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Design Corner 2021

# Competitor Brief



engineers  
without borders  
australia



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# Summary

This design competition aims to introduce students to the concepts of Humanitarian Engineering and Appropriate Technology. Over the next 3 days, you will be creating a design prototype which addresses some of the 2030 UN Sustainable Development Goals (Figure 1).

Teams consist of students from the University of New South Wales, the University of Sydney, Western Sydney University, Macquarie University and the University of Technology Sydney.

This is a great opportunity for students to develop design, teamwork and project management skills. Executives will be involved to ensure that teams will have ample resources and support to complete their builds to a high standard. These projects will be judged by industry professionals as well as Engineers Without Borders members on the final day to determine the winning design.



Figure 1: 2030 Sustainable Development Goals, DFAT

# Your Task

**Vanuatu**, a nation comprising roughly 80 islands, is often considered to be the world's most at-risk nation for natural disasters. The island nation is at risk for tsunamis, earthquakes, cyclones, and volcanic eruptions. Your task is to come up with a design prototype that will assist in **cyclone disaster relief** in Vanuatu.

You should prototype, model or create a design that can effectively articulate your solution.

Your solution may address any of the issues that have been listed below, or you could choose to focus on another impact of cyclone disaster relief you have found through independent research.

In creating your design, you are advised to consider whether your prototype is an appropriate technology to be implemented in the community.

## Prototype

Teams should spend no more than \$30 in the construction of the prototype. This amount is suitable for prototyping, and a more detailed cost analysis could be undertaken if the design was to be implemented in Vanuatu.

On Saturday, you will travel to Bunnings Randwick to purchase material with a member of the EWB Committee team, who will cover this \$30 expenditure. Further, if required, students can use tap water for demonstrating their prototype.

To model the situation in Vanuatu, you will be unable to use any advanced hardware tools such as saws, drills etc. Tape, scissors and glue should be used as an alternative during prototype design.

## **Presentation**

You will need to present a 5-minute presentation to a panel of industry professional judges discussing your prototype to your audience.

There will be questions the judges will ask you after the presentation.

Be sure to relate back to the information provided within this brief as well as following the judging criteria, found later in this document.

# What is Appropriate Technology?

A key principle of human-centered engineering is Appropriate Technology.

Appropriate Technology refers to the importance of approaching design from a context-relevant perspective. A good design suits the community and context in which it will be implemented. It is especially important to think of appropriate technologies when designing for unfamiliar cultural contexts, be these different religious practices, availability of materials or financial means of the user. In such situations, technology should be created to fit the needs of the community to ensure the long-term success of the device.

There are ten principles that should be kept in mind:

- 1. Meets the basic need of the users**

How well does your design deliver the required outcome?

- 2. Sound technology**

Does the technology suit the local conditions?

- 3. Flexible technology**

Can your design be easily adapted for different circumstances?

- 4. Use of local materials**

What materials are commonplace in your environment? How can new materials be transported or created?

- 5. Affordability**

Is your design affordable for your user or community?

- 6. Sustainability**

What happens to your design when it breaks down? Is production, use or repair carbon-intensive?

- 7. Encourages local participation**

Will your design be produced and serviced by local people? Do people need to be trained to operate your design? Will your technology create jobs for local people?

**8. Culturally/socially appropriate**

How are things currently done? How can your design work in parallel to cultural norms?

**9. Gender-conscious**

What issues are there in your community around gender, and how does your design demonstrate your awareness of these issues?

