

# CLICK*design*

Delivering service life expectations to wood users



# Objectives

## 1) Scientific

To further our understanding of different limit states (deteriorating agents) including those stemming from:

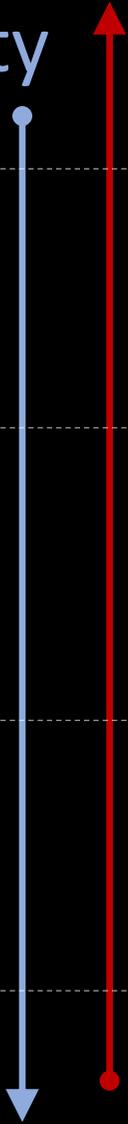
- fungal decay (+structural integrity),
- discoloration,
- termites

## 2) Practice oriented

To synthesize the scientific outcomes into practical design guidance



# Accessibility



Licensed software

*BIM compatible*

*(Aesthetics)*

Open source software

*Flexible  
Custom geometry  
3d effects*

*Aesthetics*

*Fungal decay*

Web-based

*Inherent principle  
Education  
Examples*

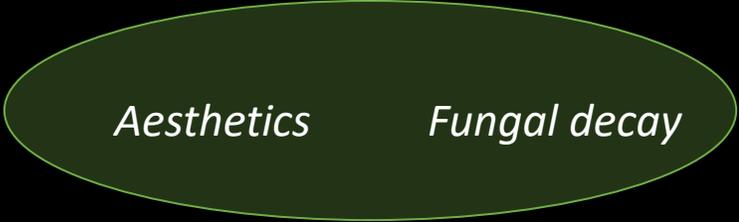
*Aesthetics*

*Fungal decay*

*Termites*

**Functionality**

**Today's focus**

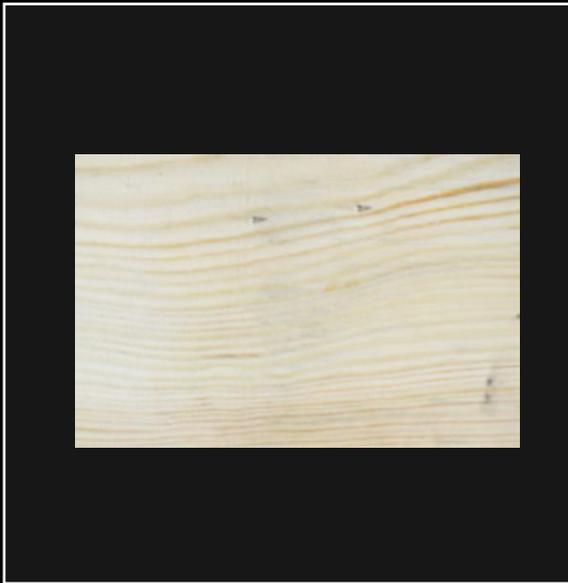


Some background...

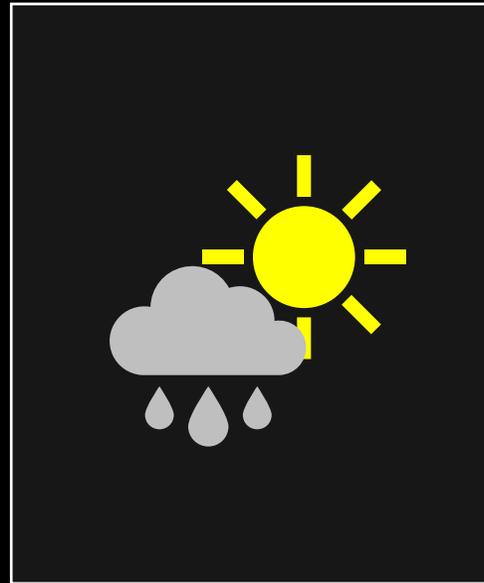


# Fungal decay & discoloration

*Material*

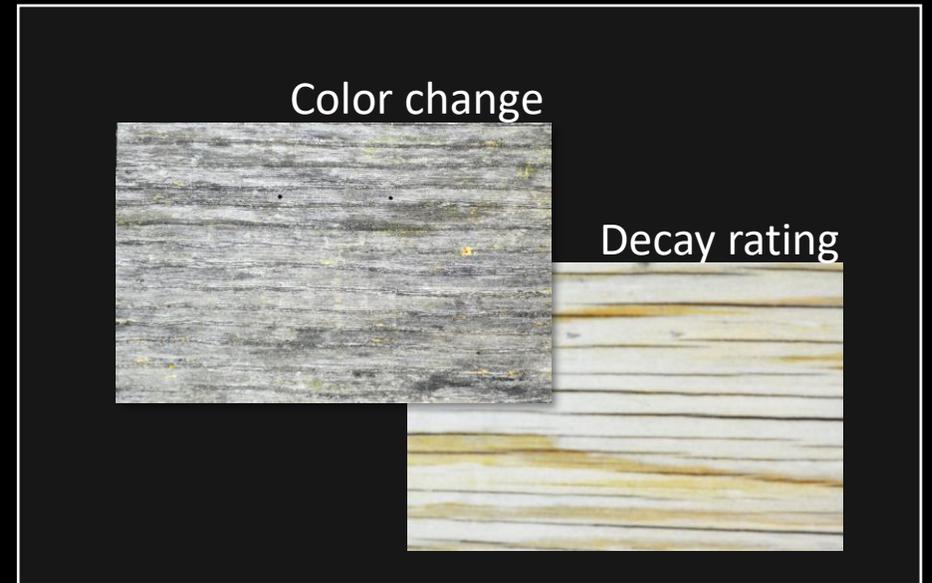


+ *Exposure*



⇒

*Response*



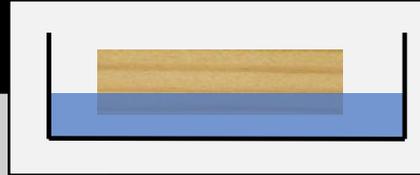
# Fungal decay – Material database

Laboratory Measurements

## Moisture dynamics

- Long-term water uptake,
- capillary water uptake,
- vapour uptake
- Water release

