

# Tree To Product



Royal Danish  
Academy

CITA – Centre  
for Information  
Technology and  
Architecture

[royaldanishacademy.com](http://royaldanishacademy.com)



# THE CONCEPT OF THE ANTHROPOCENE AND THE PLANETARY BOUNDARIES CHALLENGE TO RECONSIDER THE MATERIAL BASIS OF OUR PRACTICE



# INDUSTRIALISATION - CHEAP MASS-PRODUCED STOCK

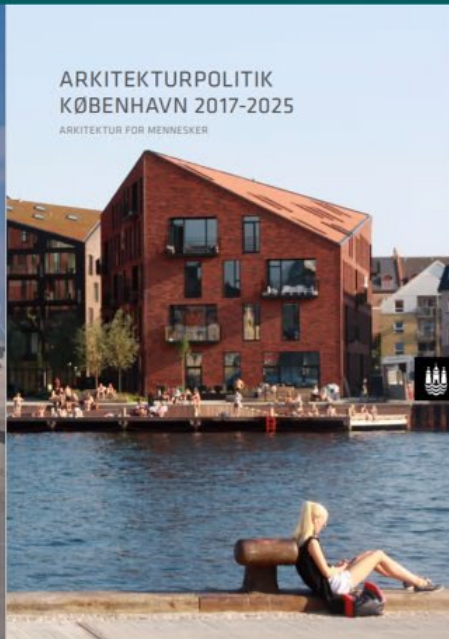




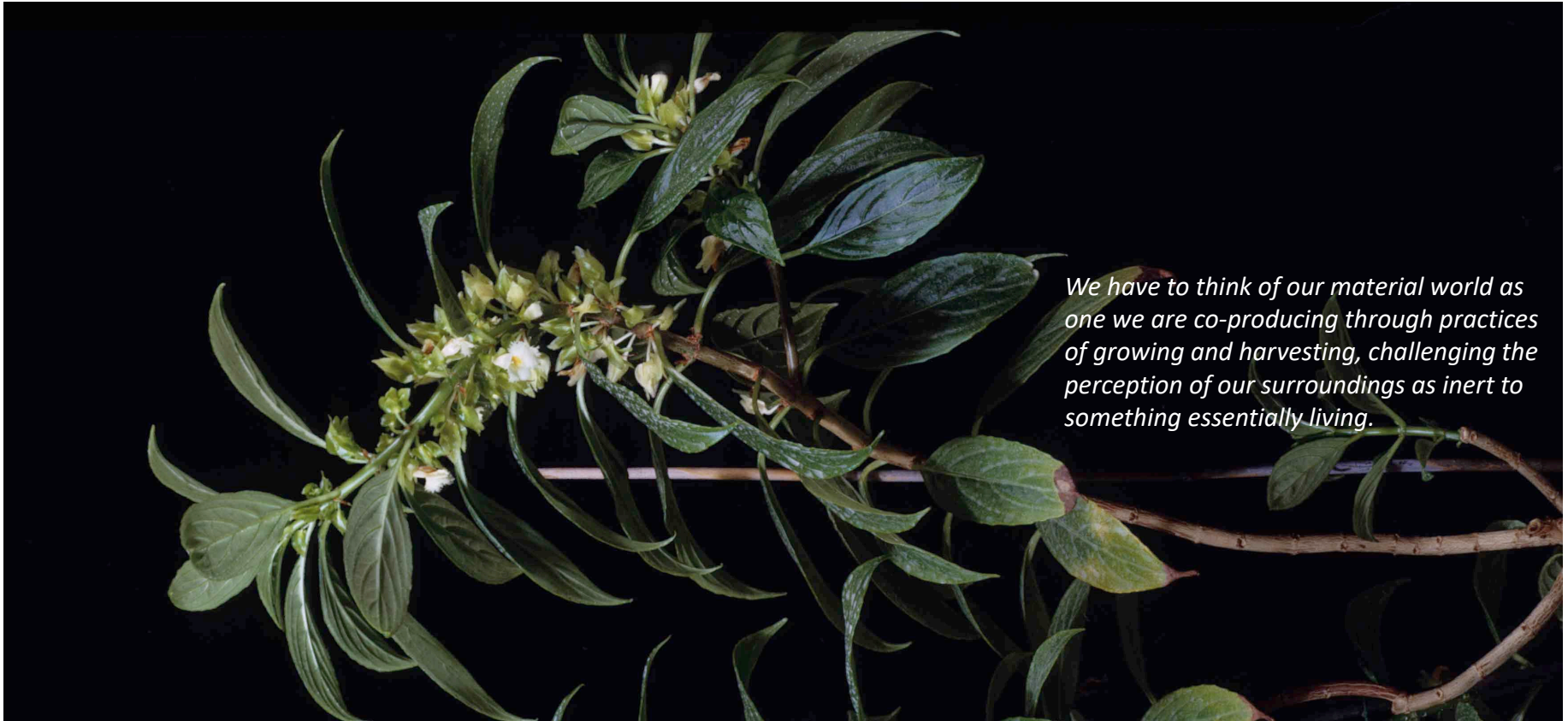
# Linear materialflows



*Industrialisation comes with a disregard for waste and overproduction. The belief being that if manufacturing is cheap enough then waste is a necessary by-product of efficiency and optimisation. Waste appears in many forms; in over-production and wasteful manufacture, in fundamentally subtractive fabrication technologies, in over-engineering and in our inability to re-extract materials on disassembly.*



