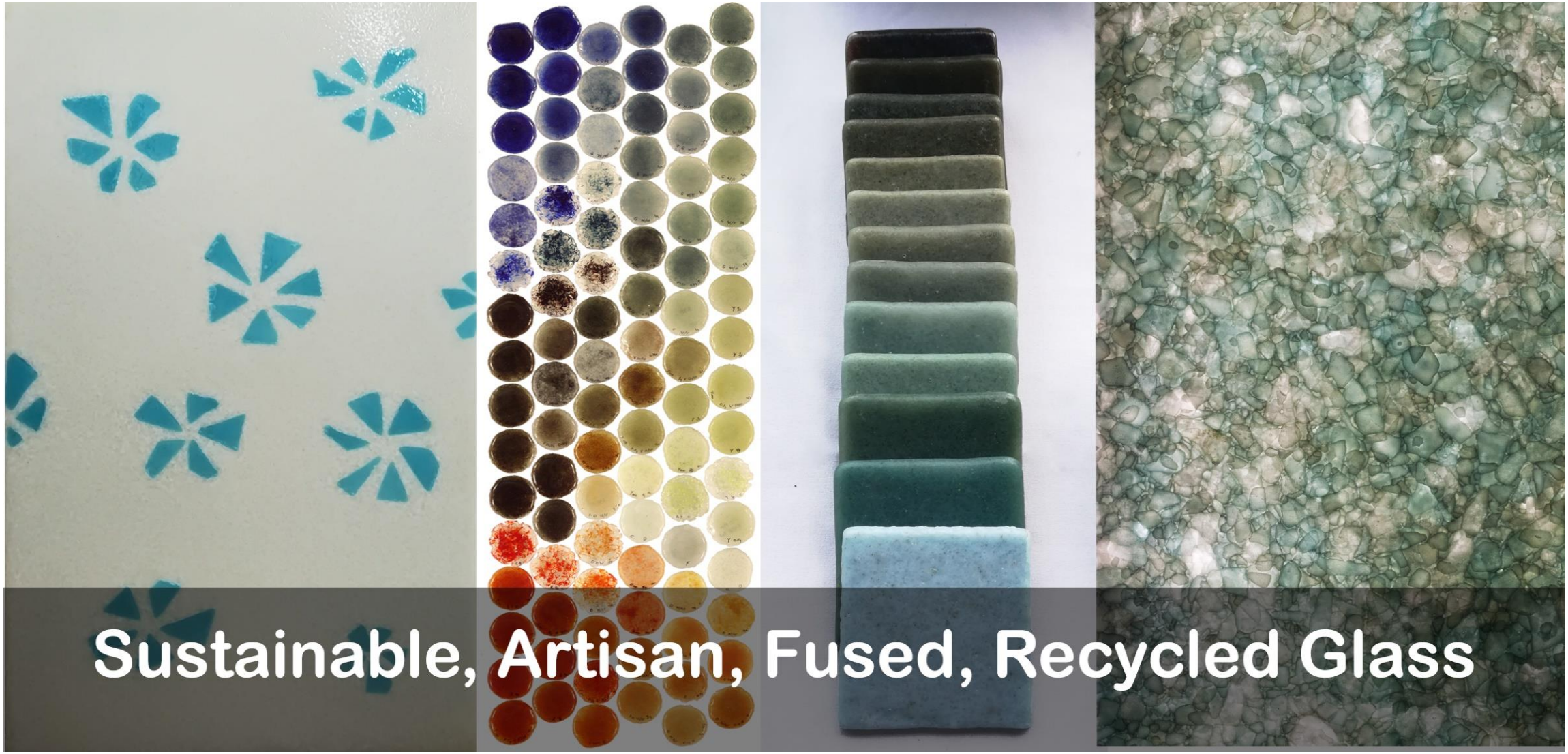
Modern World, Recycled glass

11th February 2020,
UWTSD,
Dr Tyra Oseng-Rees

Oseng-Rees
REFLECTION



Sustainable, Artisan, Fused, Recycled Glass



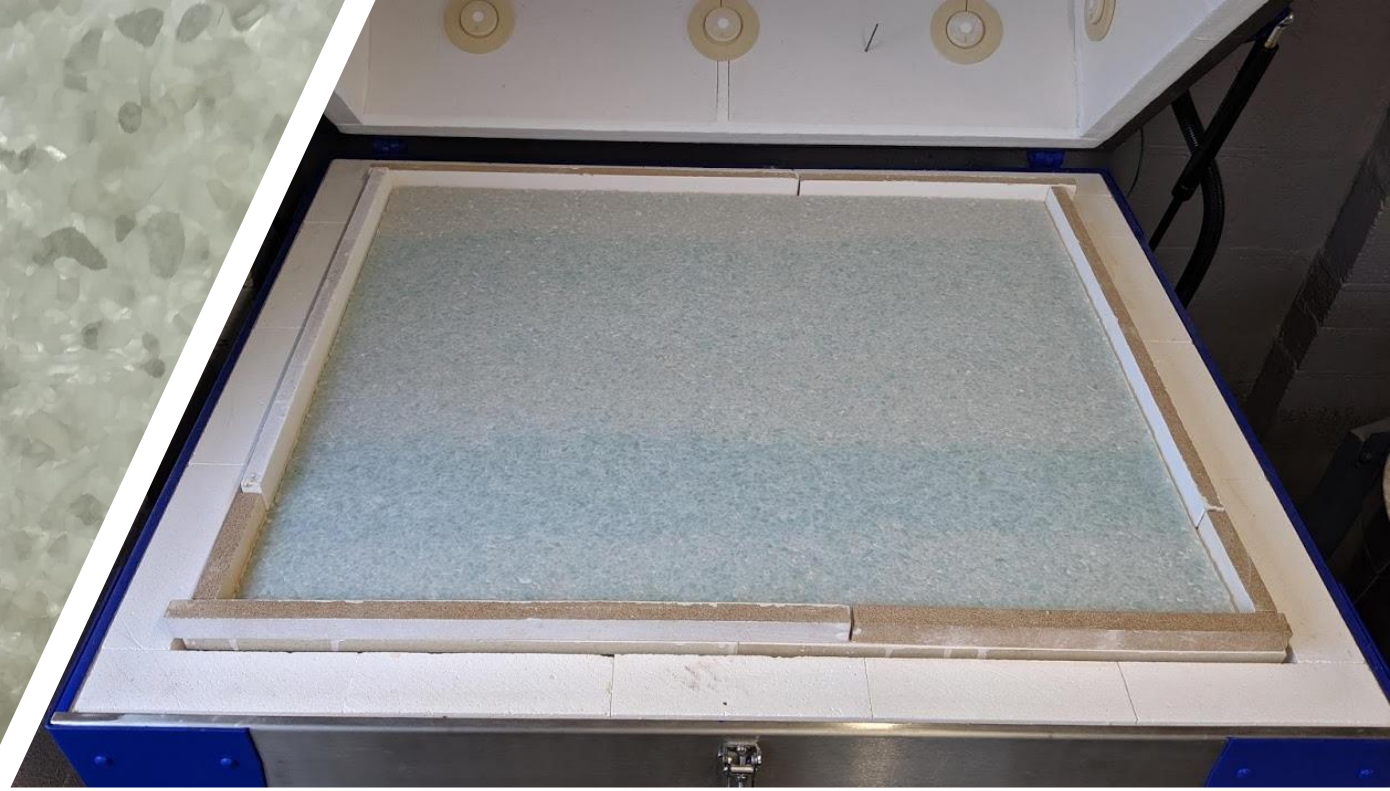

ONLY TRAINED PERSONNEL ARE TO OPERATE THIS MACHINE
Start
Bin Full
Emergency Stop
NO
YES
BABY JAWS
arco





