Ukiyo

10 Page Summary

THE GLASGOW SCHOOL OF ART

University of Glasgow

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Ukiyo: Product Overview

Who

18-67 year olds working from home in the UK.

What

A dynamic workspace converter.

When

It is recommended that users switch their workspace between sitting and standing every 30 minutes.

Where

From small apartments with minimal storage space to luxurious home office spaces.

Why

To reduce inactivity and prevent the onset of musculoskeletal disorders.

Ukiyo: The Problem

"One of the best things we can do is to alternate between sitting and standing throughout the day"

- Magaret Hanson

Expert Insights

The initial aim of this project was to determine how the posture of those working from home may be improved, however engagement with key stakeholders highlighted the root problem. Professors of Physiology and Physiotherapy, Ergonomists, Evolutionary Anthropologists and Yoga Instructors advised the **key to reducing back, neck and shoulder pain is movement, not posture**. Research literature supports this, suggesting back pain is not a consequence of poor posture. Inspired by insights, the project aim was to **encourage people to move more throughout their working from home day**.

User Insights

Initial user insights from interviews highlighted that users **do not like sitting down all day** when working from home. A recent study commissioned by Nurofen has shown that lockdown has caused a rise in aches and pains – with **over one third of British people experiencing back, head and joint pain**. Out of participants, 25% blame their new pain on their **poor home office or workstation set-up.** On the market today, exists a wide range of different home office solutions, however, upon analysis, user research concluded that existing solutions are either **too bulky** and space consuming or **do not fit in aesthetically** with the users' home environment.

Brief

Design a platform to allow users to switch their workstation between sitting and standing throughout their working from home day.

Collaboration

GCU Glasgow Caledonian University

1495 University of Aberdeen

Wilkhahn

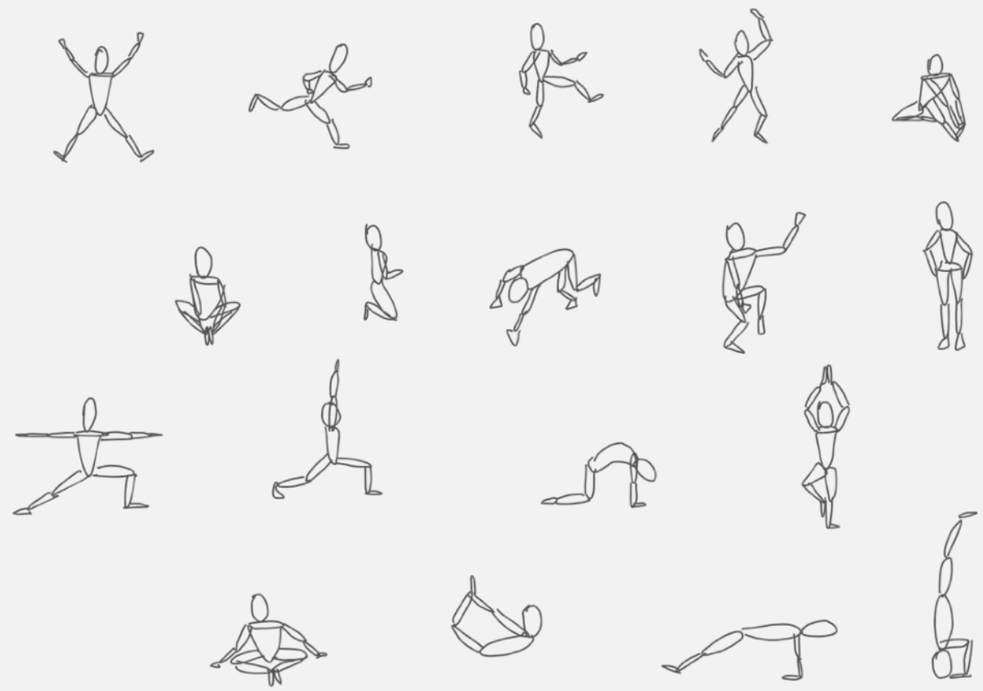
WorksOut ergonomics for workplace health