# MOVE FROM A DEPENDENCE ON THE GEOSPHERE OF NON-RENEWABLE MATERIALS TO THE BIOSPHERE OF RENEWABLES



*We have to think of our material world as one we are co-producing through practices of growing and harvesting, challenging the perception of our surroundings as inert to something essentially living.*



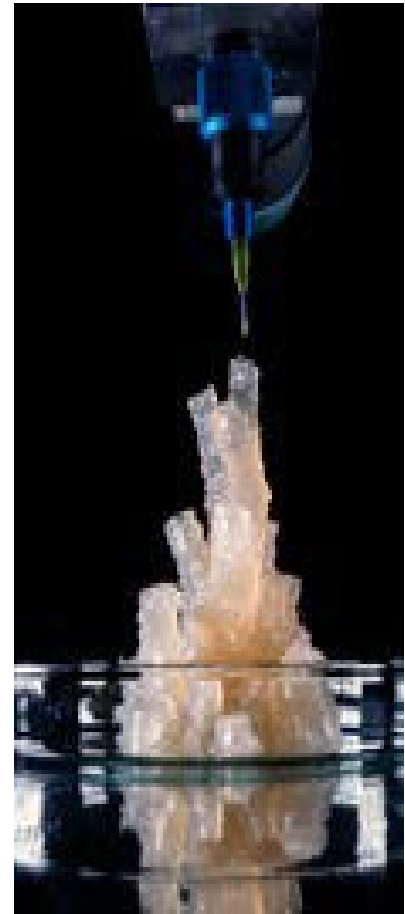


*TO ANOTHER ARCHITECTURAL IDEAL ...*



CITA PROPOSAL:  
A THREE-PART PERSPECTIVE

the harvested ...  
the designed...  
the living...





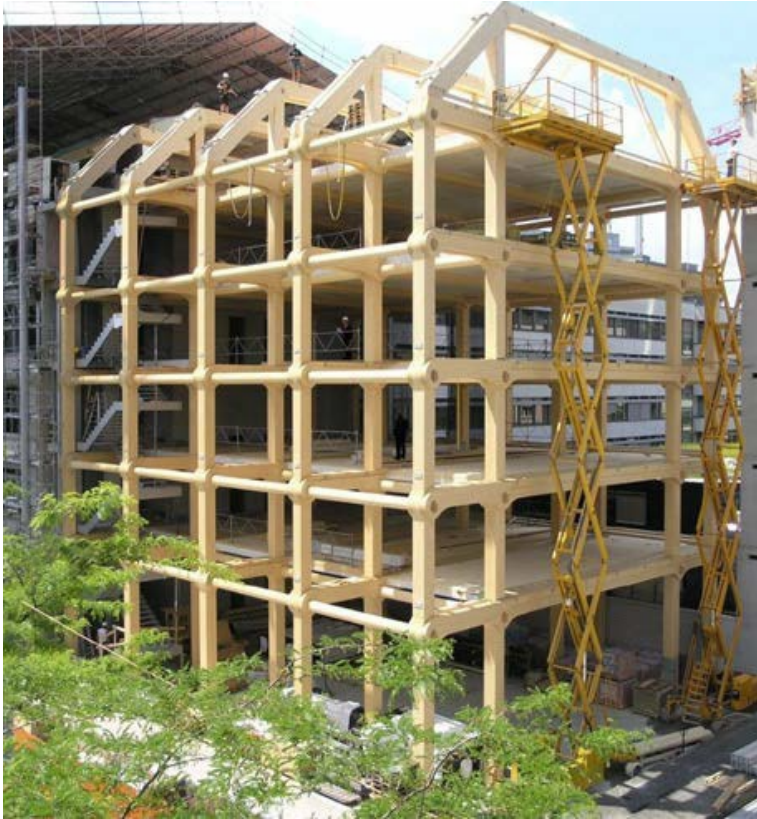
# TIMBER

BELONGING TO SILVICULTURAL CYCLES OF SEEDING, GROWING AND HARVESTING, DATES BACK MILLENNIA AND LASTS OVER A THOUSAND YEARS



# RENEWED INTEREST

FEW ECOLOGICALLY SOUND BUILDING MATERIALS BEING  
RENEWABLE, RECYCLABLE, ENERGY-EFFICIENT AND ACTING AS A CARBON SINK



# MASS TIMBER GLULAM AND CROSS LAMINATED TIMBER GIVES NEW OPPORTUNITIES



# ENDLESS FIRST TIMBER HIGHRISES

## Extending the growth model into the future



sketch tower becomes first timber  
[sketch.com](http://sketch.com)



