UTS | MQ | UNSW | USYD | WSU

Design Corner 2022

Competitor Brief

engineers without borders australia

Table of Contents

Summary

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

Teams will consist of students from across NSW, including: the University of New South Wales, University of Sydney, Western Sydney University, Macquarie University, and the University of Technology Sydney.

This is a great opportunity for you to develop your design, interpersonal, and project management skills. Your allocated team mentors will ensure that you have ample resources and support to complete your design to a high standard. Your final design will be judged by a panel of industry experts as well as a coalition of EWB organisers on the final day to determine outstanding solutions. In addition to special prizes, there will also be an opportunity to receive feedback on both the delivered design and your team's ability to present your solution.

Figure 1: 2030 Sustainable Development Goals (SDGs), DFAT.

Your Task

Due to sea-level rises and changing climate conditions, coastal erosion continues to grow as a significant problem for Australia's shorelines. Some impacts of coastal erosion include the loss of infrastructure, destruction of cultural heritage sites, and a decrease in biodiversity. With around 700,000 homes within three kilometres of the Australian coast, effective coastal erosion management is critical. Your task is to come up with a design that will assist in combatting the negative effects of coastal erosion along Australia's shores.

Your team will need to clearly communicate your design solution to a judging panel on day three with a presentation and an accompanying prototype. Your solution must relate to the issues of coastal erosion identified under 'Background', or you may choose to focus on alternate areas relating to the impact of coastal erosion found through independent research (ensure proper referencing and avoid plagiarising pre-existing solutions pertaining to the problem topic).

Whilst creating your design, ensure you consider the impacts it may have on surrounding communities and show evidence of your solution meeting an identified need in your presentation — in other words, ensure your design meets the specifications of appropriate technology (more details under the 'Appropriate Technology' section below).

Presentation

You will need to deliver a 5-minute presentation to a panel of industry professional judges. This must involve all team members and should relate to the problem topic.

You may include a slidedeck to support your presentation, or use other modalities such as video. Please ensure you remain within the 5-minute time limit, points will be deducted for going overtime (refer to the judging criteria for an overview of the exact point allocations).

Once you have presented your design, you will be given an opportunity to field questions from the judging panel and will receive feedback.

Prototype

In addition to your presentation, you must also build an accompanying small-scale prototype of your chosen design or anything which may support the presentation of your design. Your team will be provided with prototyping materials on Day 2, including:

- Paddle Pop Sticks
- Strings
- Sponges
- Masking Tape
- Scissors
- Permanent Markers
- Skewers
- Foil
- Recycled Boxes
- Pipecleaners
- Newspapers
- Butchers Papers

To model your design, you will be unable to use any advanced hardware tools such as saws, drills etc. You will need to resurface your advanced arts & crafts abilities with tape, scissors, and glue.

What is Appropriate Technology?

A key principle of human-centred engineering is **Appropriate Technology**.

Appropriate technology refers to the importance of approaching the design of an object, process, ideas, or practice 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 the financial means of people. In such situations, technology should be created to fit the needs of the community to ensure the long-term success of the technology designed.

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?

Background

Coastal erosion (or shoreline retreat/recession) is the loss of coastal lands due to the net removal of sediments of bedrock from the shoreline. This can pose a hazard when society does not adapt to the effects of coastal erosion on people, the built environment and infrastructure. Significant damage due to erosion can affect private property, infrastructure and public facilities and the loss of beach amenity. Coastal erosion can either present as a:

- **Rapid-onset hazard** (occurring in the span of days to weeks)
  Along the NSW coast, single storm events have caused coastal erosion such as those occurring in 2015 and 2016 that saw damage to beachfront properties in Sydney.

- **Slow-onset hazard** (occurring over many years, decades or centuries)
  The Twelve Apostles along the Great Ocean Road are a result of landscape change and coastal erosion over millennia. Out of the original 12 limestone features, only 8 are remaining; these remaining structures are vulnerable to further erosion from waves.

This occurs as a natural process when material is transported away from the shoreline and is not replenished by new materials being redeposited. Many coastal landforms undergo periodic cycles of erosion and deposition, including beaches, dunes and lagoons.