**10. Knowledge transfer**

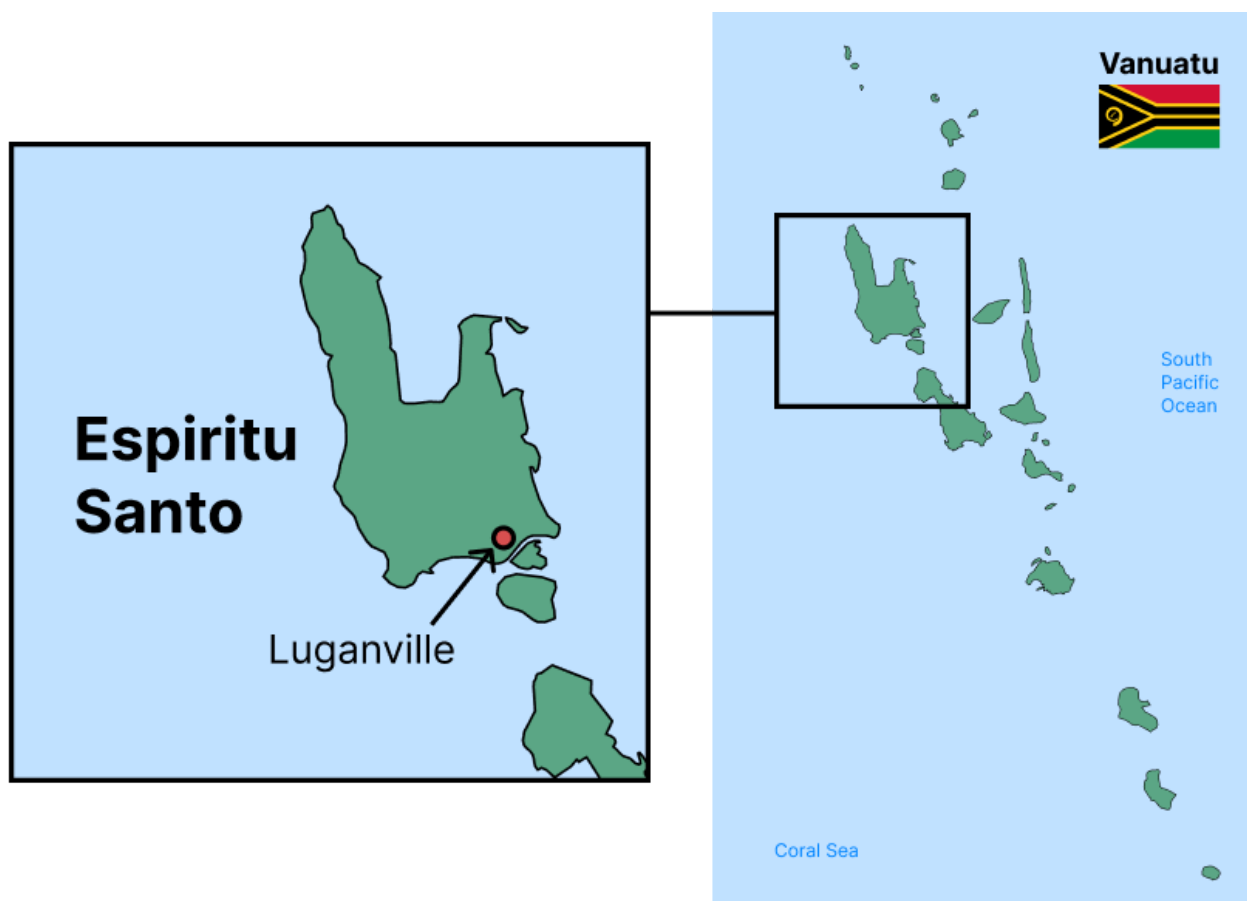
How will the knowledge about service, production and use of your design be passed on over time?

# Espiritu Santo, Vanuatu

Vanuatu is an archipelago nation east of Australia, located in the Southwestern Pacific Ocean.

This country – home to an estimated 299,882 people – comprises roughly 80 islands that stretch over 12,189 square kilometres. Of Vanuatu's many islands, Espiritu Santo is known to be its westernmost and largest at approximately 3,677 square kilometres.

Espiritu Santo's west coast bears a mountain range inclusive of Vanuatu's highest peak, Mount Tabwemasana, which rises to a substantial 1879 metres. The island and those surrounding are renowned for their beaches and coral reefs, thus attracting many tourists seeking a tropical holiday setting and diving opportunities.





Despite the beauty and abundance of natural attractions within Espiritu Santo, the island and its residents are often forced to contend with natural disasters that threaten their livelihoods and wellbeing, and can catalyse significant reductions in tourism rates.

These environmental challenges may often appear in the form of earthquakes, tsunamis, cyclones and volcanic eruptions.

Many of Espiritu Santo's residents have careers in tourism, fishing or farming of products such as copra, cocoa beans, fish and peanuts. Subsequently, a large portion of these people live in rural conditions, far from the island's limited road network.

Located on the south-east coast of Espiritu Santo, Luganville is in fact the island's only town.

# Cyclones

In meteorology, a Cyclone refers to any low-pressure area with winds spiralling inwards.