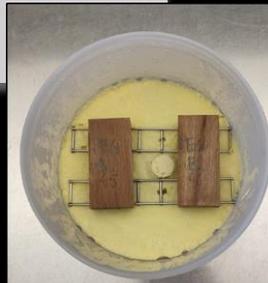
$k_{wa}$



## Inherent resistance

- Resistance to brown rot
- Resistance to white rot
- Resistance in-ground

$k_{inh}$



## Resistance dose

$$D_{Rd} = D_{crit} \cdot k_{wa} \cdot k_{inh}$$

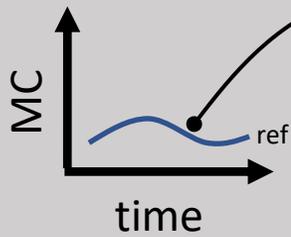
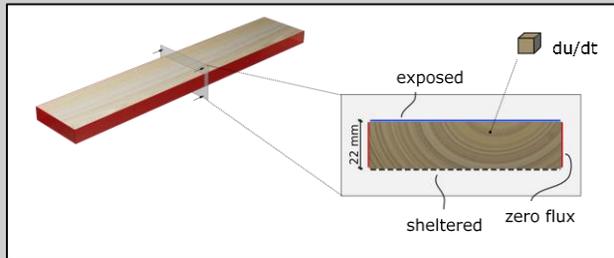
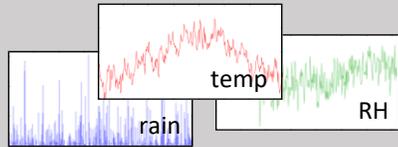
325 [d]

CLICKdesign → new database for wood resistance to fungal decay

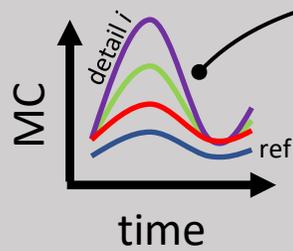
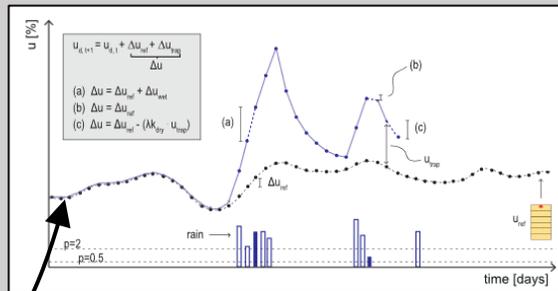
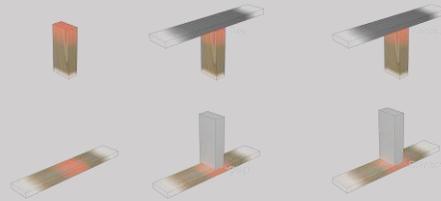


