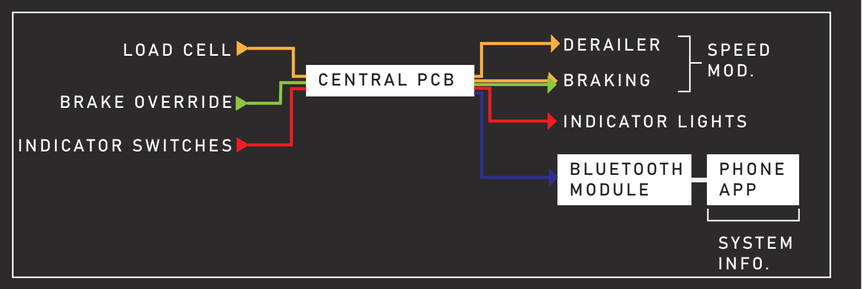
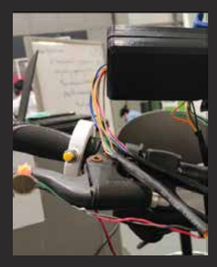
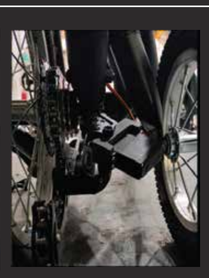
THE ELECTRONICS



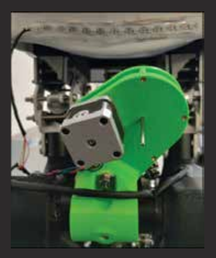


FORWARD CONTROLS



AUTO GEAR SHIFT

CENTRAL PCB



AUTO BRAKING

SPEED MODERATION & SAFETY

gaigai eliminates the need for the elderly or PWD to regulate their pedalling speed by automatically moderating their output through gear shifting and braking.

The result is physical engagement without worry - the ability to cycle in tandem without the hassle of having to match the pace of the forward rider.

HOW IT WORKS

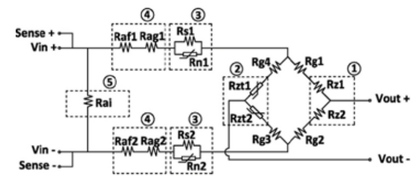
Differences in pedalling speed between the user and forward rider are detected as tensile or compressive stress on the towing arm of the trailer. This information is computed by a central microprocessor, then used to actuate an automatic derailer and rim brake system, moderating speed

CIRCUIT DESIGN UTILISING 30.002 - CIRCUITS & ELECTRONICS

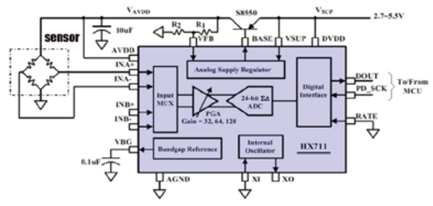
Understanding of fundamental circuit components allows the design of efficient and effective circuits.

Multiple components were considered for use in detecting stress in the towing arm, but the wheatstone bridge load cell was selected for having appropriate sensitivity and high maximum load.

1. Load cell circuit



2. Load cell amplifier



However, the load cell output is small, and requires amplification, achieved with an op-amp circuit.

Finally, backup power to save data such as gear state is provided with a supercapacitor, as it provides suitable energy storage without needing an external charging circuit. A 1F capacitor was chosen to keep the microprocessor running for 3 seconds.

gaigai

GRP 04

BIKE TRAILER FOR ALL

THE PROBLEM

Obesity is a prevalent condition amongst the elderly and people with disabilities (PWDs), with as many as 56% of PWDs not engaging in physical exercise at all.
This project proposes that leisure cycling as a form of daily travel can be employed as an appropriate exercise for them.

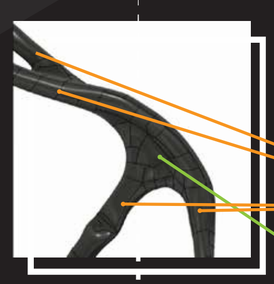
Thus, the project scope can be defined:
Designing an **inclusive**, **comfortable** bicycle trailer that allows active **physical participation** of the **cycling** process for seniors and PWD to improve their physical and mental health in parks

THE CHASSIS

Seeking to accommodate everybody creates complex challenges; factors such as high payloads require bulky structures, whilst complex geometries from varying the pedal distance and practical size limits restrict them. Add ergonomic considerations such as easy boarding access and fixed seat heights, and the chassis becomes nigh impossible for a human to design.