University of Glasgow

Shanti Yoga & Massage

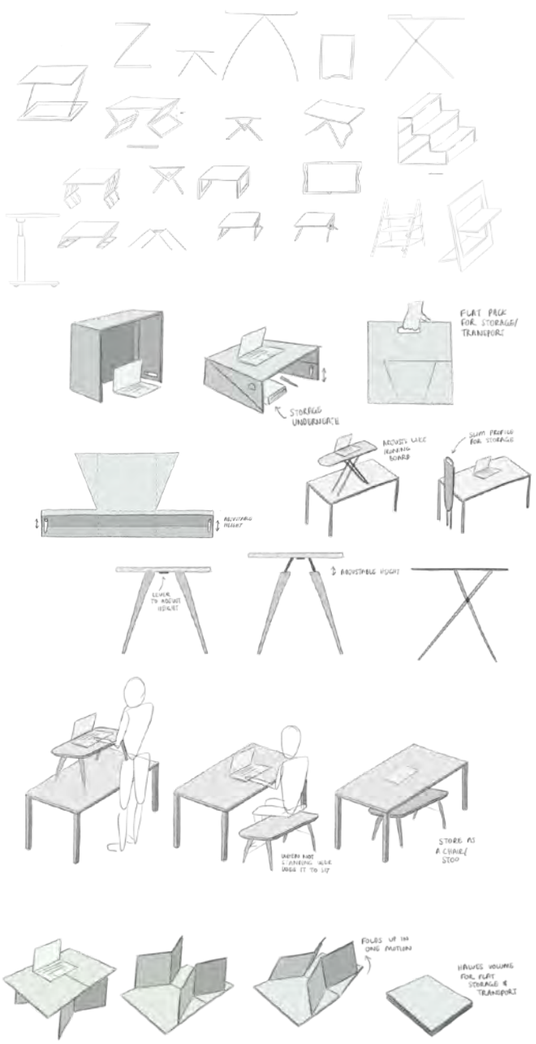
Duke University

Movement



Ukiyo: Iterative Design

2D Ideation



3D Development

3D prototyping was a core tool used throughout the design process to drive the development of the final product. Scale modelling and user feedback allowed for **quick decision making and rapid iterations**, developing the most **feasible and appealing user experiences**. The key areas explored during the 3D development were:

-Folding mechanism

-Stability

-Aesthetics

-Height adjustability

-Anthropometrics

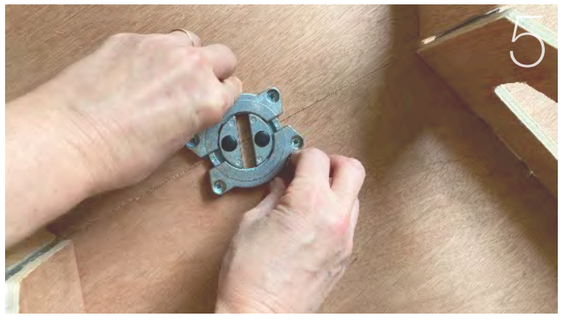
-User feedback

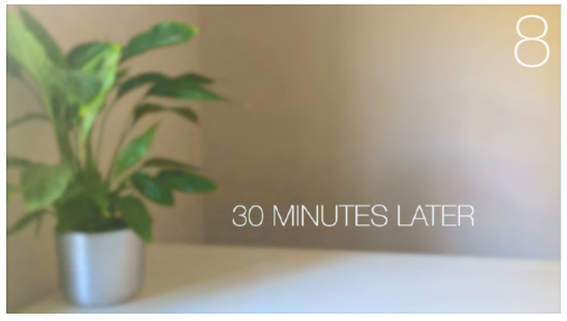
-Materials and manufacture

Initial concepts were evaluated against product requirements. As the design matured, iteration direction was based upon functional requirements and user feedback.

Ukiyo: User Journey

How is it used?





Ukiyo: Human Factors

A wide range of different human factors methods were selected and used at relevant stages in the design process. Constant, active user engagement was critical for the development of a product fit to the users' needs. The selected user group were **18-67 year olds working from home in the UK**, based upon user access, current working age range and preventative health age group.

Height Adjustability

One of the core investigations from the beginning of the project was whether height adjustability is a requirement. It was important to devise whether the product would need to have a range of incremental height settings to fit the needs of the 5th to 95th percentile of users. To determine this, anthropometric data research, co-design and user testing were conducted. It was concluded that there would be two heights that would be comfortable in the form of a **S/M** size and a **M/L** size with heights of **264mm** and **404mm**, respectively.

Surface Dimensions

it was important to establish table surface dimensions that were suitable for a range of different users and working environments. Through an analysis of existing solutions on the market and the dimensions of the tables and desks users currently work at, different platform dimensions could be determined. The table surface sizes for the S/M and M/L platforms are **710 x 649 mm** and **900 x 745 mm** respectively. These dimensions were tested with users to determine their suitability.