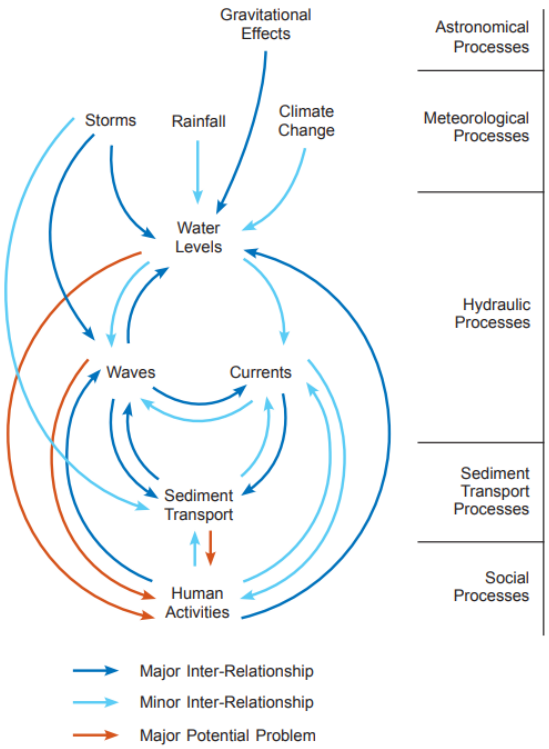
However, human activities can also strongly influence the propensity of landforms to erode, including:

- Construction of coastal structures
- Increased sea levels due to climate change
- Removal of sediments from coastal systems (e.g. by dredging or sand mining)
- Reduction in sediment supply (e.g. by the regulation of rivers)

At a larger scale, natural and human-induced climate change can modulate the likelihood and rate of coastal erosion.

Source:
https://www.ga.gov.au/scientific-topics/community-safety/coastalerosion

Coastal Management and Processes



Coastal management must be based on the understanding of local coastal processes. A fundamental part of this management strategy is the identification and amelioration of coastal hazards. The technologies that are implemented must be economically achievable while minimising the potential for adverse impacts (social, environmental and economic).

Coastal processes are the hydraulic and sedimentary processes driven by tides, currents, waves, coastal winds and tsunamis. The below figure depicts the complex interactions and feedbacks of coastal processes and human activities.

The complexity of climate change means that the processes of a particular location may change over time. This means that coastal regions must be constantly assessed to identify and quantify the processes, and understand the relevance of proposed solutions. Successful coastal management options at one location may not be suitable at another, and a thorough analysis of available data sets, investigation reports, and scientific and engineering literature is required before testing possible strategies and solutions.

Source:
https://www.engineersaustralia.org.au/sites/default/files/content-files/2016-12/climate_change_adaptation_guidelines.pdf

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 communities within Australia, and are exacerbated by the impacts of coastal erosion.

Housing & Infrastructure

Erosion of dunes and beaches adjacent to coastal areas can cause damage to structures by reducing the stability of foundations, causing settlement of the structure or directly undercutting the structure, causing collapse of the footings or exposure to wave action. Large sediment accumulations from coastal erosion causes upstream flooding. Both flooding and erosion can cause damage to housing and infrastructure, and the main areas at risk are low-lying open coast areas that are protected only by narrow natural or artificial barriers and areas of estuaries.

With some properties anticipated to become uninhabitable, there is reduction in the capacity of coastal communities to operate as they face relocation.
Short term relief includes supply of materials for the community to self-recover, salvaging and reusing debris for rebuilding (some hazards include asbestos materials used in older structures), .

Medium-to-long-term needs include construction of community safe structures, repair and replacement of residential, public and service utility infrastructure and the identification of suitable evacuation sites.

As sea levels rise shorelines will erode and accrete further, increasing the amount of infrastructure exposed to inundation and the frequency with which it will impact the already exposed. This also threatens other economically significant industries and infrastructure including ports, the fishing and seafood industries and tourism.