# Fungal decay exposure modelling

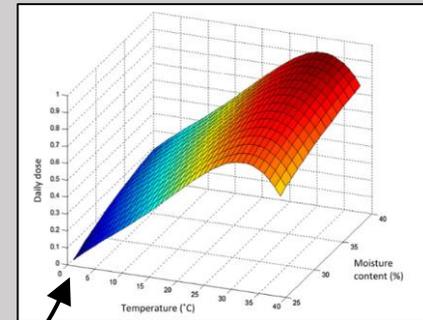
## Reference moisture content



## Moisture content of details



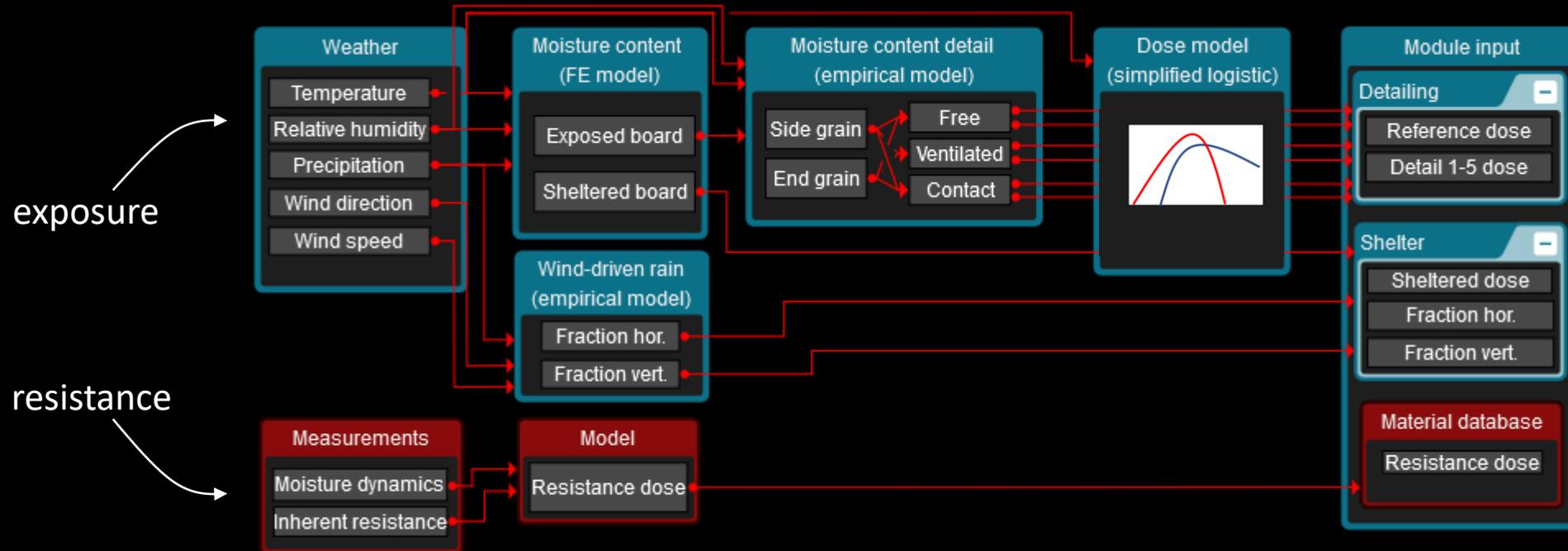
## Dose



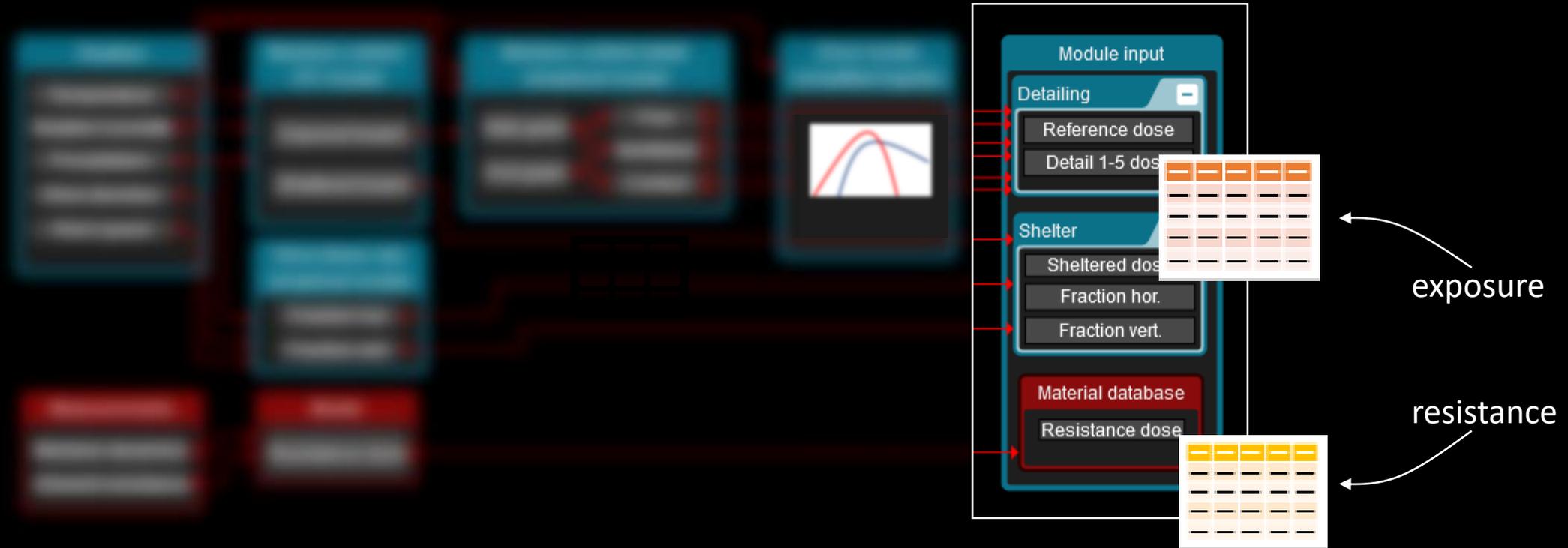
Reference = 51 dose/year  
 Detail 1 = 62 dose/year  
 Detail 2 = 76 dose/year  
 Detail 3 = 71 dose/year  
 Detail 4 = 68 dose/year  
 Detail 5 = 71 dose/year



# Fungal decay – procedure



# Fungal decay – procedure



# Decay module

Model

Location

Detailing

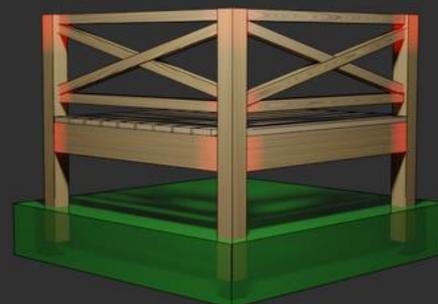
Shelter

Material

Results

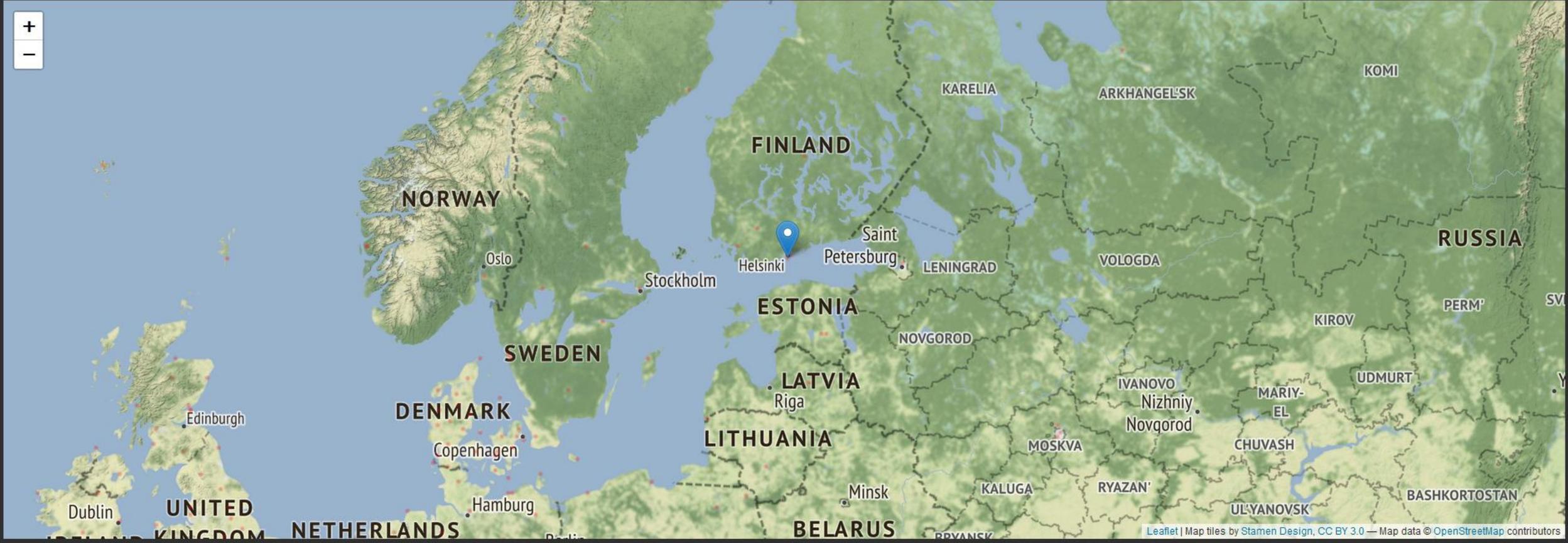
Above-ground

In-ground



# Decay module

- Model
- Location
- Detailing
- Shelter
- Material
- Results



# Decay module

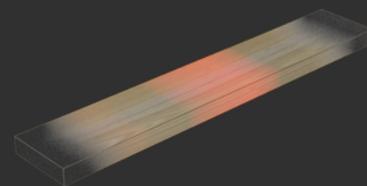
[Model](#)[Location](#)[Detailing](#)[Shelter](#)[Material](#)[Results](#)

Exposed end-grain tend to absorb more water than exposed side-grain. As a result, decay often starts near exposed end-grain.