Oseng-Kees
REFLECTION







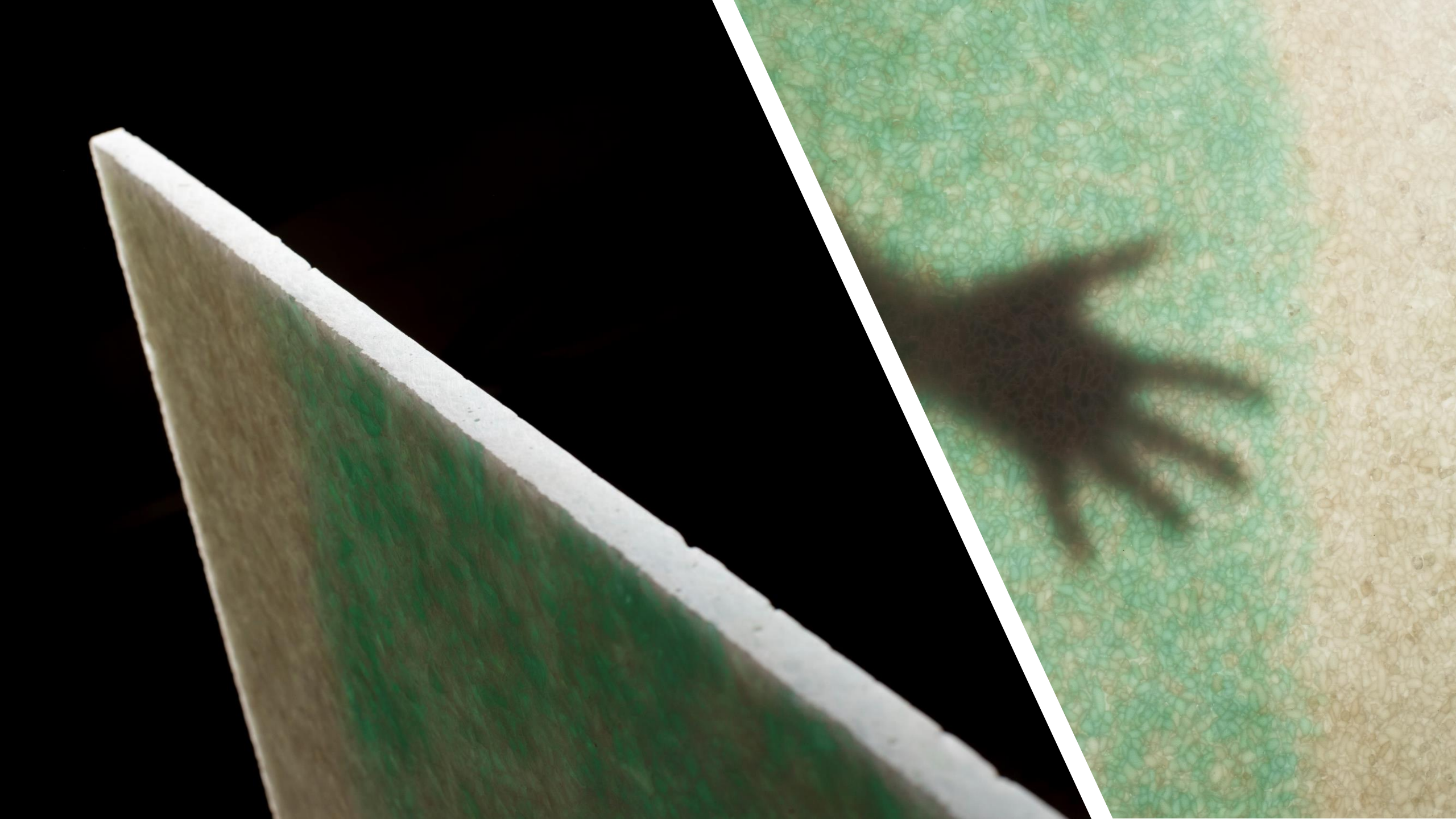


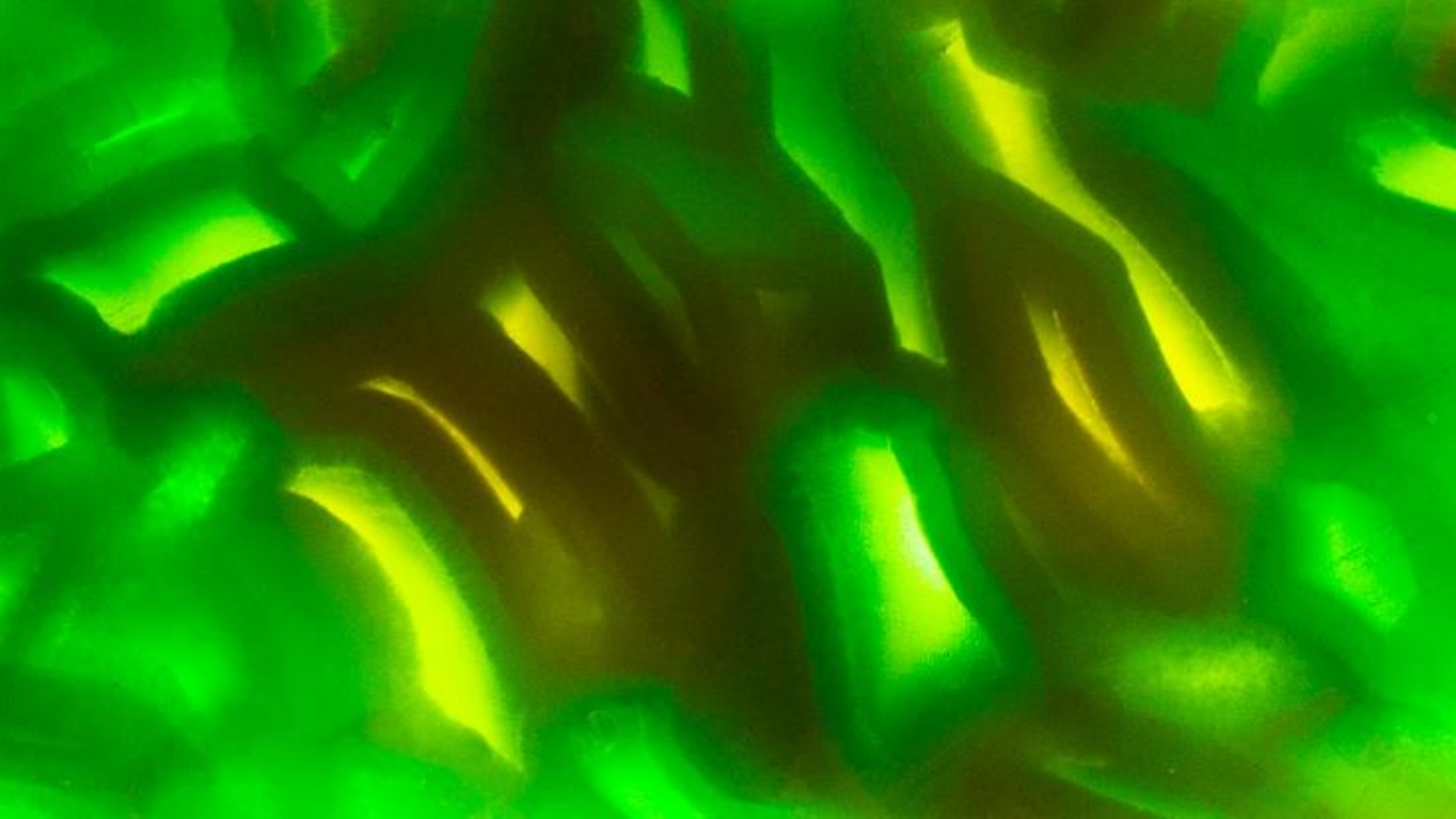


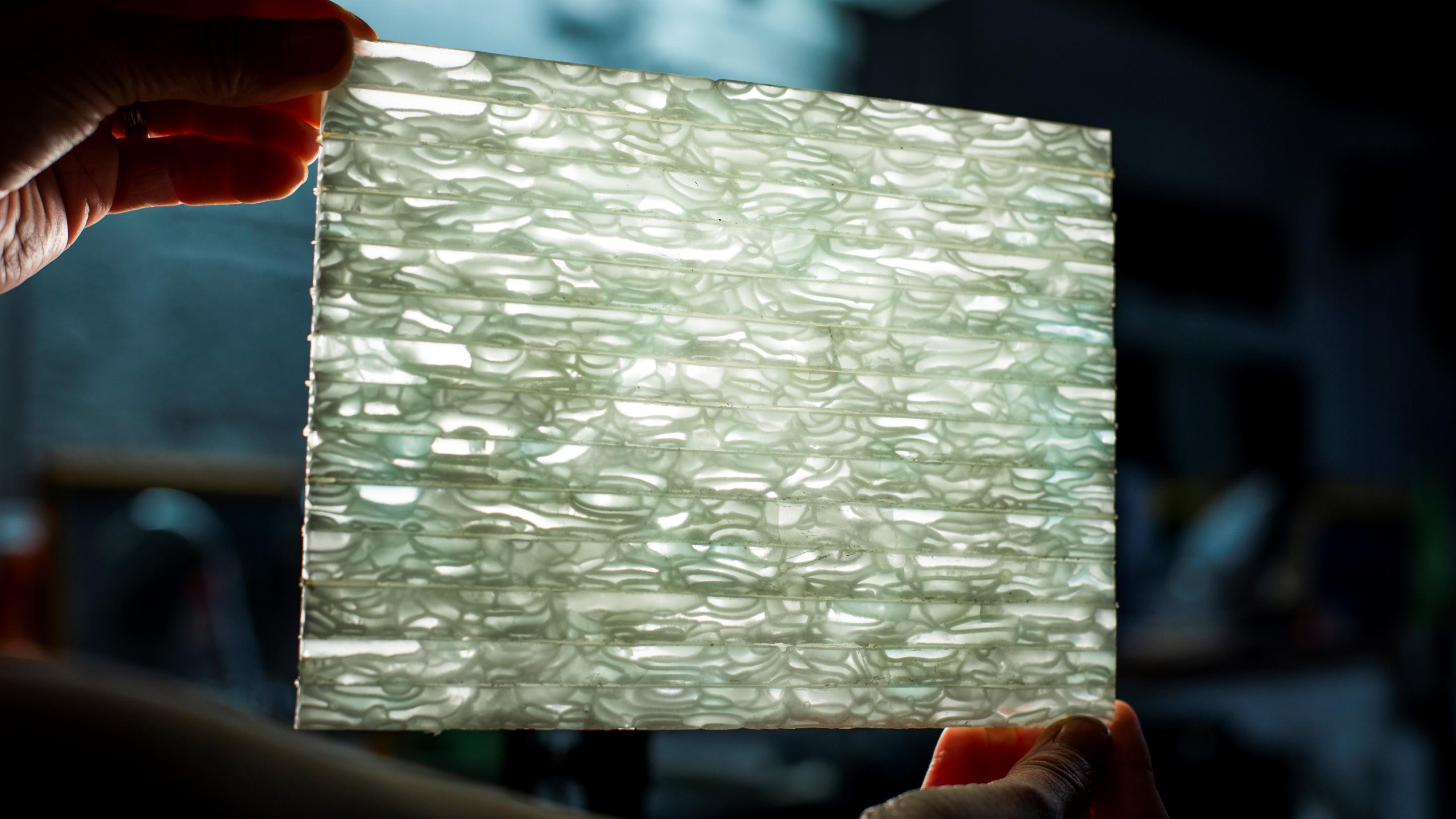












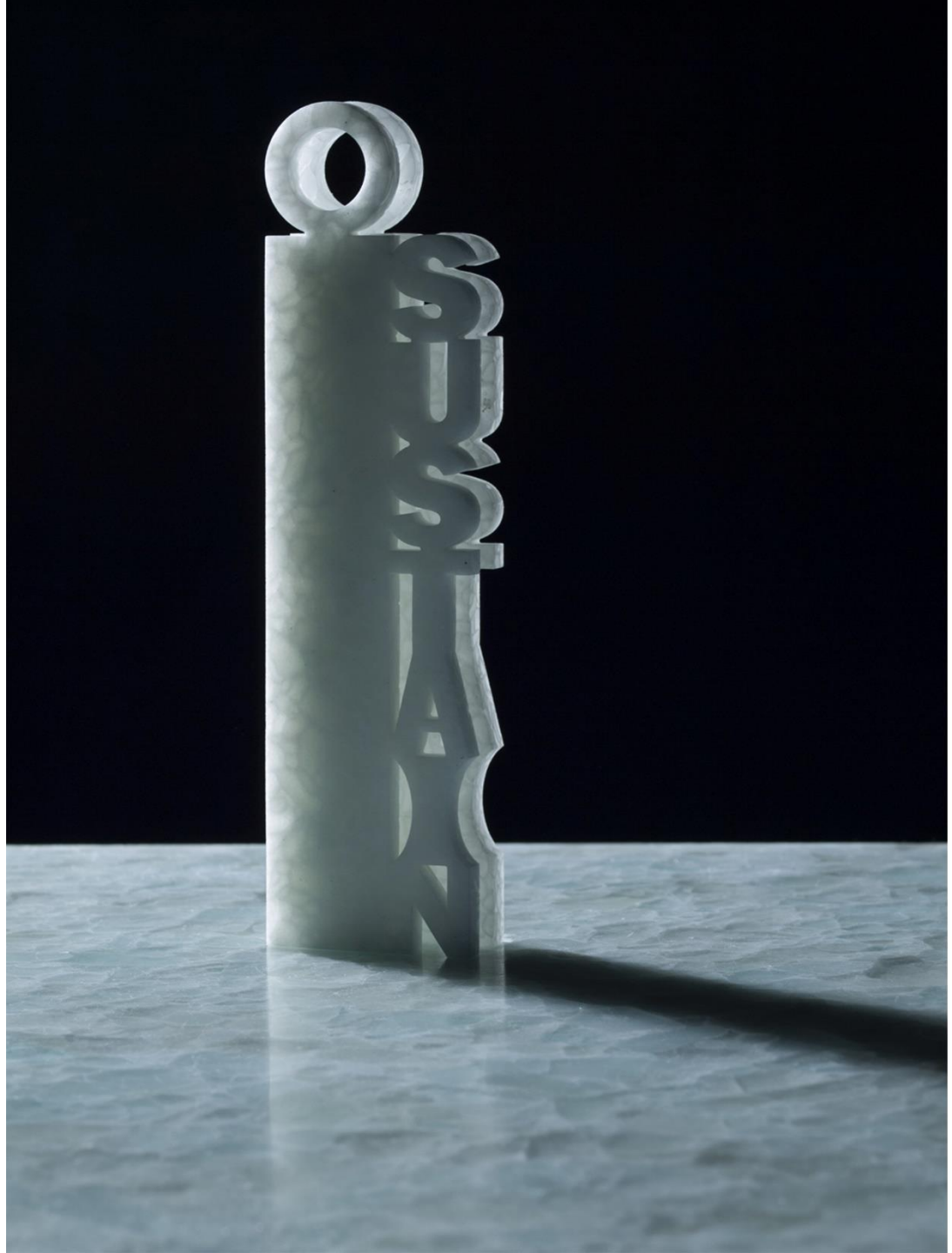



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David






Private Comission
Kitchen Splashback



iSustain 2015 trophy

waterjet-cut recycled glass





Oseng-Rees

REFLECTION




Global Reach & Significance
Public Engagement
Direct Science
Delivered by EPSRC Impact Acceleration Account
Hosted by REIS
Rising Star Early Career
Dr Jenny Baker
Prifysgol Abertawe Swansea University


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Arts, Culture & Society
Hafod Morfa Copperworks
Prifysgol Abertawe Swansea University


Arts, Culture & Society
Hafod Morfa Copperworks
Prifysgol Abertawe Swansea University




Global Reach & Significance
Public Engagement
Rising Star - Early Career
Delivered by EPSRC Impact Acceleration Account
Hosted by REIS
Dr Jenny Baker
Prifysgol Abertawe Swansea University
Oseng-Rees
Reflection


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Prifysgol Abertawe Swansea University


Arts, Culture & Society
Hafod Morfa Copperworks
Prifysgol Abertawe Swansea University



Royal Society of Architects in Wales

Exhibition, Bombay Sapphire panel









~ A story to reflect and communicate ~

Fruit bowl made with glass from an internal door











UK Native Bumblebees





Oseng-Rees
REFLECTION











Oseng-Rees
REFLECTION

MILJØSIDENE

TEKST / ILLUSTRASJON: TYRA

Hva er ordet MILJØ ?
Ordet miljø blir mye brukt i dag.
Det er klassemiljø,utemiljø,innemiljø og
forskjellige slike ting.
I marketsføring av varer er det veldig mange
miljøprodukter.
Så dette tyder på at de fleste er svært opptatt
av miljø.
Det jeg vil ta opp,er mer omm miljø og forurensing.

Lokalt har Saltdal lite betydning for "omværa."
Vi har ikke industri som forurenser noe spesielt.
Men lokalt er det alltid noe å gjøre bdre.
Som f.eks. kloakken under Torrissenbrygga,
som slipper ut urenset kloakk,og kloakken
ved camping plassen som også er urenset.
Vi har en søppelplass som ligger ved elva.
Og der kommer det sivende avfell fra innbyggerne,
også her kommer det urenset kloakk ut.
Men når det gjelder urenset kloakk har jeg og
noen andre tatt et interju av Arne Hals.

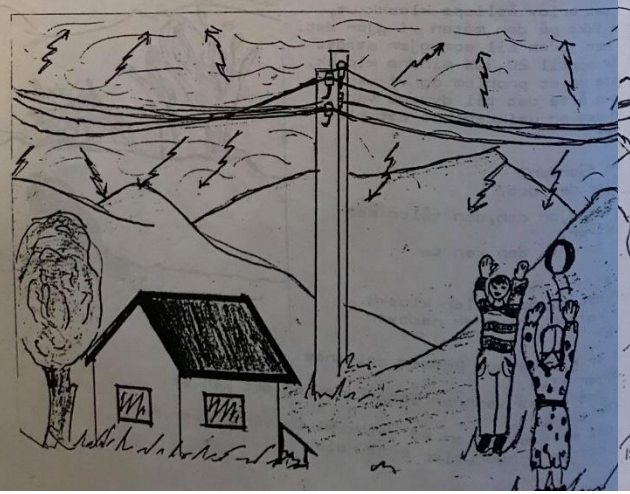
Og her er de.
-Er det lov å slippe ut urenset kloakk ut i
fjorden?
Både ja og nei.
Ja,det erlov åslippe kloakk ut,
men ikke på den måten vi gjør det.
Vi har jo en sil som gjør at det
blir opptil 20-30% mindre kloakk.
Dette er et problem og vi skal
prøve å ta det til dypere vann,
men det er usikkert om det blir
gjort.



-Enn fjorden?
-Tåler den det?
Ja,det gjør den,den tåler mer
ennelver.
Den tar hva den kan ta.

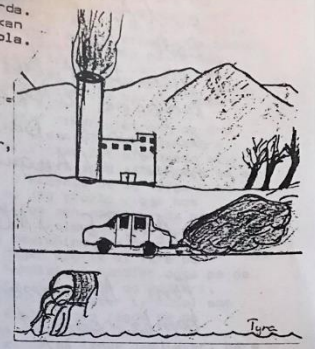
Elva
-Er det søppel eller kloakk
som kommer drivende nedover
elva?
Det er kloakk som kommer drivende
nedover elva.
Men det er et vannrør lenger ned,og det kan se
guffent ut,ja.
Og det er snakket om at det skal ta vannprøver,men
det koster penger,sier Arne Hals.

Tenk deg,en solvakker sommerdag drar noen
ti,elleve og tolvåringer bort i skogkanten
for å bygge seg en hytte de kan være i.
Og der oppdager de at trærne er saget ned,
til og med krokførra og klatretreet
er borte.
Senere fikk de høre at det var noen
folk som hadde saget de ned for å
få ei høyspentledning opp.
Ingen hviste noe om at høyspentledninga
skulle opp akkurat der.
Ja,nå er det ca. et år siden denne
saken ble diskutert og el.verket sa
at det ville være greit om de tok
å flyttet den lengere sør.
Men da de begynte hadde de bare
flyttet den ti meter bortover.
Høyspentledninger vet vi lite om,
men det vi vet er at det er en stor
risiko hvist en blir nær den.
Og likevel skal de sette ei
høyspentledning opp like inntil
byggefeltet på Nygård.



Men i "omværa" har det stor betydning som f.eks.
at ozonlaget er så hullete som en sveitserost.
Og i Afrika og andre steder blir detfødt blinde
dyr pga. at i ozonlaget er det et
hull hvor solstrålene kommer til jorda.
Solstrålene er så farlig at snart kan
vi ikke gå ut uten sikkerhet mot sola.
Vi kan få hudkreft og forskjllige
slike skumle ting.

Så hvorfor må de som sitter med
pengene bare prate og prate og si
:Vi har ikke råd:
Nå må dere bruke de små grå dere har,
og redd jorda vår,den går jo under
om noen år.
Ikke vent på at andre skal gjøre
det,gjør det selv.
Vi som er unge skal jo arve jorda,
ikke overlat alle problemene som
dere ikke klarer å ordne opp i
selv.
Vi vil vel ikke ha de,vi vil
heller ikke ha ei grå og
ødelakt jord.
Vi vil ha ei grønn og
frodig jord.



