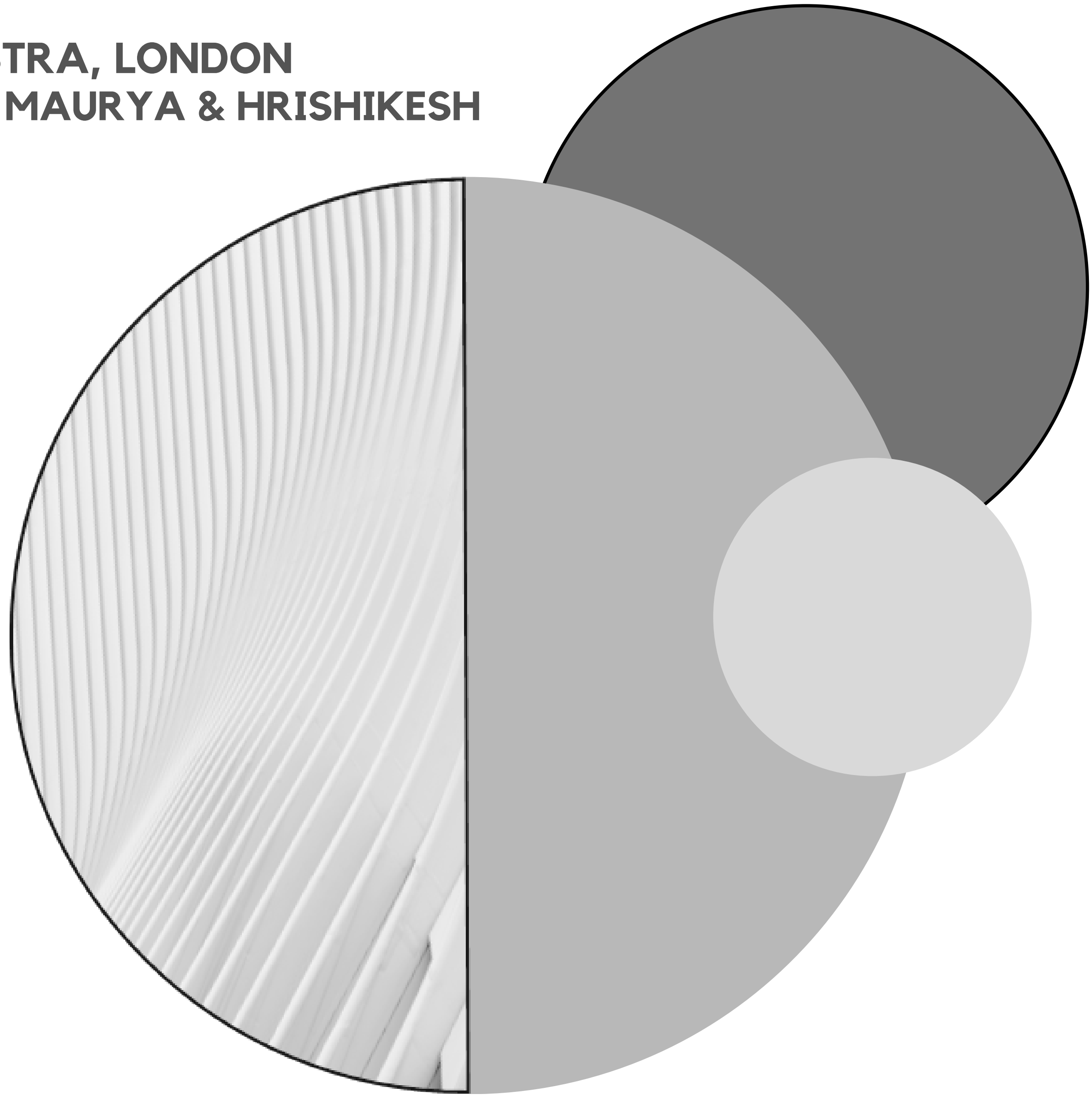
20785B

TEAM ASTRA, LONDON
KESHAV, MAURYA & HRISHIKESH

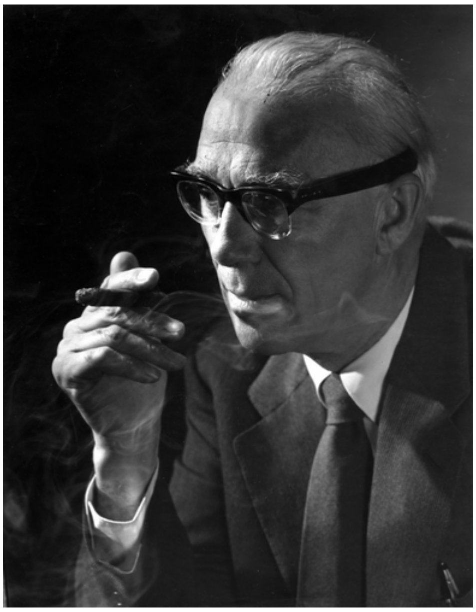


ARUP

CAREER READINESS CHALLENGE

WORD COUNT : 1000 (EXCLUDING ALL TITLES AND SUBTITLES, PICTURES AND PICTURE CAPTIONS - ALL IN RED) CONTENT (BLACK)

WHY ARCHITECTURE? WHY ARUP?



Sir Ove Arup, founder of ARUP

Architecture shapes our world today. Architecture is currently developing, from skyscrapers to domestic dwellings to large-scale marvels. It must now suit the client's objectives and perform its purpose while also being visually appealing and balancing the needs with the influence on the environment and landscape. This is a fascinating challenge that we hope to learn more about and contribute to in the future, which is why we selected architecture.

Arup is a building business that is a pioneer in the field of sustainability and innovation, as well as a significant leader in addressing environmental issues.