- Side-grain
- End-grain

Detailing where different components intersect and join are often problematic as they attract dirt and prevent water from drying out.

- No contact face or gap size >5 mm free from dirt
- Partially ventilated contact face free from dirt
- Direct contact or insufficient ventilation



# Decay module

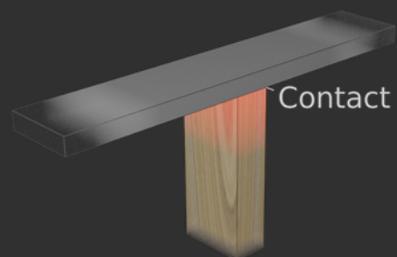
[Model](#)[Location](#)[Detailing](#)[Shelter](#)[Material](#)[Results](#)

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# Decay module

[Model](#)[Location](#)[Detailing](#)[Shelter](#)[Material](#)[Results](#)

The term shelter is here used to describe any effect which may reduce the duration of wetting of a *horizontal* wood surface. A roof overhang has an obvious sheltering effect on the cladding of a wall, but simply orienting a wooden product vertically will reduce the duration of wetting and thereby increase service life.

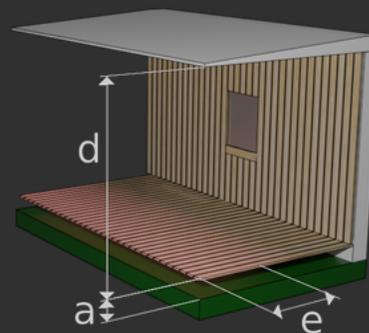
Vertical member (subjected to driving rain)

Roof overhang

NA distance to ground (a)

0 roof overhang (e)

1.0 distance from shelter (d)



# Decay module

[Model](#)[Location](#)[Detailing](#)[Shelter](#)[Material](#)[Results](#)

Name	Latin name	Treatment	D <sub>Rd</sub> (UC3)	D <sub>Rd</sub> (UC4)
Norway maple / Sycamore	<i>Acer platanoides</i> / <i>A. pseudoplatanus</i>	none	1.4	1
Black alder	<i>Alnus glutinosa</i>	none	0.9	0.7
Wild cashew	<i>Anacardium excelsum</i>	none	0.8	1
Cabbage bark	<i>Andira inermis</i>	none	4	1
Carreto	<i>Aspidosperma megalocarpon</i>	none	4	2.9
Glassywood	<i>Astronium graveolens</i>	none	4	5.1
Grey mangrove	<i>Avicennia marina</i>	none	0.8	1
Silver birch ( Downy birch	<i>Betula pendula</i> / <i>pubescens</i>	none	0.8	0.9
Pochote	<i>Bombacopsis quinata</i>	none	4	5.1
Ceibo heartwood	<i>Bombacopsis sessilis</i>	none	0.8	1
Berba	<i>Brosium sp.</i>	none	0.8	1
Copperwood	<i>Bursera simaruba</i>	none	0.8	1

# Decay module

[Model](#)[Location](#)[Detailing](#)[Shelter](#)[Material](#)[Results](#)[Append results](#)

Loc	Species	Treatment	$D_{E0\_rel}$	$k_1$	$k_2$	$D_{E\_rel}$	$D_{R\_rel}$	SL
60.1, 24.9	Norway spruce	none	0.99	2.48	0.76	1.87	1	5.4
60.1, 24.9	Norway spruce	none	0.99	1.67	0.81	1.34	1	7.5
60.1, 24.9	Norway spruce	none	0.99	1	0.91	0.9	1	11.2
60.1, 24.9	Siberian larch	none	0.99	1	0.91	0.9	3.5	39.1
60.1, 24.9	Scots pine sapwood	Metal free, organic, UC 3	0.99	1	0.91	0.9	8.1	90.4

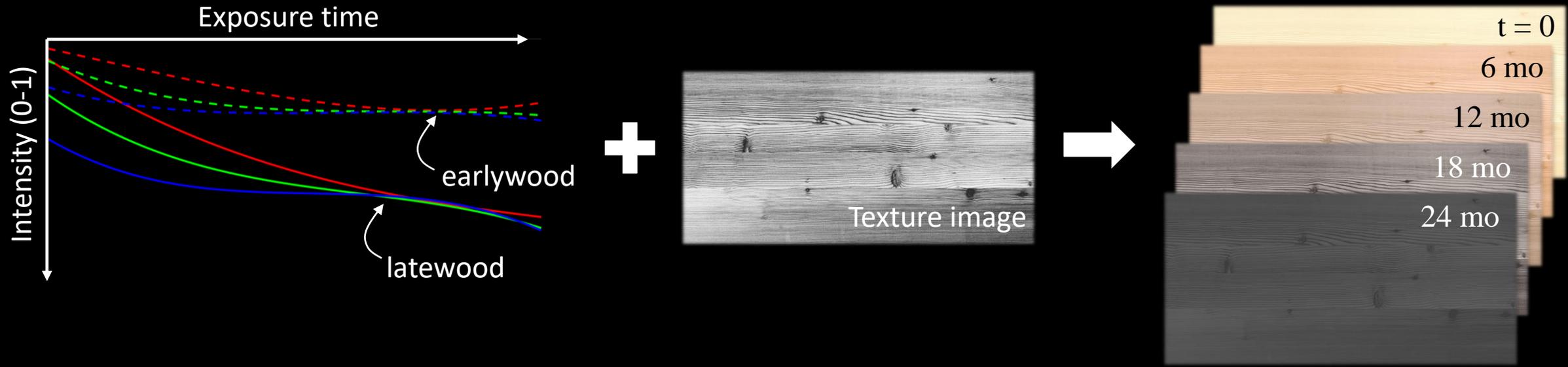
$D_{E0\_rel}$  = location;  
 $k_1$  = detailing (relative to horizontal board)  
 $k_2$  = shelter & splash (relative to horizontal board)  
 $D_{E\_rel}$  = exposure (relative to reference)  
 $D_{R\_rel}$  = resistance;  
SL = service life (years);

# Discoloration

Material database







CLICKdesign → new database for wood color change over time

OK, but how can we use this to model something useful?  
We also need the spatial variation!