Så dette sier jeg,og ikke bare jeg,mendet er
både unge og gamle som sier:STOPP!!!
Vi vil ikke ha mer av sur nedbør,solbrennhet,
hudkreft,vond lukt og tungt med å puste.
SLUTT!!!
Slutt med forurense,prøv heller å redusre
avfall.
Ta åsorter avfallet ditt,legg mat i en kompost bak huset
ditt,plast i en pose,papir i en
annen og det som ikke kan
gjennvinnes kan dere kaste
på tippen.
Røyking er både helseskaderlig
for røykere og ikke røykere.
HUSK! Du har krav på
røykfritt spise og
arbeidsrom.

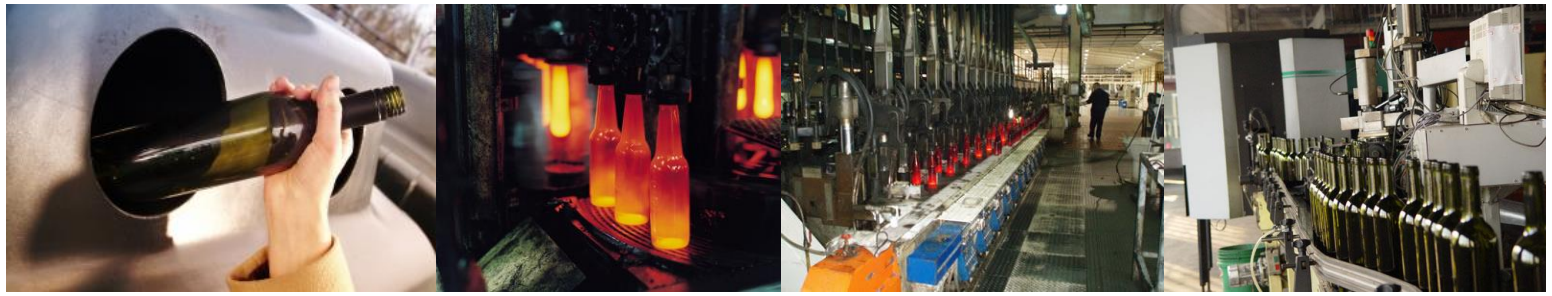


Så til deg som har lest dette
jeg mener,ikke bare sitt der
å glo,gjør noe selv.
Vi har da bare en klode å leve på.
OG til slutt har jeg noen tips
til dere.
* Be folket om å slå av motoren på bilen når
den står i ro.
* Be folket om å ta opp søppelet de kaster fra seg.
* Be mor og far om å sykle på jobben/butikken.
Så dere bruke bilen sitt flere i den,ikke bare
en og en.
* Ta hensyn til ikke røykere.

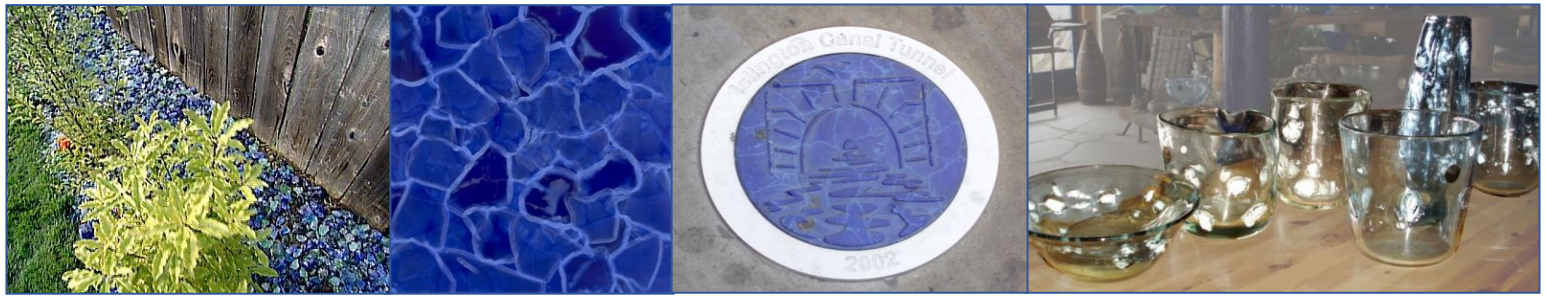
Tyra 12 år, -92

Oseng-Rees
REFLECTION

Circular Economy



Up-cycling



Down-cycling



Oseng-Rees
REFLECTION









Oseng-Rees
REFLECTION

PhD - Physical and aesthetic properties of fused recycled bottle glass

- Research questions…
  - Is it possible to re-produce or mass produce something from fused recycled bottle glass?
  - Compatibility
  - Repeatability
  - Strength/stability of the material
  - Process of manufacturing



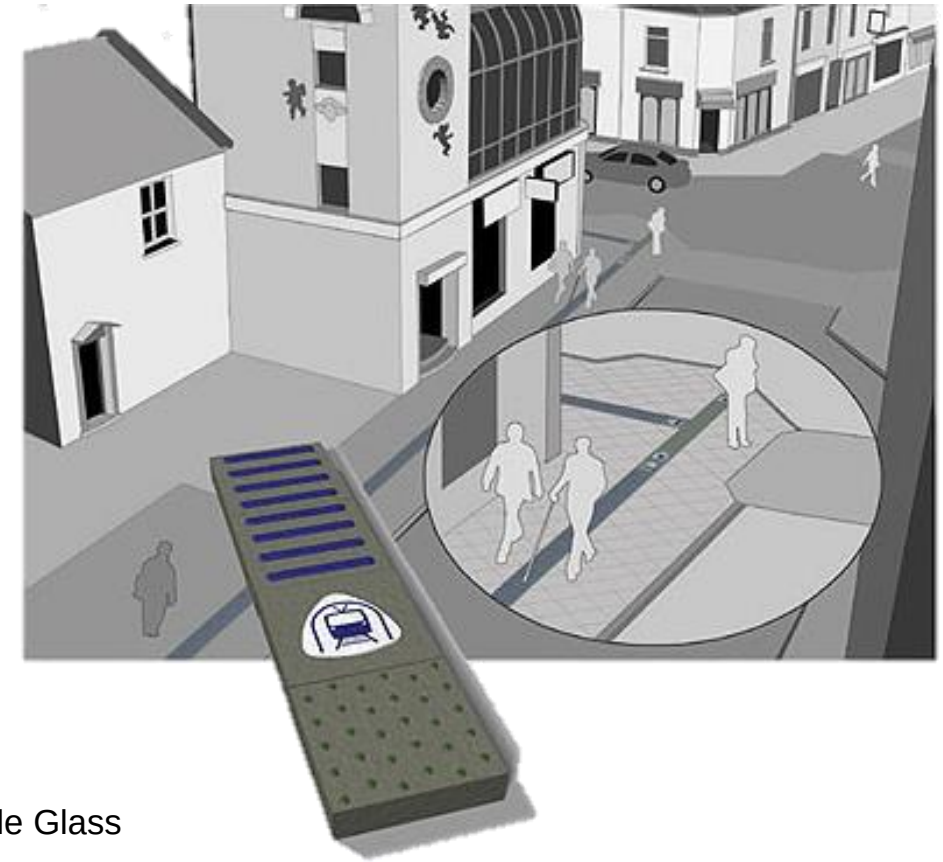


PhD proposal 2004

Recycled glass urban paving

The application?

Tactile paving
Inclusive design
Aesthetic
Materiality
Sustainability





PhD 2009
Physical and Aesthetic Properties of Fused Recycled Bottle Glass

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REFLECTION



The process of working with bottle glass; Fusing/Sintering versus Hot Glass Melt

Temperatures between:

- 800ºC to 900ºC for fusion
- Above 1040ºC for hot glass melt

Fragment sizes between:

- 0-2 mm, 2-6mm, 6-12 mm and above 12mm for fusion
- N/A for hot glass melt







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REFLECTION

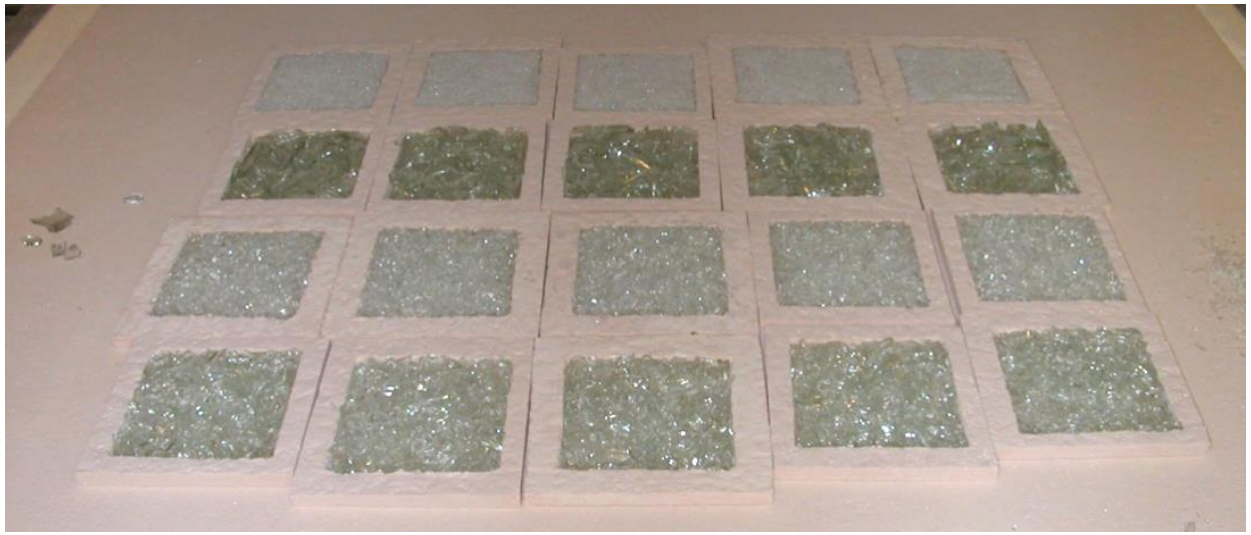
The process of working with bottle glass; Cleaning, crushing, fusing











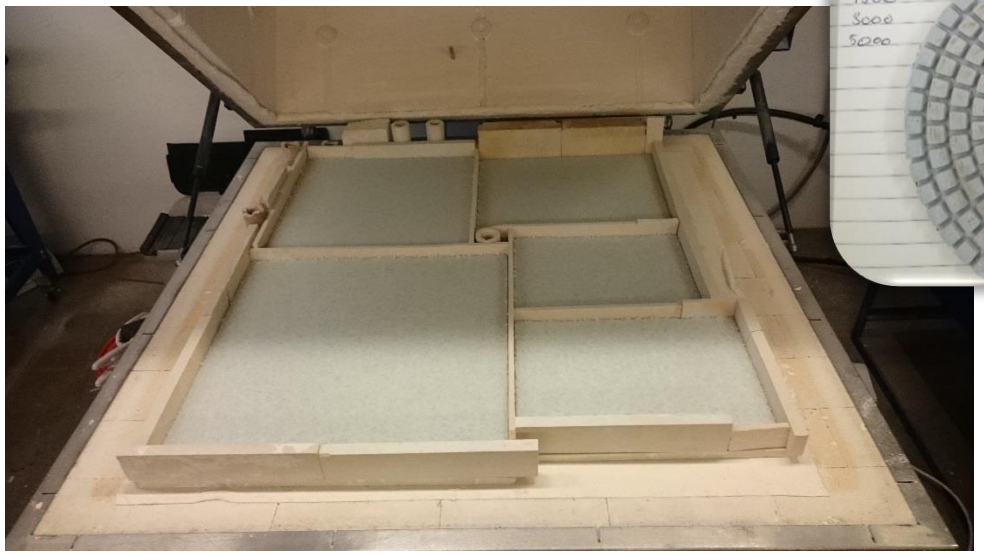
Oseng-Rees
REFLECTION

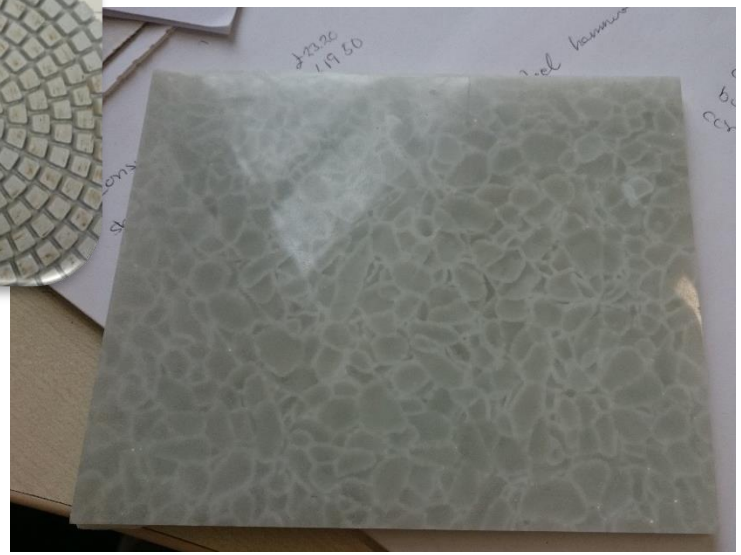
The process of working with bottle glass;
Fusing and cold working



