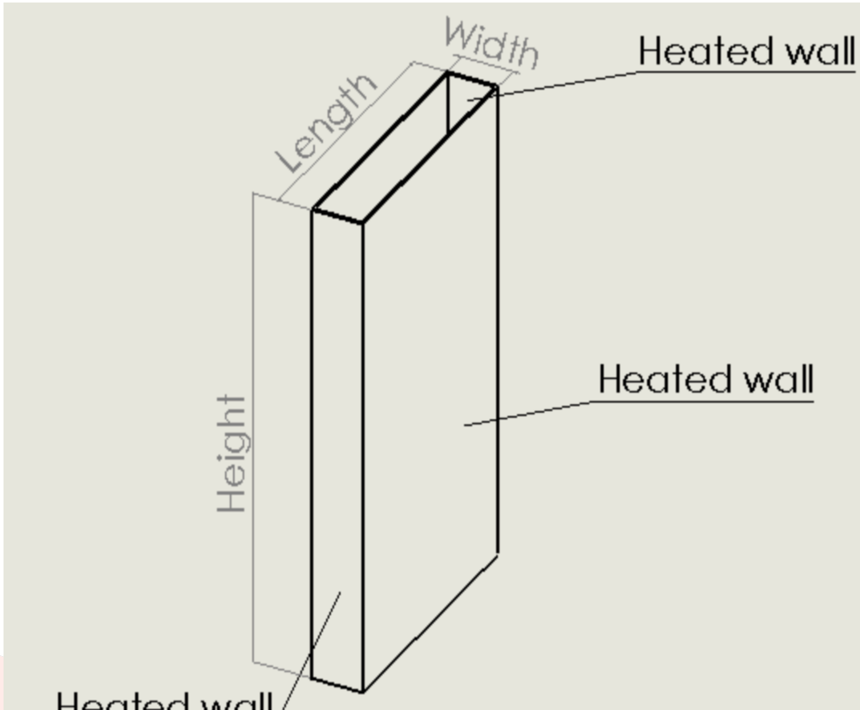

Fig.4.2

The three solid walls of the solar chimney should theoretically be insulated materials. High-density plates of 15mm thickness are used. High-density plates have low thermal conductivity, are non-conductive, and have high strength and high density. At the same time, 5cm thick polyethylene foam is laid on the outside of the heating wall to reduce the convection heat dissipation between the heating wall and the air [21] .
Fix the walls by using screws, which are not only tight, but also have good sealing performance and are easy to disassemble. Therefore, the influence of different dimensions of solar chimney on the ventilation volume can be recorded.

4.3 Design Method

4.3.1 Experimental Measurement

The Anemometer is used to measure the air flow speed. This anemometer can only give the air flow speed and cannot give the direction of the speed. According to data simulation and literature references, the air distribution at the entrance of the solar chimney is uneven, and there is a phenomenon of recirculation at the exit. The air flow speed in the middle of the solar chimney is less affected by the inlet turbulence and outlet recirculation, and the speed is relatively uniform. Therefore, the anemometer should be placed in the middle of the chimney to maintain a horizontal position.

The temperature measurement uses a thermocouple to measure the temperature of the points inside and outside the solar chimney, and then selects the average value. And using the solar radiation measuring instrument to record the solar radiation at different time.

4.3.2 Experimental Method

In order to observe the effect that different dimensions on the performance of the solar chimney, there will be five groups for testing.
In order to ensure the accuracy of the experiment, an electric heating film is used instead of the sun. Heated wall structure profile (figure 4.3.2)