Meeting with Karan

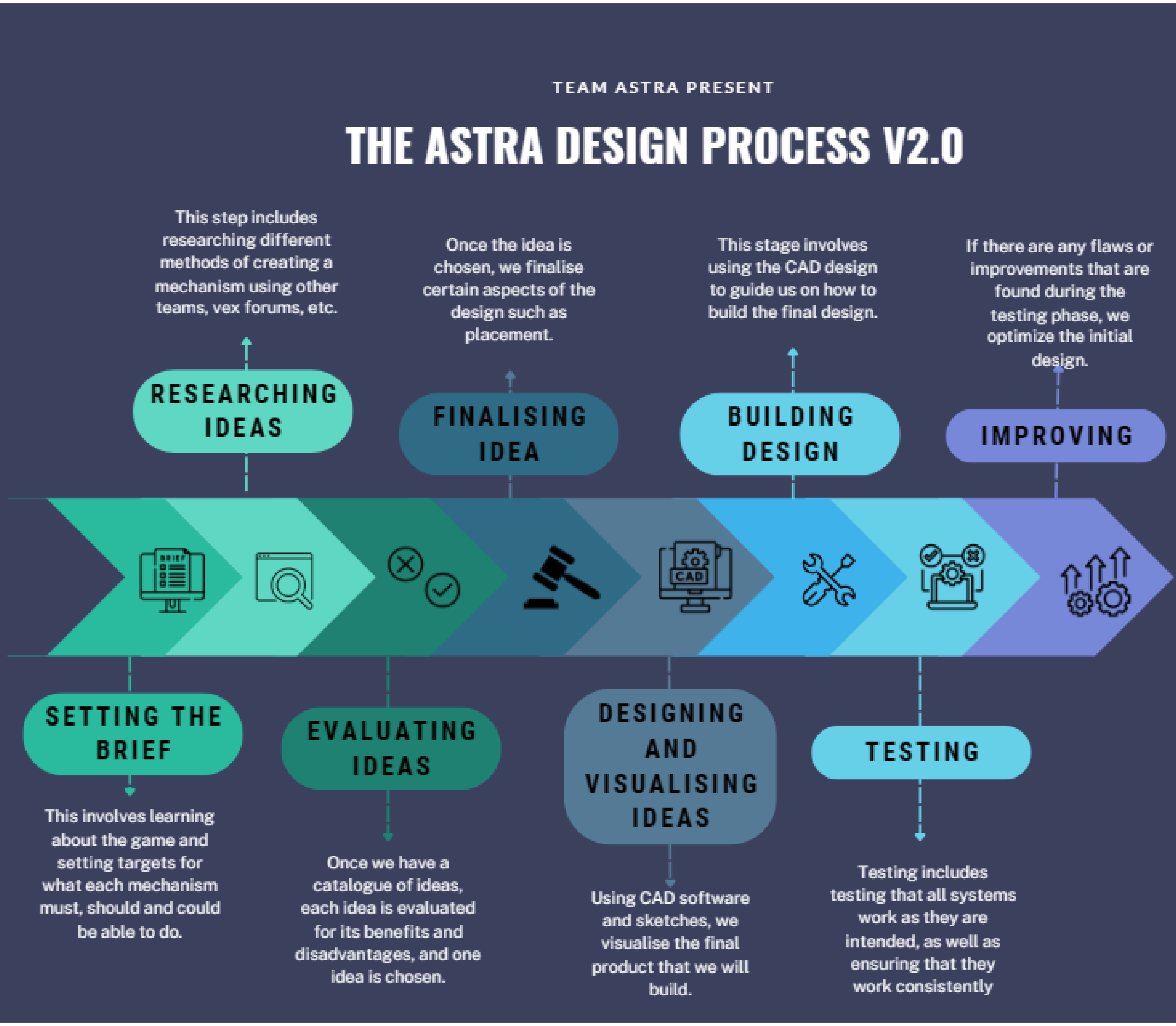
We wanted to explore ARUP and architecture because of Arup's Journey and its wide reaching impact on architecture, as well as its innovative approach to corporate structure. In order to learn more, **we contacted Karan Dewnani, a Project Manager at Arup, and were fortunate enough to schedule a meeting.**

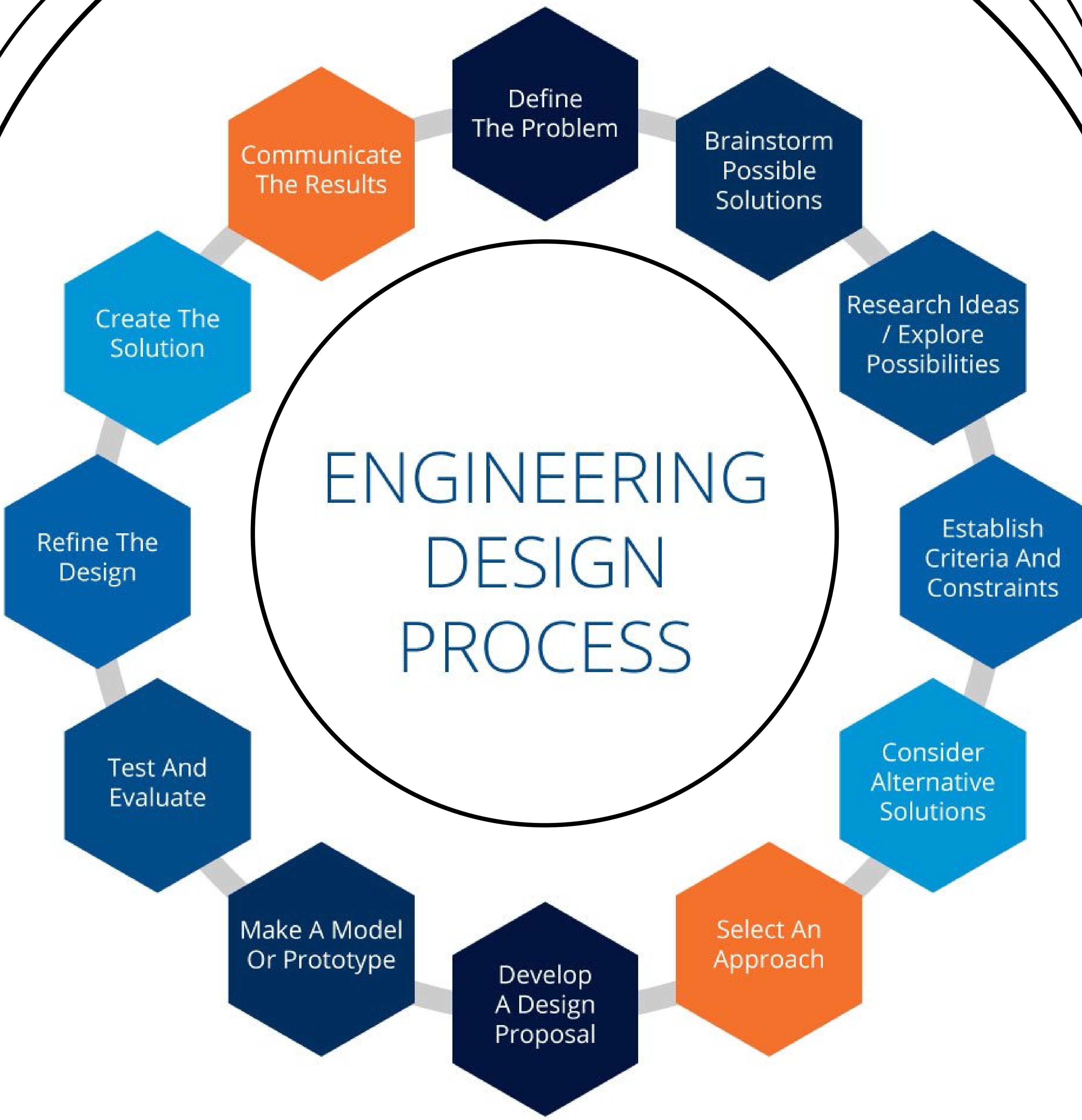
DESIGN PROCESS OVERVIEW

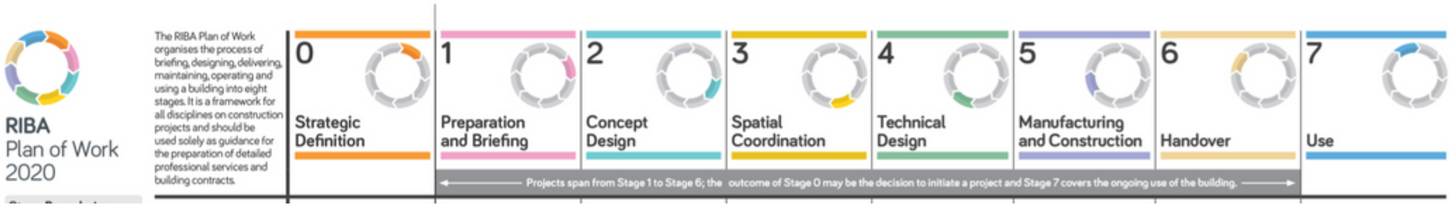
The purpose of any design process is to lay down a foundation for a team to follow in order to achieve key objectives.

The RIBA Plan of work which guides Arup and the engineering design process which all engineered products follow, is very similar to our design process. The core factors of each design process are shown clearly and are both relatively alike, although the end goals for each of us are completely different.