The United States' First Mass  
[sketch.com](http://sketch.com)



Tallest timber building to rise in Portland  
[sketch.com](http://sketch.com)



Hotel city architect demonstrates the  
[sketch.com](http://sketch.com)



sketch.com



Real timber tower proposed for Tokyo  
[sketch.com](http://sketch.com)



Top 5: The World's Tallest Timber Buildings  
[sketch.com](http://sketch.com)



High-rise wooden apartment  
[sketch.com](http://sketch.com)



High-rise timber frame building  
[sketch.com](http://sketch.com)



Skanska's first timber  
[sketch.com](http://sketch.com)





# FOCUS ON SPECIFIC TREE SPECIES TIMBER UNDERSTOOD AS HOMOGENOUS RESOURCE



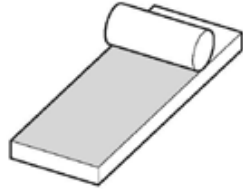


# TIMBER PRODUCTS MATERIALLY INEFFICIENT

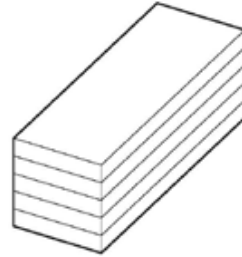
## Up To 85% Loss Of Initial Material



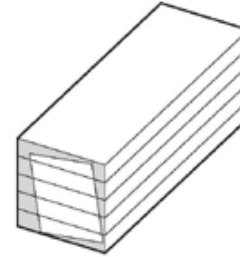
01 Rough sawn lumber  
-50% byproduct



02 Planing and cutting  
-20% byproduct



03 Straight glulam planing



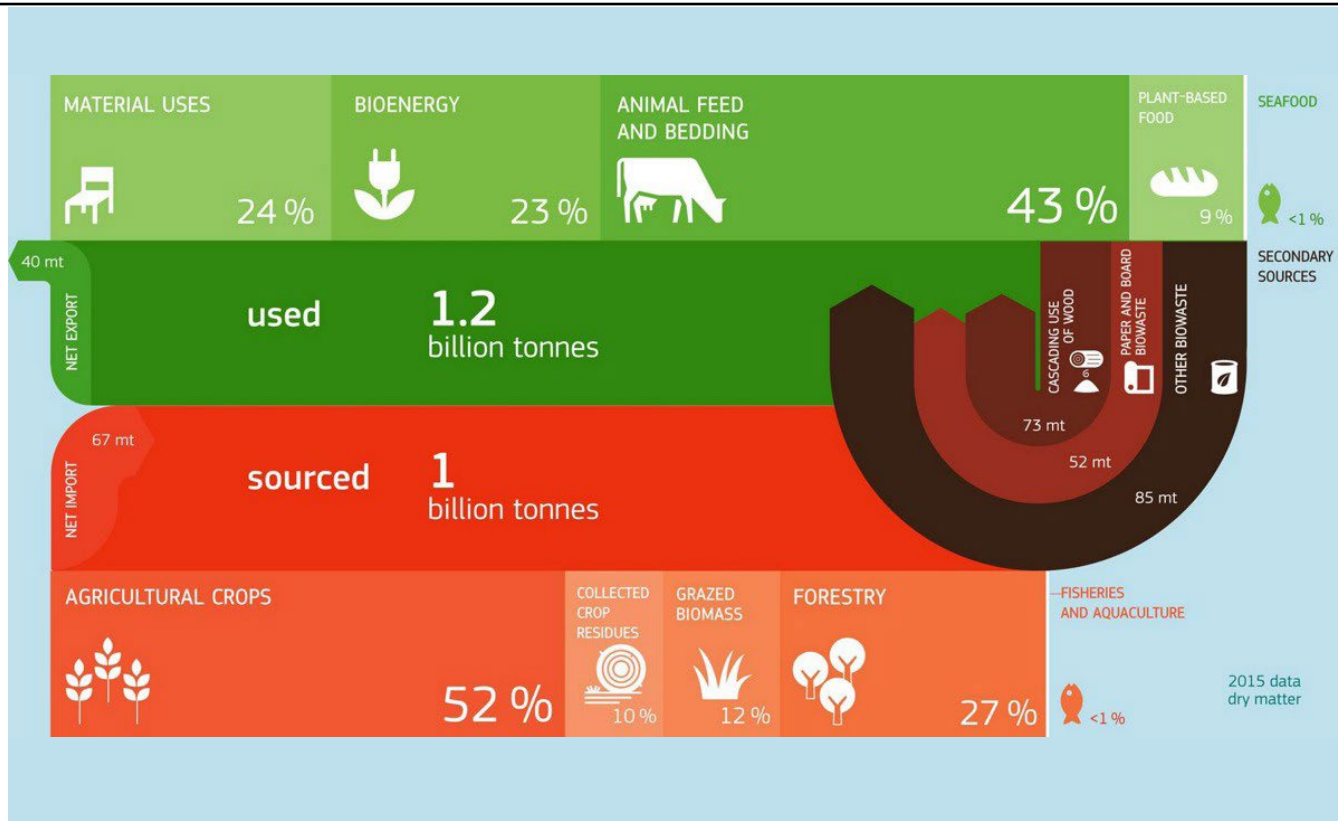
04 Free-form glulam machining  
up to 50-70% byproduct

End product may contain only ~15% of initial input material.