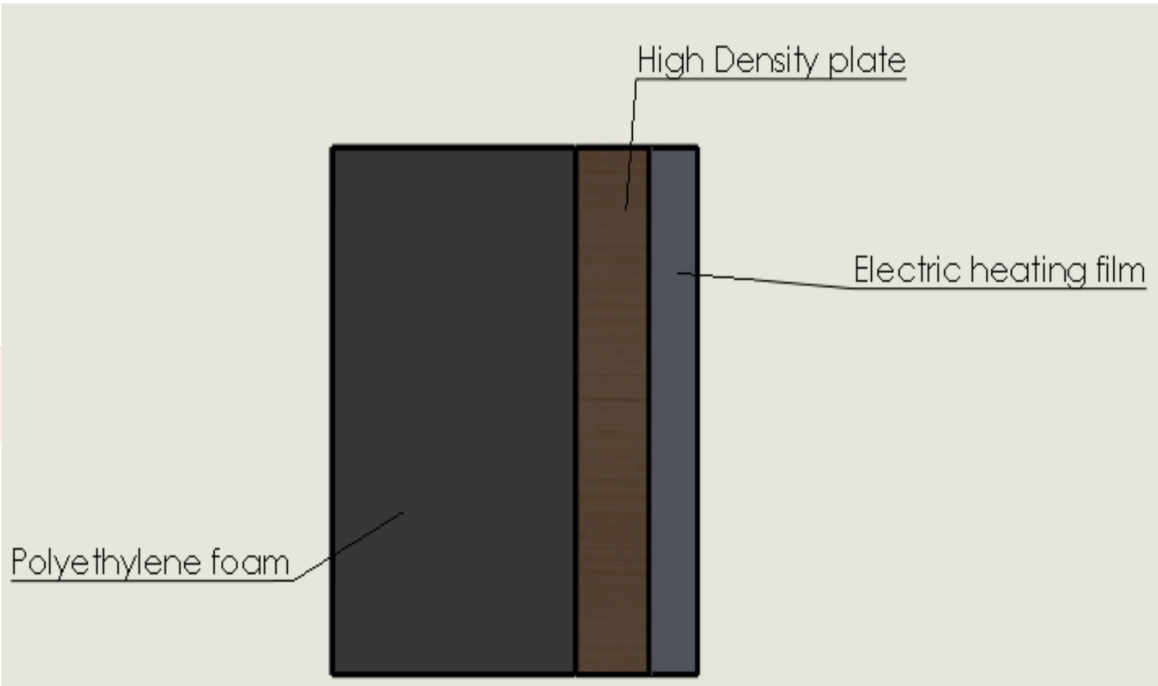

Fig.4.3.2

The control group selects an angle of 90°, a width of 200 mm, a height of 1500 mm, and a length of 1000 mm.

The first group only changes the height.

Height(mm)	1500	1800	2100	2400
Temperature Outside				

Temperature Inside				
Air Flow Rate				

The second group only changes the width.

Width(mm)	200	300	400	500
Temperature Outside				
Temperature Inside				
Air Flow Rate				

The third group only changes the angle.

Angle	30	45	60	90
Temperature Outside				
Temperature Inside				
Air Flow Rate				

In order to find the effect of different solar radiation on air flow and temperature difference

Time Period	9:00 AM	12:00	15:00	18:00
Temperature Outside				
Temperature Inside				
Air Flow Rate				
Solar radiation intensity				

5 Risk assessment and ethical considerations

5.1 Ethical consideration

For the ethical consideration, participants will be protected and the PPE should be properly worn when participating in the experiment. Team members should exchange ideas and thoughts to make sure nothing is missing. The process should be reported to the administrator to ensure the safety and reliability of the experiment. Reports and experimental data cannot be copied or falsified.

5.2 Risk Assessment

The experiment aims to explore the impact of changing the dimensions of the solar chimney on the flow field, velocity field, and temperature field. Therefore only basic Personal Protective Equipment (PPE) is required, this includes steel cap shoes, goggles and gloves to prevent injuries. The risk assessment document is completed and sent to the RMIT officer responsible for the laboratory/seminars.