Team 20785B : Design process

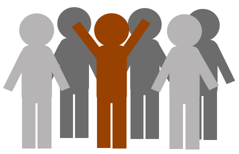



ENGINEERING DESIGN PROCESS
Define The Problem
Brainstorm Possible Solutions
Research Ideas / Explore Possibilities
Establish Criteria And Constraints
Consider Alternative Solutions
Select An Approach
Develop A Design Proposal
Make A Model Or Prototype
Test And Evaluate
Refine The Design
Create The Solution
Communicate The Results


RIBA
Plan of Work
2020
The RIBA Plan of Work organises the process of briefing, designing, delivering, maintaining, operating and using a building into eight stages. It is a framework for all disciplines on construction projects and should be used solely as guidance for the preparation of detailed professional services and building contracts.
0 Strategic Definition
1 Preparation and Briefing
2 Concept Design
3 Spatial Coordination
4 Technical Design
5 Manufacturing and Construction
6 Handover
7 Use
Projects span from Stage 1 to Stage 6; the outcome of Stage 0 may be the decision to initiate a project and Stage 7 covers the ongoing use of the building.

DEFINE THE PROBLEM

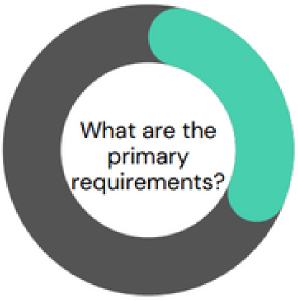
To define a problem is to simplify it into series of simple steps that must be completed in order to solve it.



'Human Centric'

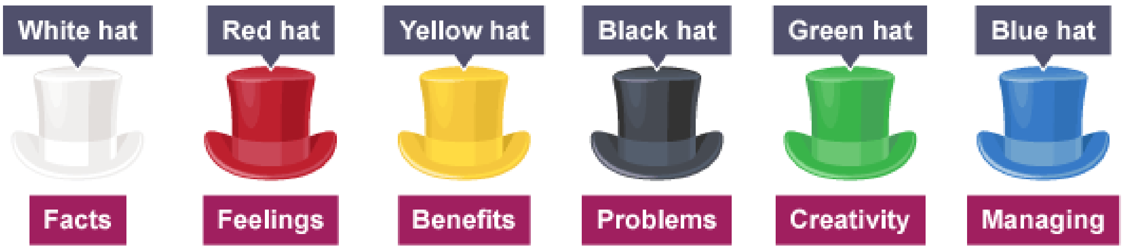
Arup's first step as a organisation is to understand and empathize with a client's problem. The first step must be '**client centric**' as Karan put it, understanding the problem the client faces and their need is essential and then it must be broken down and combined with existing primary and secondary data points to help map the project destinations and create a design brief.

Arup ensures the definition of the problem is client centric, breaks the problem down into a design brief

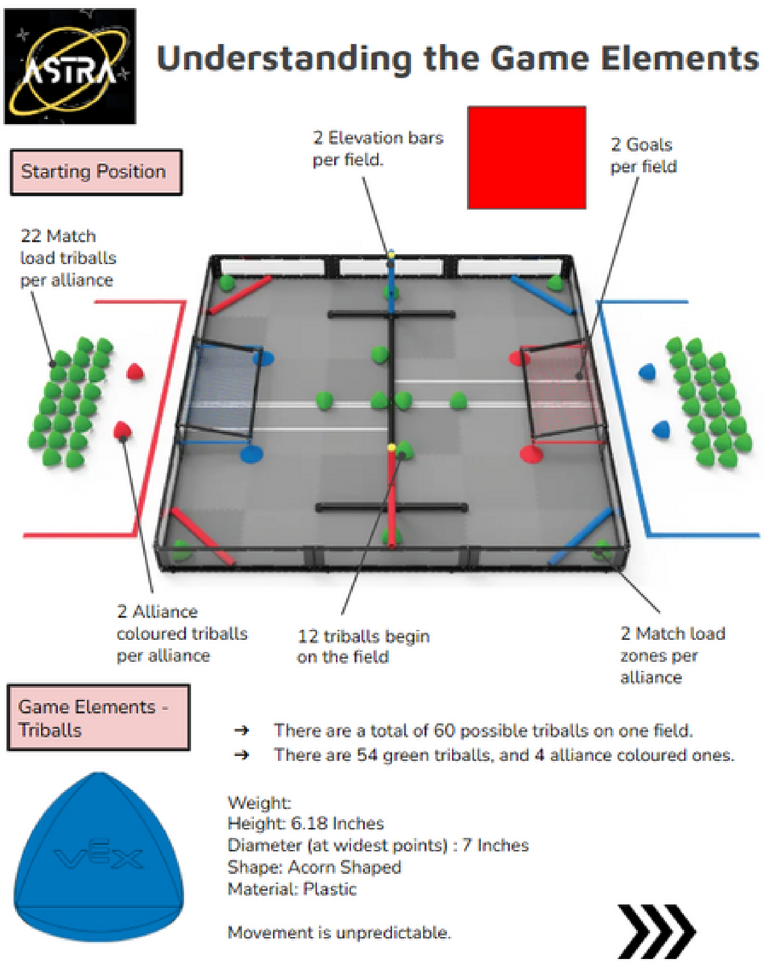


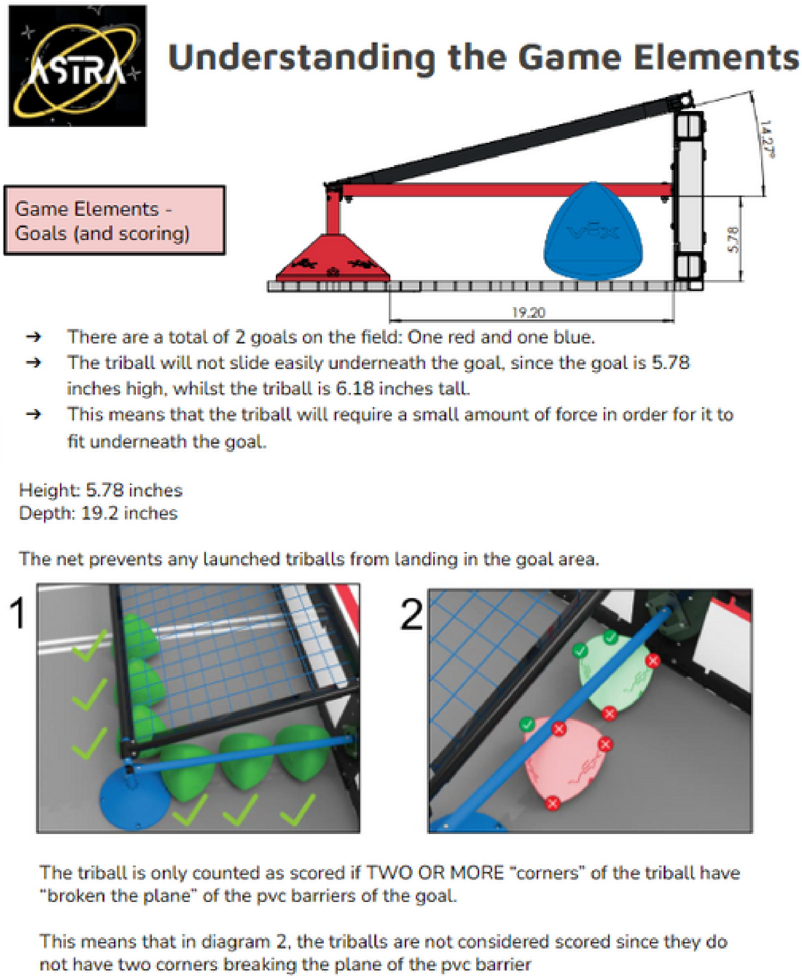
Arup using parallel thinking and the 'Six Thinking Hats' Methodology to brainstorm by Edvard .