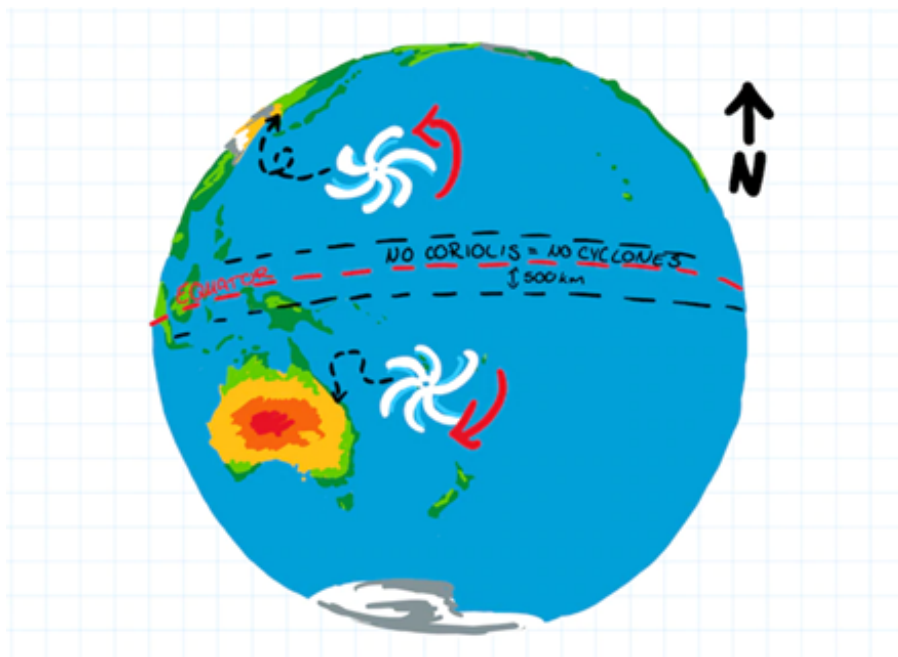
For large weather systems, cyclones rotate clockwise in the Southern Hemisphere and anti-clockwise in the Northern Hemisphere.

Cyclones are also referred to as hurricanes or typhoons.

A cyclone forms when the criteria below are met:

- Waters at a temperature of above 26.5 degrees Celsius
- Humid, rising air provides moisture to a storm cell
- The location is greater than 500 kilometres from the equator
- There is low vertical shear

**Coriolis Effect** – Since the air rotates at a greater speed at the equator than at its poles, air becomes curved as it moves around the globe.



Cyclones leave devastating effects in their wake. It is important to be aware of the following hazards after a cyclone hits:

- Downed power lines
- Unstable structures

- Contamination of waterways
- Increased activity of rodents, spiders, and flies

One such cyclone which affected Vanuatu was the Category 5 Cyclone Harold which hit on 5 April, 2020. Affecting more than 159,000 people, it tore through the northern provinces of Sanma, Penama and Malampa with winds of up to 215 km/h. Three confirmed deaths resulted from this cyclone, with more than 17,000 homes left severely damaged. An estimated 87,000 people were left without homes, meaning 28% of the population was displaced. Damage to schools, agricultural crops, buildings, power, telecommunications and the local boat fleet added additional strain to the recovery process.

# Challenges

We have identified several humanitarian engineering challenges below. You may choose to focus on one or several of these issues in creating your design solution. These challenges are commonly faced by Vanuatans, and are exacerbated by the impacts of cyclones.

## WASH (Water, Sanitation and Hygiene)

Availability of water is greatly affected by the season. Water catchment systems, such as guttering and storage tanks, are highly susceptible to damage during cyclone events, making communities who are dependent on these systems particularly vulnerable to such events.

Coastal communities rely on ocean water for laundering clothes and bathing, as this enables them to use water effectively. Cyclone events often cause contamination of seawater, affecting this supply of water.

Sanitation is predominantly facilitated through Ventilated Improved Pit (VIP) latrines and basic pit latrines - both use local bush materials and are highly susceptible to wind damage. As a result of 2015's Cyclone Pam, nearly 70% of sanitation superstructures were destroyed. Waste collection in peri-urban settlements were usually dumped or burnt. Short-term needs include providing water, sanitation and Hygiene services to assess needs, adding landfill capabilities, including safe disposal of hazardous medical waste. Long-term needs include: rehabilitating damaged sanitation and water systems to reduce disaster risk, and enabling the operation and maintenance of rural water supplies.