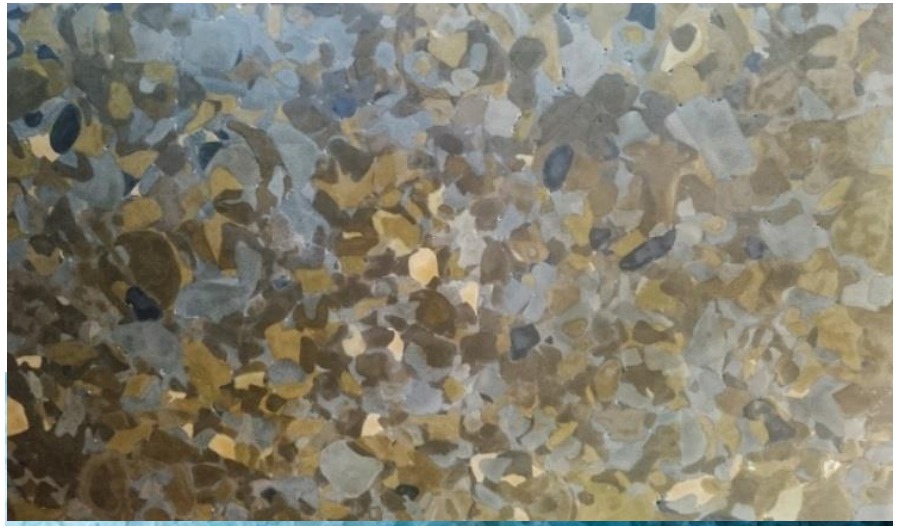






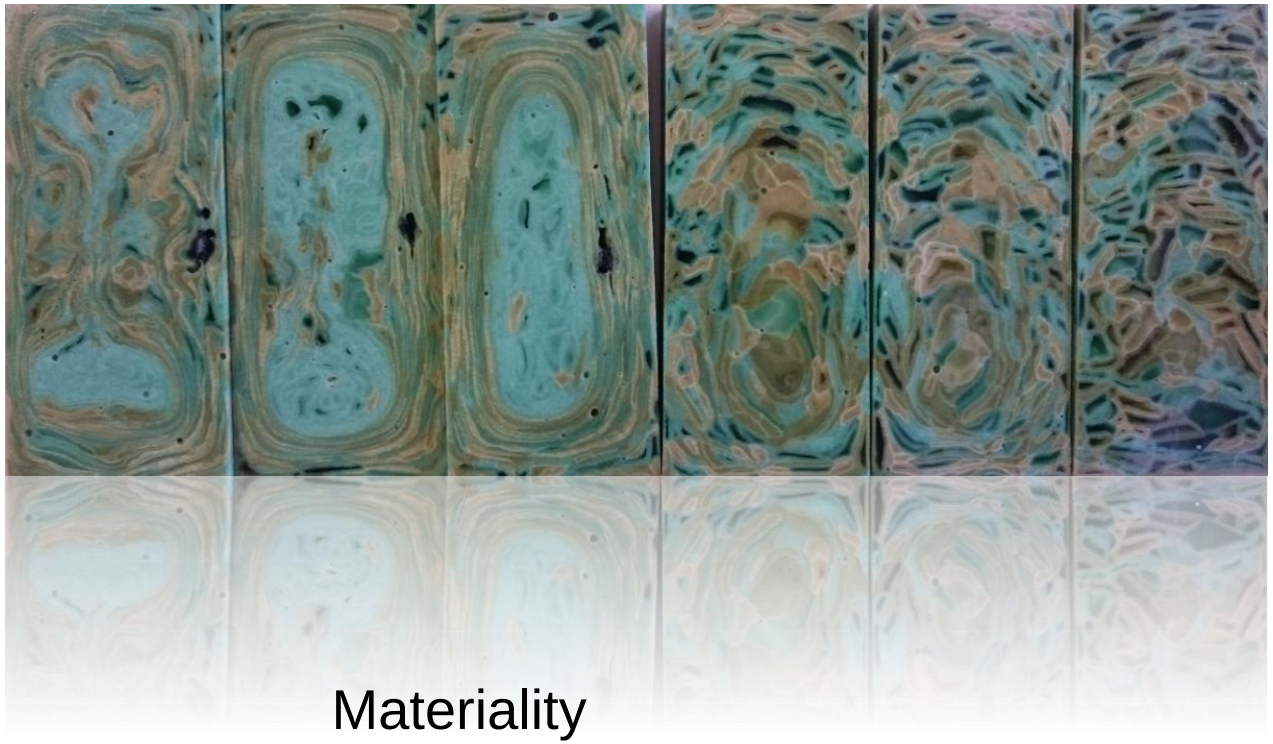


Oseng-Rees
REFLECTION

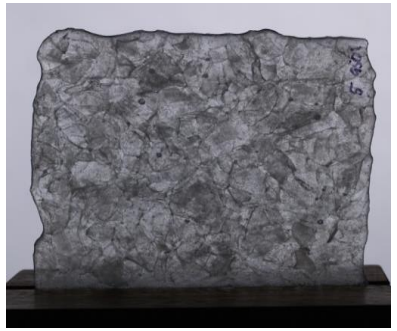








Materiality







Oseng-Rees
REFLECTION

The process of working with bottle glass; Colour

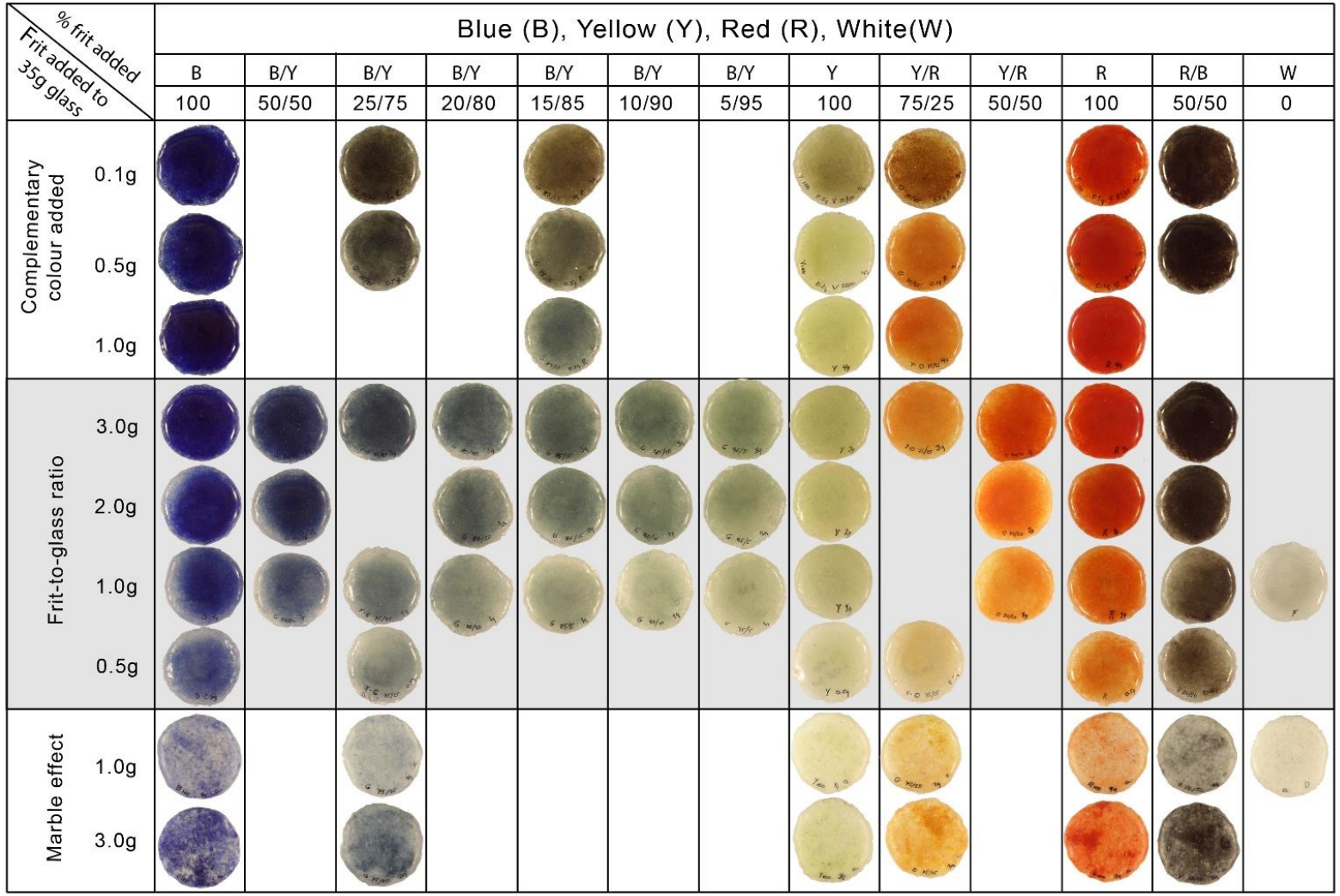






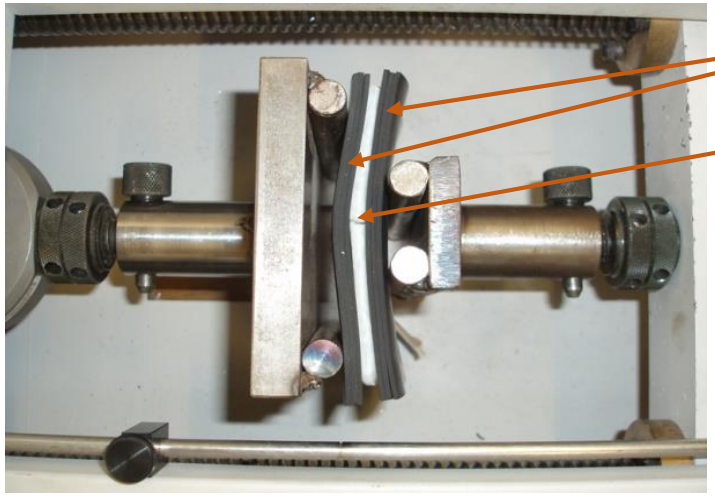
Oseng-Rees
REFLECTION

The process of working with bottle glass; Colour

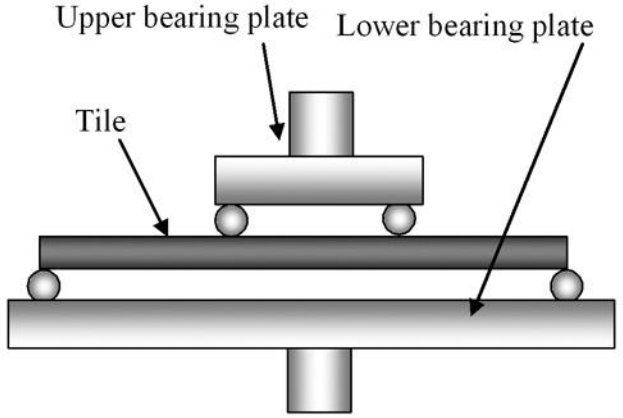


Oseng-Rees
REFLECTION

The process of working with bottle glass; Strength



- **The specimen is clamped between two bearing plates (upper and lower).**
- **An increasing load is applied to the centre of the specimen.**



- **The instrument automatically generates Force versus Displacement data.**
- **The energy and maximum force required to break the sample can be measured.**
- **The maximum break force allows the Modulus of Rupture (R) for the sample to be calculated.**

$$R = \frac{PL}{bd^2}$$

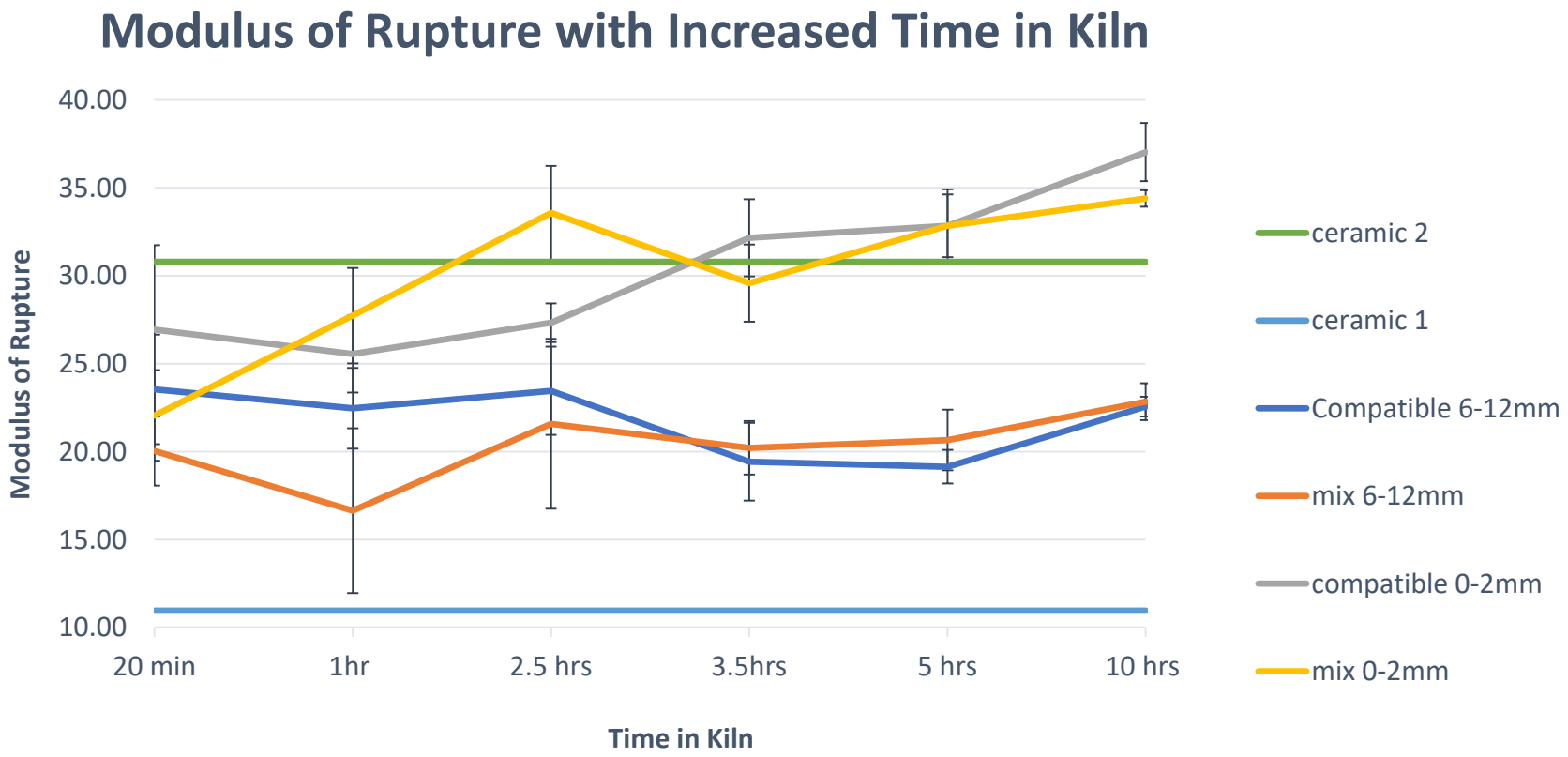
Where P = maximum breaking force, L = span length between the outer supports of the lower bearing plate, b = sample width and d = sample depth.