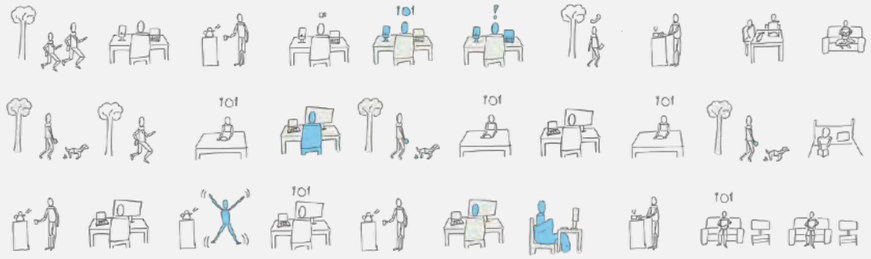
Weight

To determine the maximum permissible force required to lift the product with one hand, anthropometry tables were used to determine the 5th percentile of 65 to 69 year old female right hand gripping force capabilities. The result was **13kg**, requiring the weight of the product not to exceed this, enabling ease of transportation and storage for all users. The **final product weights are 4.12 kg for the S/M and 6.3 kg for the M/L**.

Storage & Assembly

Early testing of initial prototyping highlighted the problem of timely user assembly. It was therefore very important to reduce the amount of time required for the user to erect and lower the platform during use. A **paper pop-up inspired V-fold mechanism** fits the requirements of the product with its **ease of assembly, disassembly and flatpack nature, making it easy to store**.

Methods



Interviews & User journey's to highlight pain points

Anders

Personas

Home working Posture

Workspace Audit

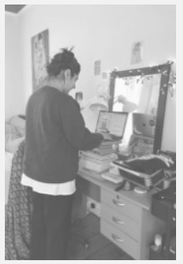
Anthropometrics

Storage Audit

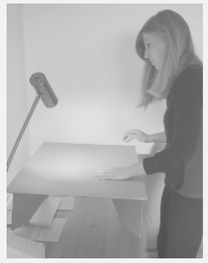
Workstation Footwear

Co-design

User Feedback 1



Height Testing



User Feedback 2

Dimensional Feedback

User Feedback 3

User Feedback 4

User Feedback 5

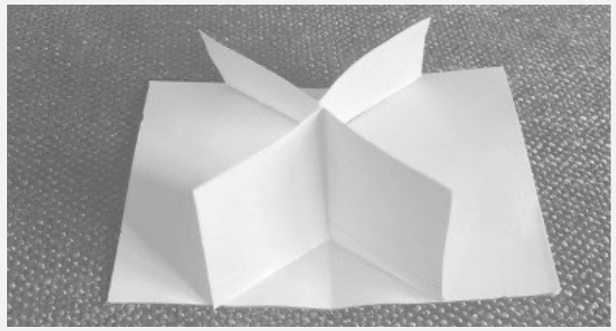
Ukiyo: Pop-up Structure & Stability

Pop-up Structure

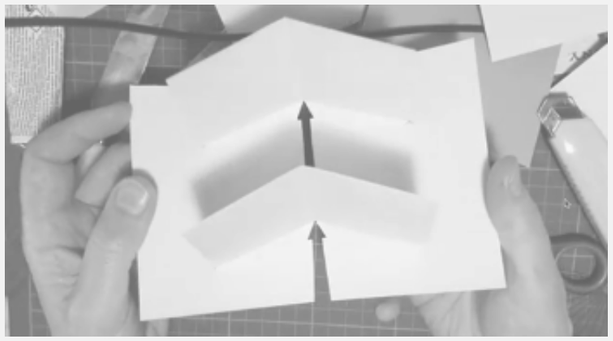
The product pop-up concept uses a V-fold mechanism, fitting the user ***storage*** requirements and creating a **delightful, satisfying** user experience. However, complexity arose when this concept was translated to material with a thickness greater than regular craft card. Further research and co-design experimentation showed that the same spherical motion of the v-folds could be obtained with **two indirectly coupled top-surfaces**, overcoming the problem of thicker materials. The lack of need for an additional hinge in between these two surfaces **simplifies the design** as well as potentially simplifying the manufacturing process. With this however, comes reduced stability.