Arup divides the crew into multiple small groups to facilitate parallel thinking. Each group can focus on a small subset of stakeholders, approaching and building a solution based on their priorities while protecting their interests. These ideas follow an initial concept note that is distributed to all stakeholders and internal teams and identifies the primary issue with the new infrastructure. Sir Ove Arup was a firm believer in brainstorming, and the Sydney Opera House featured 12 prototype sail designs.



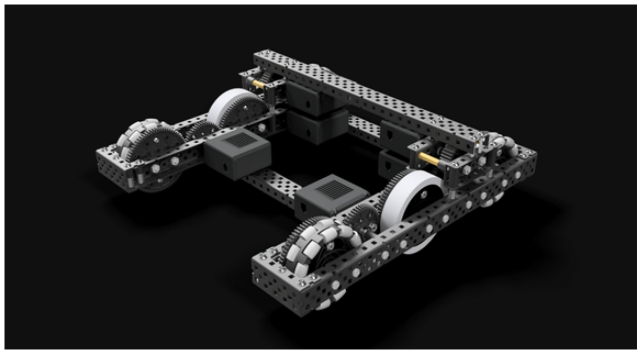
EDWARD DE BONO'S THEORY

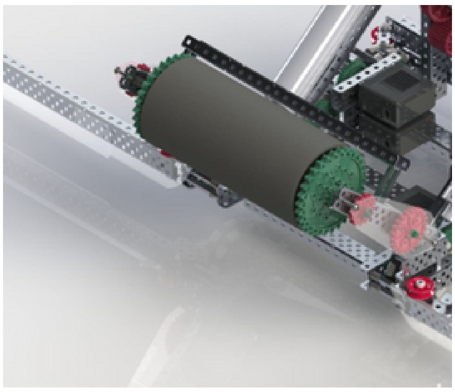




Although we weren't following the requirements of the 'client', the objectives of the game were still in question. We considered the aspects of the game and brainstormed which functionalities we should prioritise on our robot. We anaylsed each problem and ranked in terms of importance.

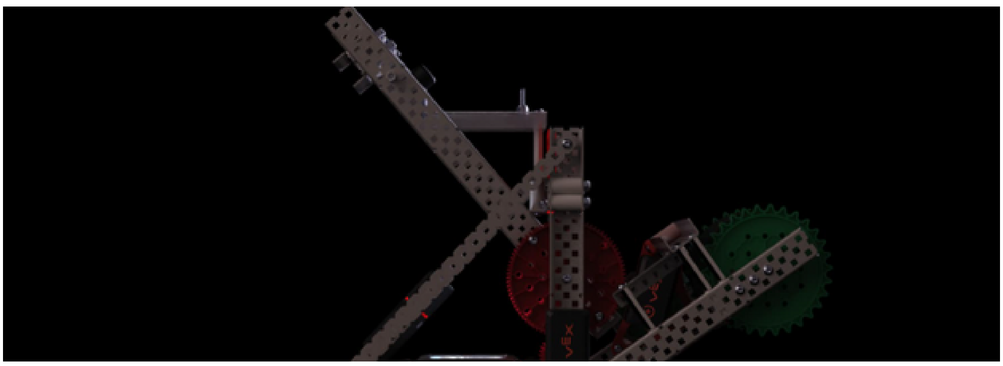
Our process is much the same. Researched-based, problem-centric design. We broke down the problem into 3 sections: the rapid **intake of tribals**, the targeted **dispersal of tribals,** all whilst **efficiently traversing the field.** Therefore we debated a few key robot design factors below.





A floating intake which lifts up to house the irregularly shaped triball

A drive train geared 48 to 84, giving us plenty of speed and talk to traverse the field well



A slapper with multiple slips on the rotation of the slip gear allows rapid firing of the triball. A platform that can ensure the consistency of each shot

IDEATE/DESIGN

To ideate is to imagine or conceive a range of ideas combatting the problem while design is communicating these ideas through simple sketches

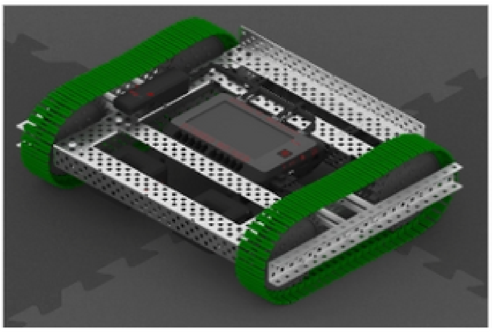
Karan emphasized the value of quickly generating ideas, advising against fixating on a single perfect design. Instead, he advocated for exploring multiple designs and developing the most promising ones. He underscored the necessity of thinking outside the box as the key to innovation, a sentiment that strongly resonates with our approach to forming ideas.

Ideas for the Drivebase

Option 4 - Tank Tread Drive

The tank tread is also very less commonly used.

This drivebase utilises chains instead of traditional circular wheels.

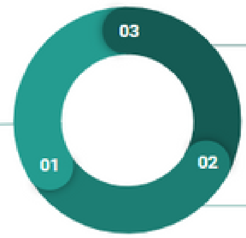


[This picture is from the official vex website]

PROS	CONS
➔ Ability to use screw joints and bearings, similar to a tank drive.	➔ Cannot get over the middle PVC barrier due to the lack of solid wheels.
➔ You can use motors in any position long the drivetrain, adding more customizability.	➔ Has quite bad traction on wheels, making the robot susceptible to being pushed by other robots on the field.

Conclusion Of Analysis

Tank Drive - Benefits



01: Very compact in size - makes it easier for the robot to fit within the size dimensions.

02: Very customisable - allows the robot to be more fine tuned to the game strategy that we intend to go for.

03: Relatively simple to build, with lots of online resources to aid with the building process.

We choose to go with the tank drive feeling that it met all of the criteria below which we defined as our musts.

FAST:
➔ In the Over Under Game, the aim is to score as many triballs into goals as possible, so we need the robot to be able to move very rapidly in order to score as fast as possible. It is very compact in size and hence meets this criteria as it it is lightweight.

STRONG:
➔ During the game, our robot will most likely end up hitting other robots a lot of the time during the match, as well as slamming into goals and triballs throughout the match, so we need the drivebase to be able to withstand these impacts.