Source: Charisi S, Thiis TK, Stefansson P, Burud I. Prediction model of microclimatic surface conditions on building façades. Building and Environment. 2018 Jan 15;128:46-54.

# Color change

Environmental analysis



# What we need

- To know which faces that are exposed to rain/solar radiation
  - Simulation
  - Weathering criterion



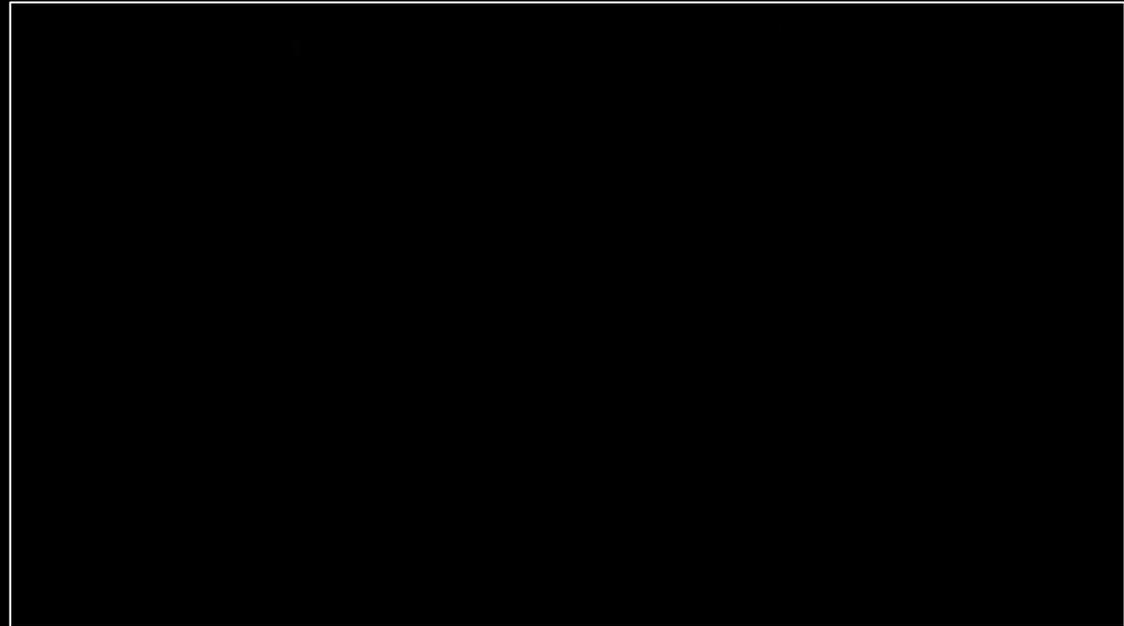
# What we need

- To know which faces that are exposed to rain/solar radiation
  - Simulation
  - Weathering criterion
- Wood texture
  - Procedural