(50% x 80% x 40% ≈ 16%)

Ramsgaard Thomsen, M., Nicholas, P., Tamke, M., Svilans, & Tom. (2020). A New Material Vision. In F. Melendez, N. Diniz, & M. del Signore (Eds.), *Data, Matter, Design Strategies in Computational Design*. Routledge.

# BIOMASS IS A LIMITED RESOURCE



# IMPACT: AVAILABILITY & ECONOMY

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## Topchef hos Enemærke & Petersen om træpriser: “Det er ikke prisstigninger, vi normalt ser. Det er så voldsomt, at materialerne stiger så meget på så kort tid”

Prisstigninger på træ og andre byggematerialer gør det farligt for entreprenører at give tilbud langt frem i tiden



Teures Holz durch Bauboom

## »Da wird ein Preis kommen, den es so noch nicht gegeben hat«

Schnittholz ist so teuer wie nie zuvor. Wer ein Haus bauen will, muss darauf hoffen, dass der Markt irgendwann einbricht. Doch Branchenexperte Gerd Ebner warnt: Der eigentliche Boom starte gerade erst.

Ein Interview von **Maria Marquart**  
06.06.2021, 13.44 Uhr



## Lumber mania is sweeping North America

A lumber frenzy has taken over homebuilding, Home Depot, and the internet.

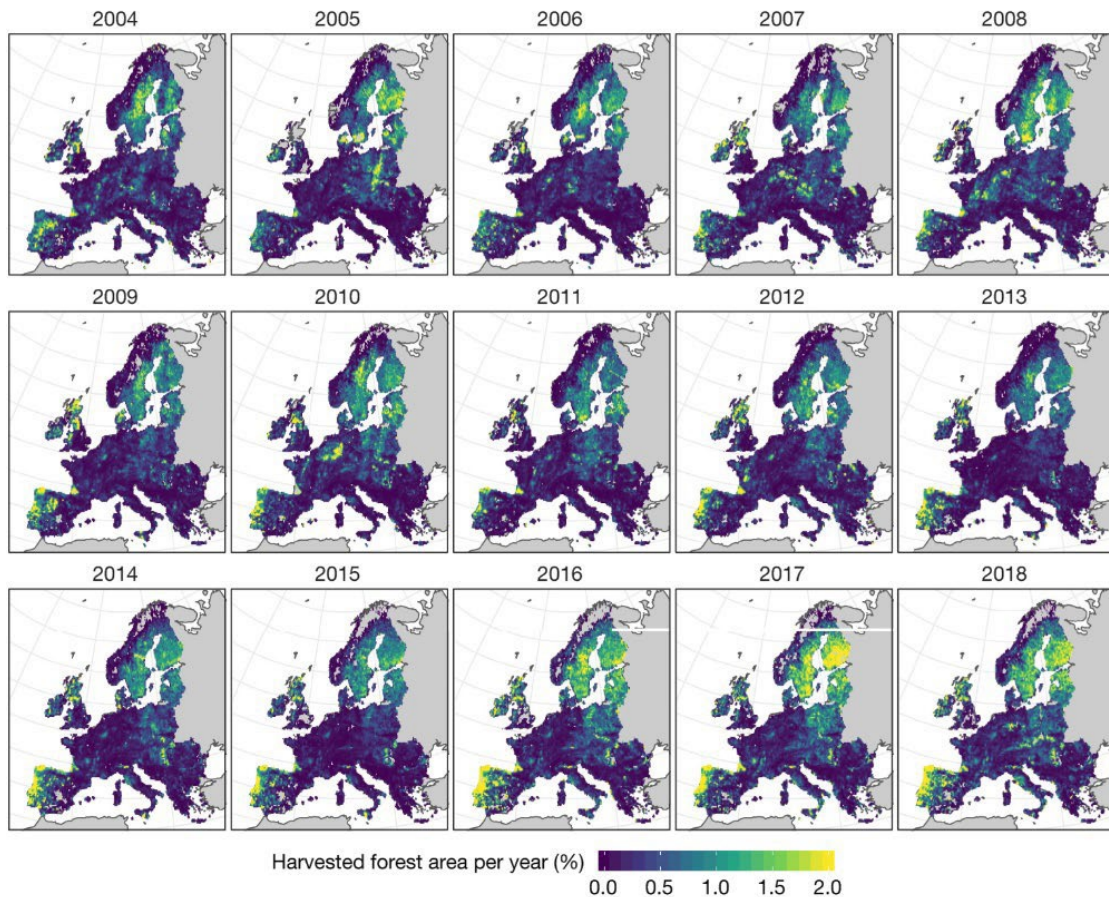
By Emily Stewart | [emily.stewart@vox.com](mailto:emily.stewart@vox.com) | May 3, 2021, 10:00am EDT