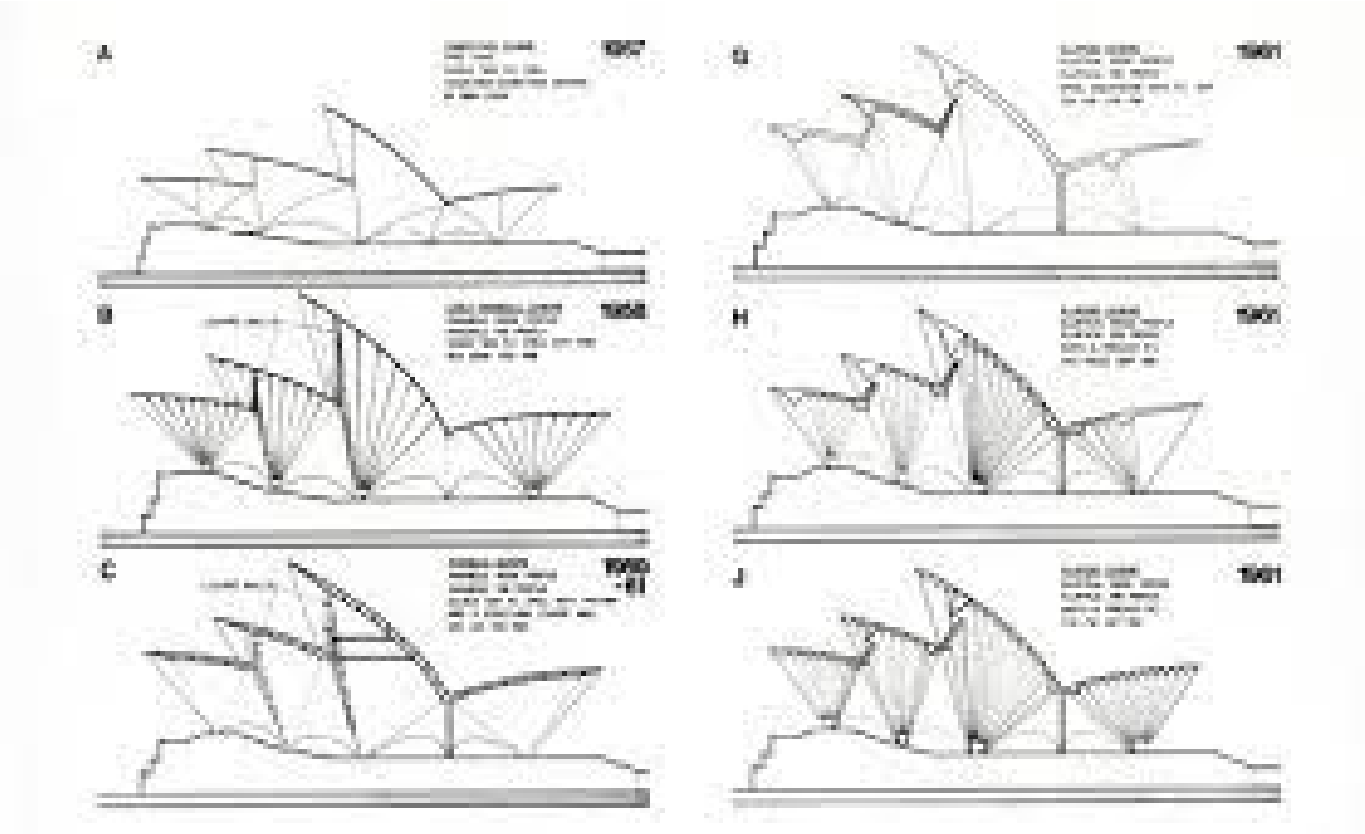
DIMENSIONS
➔ The robot must fit inside the 18inch x 18inch maximum dimensions, so therefore we cannot have a drivebase any larger than this.

This is our way of following Arup's process: considering lots of different designs, then having another team member evaluate the ideas in order to introduce a fresh perspective, so that we look through more than one lens.

Rather of honing one product design, our ideating technique focuses on discovering the perfect one from a sea of others. As a result, we examine all of the alternative methods for solving the problem and discuss which are most likely to be more effective for this particular game specifications

Arup ensures that each part of the problem is broken down an the best solution for each problem is created for the client. This is further demonstrated below

ARUP'S TRIAL SCHEMES



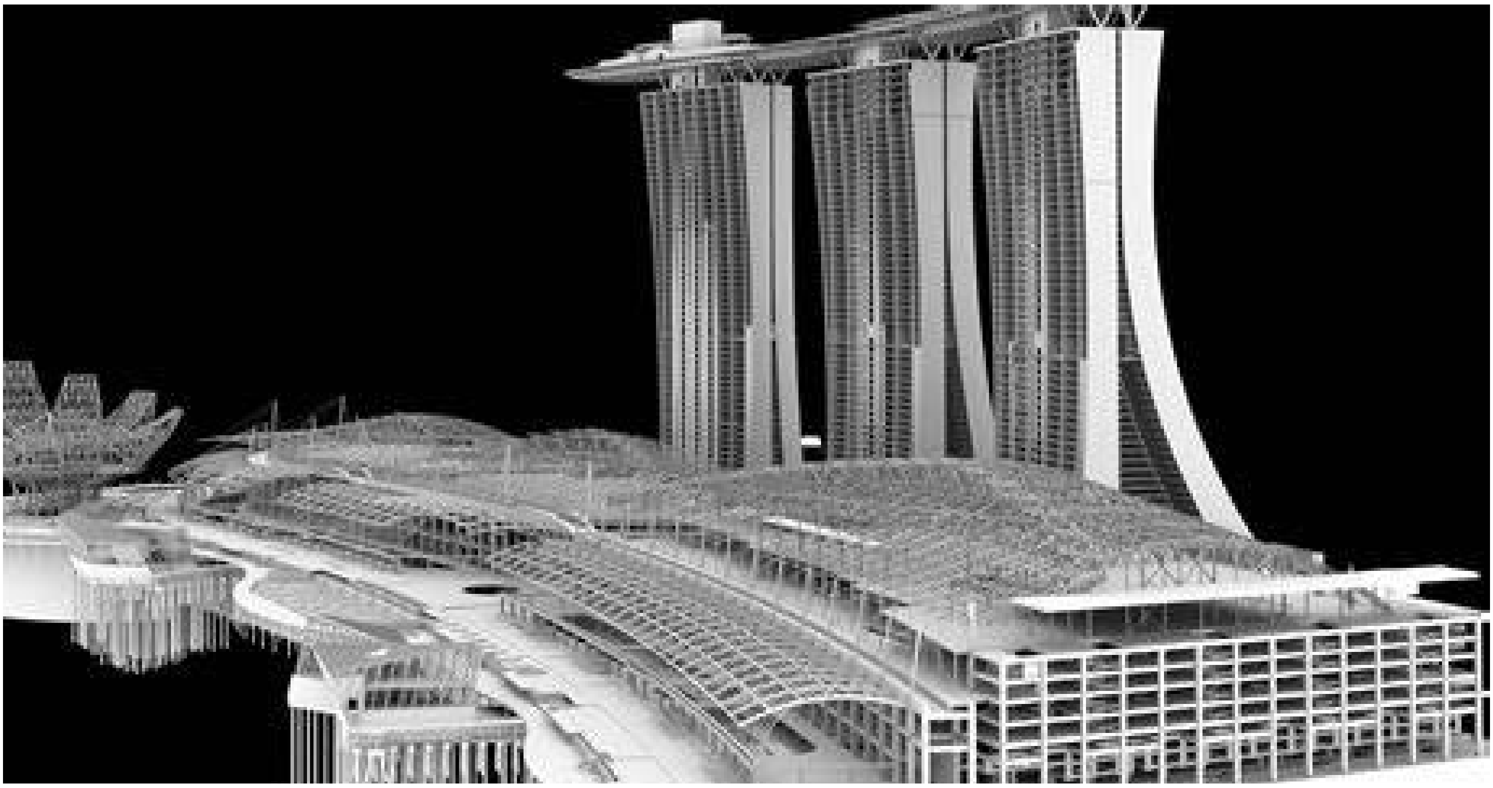
Case Study: Sydney Opera House

In the diagram above, you can see a few of the diagrams drawn by the design trial schemes, which show how each of the trial schemes came up with different ideas, each with different flaws and advantages. with different flaws and advantages.

Karan's analysis of ARUP's impact on architecture and problem-solving method revealed that, for the Sydney Opera House, the business investigated 12 trial concepts, each describing a different design for the distinctive roof. They chose the spherical solution and installed ten roof sails made of 75-meter-diameter sphere parts. This emphasises the necessity of varied perspectives in both large and small-scale projects, which prevents ideas from being suppressed. ARUP's use of focused trial schemes allowed them to widen their solutions, promoting unique and inventive problem-solving approaches.