Loss of Biodiversity

Excess sediment from coastal erosion can be damaging to the ecological health of waterways and reduce their environmental, social and cultural values. Mobilised coarse sandy sediment tends to accumulate in areas of slow-flow and may smother bottom-dwelling organisms. Deep permanent river pools, that

are valuable habitats for aquatic fauna and refuges for wildlife during summer and drought, may become filled by coarse sediments.

Without healthy ecosystems particles of mud and pollution settle on the bottom so cities and towns downstream would not get the same clean, clear water that they rely on.

Immediate recovery for this would target management of water resources and regeneration of vegetation, while the long term goal would be to build more resilient landscapes that will provide refuges and wildlife corridors for plants and animals to adapt as climate change alters their existing habitat.

Community Wellbeing

Aside from the negative monetary and physical impact of coastal erosion, the social aspect of coastal communities can also be damaged due to coastal erosion. Meeting places such as benches, walk trails, heritage and Aboriginal sites are often wrecked during coastal erosion. The disappearance of such sites can often lead to reduced recreational values of the coastal shorelines ultimately decreasing tourist traction.

Displacement of coastal land can also lead to community overcrowding on the remaining inland, depending on how much usable land remains and the execution of a reallocation plan.

Mental health issues including anxiety, depression and suicide can emerge from the loss of property and cultural sites of significant value. A study conducted in Lower St. Lawrence, a region exposed to the waters of the estuary of the St. Lawrence River in eastern Quebec, Canada (2019) highlights the prevalence of mental health impacts to be double of the physical health (30% vs 14%). Affected people were 2.33 more stressed in normal times than unaffected respondents.

Economic Damage

Coastal shorelines offer economic benefits for the local community through generating revenue with tourism opportunities. The recreational services can often bring about tourist expenditures at a domestic and international level. (In 2018/19, Gold Coast had a total of 5.3 million visitors including 4.2 million domestic and 1.1 million international visitors) Optical satellite images and analysis methods classify 30% of the world’s coastline as still being sandy however, less than 50% of them are still considered to be stable with most of them experiencing rapid corrosion rates.

The ripple effect of such economic downturn from coastal erosion can be extended from front line businesses to their suppliers, employees and onwards. Furthermore, with an analysis into the housing market, the unpredictable land changes from erosion results in significantly decreased economic value and property development.

Other Possible Areas of Focus

- Frequent algal blooms and coral bleaching which result from the warming of sea surface temperatures
- Increase in overall carbon dioxide levels which can change the pH of the water making it more acidic

Sources:

- National Assessment of Risks on Australian Coasts, https://www.awe.gov.au/science-research/climate-change/adaptation/publications/climate-change-risks-australias-coasts.
- https://www.awe.gov.au/sites/default/files/documents/risks-coastal-buildings.pdf

Case Study

Aboriginal Sites of Significance: North Sydney

Northern Sydney is home to over 200 sites of Aboriginal Heritage Significance containing shelter sites, rock art, engravings, waterholes and fish traps.

Site Type	Total Sites
Burial	4
Engraving	6
Fish Trap	2
Grinding Groove	1
Isolated Find	1
Midden	137
Not a Site	1
Open Artefact Scatter	1
Shelter	1
Shelter Art	14
Shelter Deposit	4
Shelter Midden	68
Shelter PAD	1
Waterhole	1
Total	**242**

Council	Total Sites#
Ku-ring-gai	12
Lane Cove	32
North Sydney	22
NthnBeaches-Manly	27
NthnBeaches-Warringah	8
NthnBeaches-Pittwater	52
Willoughby	89
Total	**242**

While these sites are subject to natural deterioration, monitoring of these areas over a 2 year period has indicated a strong increase in damage due to the effects of coastal erosion including sea-level rise, flooding behaviour and changing wave characteristics as a result of increased commercial and recreational boating traffic and storm surges. Impacts of these include: king tides, coastal inundation, and shoreline erosion.