Contrary to what the memes might have you think, the driver of the truck in the above picture is not a billionaire. | Peter Gercke/picture alliance/Getty Images



# IMPACTS: DECARBONISATION



Young forrests store less carbon than older forrests

Ceccherini, G., Duveiller, G., Grassi, G., Lemoine, G., Avitabile, V., Pilli, R., & Cescatti, A. (2020, July 1). Abrupt increase in harvested forest area over Europe after 2015 . *Nature*, 583(7814), 72–77.



# IMPACT: BIODIVERSITY

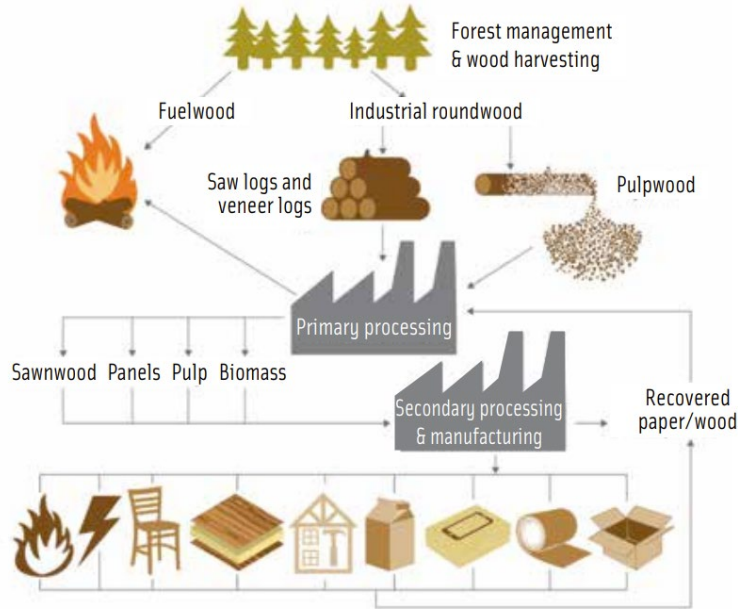


<https://www.dn.se/sverige/fageln-som-blivit-symbol-for-striden-om-skogen/>





# FORREST SUPPLY CHAIN



WWF and IIASA 2012

In Germany only 4% of the annual timber harvest is used for building grade timber

Wissenschaftlicher Beirat Waldpolitik.  
*Erhöhung der stofflichen Nutzung von Holz  
in Gebäuden im Einklang mit der  
Rohstoffverfügbarkeit – Stellungnahme des  
Wissenschaftlichen Beirates Waldpolitik.*  
Tech. rep. Nov. 2018.

SWEDEN

2010-2020: 50 MRD. SEK INVESTMENT INTO NEW TIMBER PRODUCTION FACILITIES

AIM:  
BY 2025 - 50% OF ALL APARTMENT BUILDINGS AND 30-35% OF ALL OTHER BUILDINGS WILL BE CONSTRUCTED IN TIMBER

Svensk Träbyggnadsindustri LTU & LU. Färdplan För Industriellt Träbyggande 2020



# HOLZBAU OFFENSIVE BADEN-WÜRTTEMBERG



Wir gehen voran!  
mit Digitalisierung und neuen Methoden.

Veranstaltungen

[Alle Veranstaltungen anzeigen >](#)