Sector	Program of Activity	Value (VT 1,000)	Responsible Agency
Water and Sanitation	Rehabilitation of damaged water systems in communities using a BBB approach to reduce disaster risk (in rural and peri-urban areas)	360,845	MLNR
Water and Sanitation	Rehabilitation of damaged water and sanitation systems in health and education sector using a BBB approach to reduce disaster risk (in rural and peri-urban areas)	200,000	MLNR MoH MoET
Water and Sanitation	The creation of legal and contractual environment to enable private sector in operation and maintenance of rural water supplies	2,000	MoF URA
<b>Total</b>		<b>570,845</b>	

Note: MoH = Ministry of Health; MoET = Ministry of Education and Training; MoF = Ministry of Finance.

**Table 50.** Medium- to Long-Term Recovery Needs for the Water, Sanitation, and Solid Waste Sector

There is a lack of transportation services throughout the city, requiring residents to make journeys by foot to and from water sources. These journeys are estimated to take up to 2 hours per day. Access to water sources may be affected by damage to roads and infrastructure resulting from cyclones.

## Farming & Food Production

2015's Cyclone Pam caused roughly 6 billion VT's worth of damages (approx. \$70 000 000 AUD). Around 80% of Vanuatu's population relies on agriculture for livelihood and food security, with at least 71% of rural populations being supported by agricultural activities. Crops were the most affected agricultural subsector, with damage not only affecting permanent cash crops but also machinery, nurseries, driers and pulperies. The second most affected subsector was forestry, with losses attributed to the sandalwood industry, indigenous species and mahogany trees. Short-term recovery strategies include production and distribution of seeds and planting material, tools and equipment, land clearing and recycling of byproducts of planting material for the forestry subsector. Long-term strategies aim to increase disaster resilience of affected farming, fishing and natural resource-dependent households.

Subsector	Programs	Amount (VT 1,000)	Responsible Agency
Crops	Food and cash crops long-term recovery and resilience	340,864	MALFFB, development partners, private sector
	Community food security restoration	98,695	MALFFB, development partners, NGOs
	Rehabilitation of damaged infrastructure and assets	64,850	MALFFB, development partners
Livestock	Support to commercial livestock farmers	64,89	MALFFB, development partners, private sector
	Support to animal welfare and resilience	186,645	MALFFB, development partners, private sector
	Rehabilitation of damaged infrastructure and assets	82,460	MALFFB, development partners
Forestry	Forest seed, nursery, and rehabilitation	147,270	MALFFB, development partners, NGOs
	Rehabilitation of damaged infrastructure and assets	50,320	MALFFB, development partners
Fisheries	Rehabilitation of damaged infrastructure and assets	68,804	MALFFB, development partners, NGOs
Cross-sector	Improved disaster response and resilience	122,470	MALFFB, development partners, NGOs
<b>Total</b>		<b>1,162,378</b>	

**Table 8.** Medium- to Long-Term Recovery Needs for the Agriculture, Livestock, Forestry, and Fisheries Sector

Note: MALFFB = Ministry of Agriculture, Livestock, Forestry, Fisheries and Biosecurity.

## Housing & Infrastructure

Just 27% of housing is considered to be permanent. These structures are constructed from engineered concrete floors, timber-framed walls, and corrugated iron roofs. Other housing is traditional and semi-permanent,

constructed from thatch, woven palm fronds (natangura), woven cane, concrete, lightweight timber or corrugated iron.

In considering cyclone recovery, short-term needs include supplying materials which allow for the community to self-recover with agency, supplying materials from neighbouring islands, salvaging and reusing debris for rebuilding (some hazards include asbestos materials used in older structures).

Medium-to-long-term recovery needs include construction of community safe structures, housing reconstruction and identification of suitable evacuation sites.