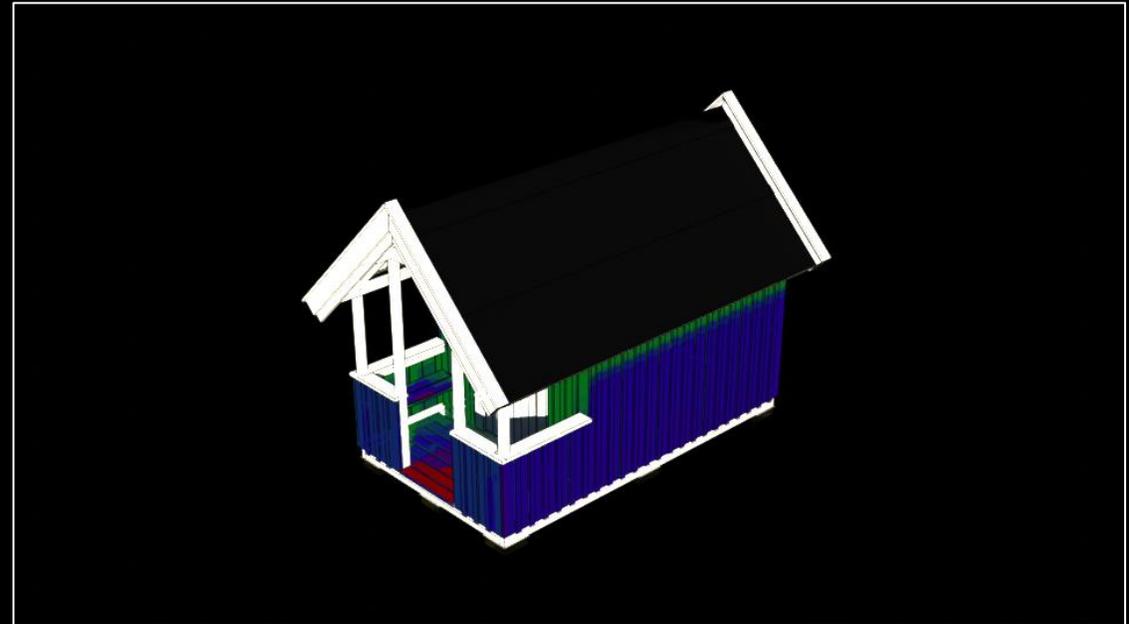
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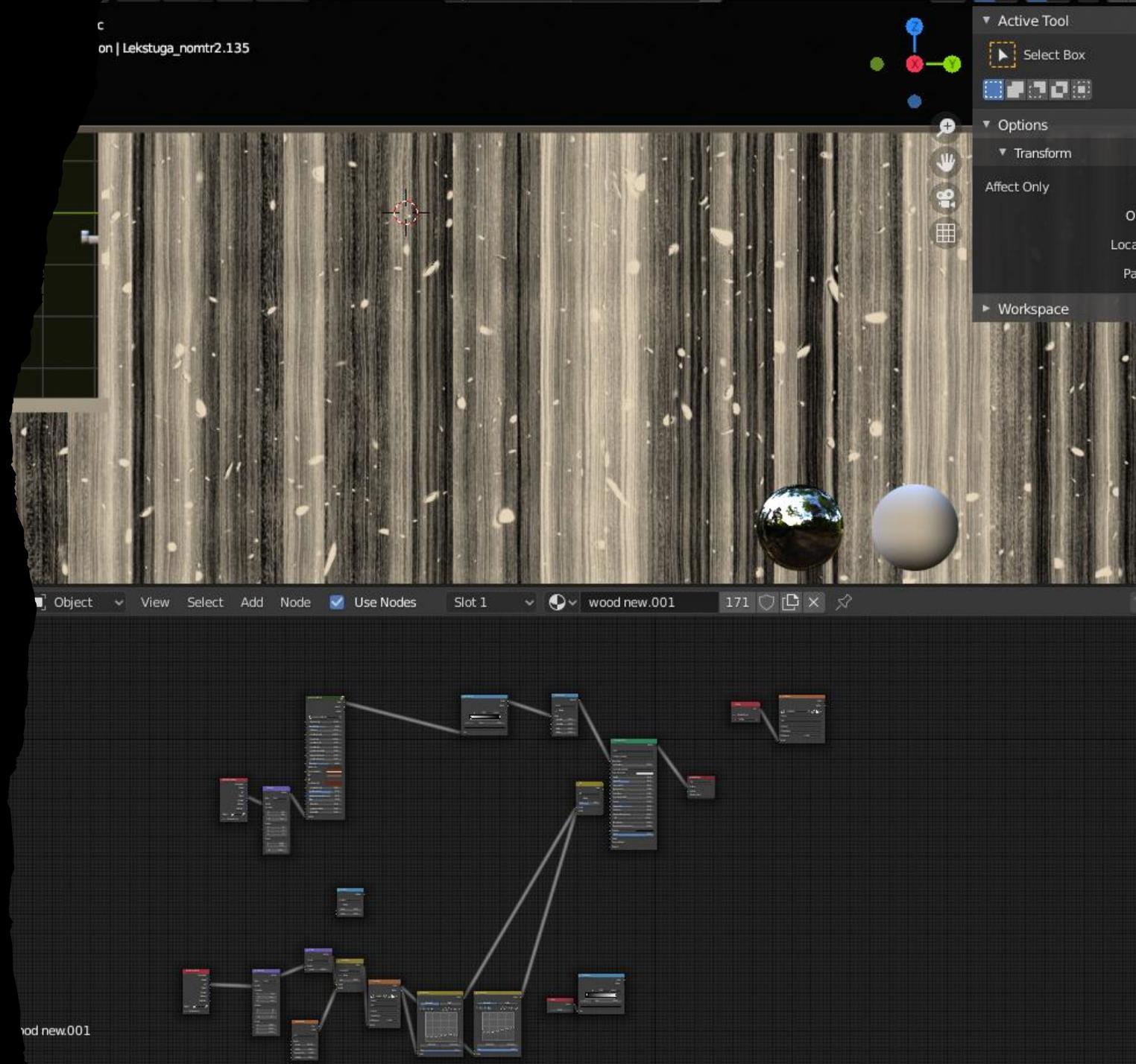
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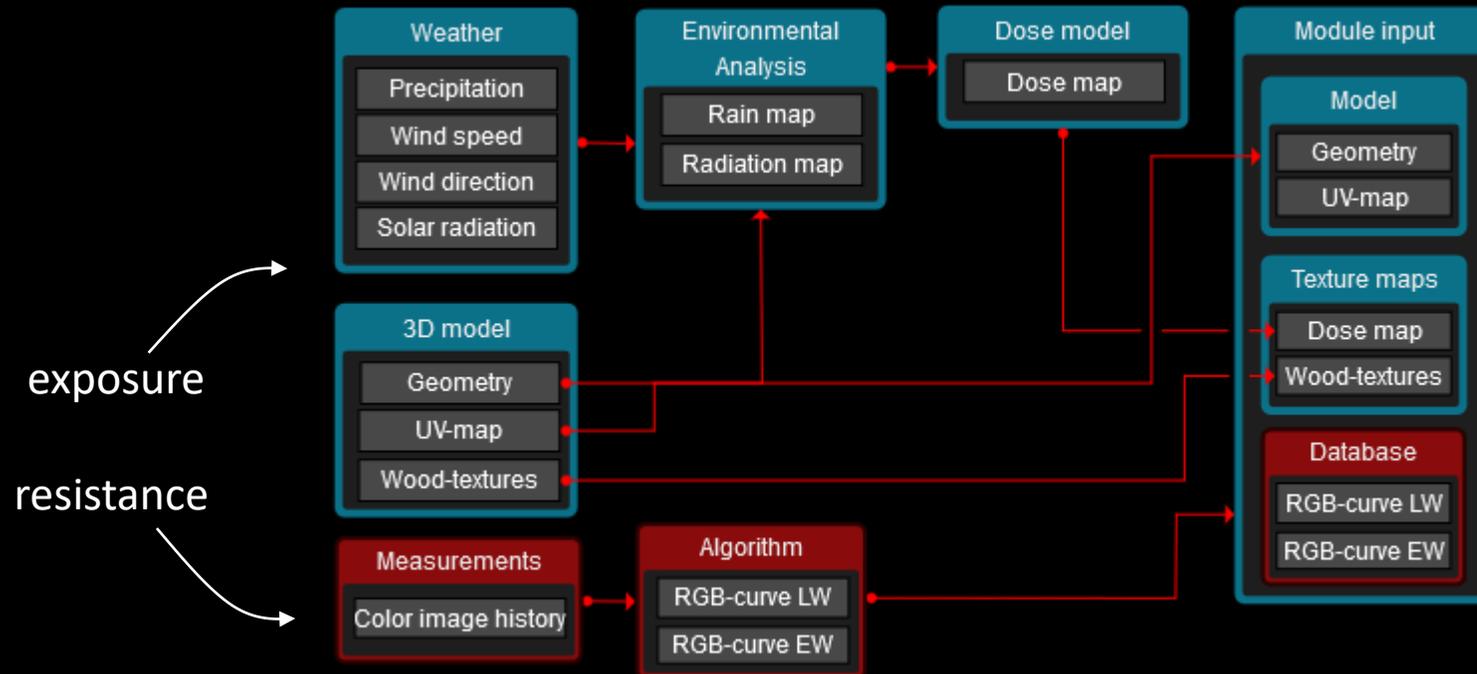