Safe@RMIT

ACTIVITY RISK ASSESSMENT: SEH-RA-005

RA No.:	SEH-RA-005	Date:		Version No.:	1
Activity Title: Solar Chimney Experiment					

SECTION 1: GENERAL INFORMATION

Campus location: Bundoora	Bldg. / level / room	College: SEH	School / Discipline / Facility:
Person undertaking the activity / Position: Haoze Xia Jarrod Lawson Junxu Jin		Supervisor / Position: Dr Long Shi	

Lists the main steps in the activity (add more lines as required).		Are any of the following licenses / permits required:
Step #	Description	☐ Poisons permit covering scheduled drugs / poisons (S4/S7/S8/S9/S10)
1	Equipment set up	☐ Confined space entry permit ☐ Licence for using radiation sources or Genetic Modified Material
2	Measure and record data	☐ Animal Ethics / Human Ethics approval ☐ Other : specify - If any boxes are checked, specify the applicable permit or licence number:

• Plant / equipment	• Animals / Insects	• Biological materials (*e.g. bacteria, viruses*)	• Confined spaces	• Hazardous chemicals
• High pressure / vacuum	• Electrical	• Fumes / vapours / dust	• Manual Handling (lifting, pushing, moving objects)	• Repetitive movements, awkward postures
• Mechanical (rotating parts, crush / pinch points)	• Vibration	• Trip / slip hazards / uneven ground or work surface	• Extreme temperatures (High / Low)	• Working at heights or below ground level (e.g. excavations)
• Interaction with public (threat to safety)	• Interaction with public (threat to security)	• Overhead power lines	• Working in isolation	• Noise
• Radiation *(including UV)*	• Lasers	• Traffic hazards (vehicles, forklifts, aircraft, drones)	• Gases	• Other (Specify):

NOTE: If the activity involves the use **of radiation / biohazards / lasers** – you must complete a separate risk assessment form designed specifically to address these hazard types.

SECTION 4: RISK ASSESSMENT

Step # *(from Sect 1)*	Hazards *(list the hazards in each step)*	Associated Risks *(resulting in damage, injury or illness)*	Initial Risk Score & Rating (before controls) *(Refer to risk score matrix in Section 2)*				
			C	E	P	Score (CxExP)	Rating (low, medium etc)
1	Equipment set up	Bruise	1	1	1	1	Low
2	Measure and record data	Paper cut	1	1	1	1	Low

SECTION 5: RISK CONTROL PLAN

Hazard *(from Section 4)*	Risk control measures required to reduce the risk		Residual Risk Score (after controls) *(Refer to risk score matrix in Section 2)*				Residual Risk Rating (low, medium etc)	Person responsible for implementing controls
	Select risk control(s)	Details of risk controls *(provide a brief description)*	C	E	P	Score (CxExP)		
	☐Elimination ☐Substitution ☐Isolation ☒Engineering ☐Administration ☐PPE	Be careful and using a lift	1	1	1	1	low	
	☐Elimination ☐Substitution ☐Isolation ☒Engineering ☒Administration ☐PPE	Wear grove	1	1	1	1	low	

SECTION 6. DECLARATION (To be signed by the person conducting the Activity or, in the case of prac classes / field trips, by the Academic in charge)

I have read and understood all Risk Assessments relating to equipment used in this activity.	Signature:

SECTION 7: CONSULTATION

Technical staff or equivalent (e.g. Research Officer) in the area where the Activity is to be conducted **must** be consulted to ensure **all** risks and hazards have been identified and appropriate controls are in place (signature not required).

Position	Name	Comments (optional) – no signature required
Technical Officer (or equivalent) **consulted**:	Dr Long Shi	

SECTION 8: APPROVAL

Position	Name	Signature	Date
Person undertaking activity (for prac classes/ field trips, just list as "students"):	Haoze Xia Jarrod Lawson Junxu Jin		
Supervisor (for prac classes / field trips, Academic in charge to sign):	Dr Long Shi		
Discipline Leader / Manager *(required for sign off if any residual risk score is assessed as equal to or greater than 50.)*			

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