Stability

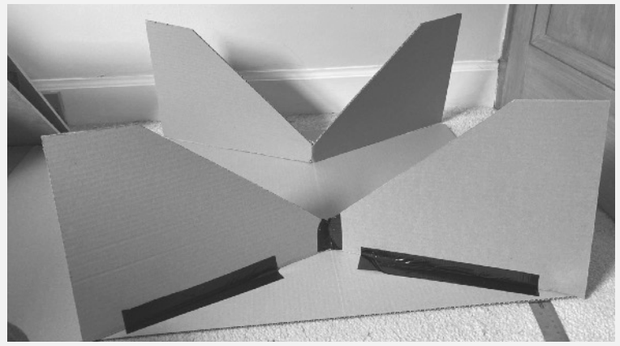
An important consideration throughout the whole development process was product stability. This problem was highlighted very early on in the initial prototypes. As the design matured, integrating stability into the pop-up concept was an increasing challenge. Various stability methods were explored, from aluminium sliders on the top surface to leg brackets. The final solution uses a **robust under-table locking mechanism** which is **easy to use** and **discretely hidden from users** during use. Additionally, the **legs** of the structure have been **extended out to the corners** of the top surface and **splayed at an angle of 10°**, enhancing product stability when in use.



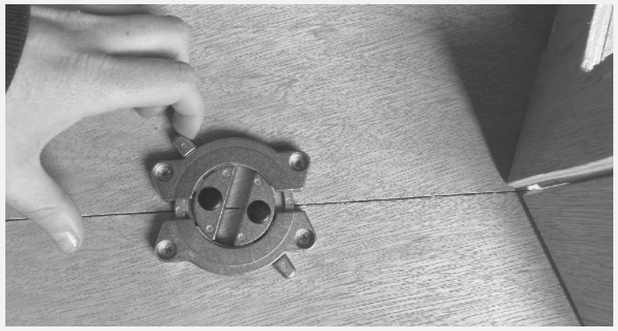
Initial pop-up concept



Codesign: Pop-up with indirectly coupled top surfaces

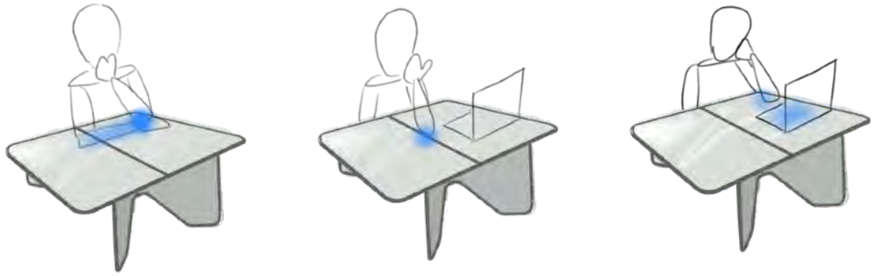


Prototyping leg splay



Testing under-table locking mechanism

Ukiyo: Stiffness & Deflection



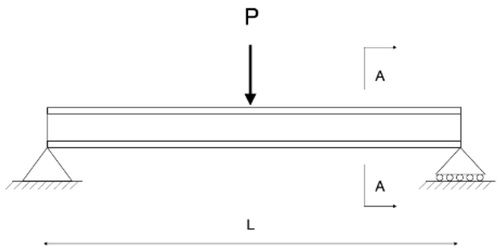
1 Point Load : 20kg + Distributed Load : 5kg

2 Point Load : 30kg

3 Point Load : 30kg + Distributed Load : 3kg

Light, Stiff Structures

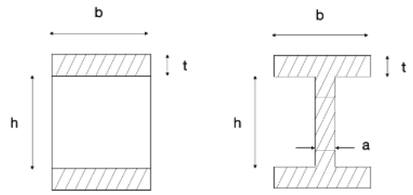
The product material must be light, whilst retaining strength and stiffness to prevent the surface from deflecting in use. An investigation into **light, stiff and strong materials** was undergone. Honeycomb has **superior bending stiffness** qualities to I-beams, however a **material thickness of 62mm** would be required, **exceeding the maximum folded product thickness**. Additionally, the honeycomb manufacturing process is detrimental to the environment. As a result, sheet wood materials were investigated, with plywood concluding to be the most suitable compromise between stiffness, weight, price and environmental impact.