Royal Danish Academy

CITA



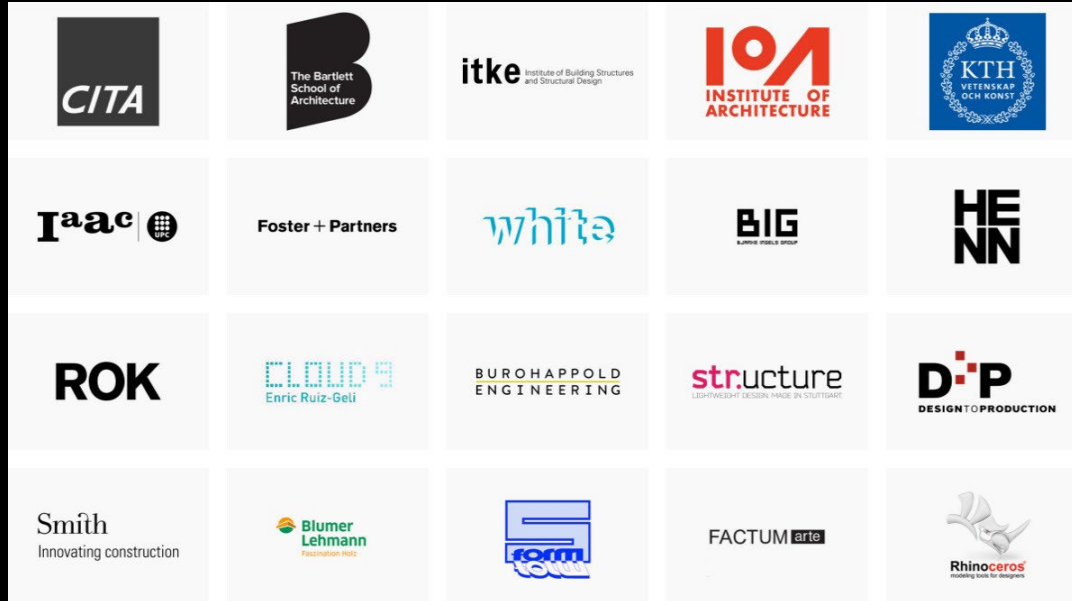


**CHALLENGING**  
THE TRADITIONAL THINKING OF DESIGN

## INNOCHAIN PROJECT

The InnoChain ETN network is a shared research training environment examining how advances in digital design tools challenge building culture enabling sustainable, informed and materially smart design solutions. The network aims to train a new generation of interdisciplinary researchers with a strong industry focus that can effect real changes in the way we think, design and build our physical environment

# INNOCHAIN NETWORK



*6 Academic institutions*

*14 Industrial partners*

*15 Early-Stage Researchers (ESRs)*





# ESR 2 - PARTNERS

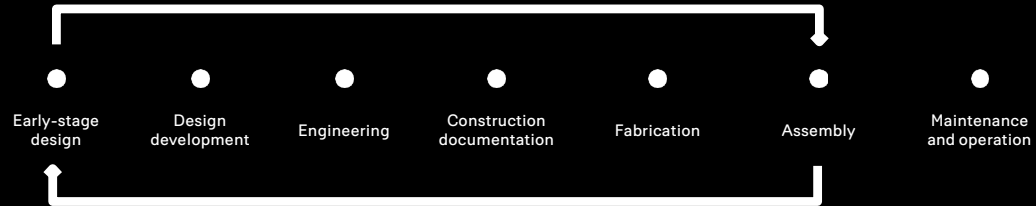
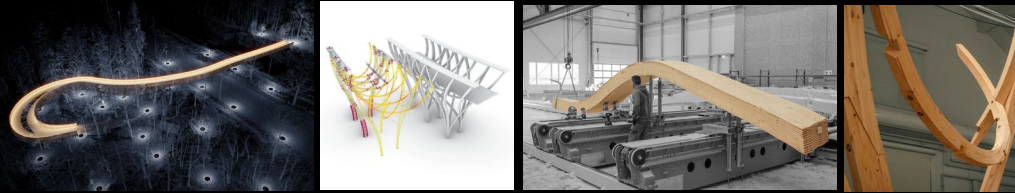
*Academic partner (DK)*