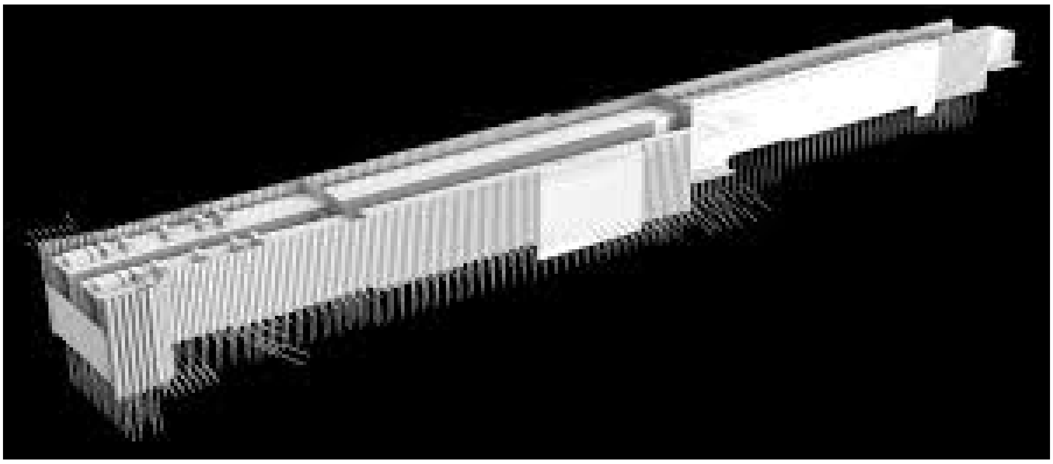
VISUALISE

To help conceptualize an idea, making it much more tangible to envisage or the creation of preliminary versions of a product from a design.



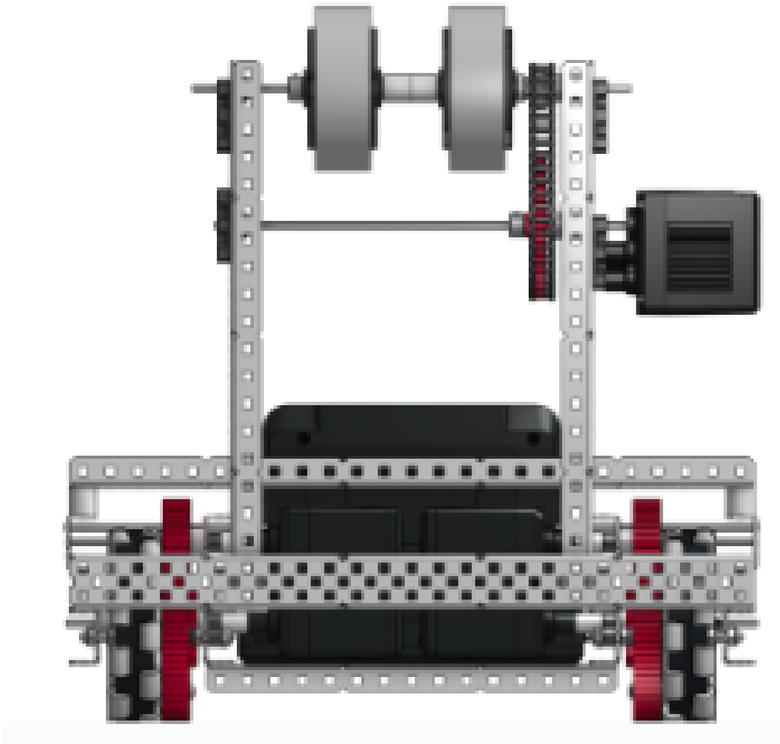
We employ stress testing (similar to how Arup uses tools such as HOLO-BIM for seismic testing), but instead of modelling pressures on a building's structural integrity, we simulate match scenarios like defence to check that the robot is robust enough to survive impact. We also test different robot mechanisms to guarantee that they perform consistently and without defects. This helps us to discover any issues with the robot and determine how to iterate the design and correct our mistakes.

//www.arup.com/news-and-events/arup-presented-the-highest-award-in-building-information-modelling-bim-excellence



CAD

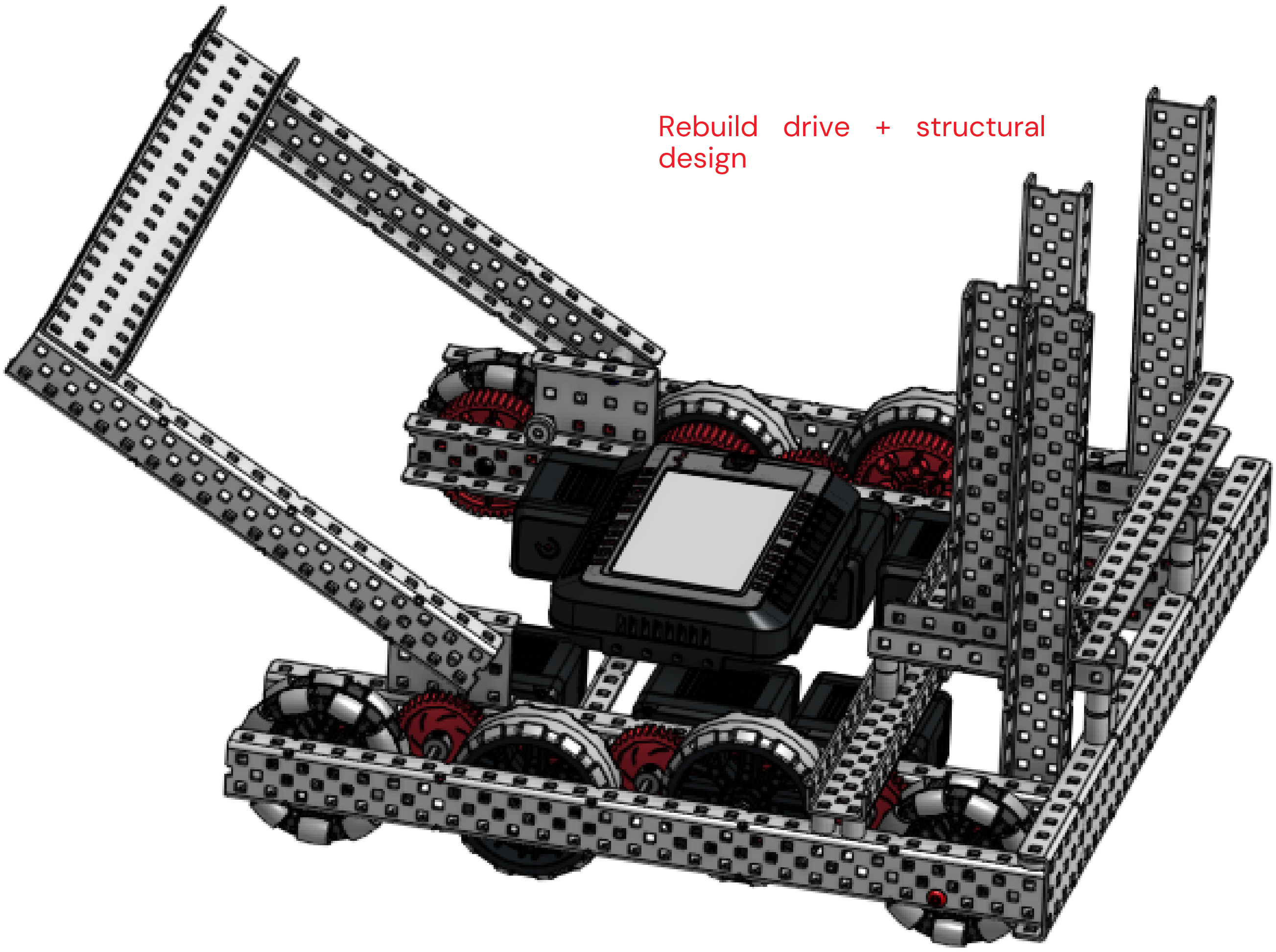
Visualisation is extremely important to our final outcomes. We took advantage of onshape, a unique CAD software to point out any flaws and issues with the current design without blindly going into the building process. This benefited our progress in many ways.