THE APPROACH

Thus, to navigate complex requriements, gaigai uses a frame created using generative design - a computer optimised chassis. A novel generative-to-parametric process is then used to simplify manufacturing - keeping the weight and strength benefits of the generative mod el at a fraction of the price

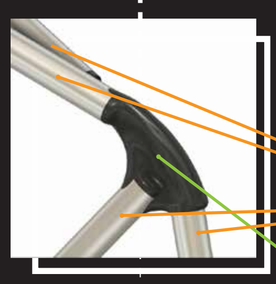


IDENTIFICATION OF 'NODES' & 'EDGES'

GD Model can be interpreted as a Graph, with nodes and edges

EDGE

NODE

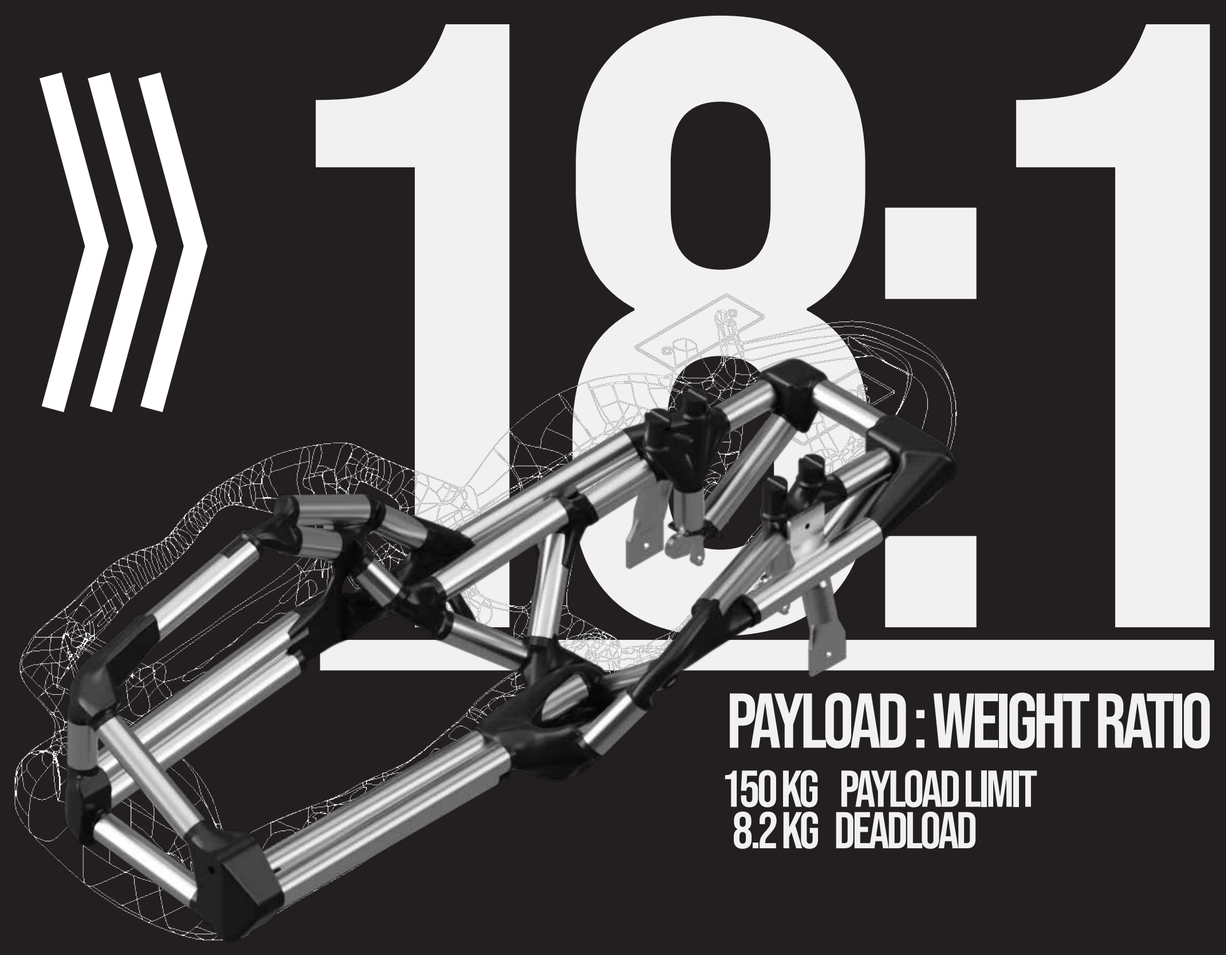


CONVERSION TO JOINTS & BEAMS

Edges are converted to aluminium pipes where possible, and nodes that cannot be converted remain as monolithic units

AL BEAM

CF NYLON JOINT



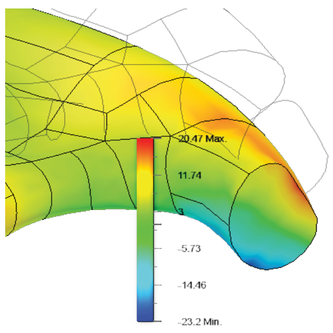
FURTHER WEIGHT SAVING UTILISTING 30.001 - STRUCTURES & MATERIALS

The generative software utilised, Autodesk Fusion 360, often fails to converge to the desired safety factor, resulting in an overengineered structure with as SF of 7+.

To compensate for this, gaigai exploits Fused Deposition Modelling (FDM) 3D Printing's propensity to create porous parts.

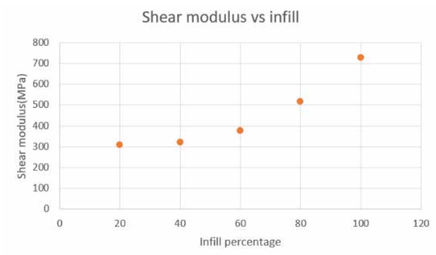