Oseng-Rees
REFLECTION

The process of working with bottle glass; Strength

Time in kiln	6-12mm						0-2mm					
	compatible			mix			compatible			mix		
	MPa	R	stdv	MPa	R	stdv	MPa	R	stdv	MPa	R	stdv
20 min	6.23	23.54	3.11	9.64	20.03	1.96	5.01	26.94	4.80	4.14	22.06	2.58
1hr	7.12	22.46	2.30	9.77	16.64	4.69	3.84	25.56	2.21	3.49	27.73	2.71
2.5 hrs	4.69	23.46	2.51	4.58	21.58	4.83	3.07	27.32	1.10	3.55	33.57	2.68
3.5hrs	1.29	19.43	2.21	1.34	20.21	1.52	1.73	32.16	2.19	1.61	29.58	2.19
5 hrs	0.93	19.14	0.95	0.98	20.66	1.73	1.47	33.13	1.78	1.16	32.84	2.07
10 hrs	1.12	22.56	0.56	1.12	22.83	1.05	1.50	37.03	1.66	1.26	34.39	0.47

Commercial tiles	R
Ceramic 1	10.95
Ceramic 2	30.79



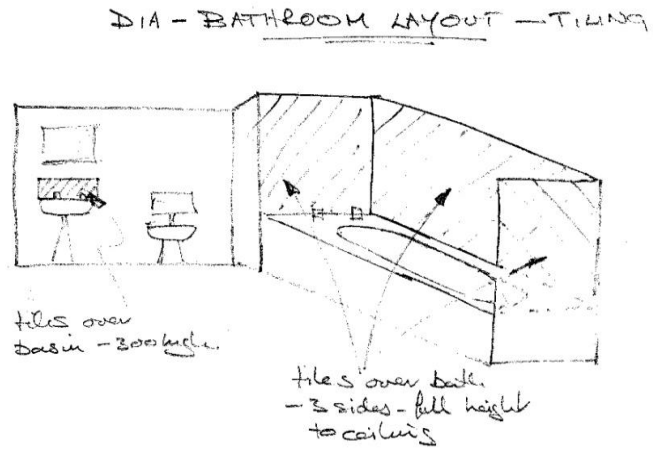
Oseng-Rees
REFLECTION

The Gwalia Project

Grŵp Gwalia working with architects Philip Roberts and Elfed Roberts







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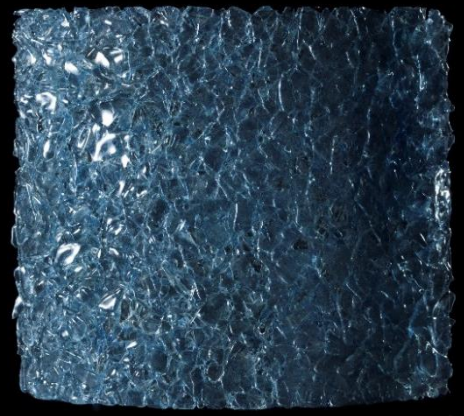














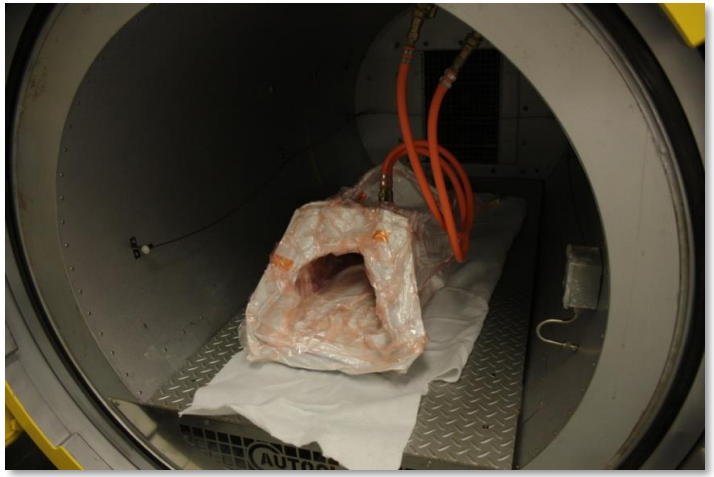
Next Logical step after the PhD?

Design and Manufacture of Motorsport Carbon Fibre Structures













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REFLECTION



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REFLECTION



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Back to focus….

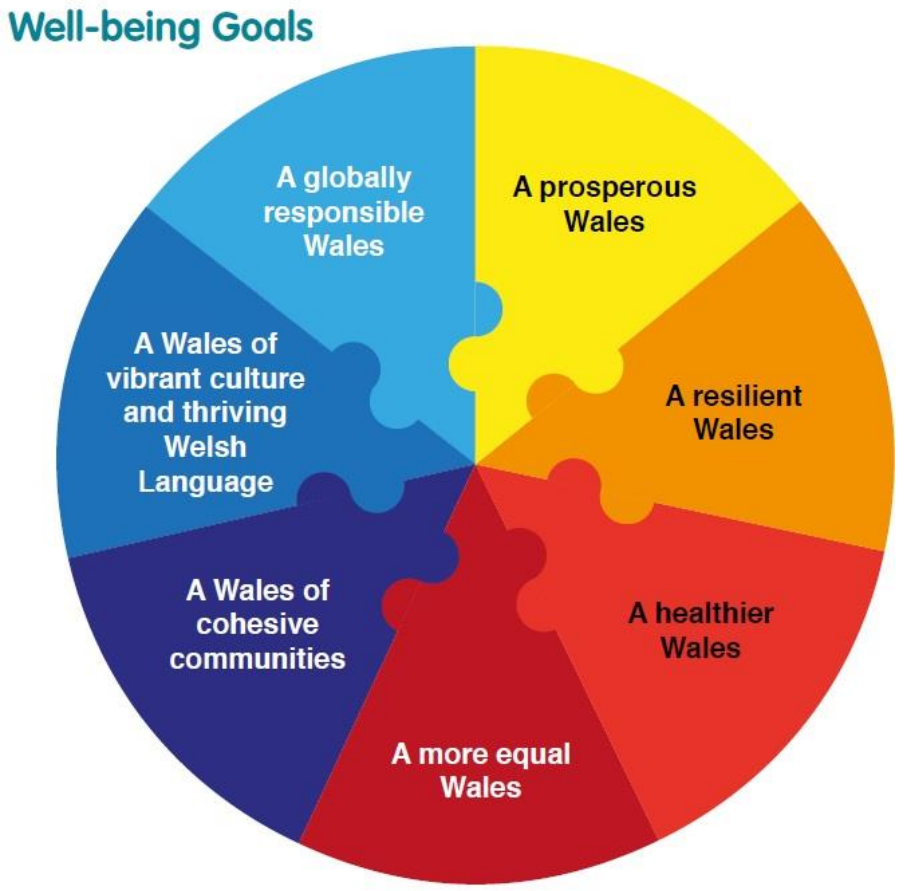
…pursuing the sustainability and recycled glass research…

Sustainability

- Sustainable development is development that fulfills existing needs, without bringing future generations' possibilities for fulfilling their needs in jeopardy" (United Nations [UN], Report of the World Commission on Environment and Development: Our Common Future, 1987).
- The **four pillars** of **sustainability**

Wellbeing of Future Generations Act (Wales) 2015

- One Act
- Four Sustainability Development Pillars –
  - *Social*
  - *Economical*
  - *Environmental*
  - *Cultural*
- Five Ways of Working
- Seven Goals and their definitions
- 46 Population Indicators



Public bodies need to make sure that when making their decisions they take into account the impact they could have on people living their lives in Wales in the future.

Oseng-Rees
REFLECTION

Five ways of working

Long term

The importance of balancing short-term needs with the need to safeguard the ability to also meet long-term needs.

Prevention

How acting to prevent problems occurring or getting worse may help public bodies meet their objectives.

Integration

Considering how the public body's well-being objectives may impact upon each of the well-being goals, on their other objectives, or on the objectives of other public bodies.

Collaboration

Acting in collaboration with any other person (or different parts of the body itself) that could help the body to meet its well-being objectives.

Involvement

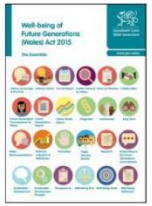
The importance of involving people with an interest in achieving the well-being goals, and ensuring that those people reflect the diversity of the area which the body serves.

It will expect to:

- Work together better
- Involve people reflecting the diversity of our communities
- Look to the long term as well as focusing on now
- Take action to try and stop problems getting worse - or even stop them happening in the first place.

Oseng-Rees
REFLECTION

Circular economy contribution to the well-being goals



Goal	Circular economy contribution
A prosperous Wales	• Potential savings to the Welsh economy of over £2 billion by it adopting a circular economy • Potential for up to 30,000 jobs to be created in Wales through moving towards a circular economy. • Significant carbon savings.
A resilient Wales	• Less wastage of food leading to reduced need for food production, leading to reduced impacts on habitats and biodiversity both in Wales and around the world. • Lower demand for other raw materials sourced from around the globe, leading to reduced mining, destruction of ancient forests and exploitation of other undeveloped habitats, thus protecting species and biodiversity. • Reduced greenhouse gas emissions associated with the production of goods consumed in Wales, and a reduced impact of climate change on biodiversity. • Greater resource resilience / security of supply for manufacturing.
A healthier Wales	• Protecting and improving health through reducing emissions associated with waste and its management • Improving health by reducing poverty through creating jobs in the circular economy, saving money (eg. Love Food, Hate Waste) and through the provision of free / low cost household items (via reuse)

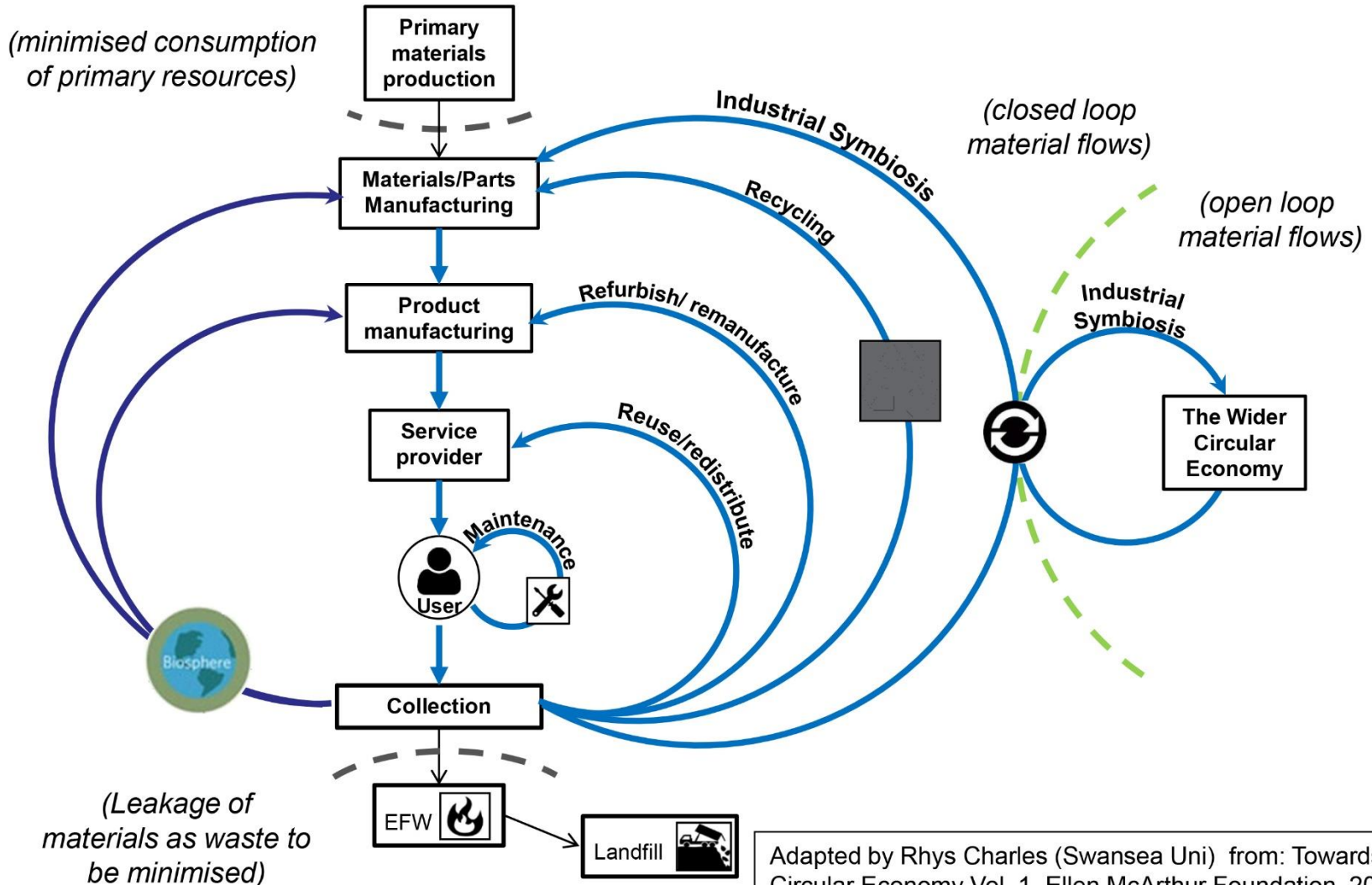
Slide from:
Dr Andy Rees, OBE
Head of Waste Strategy Waste & Resource Efficiency Division, Welsh Government

Circular economy contribution to the well-being goals

Goal	Circular economy contribution
A more equal Wales	• Providing jobs, training, skills across a diverse range of the population • Providing surplus food and high quality, affordable second hand domestic goods to those in poverty
A Wales of cohesive communities	• Involving and engaging communities in sustainable waste management, including repair, remanufacturing, recycling, reuse and surplus food redistribution
A Wales of vibrant culture and thriving Welsh language	• Further embedding sustainable development behaviours and cultures within people • Using the arts as appropriate to help with raising awareness and behaviour change • Using the Welsh language creatively in communications • Making high value art / craft out of recyclate – 'upcycling'
A globally responsible Wales	• Making an important contribution to the Welsh Government's one planet resource use goal; • Helping reduce or reverse global biodiversity loss.