Flywheel

Drive + 4 bar lift prototype

Rebuild drive + structural design

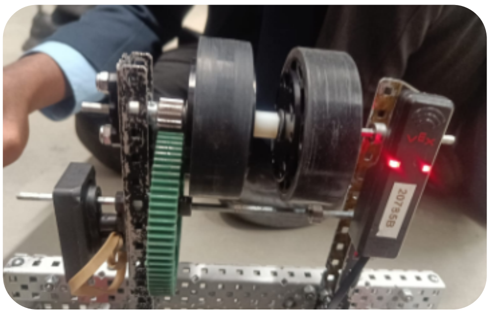


TEST

To test is to scrutinize the strengths and weaknesses of a product by putting it under strain. To iterate is to intergrate the feedback from testing to create several improved versions of the same product.

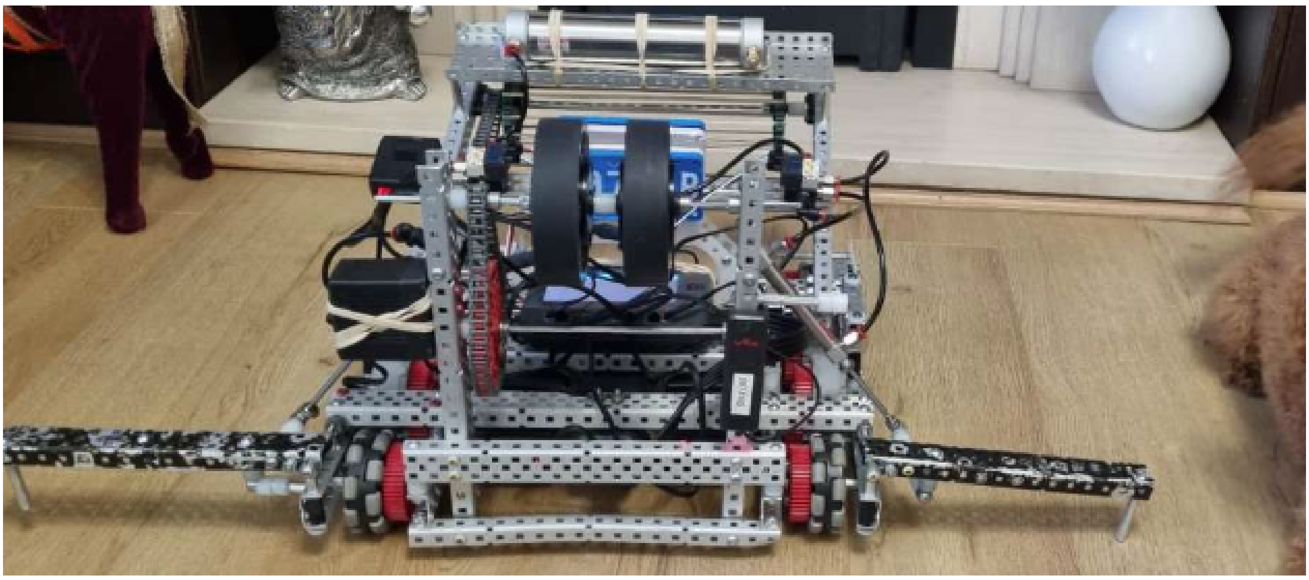
Testing is critical in architecture; with thousands of people and stakeholders relying on Arup to deliver, there is no room for unforeseen errors. As a result, before handover, they must do risk assessments and building performance analyses, as well as test each of their projects against simulated scenarios.

We employ stress testing (similar to how Arup uses tools such as HOLO-BIM for seismic testing), but instead of modelling pressures on a building's structural integrity, we simulate match scenarios like defence to check that the robot is robust enough to survive impact. We also test different robot mechanisms to guarantee that they perform consistently and without defects. This helps us to discover any issues with the robot and determine how to iterate the design and correct our mistakes.



Whilst testing the flywheel we noticed that the triballs werent being launched as far as was required. We concluded this was due to the turning effect about the axel was too low, allowing us to decide our next iteration.

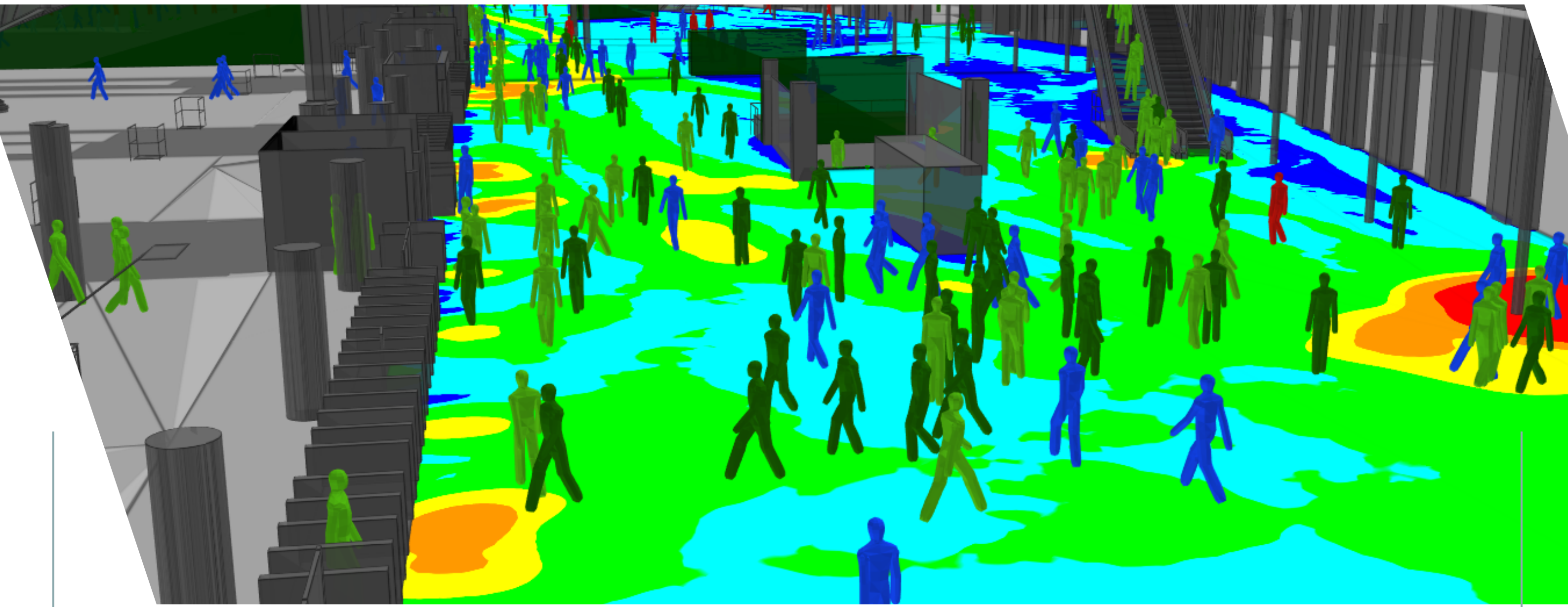
We initially had two mechanisms in mind for the sleds aluminium gussets and Versa hubs. Unfortunately through field testing, we found both methods were unsuccessful as they either were too low or had a too flat of an arc (in that order)



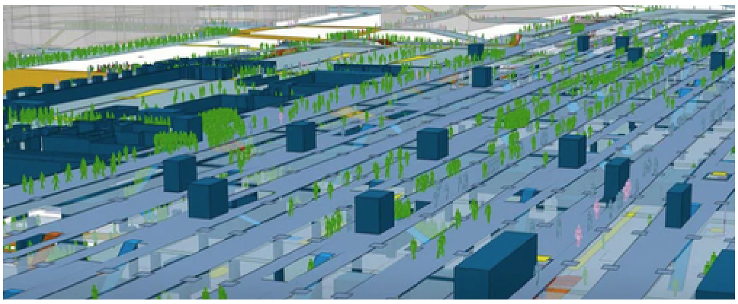
We also tested our wing mechanism, as you can see a key problem was the right wing making contact with the floor which would cause driving difficulty. Therefore we added a simple stopping mechanism which would hit the drive before the wing hit the floor.