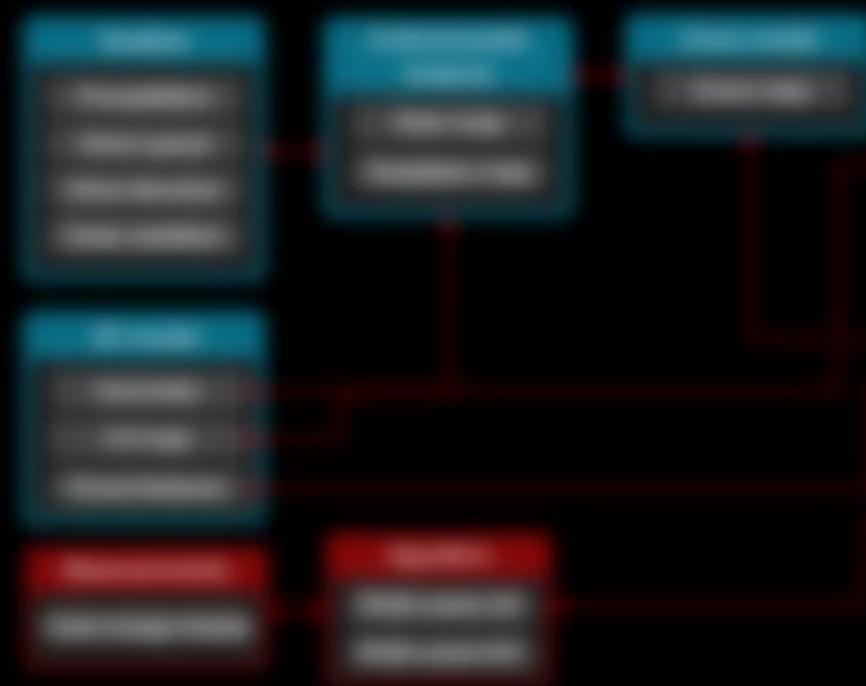
# What we need

- Faces exposed to rain/radiation
  - Simulation
  - Weathering criterion
- Wood texture
  - Procedural

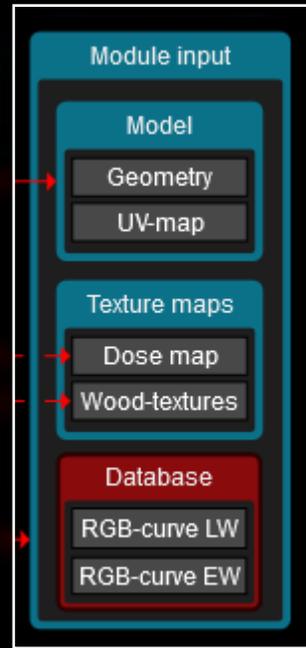


# Fungal decay – procedure





### Tool input

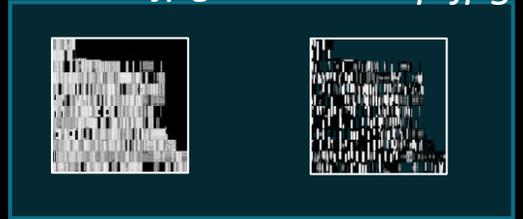


*Model.glb*

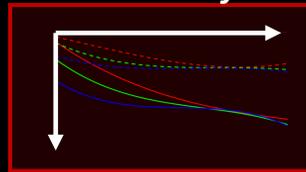


*texture.jpg*

*dosemap.jpg*



*database.json*



# Aesthetics



Accessibility



Functionality

Licences software

*BIM compatible*

**PROOF OF CONCEPT**

*(Aesthetics)*

Open source software

*Flexible  
Custom geometry  
3d effects*

**ALMOST THERE**

*Aesthetics*

*Fungal decay*

Web-based

*Inherent principle  
Education  
Examples*

**COMPLETE**

*Aesthetics*

*Fungal decay*

*Termites*



Everything available @

<https://jklewski.github.io/CLICKdesign/>





# CLICKdesign resources

- Home
- Applications
- EDU-PAK
- Documentation



## Fungal decay

How does woody materials perform under different environmental conditions?

[Go to app](#)



## Aesthetics

How does the color of woody materials change over time due to environmental effects?

[Go to app](#)



## Termite mapper

Is your project in a termite-infested region and which national rules apply?