**Table 24.** Medium- to Long-Term Recovery Needs in the Housing Sector

Program of Activity	Value (VT 1,000)	Agency
Multihazard mapping of urban areas and action plan identifying safe areas for future growth, installation of tsunami warning systems	291,896	Government, World Bank (MDRR project)
Training in risk to promote risk awareness	500,000	NGOs
Informal settlement study, including mapping of housing and tenure status in selected informal settlements	77,000	UN-Habitat
Construction of community safe structures, including identification of buildings for new construction or reinforcement	400,000	World Bank, NGOs
Consultative preparation and adoption of a National Housing Policy	37,500	Government, World Bank (to be confirmed)
Owner-led/self-reliant incremental housing reconstruction in all areas, making use of simple, low-cost measures to improve resilience of new housing stock	10,594,887 <sup>a</sup>	Private households (may include some sector assistance, e.g., with water tanks)
Identification of locations and structures suitable for safe evacuation sites in all areas and preparation of a costed action plan to retrofit such buildings (access by people with disability, lighting for security for women and children, WASH facilities)	30,000	Government, World Bank (in urban areas only, rural to be confirmed)
<b>Total</b>	<b>11,931,283</b>	

Note: MDRR = Mainstreaming Disaster Risk Reduction; WASH = water, sanitation, and hygiene.

a. This figure includes an additional 15% above replacement costs, in order to incorporate the cost of BBB. It excludes any provision for house insurance, as only houses with Category 5 cyclone certificates are eligible for insurance payments. The total number of such houses is understood to be less than 10.

Damage to public buildings was sustained as a result of poor construction to roofing structures. This resulted in the loss and damage of public records. Recovery efforts would include the reconstruction of public buildings, bearing in mind that many public buildings were constructed from asbestos sheeting, a hazardous material.

Partial damage was sustained at airports across the nation. Significant damage to marine vessels and partial damage to wharves and jetties was also recorded. 80% of road networks were blocked due to fallen trees, with many bridges and roads being washed out. Essential services were cut off to major centres and emergency supplies were restricted. Short-term recovery needs include temporary repair of bridges and clearing debris, and repairing damage at

airports. Long-term recovery includes community consultation for engineering designs, building roads that are sustainable and climate resilient, redesigning roads to emphasise drainage, and replacing corroded pipes of corrugated iron with concrete drainage structures.

## **Energy Supply**

There are only 2 electricity grids in Luganville, and communities outside of this central town lack access to reliable power. As a result, solar power is popular in rural communities; however, the cost of solar power means many households lack access or use their limited power for lighting and charging mobile phones. This lack of access means that energy was not selected as an area of focus for cyclone disaster relief, but we encourage you to consider the existing power grid in developing your solutions.

## **Other Possible Areas of Focus**

- Displacement of children due to disasters
- Access to mental health support to process trauma and aid psychosocial recovery
- Improving lack of access to adequate nutrition following disasters
- Decreased access to healthcare and vaccination programs following disasters

**Source:** Post Disaster Needs Assessment, Government of Vanuatu:

<https://www.gfdrr.org/sites/default/files/publication/pda-2015-vanuatu.pdf>

# Character Profile

## **'Ehukai**

'Ehukai is a dedicated husband to his wife Heepuenui and loving father to his three children. He and his family live in Luganville, a city in Espiritu Santo. You are likely to find him on a cocoa farm, working hard to earn his annual income of \$1000 that only just manages to keep his family afloat. His biggest dream is to see his children complete their education, an opportunity he never received.

Each day, he wakes up at 5am to start work on his crops and although it is exhausting, he always marvels at the beauty of nature found in each tree and seed pod. Around mid-afternoon, 'Ehukai goes fishing to gather food for his family's dinner. A majority of the population use fishing as their source of income in Luganville so though this provides a sense of a social life and a much needed change from his farm work, it can also be challenging to catch enough fish for his family of 5.

When Cyclone Pam hit in 2015, 'Ehukai's life was turned upside down. His much loved cocoa trees, the fermentation boxes and Kukum drier were destroyed. 'Ehukai knows that it will take at least 3 years for his farm to fully recover. He had been saving-up to upgrade his cacao bean drying system from a Kukum dryer to a solar drying house. The smoke from the woodfire used to power the Kukum dryer poses health issues and risks contaminating a proportion of the beans. 'Ehukai and his co-workers are malnourished and suffer from poor health due to the exhausting work days and exposure to smoke. On top of his poor physical health, 'Ehukai also experiences trauma from all the destruction he observed. Due to the costs, 'Ehukai was forced to make the difficult decision to pull his children out of school to help out on his farm.