Slide from:
Dr Andy Rees, OBE
Head of Waste Strategy Waste & Resource Efficiency Division, Welsh Government

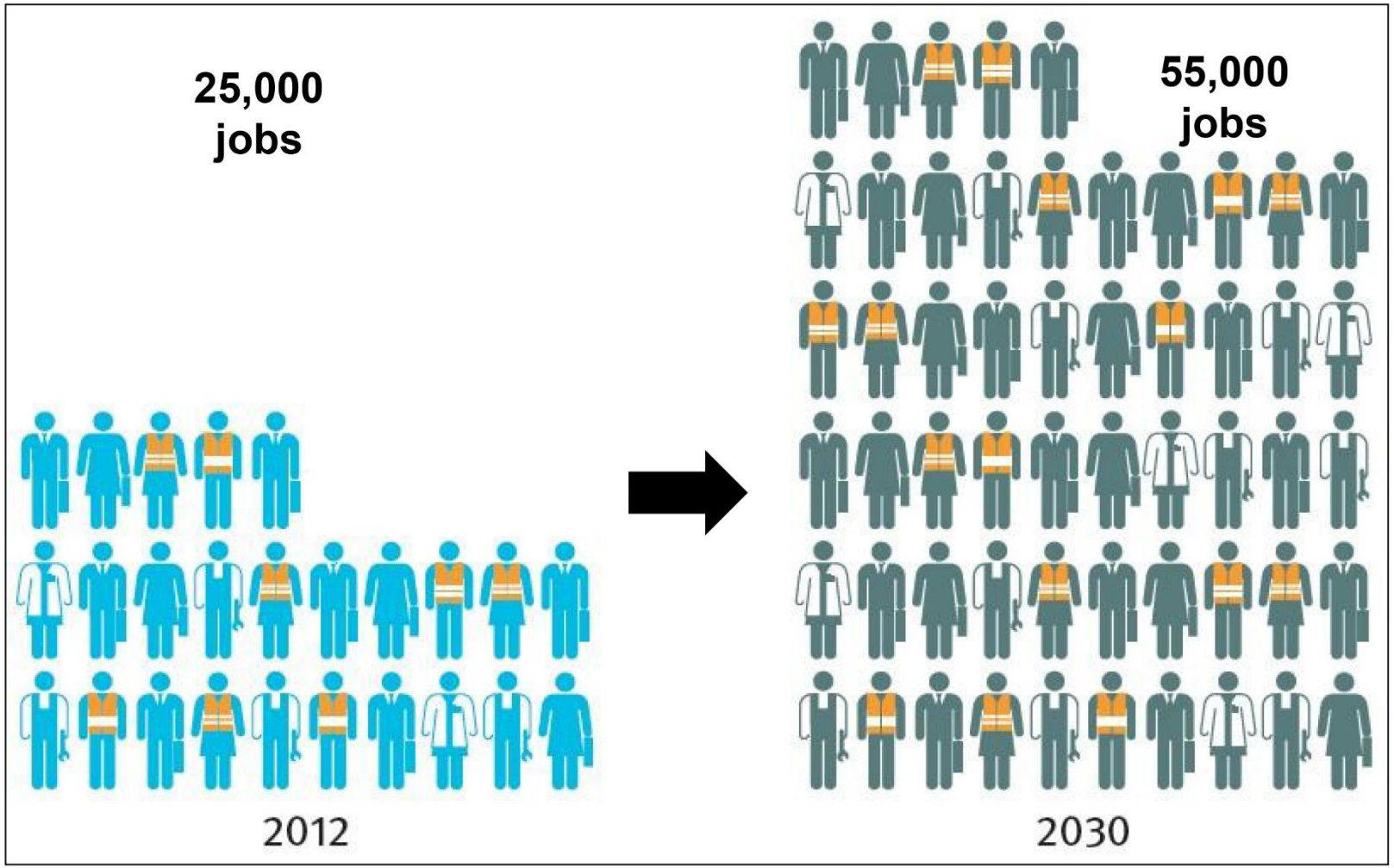
Material flows in a Circular Economy



Adapted by Rhys Charles (Swansea Uni) from: Towards a Circular Economy Vol. 1, Ellen McArthur Foundation, 2013.

Slide from:
Dr Andy Rees, OBE
Head of Waste Strategy Waste & Resource Efficiency Division, Welsh Government

Potential employment benefits to Wales of operating a ‘transformational’ circular economy



Source: ‘Employment and the circular economy - Job creation in a more resource efficient Britain’, January 2015; by WRAP and the Green Alliance)

Slide from:
Dr Andy Rees, OBE
Head of Waste Strategy Waste & Resource Efficiency Division, Welsh Government

Glass recovery 2012 (British Glass)

- About 93% of waste glass produced by businesses, such as pubs and clubs, is recycled, 2010
- Four fifths of councils provide kerbside glass collections to households.
- According to British Glass, 81% of glass recycled in 2005 was re-melted, but in 2010 that had fallen to 64%.
- Re-melt saves about 0.3 tonnes of carbon per tonne of glass recycled; aggregate saves none.

Research proposal presented May 2015

Recycled glass urban paving for SA1

What to do?

Cross disciplinary

Engineering
- Freeze/thaw cyclic testing
- Impact test
- Durability
- Accelerated weathering tests

Product design
- Product development
- Urban design
- Mass manufacturing /upscaling production line

Art & Design
- Design development
- Aesthetic development

Psychology
- Likability test
- Behavioral change towards sustainable products

Business
- Business case for spin-out
- Industrial links

Architectural /Built environment
- Building specs
- Space development

Why do it?

Raise profile in Sustainability

Economic
- Research funding (EPSRC/ AHRC)
- Business investment for equipment, test center and manufacturing
- Business start-up SA1 Innovation Quarter

Cultural
- Upcycled recycled glass products for the built environment
- Using arts to raise awareness of sustainable awareness

Social
- Public realm
- Usability test
- Community engagement
- Research support staff
- PhD scholarship
- Jobs in the industry
- Safeguarding and creating jobs

Environmental
- Recycled material
- Locally manufactured
- Locally sourced material
- Job creations in the circular economy

Wider benefits

A unique sustainable architectural showcase for Swansea Waterfront Innovation Quarter

Increase expertise and reputation
- Heritage from UWTSD
- Business links/ R&Ds
- Spin-out companies
- Create a test centre
- University collaborations
- Oslo and Akershus University College
- Sheffield University,
- Cardiff University
- Swansea University

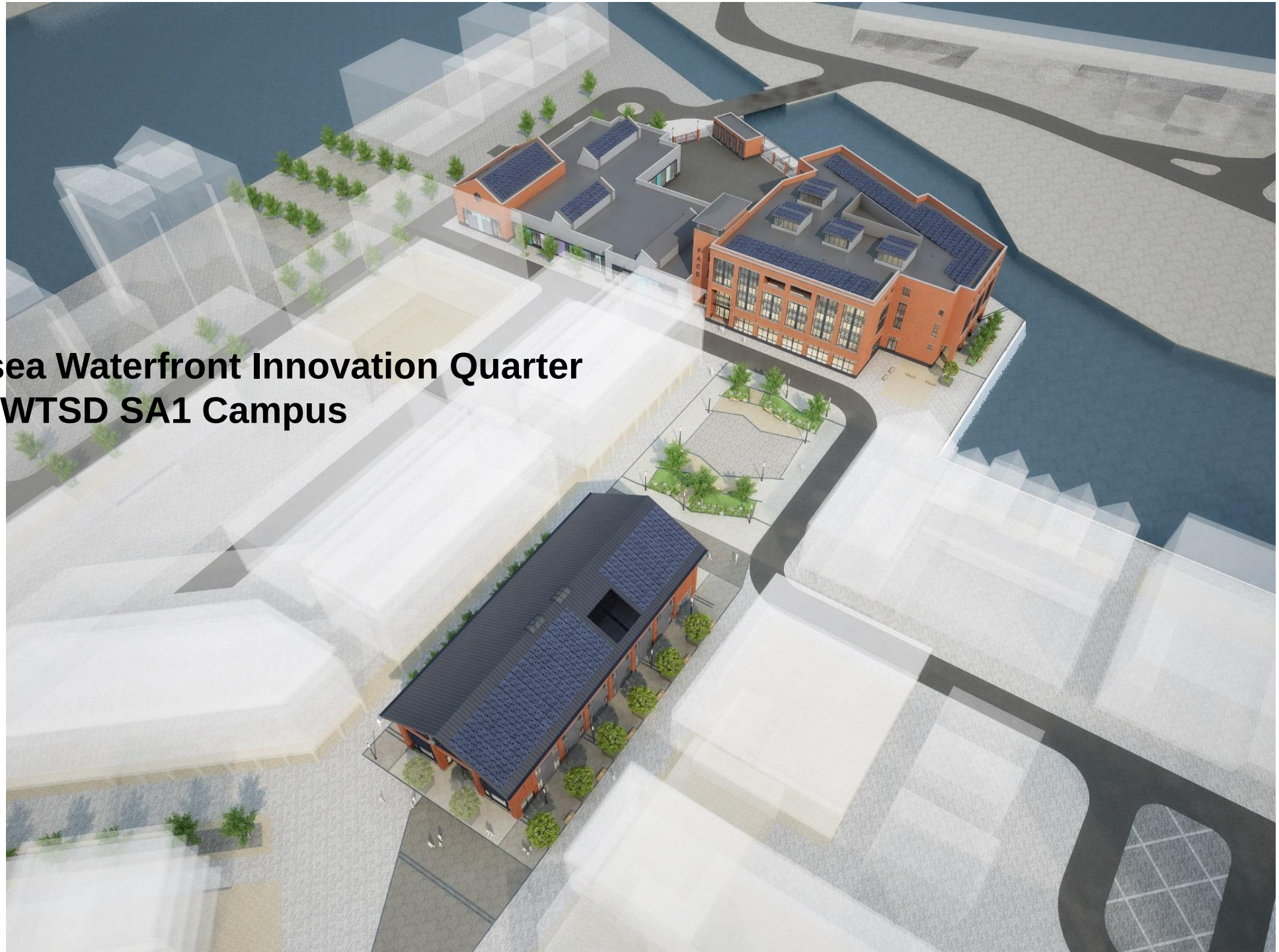
Research funding
- EPSRC, AHRC

Interdisciplinary research environment
- REF outputs
- PhD scholarship

Recruit students and post doctorial
- Feed into teaching
- MA in sustainability

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Swansea Waterfront Innovation Quarter
New UWTSD SA1 Campus



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2.72 Materiality

The emphasis here is on a base set of materials that are honest, simple and natural. Recycled, rugged and of the earth. At the same time these will be softened by warm and sound absorbing materials such as felt and cork.

Texture, colour and surface are inspired by minerals and timbers in the environment, worn and weathered by time.

The concept design will build on these and bring together a harmonious set of finishes that are fit for purpose and the design concept.

















Low temperature fused recycled glass as an interior installation for the new UWTSD campus at Swansea Waterfront Innovation Quarter

Outcome: Reception desk at IQ building, ground floor.

- There will be a requirements to ***comply with certain technical specifications*** if they were to incorporate into a functional aspect of the scheme
- An ***understanding of the behaviour*** of recycled glass as a design material
- ***Design and manufacture*** of architectural products from recycled glass with an evaluation of sustainability and strength for design application

Student projects:

1. Revising the methods of crushing glass by refurbishing/updating/modifying existing technology
2. Research and test the methods of hardening stainless steels for glass crushing purposes
3. Characterising the mechanical properties of glass products
4. Carbon footprint and life cycle analysis
5. Aesthetic exploration of the recycled glass material
6. Furniture development



Artistic visualisation of a reception desk made from fused recycled glass by interior architect Kenton Simmons

Low temperature fused recycled glass as an interior installation for the new UWTSD campus at Swansea Waterfront Innovation Quarter



Project director: Dr Tyra Oseng-Rees

Research Staff: Dr Juan Ferriz-Papi, Built and Natural Environments,
Ian Standen, Architecture,
Dr Gregory Owen, Engineering,
Dr Lara Hopkinson, Architecture, Built and Natural Environments,
Allan Nantel, Built and Natural Environments,
Lisa Burkl, Glass, Swansea College of Art,

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One panel made from Low Temperature Fused Recycled Glass
with light shining onto and light passing through the same panel



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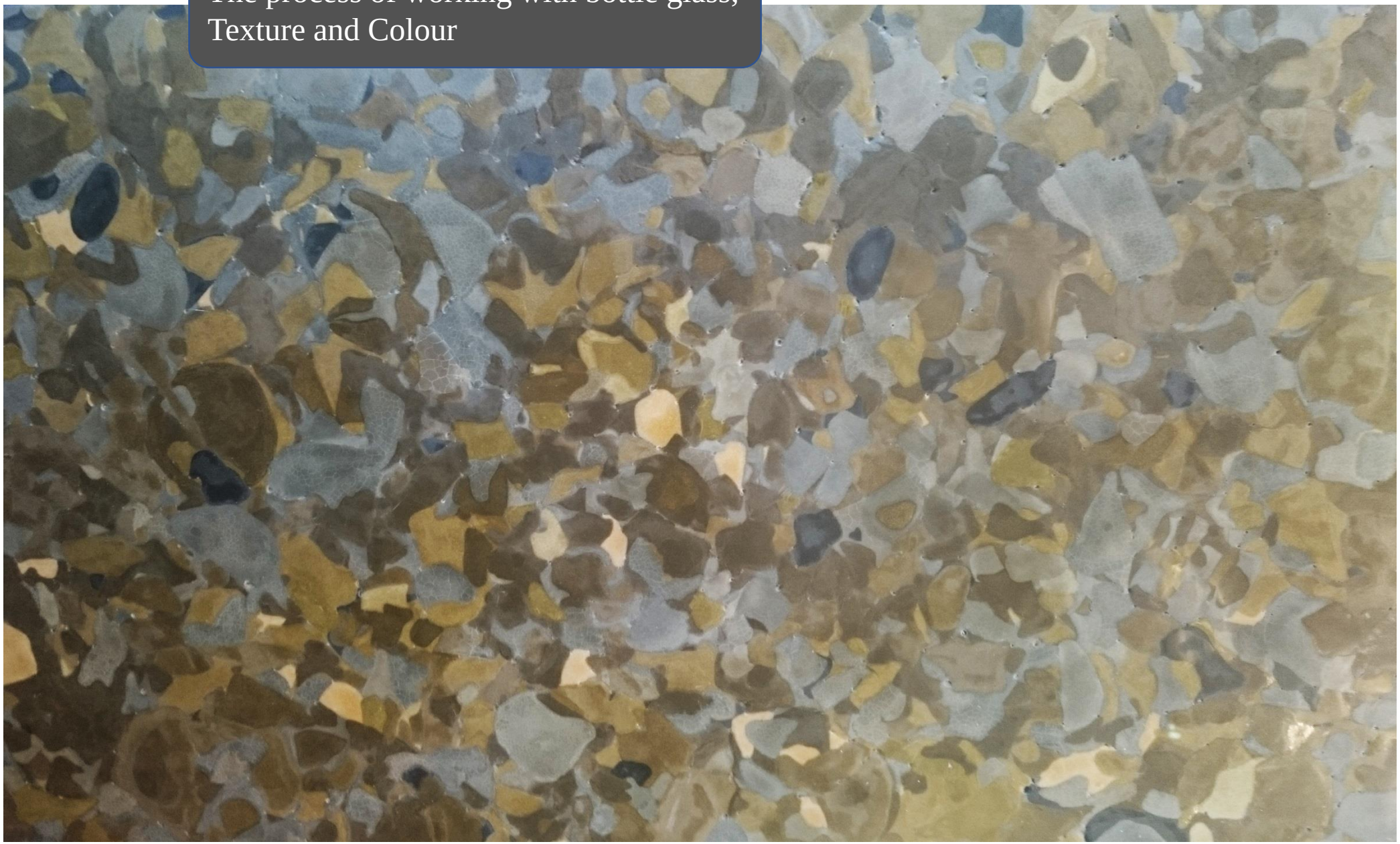
The process of working with bottle glass;
Texture and Colour





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The process of working with bottle glass;
Texture and Colour



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The process of working with bottle glass;
Texture and Colour



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Objectives of the live project:

- Design of the reception desk to fit the functionality brief set by the SA1 team
- Low temperature fused recycled glass to be the main component of the reception desk
- The recycled glass material will be used as cladding onto a structural carcass made from timber
- Provide/develop requirements for the application: aesthetics such as colour, texture, etc.
- Analysis of characteristics of the material and possible variations according to composition, such as mechanical strength or reaction to chemicals
- Analysis of environmental performance (carbon footprint)
- Design and manufacture of glass crusher
- Manufacturing of final material
- Publication of results

Showcase with Low Temperature Fused Recycled Glass for a reception desk in the SA1 Waterfront Development



Disciplines:

- Arts
- Design
- Architecture
- Project Management
- Environmental Conservation
- Mechanical Engineering

External companies:

- Kier Construction
- Stride Treglown
- Kenton Simmons interior architect

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Student Projects in 2016/17

- **Art glass student**: Recycled glass aesthetics, texture and design development
- **Engineering student**: Design and manufacture of a bespoke glass crusher
- **Environmental conservation student** : Carbon footprint of recycle glass manufacturing
- **Project and Construction Management student**: Impact resistance with/without Recyclamine recyclable epoxy coating
- **Architectural Technology student:** development and making of desk carcass and fittings

Design exploration by glass art student

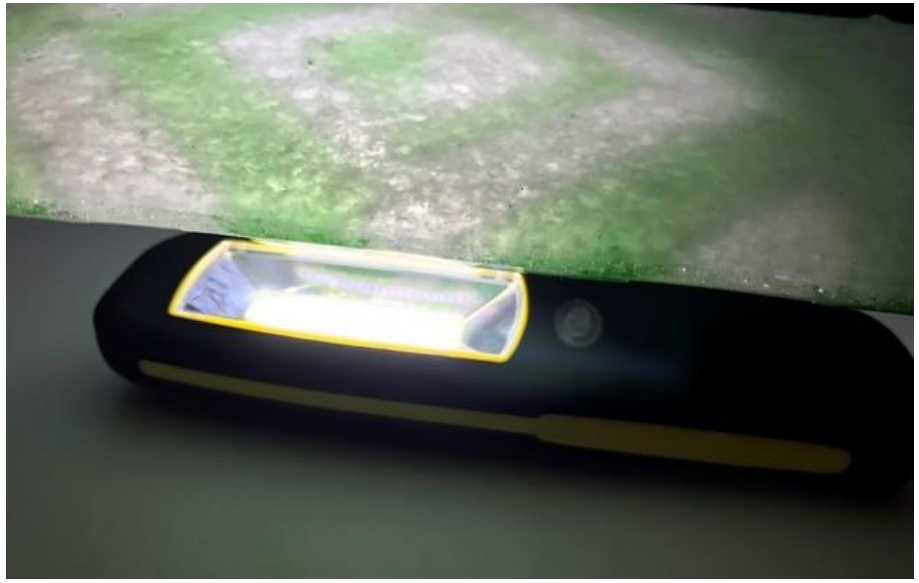








Design exploration by art student





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TWININGS




Large
Large
Large










Desk design to accommodate wheel chair access
Option for glass work surface on support backing panel
Lighting to panels can be either back lit or end lit
1
FACE MATERIAL IN RECYCLED GLASS PANELLED SYSTEM ON SUPPORT FRAMEWORK WITH SILICONED BUTT JOINTS
FACE
RECEPTION DESK OPTION - Elevation
1


Desk design to accommodate wheel chair access
Option for glass work surface on support backing panel
Lighting to panels can be either back lit or end lit
FACE
Fluted slab option lit at ends and ribbed slab lit behind with LED lights
RECEPTION DESK OPTION - Elevation
3



Patterned



Ribbed / Fluted





Patterned/coloured/ geometric



Monolithic

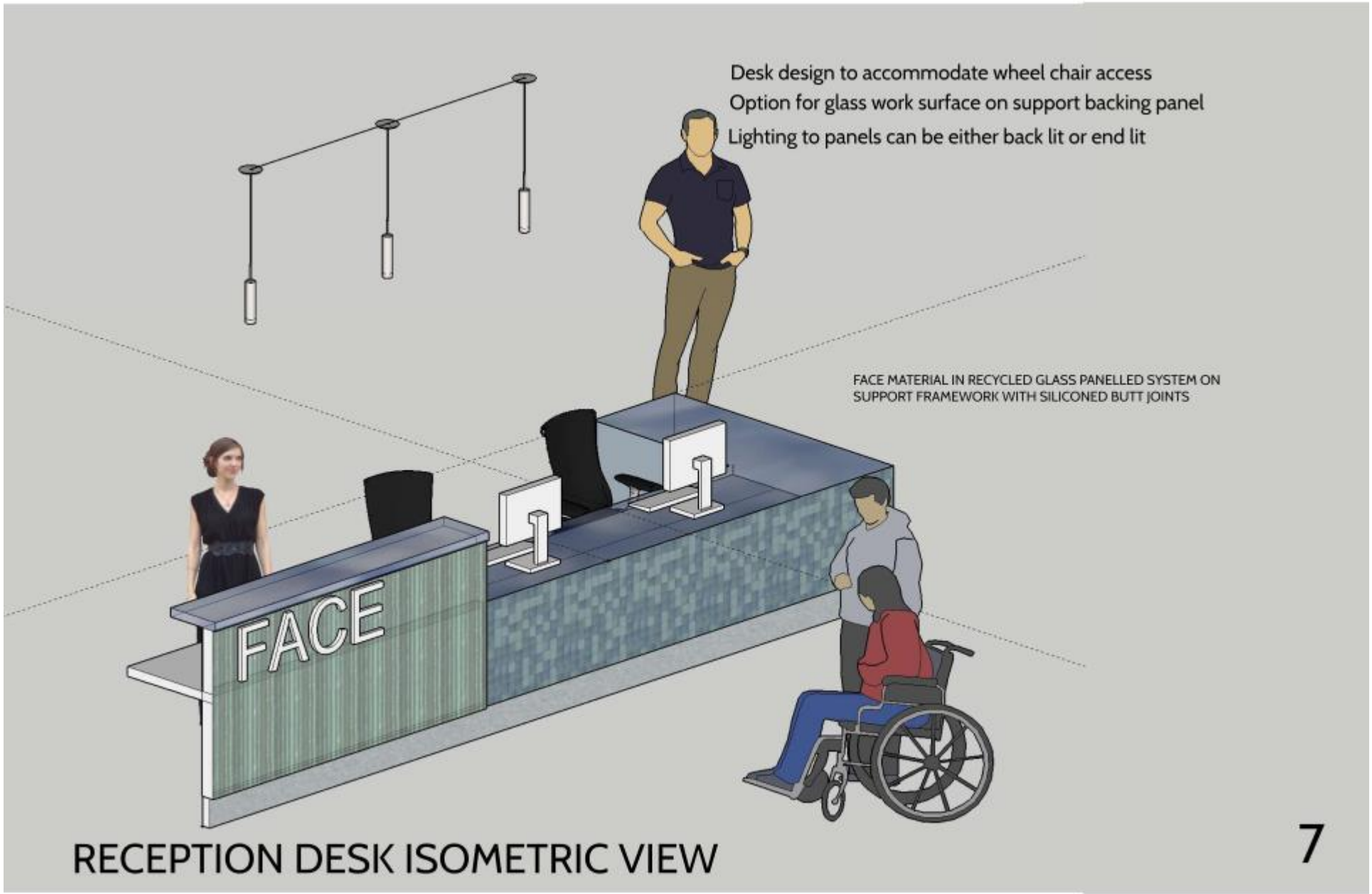
A selection of the recycled glass patterns

Recycled glass work surfaces possibilites:
A Tile or slab on fully supported deck
B Slab on support framework aperture

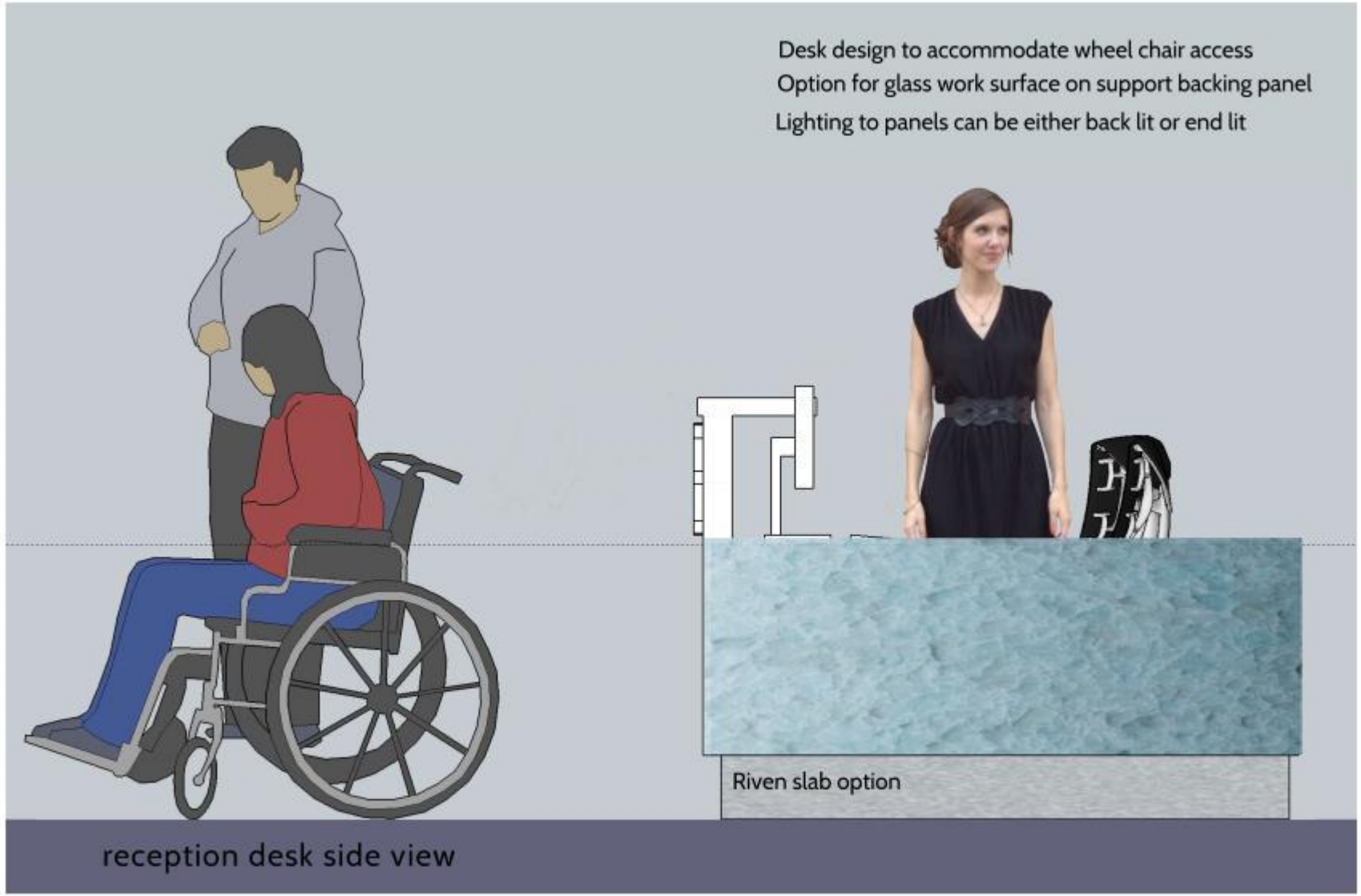


reception desk plan

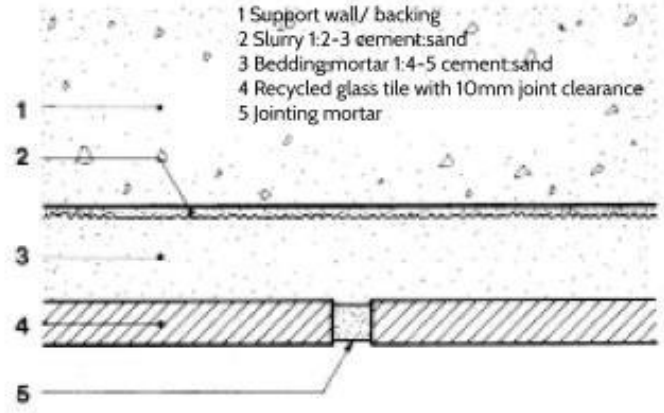
RECEPTION DESK INDICATIVE PLAN



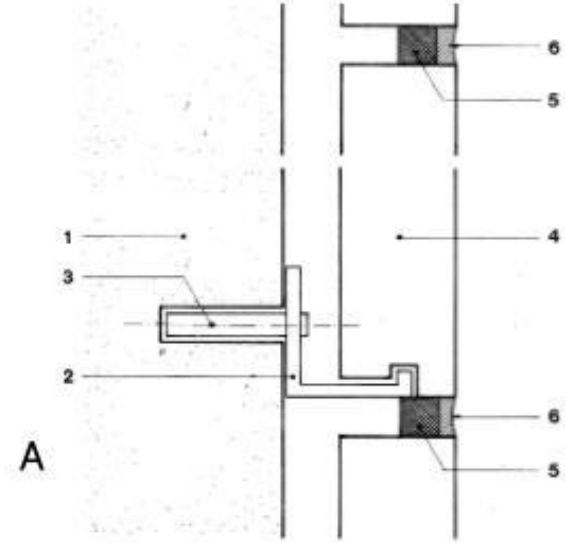
RECEPTION DESK ISOMETRIC VIEW



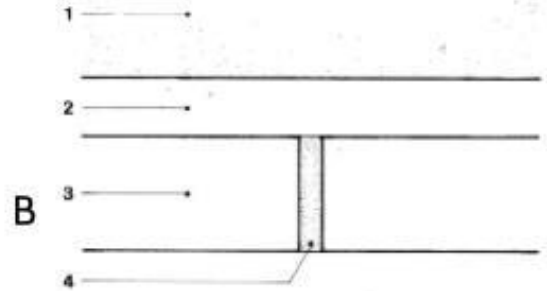
RECEPTION DESK SIDE VIEW



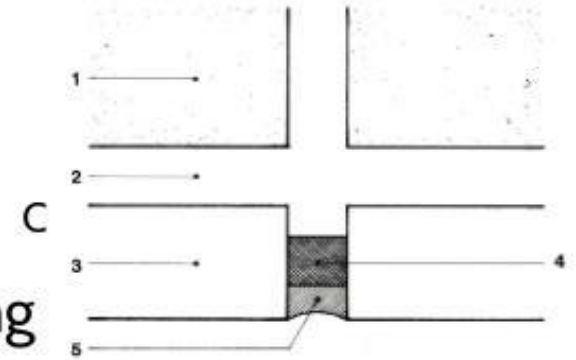
RECYCLED GLASS TILE FORMAT TO MASONRY BACKING WALL