ARUP DESIGN TESTING

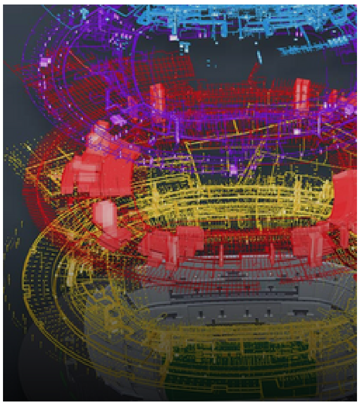
Arup is a key player in the construction of public transport facilities. Therfore it is key to understand how their design would function as a convenient spacious and aesthetic design for the public as shown here.



Consequently, Karan mentioned that due to this they focus on the use of simulation softwares to try and visualize their designs. ARUP decided to use Oasys Mass Motion, crowd simulation software, an industry leading and award winning program used by engineers and architects accross the globe.



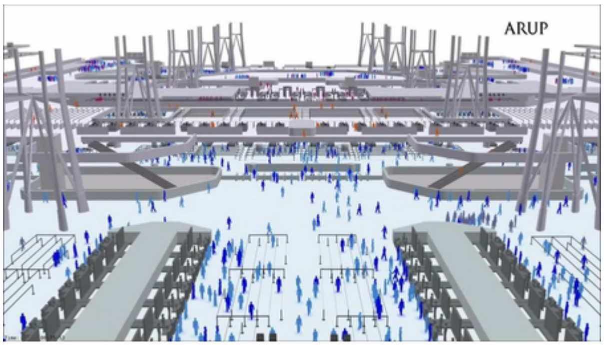
THE TORONTO UNION STATION - CROWD SIMULATION - HIGHLIGHTED ALL FLAWS WITH DESIGN ROUTES AND ANY CONGESTION FORMED



THE LAYERS OF AS ROMA STADIUM- THE ENERGY EFFICIANT COLLOSEUM - INCORPORATING THE INDUSTRIES MOST SUSTAINABLE TECHNOLOGY TO HOUSE 60,000

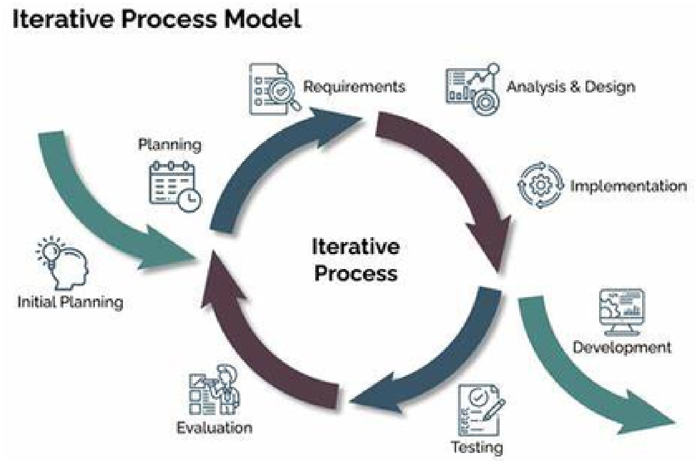
TOUYON INTERNATIONAL AIRPORT TERMINAL 3

A 3D SIMULATION MODEL IN A COLLISION AVOIDANCE - AN ENVIRONMENT TO FULLY ASSESS THE PROPOSED PERFORMANCE OF TERMINAL 3. THE PASSENGER JOURNEY WAS VISUALISED AND DESIGNED IN DETAILED.



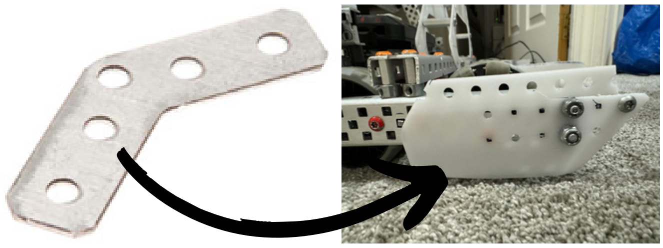
ITERATION

We believe in rapid iteration, drastically improving the overall build quality and features of our robot through rigorous testing. We maintained a constant cycle of improvement which allows us to create the very best vrc program.



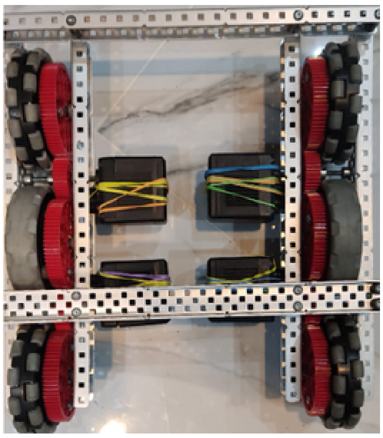
Arup is able to learn from each of its projects, embracing new technology and able to capitalize on new trends like biomimicry in architecture or greener buildings. In fact it took 12 iterations to perfect the sails (Sydeney)

The final AR generation/ iteration of the Milan carbon-neutral project

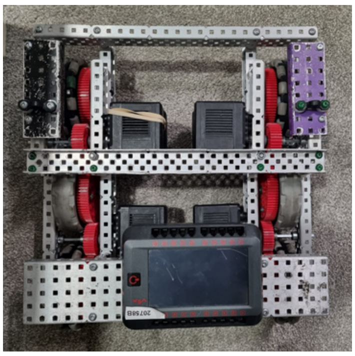


New more effective delrin sleds

Sprocket flywheel (more effective than a geared flywheel) + Larger wheels means larger force (moments)

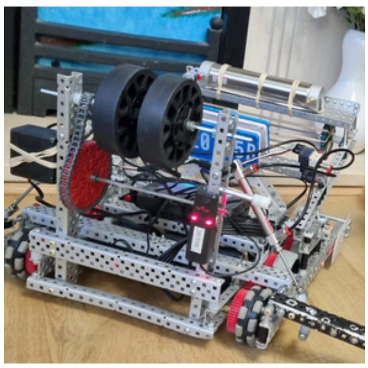


Coventry Regional



QE Regional

Now



HOW VEX HAS HELPED US?

VEX has tremendously helped us, making us more equipped to work in small teams in a professional and organized while also also instilling us with importance of design iteration.

Critical thinking - the ability to analyze, evaluate and reason are essential in careers, and this is exactly what VEX forces to help challenge complex engineering problems

It is essential in careers to to effectively communicate to share and promote ideas while closely working with your team to create thoughtful and holistic solutions. VEX instills close teamwork in all

To progress in a career, it is essential to come up with new ideas and products, exactly which is what VEX forces us to do. VEX forces one to think about new ways of challenging an evolving problem.

Willing to consider new ideas without being prejudiced to help come up with better products is key in both VEX and in careers, both in STEM/engineering but also other careers

CRITICAL THINKING | **BOOST COLLABORATION** | **FOSTER INNOVATION** | **OPEN MINDEDNESS**

VEX SKILLS

- EFFICIENCY IN RESOURCE USE
- REDUCE PROJECT COSTS
- MEETING DEADLINES
- COMMUNICATION SKILLS
- MANAGING PEOPLE
- CONFLICT MANAGEMENT