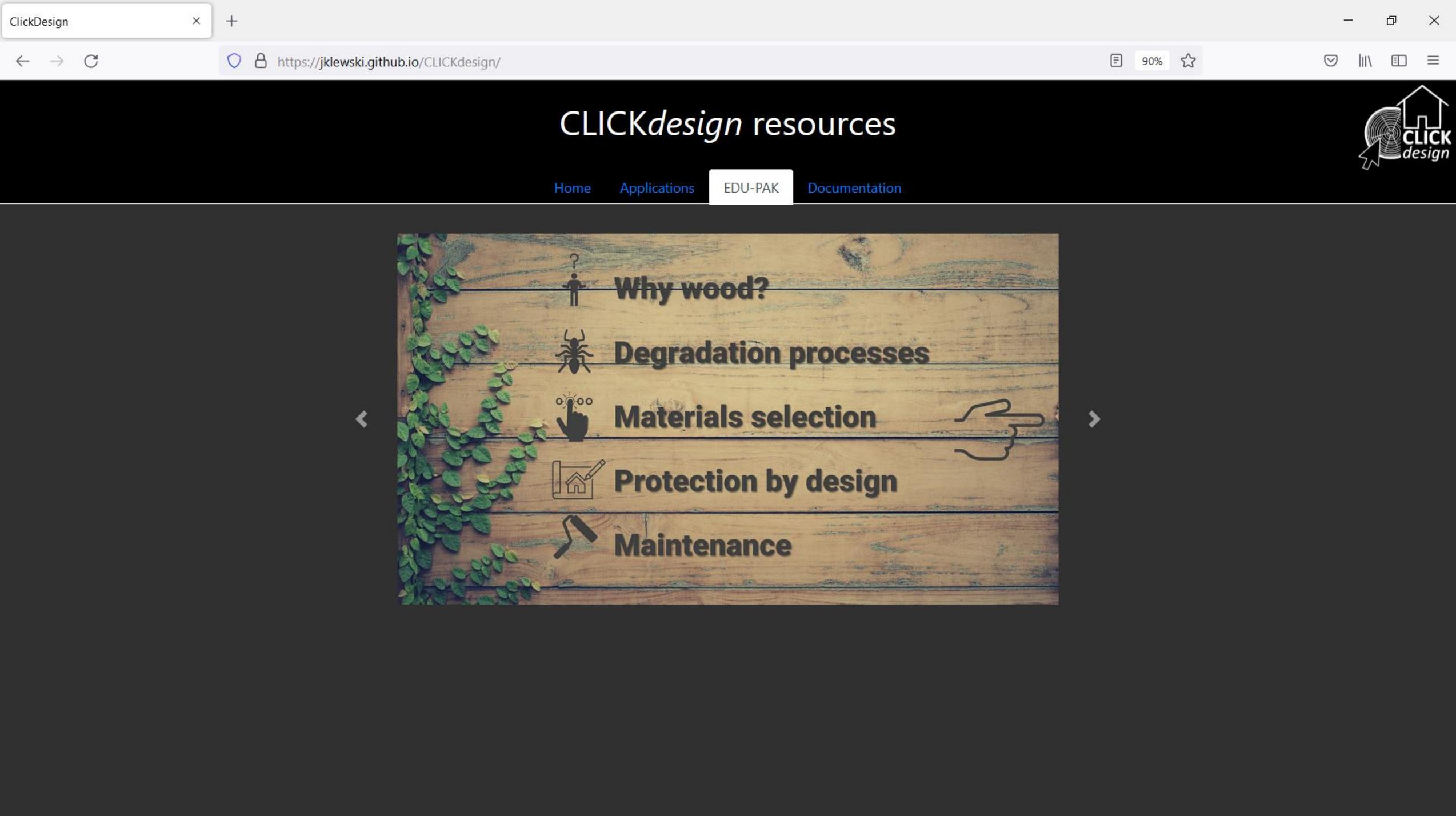
[Go to app](#)



## Structural integrity

How does the material strength and capacity of timber change over time?

[Go to app](#)



# CLICK*design* resources



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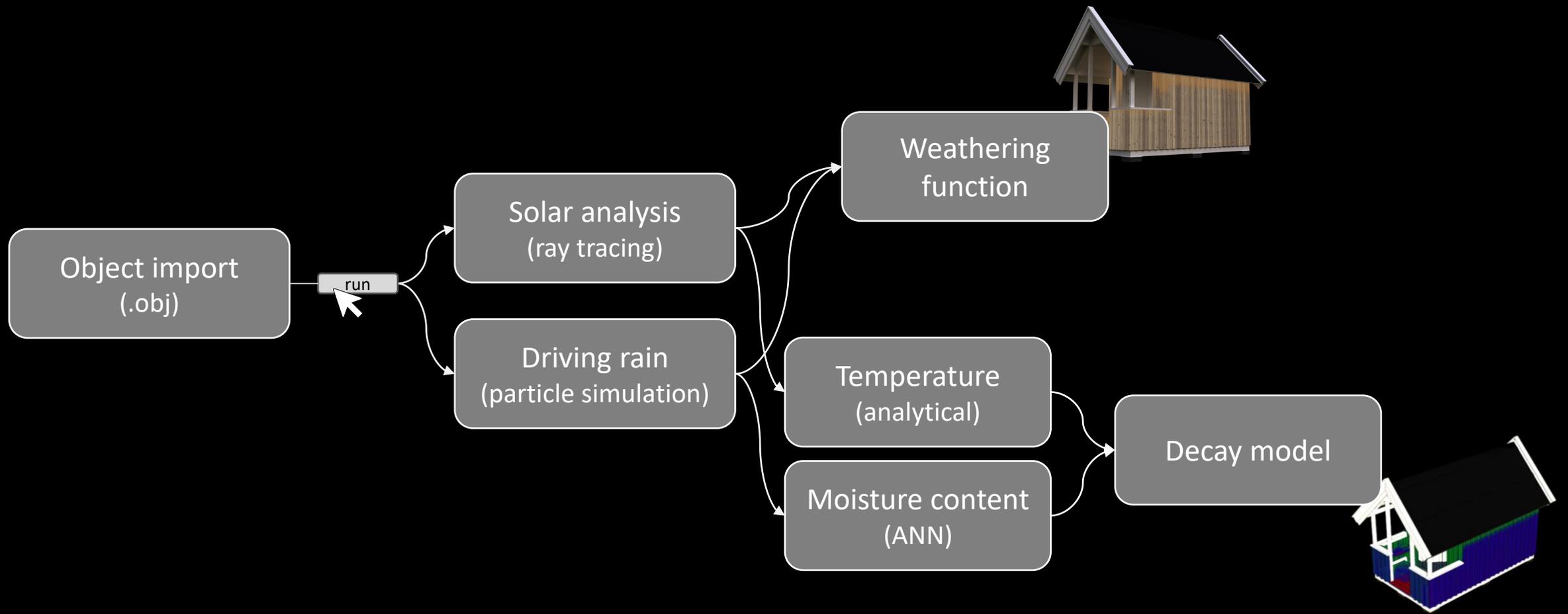
-  **Why wood?**
-  **Degradation processes**
-  **Materials selection**
-  **Protection by design**
-  **Maintenance**

# Ongoing work

- 1) A single model for analyzing decay risk and aesthetics?
- 2) Is this possible without
  - (a) proprietary software,
  - (b) several days of computational time
  - (c) much laborous input from the user? (e.g. fiddling with mesh)

Yes, probably!





(one)CLICK *design* solution (or at least very few clicks..)



Thanks for listening!

Questions?