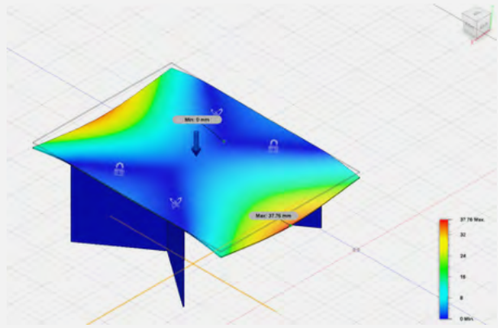
Beam Bending edge of a desk converter

Material & Geometry Refinement

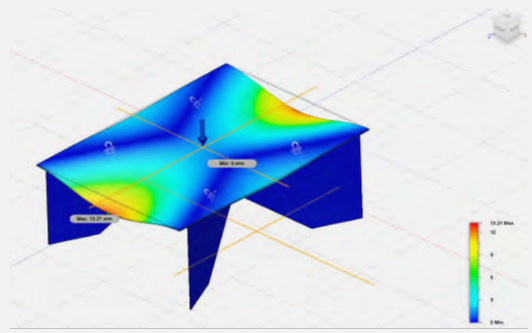
FEA was a key tool throughout the project, used to identify weaknesses in the product structure, minimise deflection and to verify material choice. The required plywood thickness is **9mm**, ensuring the **maximum deflection** that the product should see under worst case loading is **2.3mm,** within BS ISO 21016:2007 requirements. The geometry was refined by performing, FEA on the legs of the product, concluding that the **minimum leg widths should be 30mm and 40mm** for the S/M and M/L sizes respectively, reducing the total product weight by almost 1kg for each size.



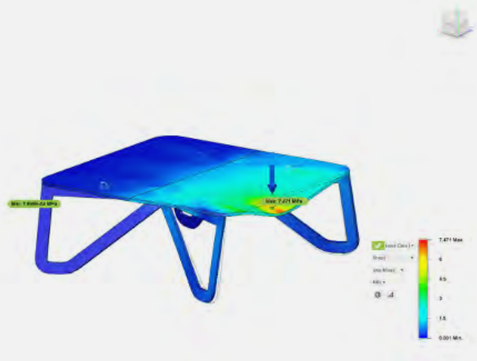
Cross section of Honeycomb & I-beams



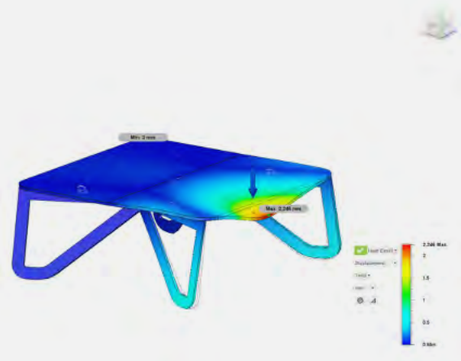
Maximum Deflection with a 30kg Point Load



Modified Maximum Deflection with a 30kg Point Load



Maximum stress in 9mm Plywood with 30kg point load



Maximum deflection in 9mm Plywood with 30kg point load

Maximum Stress in 9mm Plywood with 30mm leg width and 10kg point load

Maximum Stress in 9mm Plywood with 25mm leg width and 10kg point load

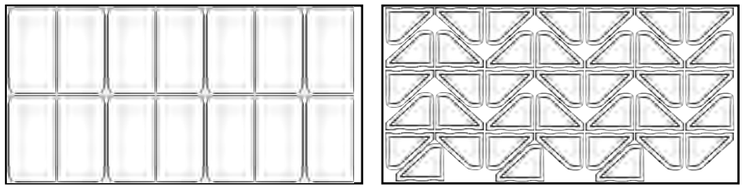
Ukiyo: Defining & Detailing

Plywood

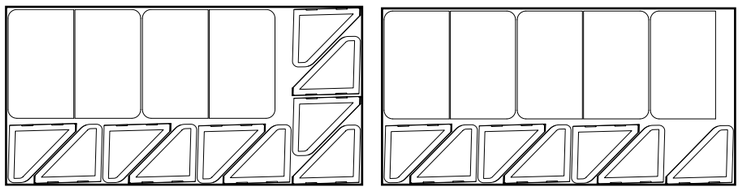
User studies conducted throughout the project have shown that wood is favourable as a material, aesthetically as well as due to environmental reasons. Plywood is a natural material that has been engineered to **reduce warping** in its **thin** form, whilst maximising strength. **Appleply with AA Grade, plane sliced Birch veneer** has been selected due to its strength, light wood Scandinavian aesthetic qualities and **premium surface finish.** For 5 standard 1220mm x 2440mm plywood sheets, **eleven M/L** units will be produced. For the S/M size, it is possible to route **7 top pairs** on one sheet and **legs for 9.5** units on another.