As the family adjusts to new life after Cyclone Pam, 'Ehukai feels disillusioned about the future. He feels as if he has failed to provide for his family, particularly as he sees his children falling into the same patterns as he did. Their family does not have adequate access to hygiene and sanitation facilities and 'Ehukai also fears for the health of his children, particularly with grueling farm work and constant smoke inhalation. His family's wellbeing and education are being compromised in an attempt to sustain their day-to-day living and basic necessities.



# Judging Criteria

Your judging panel has been asked to consider the following when assessing your prototypes and viewing your final presentation:

- How have the needs of the community, as described in the brief, been addressed?
- Is the proposed solution an appropriate technology?
- Has adequate attention been paid to the cultural and socioeconomic context?
- Has attention been paid to the sustainability of materials used in the proposed design?
- Have the presenters spoken clearly and communicated effectively?
- How has the team engaged with the engineering design process? (for example: formulating a problem statement and examining several design alternatives)

On the following page is a copy of the rubric that has been provided to our judges.

## Rubric

Criteria	Team					
	1	2	3	4	5	6
<b>Presentation</b> – Effective use of prototyping (or other display method), engaging pitch, teamwork and collaboration evident.						
<b>Appropriateness</b> – Idea is culturally and socially appropriate, suits the local conditions.						
<b>Sustainability</b> – Idea can be employed long term; implementation plan is evident.						
<b>Innovation</b> – Idea is creative, effective use of the design thinking process is evident.						
<b>Cost Effectiveness</b> – Idea considers material costs, implementation, operation/program delivery costs and maintenance costs. Potential economic benefits to the community is evident.						
<b>Total</b>						

Please score each criteria out of 10, with the maximum total for each team being 50.

# Schedule

## Opening Night at MQ

**Date:** 14 May 2020, Friday evening

**Time:** 5:30pm – 7:30pm

**Location:** G51 Dance Floor, 44 Waterloo Road, Macquarie Park NSW 2109

Time	Activity	Description
5:30pm	Sign-in	
6:00pm	Presentation on the Design Brief	The scope and context of the project will be introduced.
6:15pm	Icebreaker	Teams have the opportunity to get to know each other.
6:30pm	Planning session	Teams generate initial ideas and do preliminary research.  Teams develop more detailed ideas and begin to visualise the physical design.
7:00pm	Dinner	Light refreshments and pizza will be provided.
8:00pm	Formal end of the day	

## Design Workshop at UNSW

**Date:** 15 May 2020, Saturday

**Time:** 9:30am – 5:30pm

**Location:** K-J17-101, 102, 201, 202 (Ainsworth 101, 102, 201 & 202)

Time	Activity	Description
9:30am	Sign-in	Students come in and settle in
10:00am	Start	Itinerary for the day
10:05am	Presentation	Design thinking with Aidan Turner + Introductory video for External visitors
10:30am	Brainstorming	Students get the opportunity to brainstorm their ideas
12:05pm	Bunnings	1-2 reps per team to travel to Bunnings to purchase materials (via bus or own transport)
1:30pm	Lunch	Break for lunch
2:30pm	Work on Prototyping	Prototype development stage and participants get the opportunity to build their prototype for judging
4:00pm	Prepare for presentations	Develop their slides and other materials for the presentations
5:30pm	Formal finish	Explain what the judging day will look like and end of the day

External Visitors Link:

<https://www.covid-19.unsw.edu.au/safe-return-campus-external-workers>

If you are not a current UNSW student, please watch the above video before attending Saturday's events.

## Industry Showcase at UTS

**Date:** 16 May 2020, Sunday

**Time:** 8:30am – 4:00pm

**Location:** CB.11.00.401, CB.11.00.405 (UTS Collaborative Theatre, Building 11, Floor 0, Room 401 and Room 405)

**Note:** Enter UTS Building 11 through Jones Street

Time	Activity	Description
8:30am	Sign-in (optional time to work on presentation)	
10:00am	Welcome (official start of day)	Present day's schedule
10:10am	Talk with Industry	
10:40am	Judges Introduction	
11:10am	Presentations start	
12:40pm	Lunch	
1:10pm	Presentations resume	
2:50pm	Judging	
3:30pm	Wrap-Up	Awards and feedback presented
4:00pm	Formal Finish	

# Key Contacts

For any questions or queries, feel free to contact the following EWB chapter representatives:

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# Media consent

Photos will be posted to the EWB University Chapter Facebook pages within a few weeks of the event. By participating in this event, you consent to be photographed and the use of your photos in future publication/promotional materials.