By understanding the how infill density affects bending mechanical properties of carbon fibre nylon, infill density may be calibrated to reduce the SF of a structure and save material.

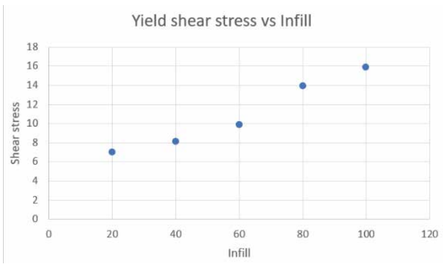
1. IDENTIFICATION OF DOMINANT LOAD TYPE



(Segment stress distribution consistent with dominant loading being bending)

2. 3-POINT BEND TEST ON VARYING CF-NYLON INFILL DENSITIES

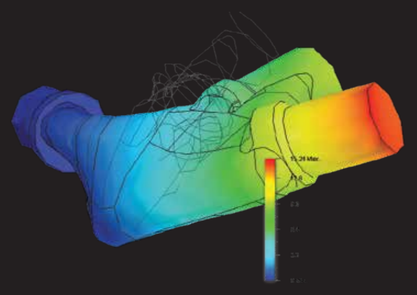




CONCLUSION

Linear relations between shear modulus and infill density, as well as yield strength and infill density.
Therefore, required infill may be interpolated using ratio of desired SF over generated SF. As desired SF is 2 and generated SF is 7.5, an infill of 30% is used.

INTEGRATED SUSPENSION



Natural flexibility in the carbon fibre nylon joints eliminates the need for suspension; allowing the entire chassis to dampen and absorb shock equivalent to a 22.8kN/m spring.

COST SAVINGS

$1228 MONOLITHIC GD MODEL

$518 CONVERTED MODEL

Without even considering cost savings from simpler fabrication, the converted model reduces the usage of expensive carbon fibre nylon by 67%, using cheap aliminium pipes instead and allowing a 58% reduction in material cost alone.