*Architecture practice (SE)*



*Timber contractors (CH)*

# INDUSTRY 4.0 - THE DIGITAL CHAIN

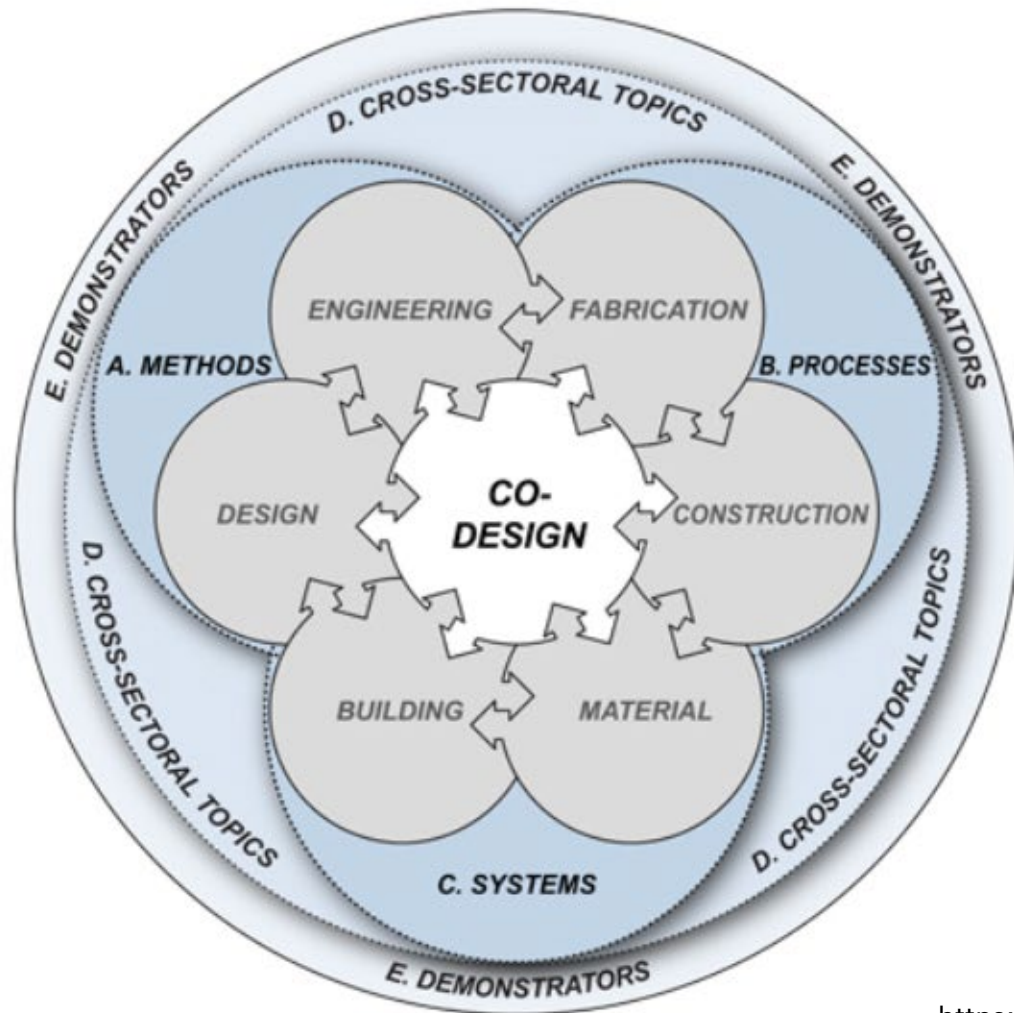


white

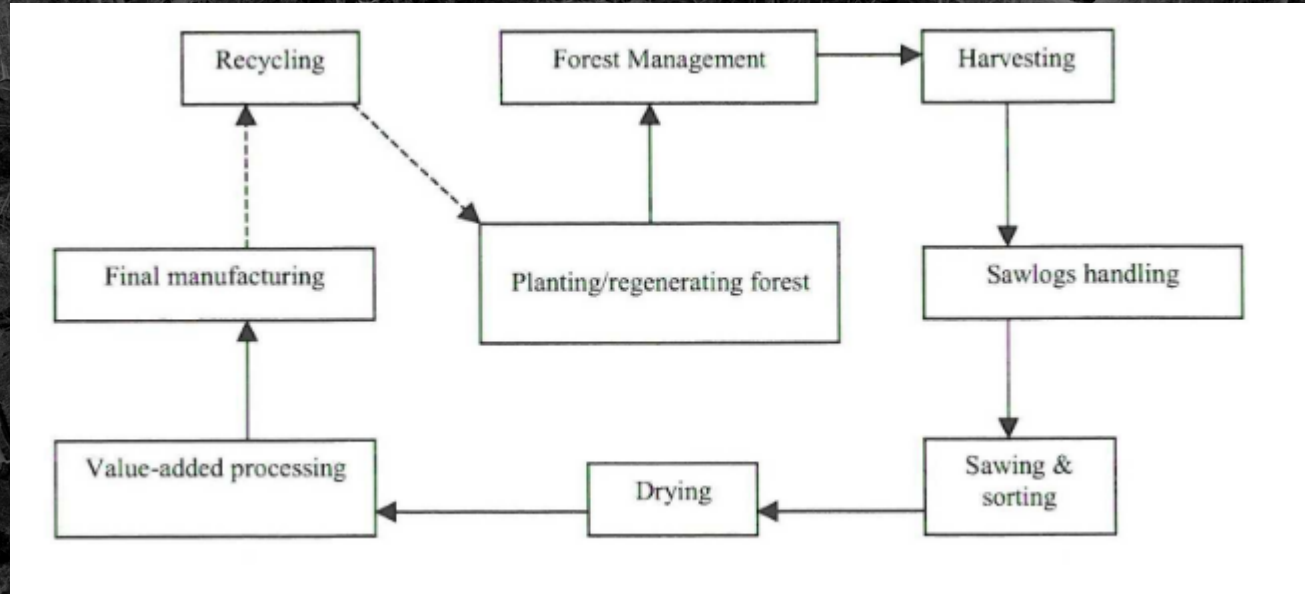
Blumer  
Lehmann

*MODELLING*

*MATERIALIZING*



# THE FORESTRY WOOD PRODUCTION CHAIN



FORESTRY-WOOD PRODUCTION CHAIN. Grönlund A. (1992) Sawmill Technology (Sågverksteknik) in Swedish. Markyard, Sweden : The Swedish forest industry association., 1992.