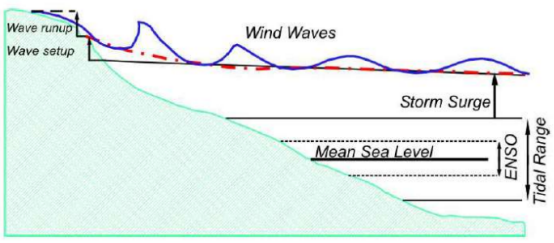


Figure 2: Schematic illustrating the contributions to coastal sea levels. Extreme sea levels comprise some combination of storm surge and astronomical tide, often referred to as a storm tide. Note that a stormtide can comprise a large surge in combination with a small or even negative tide or a moderate surge in combination with a particularly high tide. Sea levels may be further amplified at the coast due to wave breaking processes such as wave setup and run-up.

CHART 4: WAVE AND SEA LEVEL (MCINNES ET AL, 2012: 5).

Many monitoring and management strategies have been constructed to minimise damage; however, an engineering perspective of a long term solution is yet to be identified. Recognising the cultural and historical significance of these sites, it is imperative that these areas are preserved for current, future and past generations.

Source:
Coastal Erosion Aboriginal Heritage Strategy, Northern Sydney 2019. Written and compiled by the Aboriginal Heritage Office.

Judging Criteria

The judging panel has been asked to consider the following when assessing your prototypes and reviewing 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)

The next page contains a rubric with exact point allocations to be used by the judging panel when reviewing your design.

Rubric

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

Please score each criteria out of 10 points, with the maximum total for each team being 50 points. If presentations exceed the 5-minute time limit, please deduct 1 point for each minute over.

Schedule

Day 1: Opening Night

Date: 25th March 2022, Friday evening
Time: 5:30pm – 8:00pm
Location: UTS Building 2, CB02.06.150

Time	Activity	Description
5:30pm	Sign-in	
6:00pm	Welcome presentation	Welcome presentation, message from Engineers Australia, overview of what's to come.
6:15pm	Icebreakers	Opportunity to get to know one another within your teams.
6:30pm	Planning session	Initial planning and brainstorming of design.
7:00pm	Dinner	Light refreshments and pizza will be provided.
8:00pm	Formal finish	

Day 2: Design Workshop

Date: 26th March 2022, Saturday
Time: 9:30am – 4:30pm
Location: UTS Building 2, CB02.06.150

Time	Activity	Description
9:30am	Sign-in	
10:00am	Welcome	Welcome presentation and itinerary for the day.
10:30am	Brainstorming	Students get the opportunity to brainstorm their ideas.
11:30am	Prototyping	Materials are handed out and initial prototyping and ideating begins.
1:00pm	Lunch	Break for lunch.
2:00pm	Work on prototype	Prototype development.
3:30pm	Pitch workshop	Presentation on producing the perfect pitch for your design and prototype.
3:45pm	Prepare presentations	Plan and create presentations.
4:30pm	Formal finish	

Day 3: Industry Showcase

Date: 27th March 2022, Sunday
Time: 9:30am – 4:30pm
Location: UTS Building 2, CB02.06.150

Time	Activity	Description
9:30am	Sign-in	
10:00am	Welcome	Welcome presentation and itinerary for the day.
10:30am	Q&A panel with judges	Opportunity to get to know the judging panel.
11:00am	Presentations start	Presenting designs.
12:00pm	Lunch	Break for lunch.
1:00pm	Presentations resume	Presenting designs.
2:30pm	Judging	Judging panel convenes and decides on point allocations.
4:30pm	Formal Finish	

Key Contacts

For any questions or queries, feel free to contact your allocated team mentor for each day or the following EWB chapter representatives:

Name: Nathan Lecompte (MQ)
Email: macquarie@ewb.org.au

Name: Sachin Rajapaksha (UTS)
Email: uts@ewb.org.au

Name: Elise McCaul (UNSW)
Email: unsw@ewb.org.au

Name: Zoe Soo (USYD)
Email: usyd@ewb.org.au

Name: Preston Fisher (WSU)
Email: wsu@ewb.org.au

Media Consent

Photos will be posted to EWB university chapter social channels within a few weeks of the event. By participating in this event, you consent to being photographed and the use of your photos in future publication/promotional materials. If you would like to revoke media consent, please contact one of our representatives to indicate appropriate reasoning along with some form of identification (an ID with only a full name and headshot visible is acceptable).