A - SECTION THROUGH VERTICAL FACE RECYCLED GLASS FACING PANEL
1 Support framing/ carcass backing
2 Stainless steel support brackets
3 S/S fixings to support carcass
4 Recycled glass slab with 10mm joint clearance
5 Expanded rubber or polyethylene back up material
6 Two part polysulphide gun sealant



B - PLAN THROUGH VERTICAL JOINT RECYCLED GLASS FACING PANEL
1 Support framing/ carcass backing
2 Void (approx 20mm) or to suit lighting type
3 Recycled glass slab (circa 20-25mm) with 10mm joint clearance
4 Cement : sand mortar 1:4



C - PLAN THROUGH VERTICAL MOVEMENT JOINT RECYCLED GLASS FACING PANEL
1 Support framing/ carcass backing
2 Void (approx 20mm) or to suit lighting type
3 Recycled glass slab (circa 20-25mm) with 10mm joint clearance
4 Expanded rubber or polyethylene back up material
5 Two part polysulphide gun sealant

RECEPTION DESK - Detailing











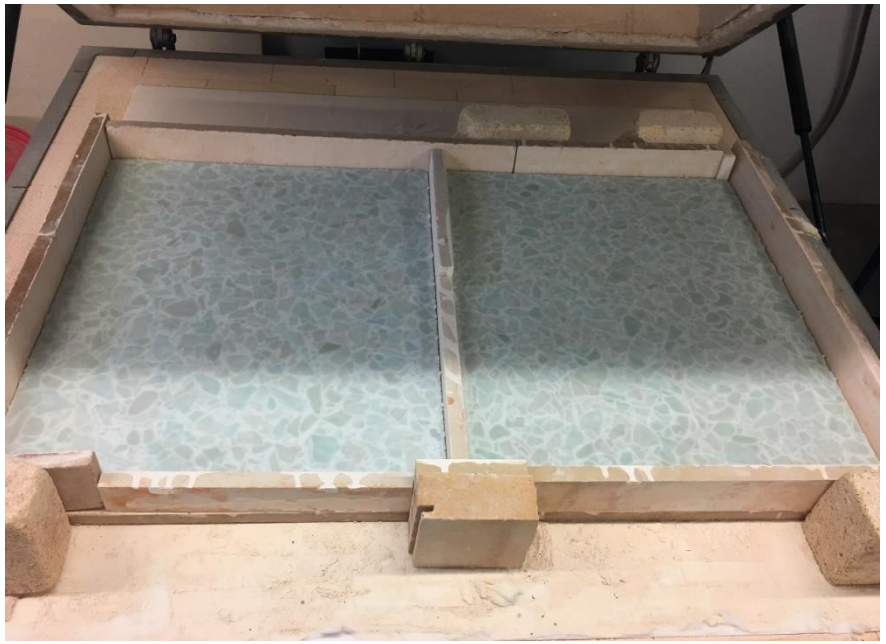


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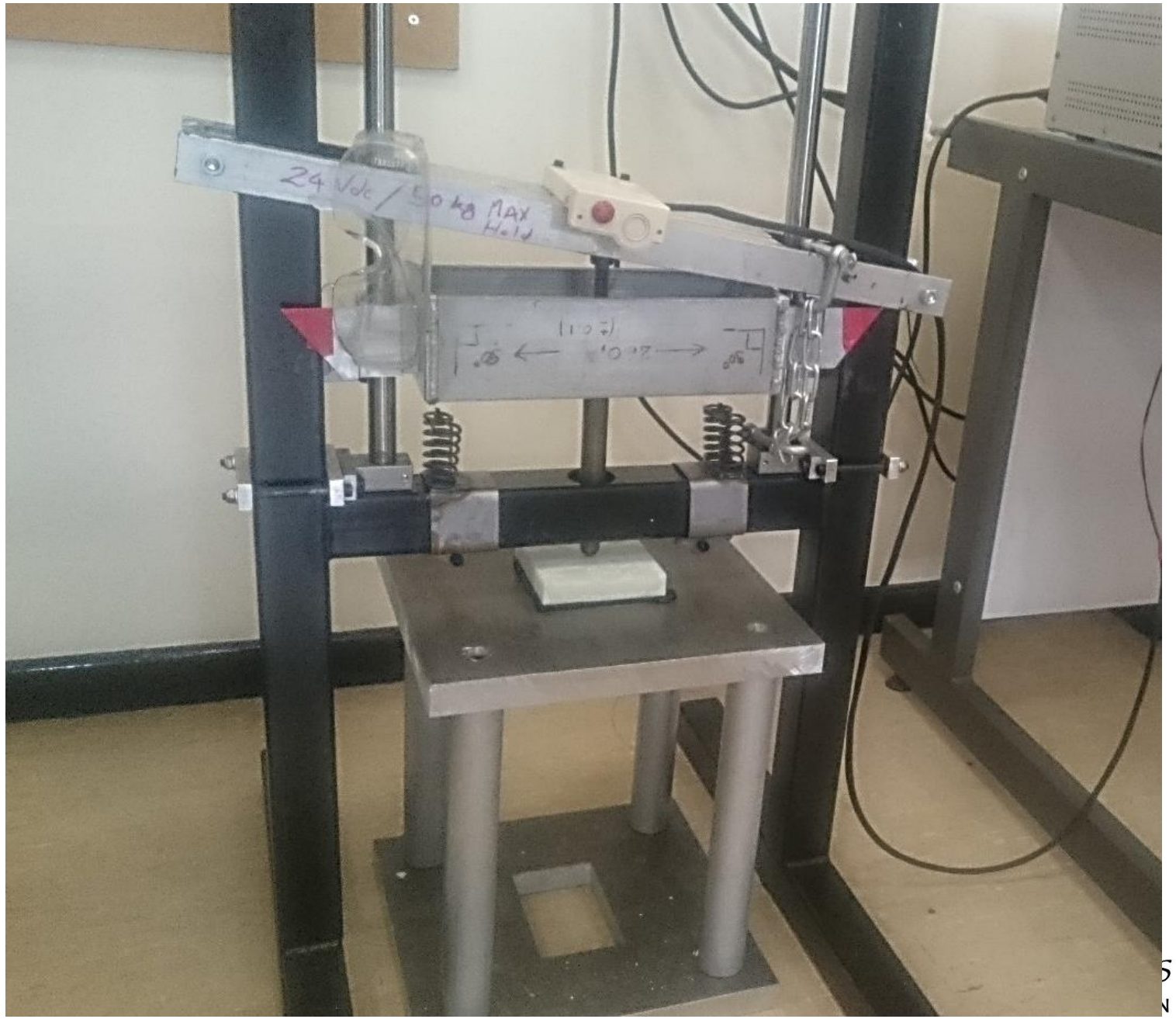


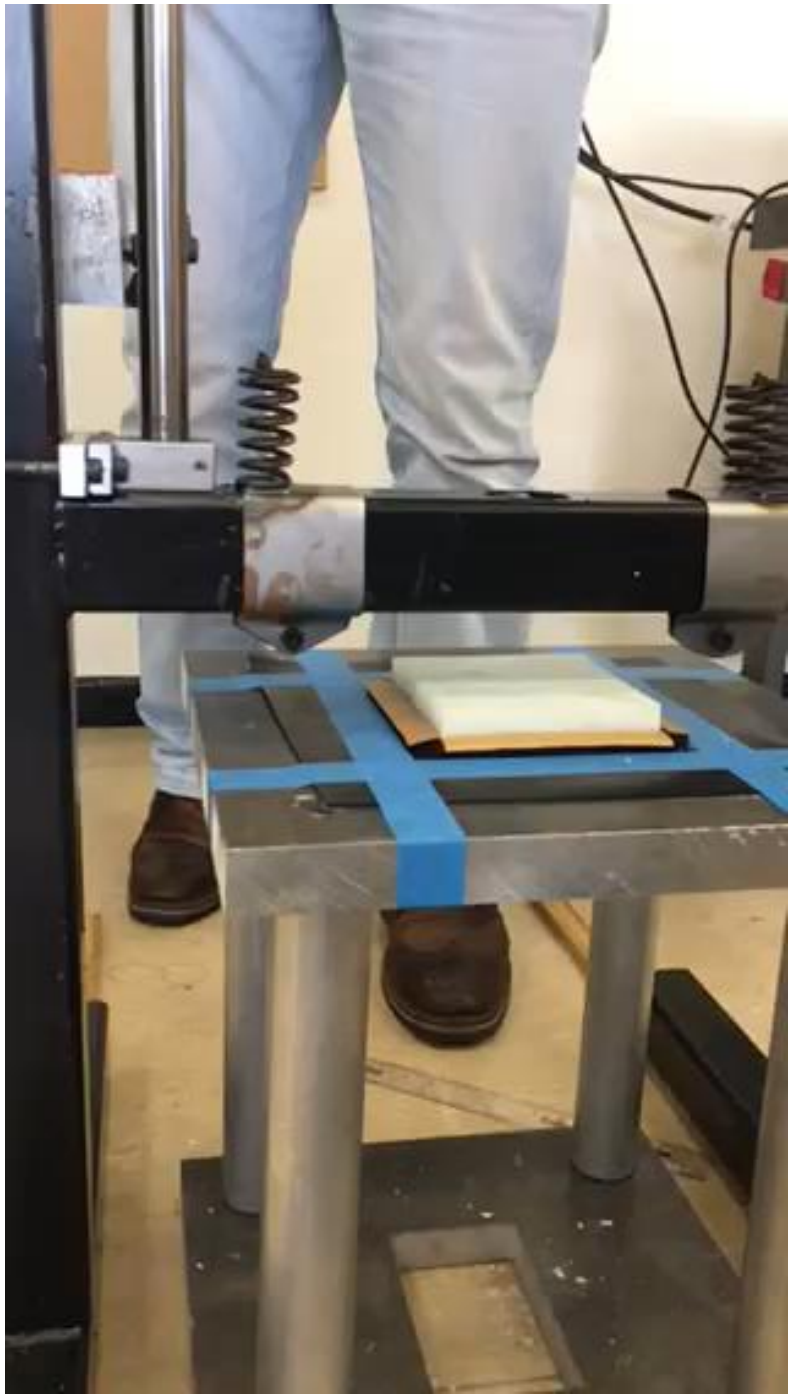




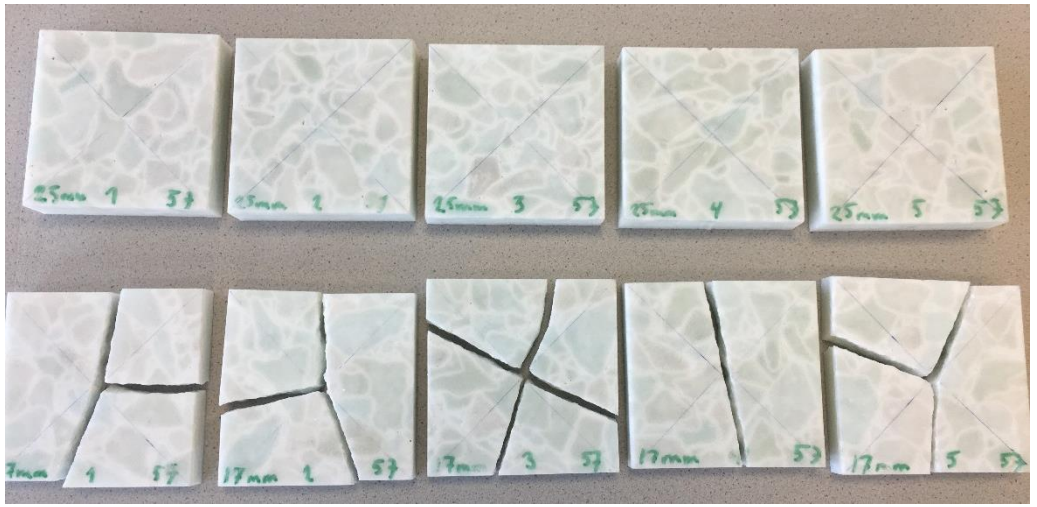
Material Integrity and testing by Project and Construction Management student




24 Vdc / 5048 MAX



Early test results



Publication after results from dissertation:
D.Halley, T.Oseng-Rees, L.Pagano & J.Ferriz-Papi, 2017**, Procedure for impact testing of fused recycled glass,** *World Academy of Science, Engineering and Technology, International Journal of Architectural and Environmental Engineering,* Vol:11, No:10 2017

Summary of feedback

Goal 1: A prosperous Wales

An innovative, productive and low carbon society which recognises the limits of the global environment and therefore uses resources efficiently and proportionately (including acting on climate change); and which develops a skilled and well-educated population in an economy which generates wealth and provides employment opportunities, allowing people to take advantage of the wealth generated through securing decent work.

- Low carbon manufactured recycled glass
- Circular economy
- Locally sourced material
- Industry collaboration
- Cradle-to-cradle Design approach
- Showcase to British householders how waste glass can be up-cycled to an aesthetically pleasing material

Summary of feedback

Five ways of Working:

- **Long term view**
  - Provided more lifelong learning skills for future learning/teaching in interdisciplinary projects and sustainable development
- **Prevention**
  - Close supervision and project flexibility helped detecting problems and change their topics or adapt to new circumstances
  - Members of staff prepared to *'walk the extra mile'* if needed
- **Integration**
  - Students had the opportunity to be supervised from staff with different expertise areas
  - Integration of students from different background to the same project
- **Collaboration**
  - Collaboration between Schools and Faculties in the same project
  - Collaboration between students across different disciplines
- **Involvement**
  - Benefits of participating in a life project with real customers. Students' contribution was positive
  - Better understanding between aesthetical and engineering aspects

This collaboration addressed the following goals:

- Demonstrate a low carbon footprint to its manufacturing process
- Demonstrate a Circular Economy approach to design and manufacturing
- Encourage industry collaborations
- Development a range of new aesthetics and textures of the recycled glass material
- Demonstrate the five ways of working according to the Wellbeing of Future Generation Act
- Deliver on the first goal of the Wellbeing of Future Generation Act, A prosperous Wales
- Demonstrate material characterisations in terms of strength and stability
- Explore possibilities for a business start-up
- Enhance learners' experience with a real case study and the application of their research to industry.

Crystal house

- https://youtu.be/LRhPa8AOGvI
- https://www.youtube.com/watch?v=b5P3HBFhREU



What next?

Long term view
Prevention
Integration
Collaboration
Involvement



Thank you…

Dr Tyra Oseng-Rees, BA(hons), PhD, FRSA
tyra@osengreesreflection.com
Founder and Director

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