Materials & Manufacture

Appropriate materials and manufacturing methods have been resolved, with a **routed plywood top surface and legs**; **Stainless Steel waterjet hinges**; a **pressure die cast zinc-aluminium alloy top connector** and **injection moulded polyurethane rubber feet** - ensuring the product meets product, user, environmental and safety requirements. Additionally, the plywood surfaces will be painted with **clear matt, wood wax oil** to protect the surfaces for longevity. **Material was minimised** from the structure, reducing not only product weight but also material consumption.



Routing Layout for S/M



Routing Layout for M/L

Plywood

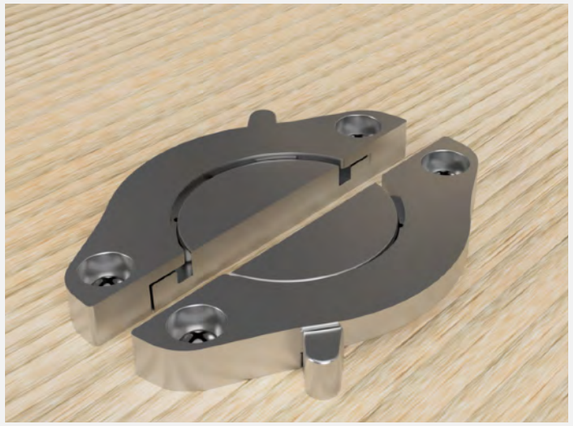
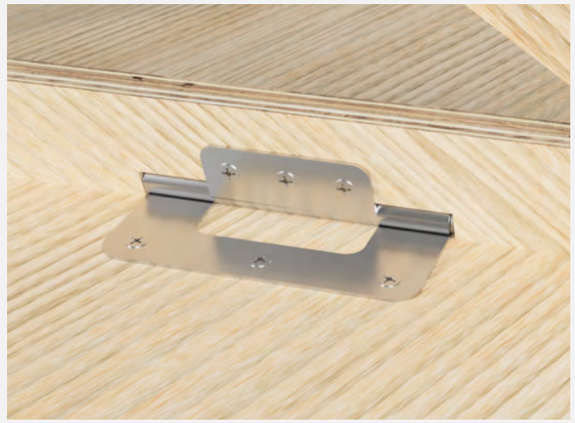


Table-top Connector



Hinge

Rubber Feet

Ukiyo: Assembly

Part No	Description	Material	Finish	Quantity
1	Table Top	AA Grade, Appleply Birch	Clear Matt Wood Wax Oil	2
2	Table Hinge	Stainless Steel, martensitic, AISI 410, hard temper	-	8
3	Leg 1	AA Grade, Plane Sliced, Appleply Birch	Clear Matt Wood Wax Oil	2
4	Leg Hinge	Stainless Steel, martensitic, AISI 410, hard temper	-	2
5	M3 x 5 x 8.5 mm Countersunk Screw	Stainless Steel	-	56
6	Leg 2	AA Grade, Plane Sliced, Appleply Birch	Clear Matt Wood Wax Oil	2
7	Foot Grip	Natural Rubber	-	4
8	M4 x 7 x 12 mm Rounded Head Screw	Stainless Steel	-	4
9	Connector Outer	Zinc-Aluminium Alloy ZA-27	-	2
10	Connector Spring	POM	-	2
11	Connector Inner	Zinc-Aluminium Alloy ZA-27	-	2

Assembly Steps

1. The **table-top connector** is secured in the centre of the top surface with 4 screws in a jig, ensuring accurate placement.All screws used in assembly are M3 x 5 x 8.5 mm stainless steel Phillips Countersunk screws.
2. The **feet grips** are secured into the holes in the wooden legs via a press fit.
4. The **hinges** are secured to each leg with 3 screws in a jig, ensuring accurate hinge and screw placement.
5. The **legs** are then attached to the top surface via the **hinges** with 3 screws, also in a jig, ensuring the correct angle of installation is obtained.
6. The product is folded flat ready for packaging.

Ukiyo: Product Values

Movement

Users now have a tool to create a more dynamic workspace, enabling them to transition their work set-up throughout the day, between sitting and standing. Therefore, reducing the likelihood of experiencing musculoskeletal issues when working from home.

Storage

With its unique, engaging folding mechanism, users are able to easily assemble and disassemble it into a flat-pack state that can be effortlessly stored.

Sustainability

The simplistic design of the product with quality material choice and the use of mechanical fasteners over glue, ensures a robust product where users can easily replace the parts and maintain the product throughout its lifetime.