# THE DIGITAL FORESTRY CHAIN



TREEMETRICS

Collecting Data via Satellite, Air and Terrestrial Sensors up to Tree level





# THE DIGITAL FORESTRY CHAIN



Komatsu

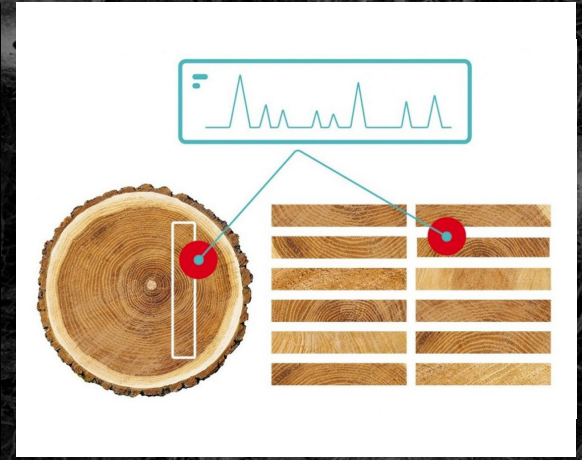
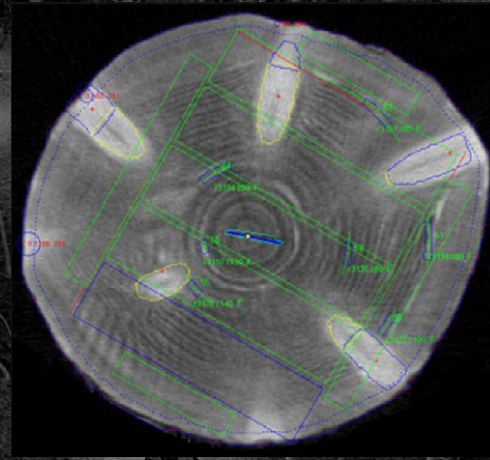


Tuomo Palonen and Heikki Hyyti, Autonomous Systems, Aalto University

Harvester as data-gathering and data utilising hub



# THE DIGITAL FORESTRY CHAIN



MICROTEC

Computer Vision and CT Scanning allows to optimize cutting patterns and track individual logs and boards from the logyard to the final grading



# THE DIGITAL FORESTRY CHAIN



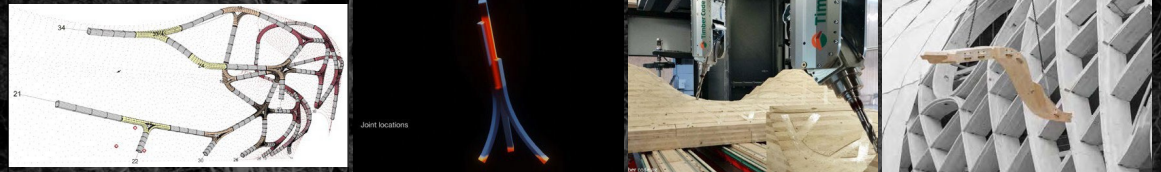


# TREE TO PRODUCT PROPOSITION



FORESTRY-WOOD PRODUCTION CHAIN

DIGITAL CHAIN





# TREE TO PRODUCT PROPOSITION





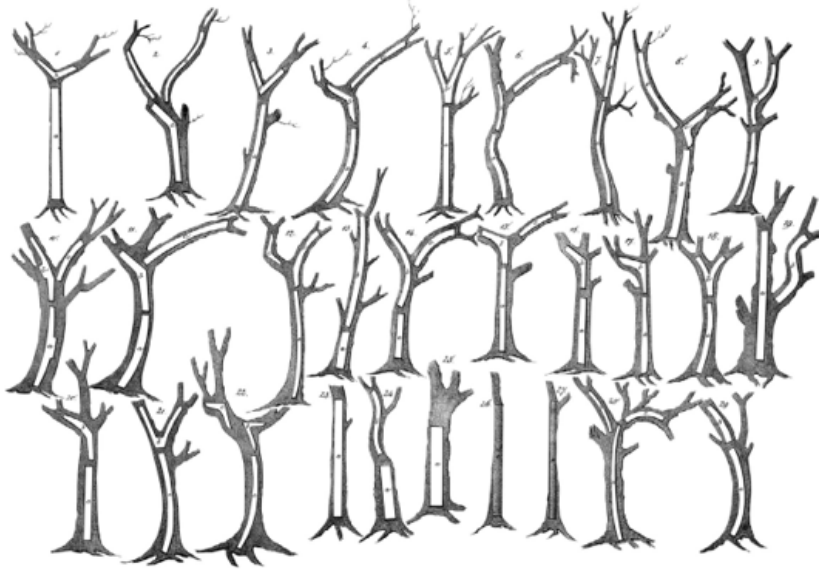
Rawlam / CITA



Hygroshape / ICD



# FORREST AS RESSOURCE CRAFTSMANSHIP



Use of naturally grown tree shapes for shipbuilding  
Jägerschmid 1828



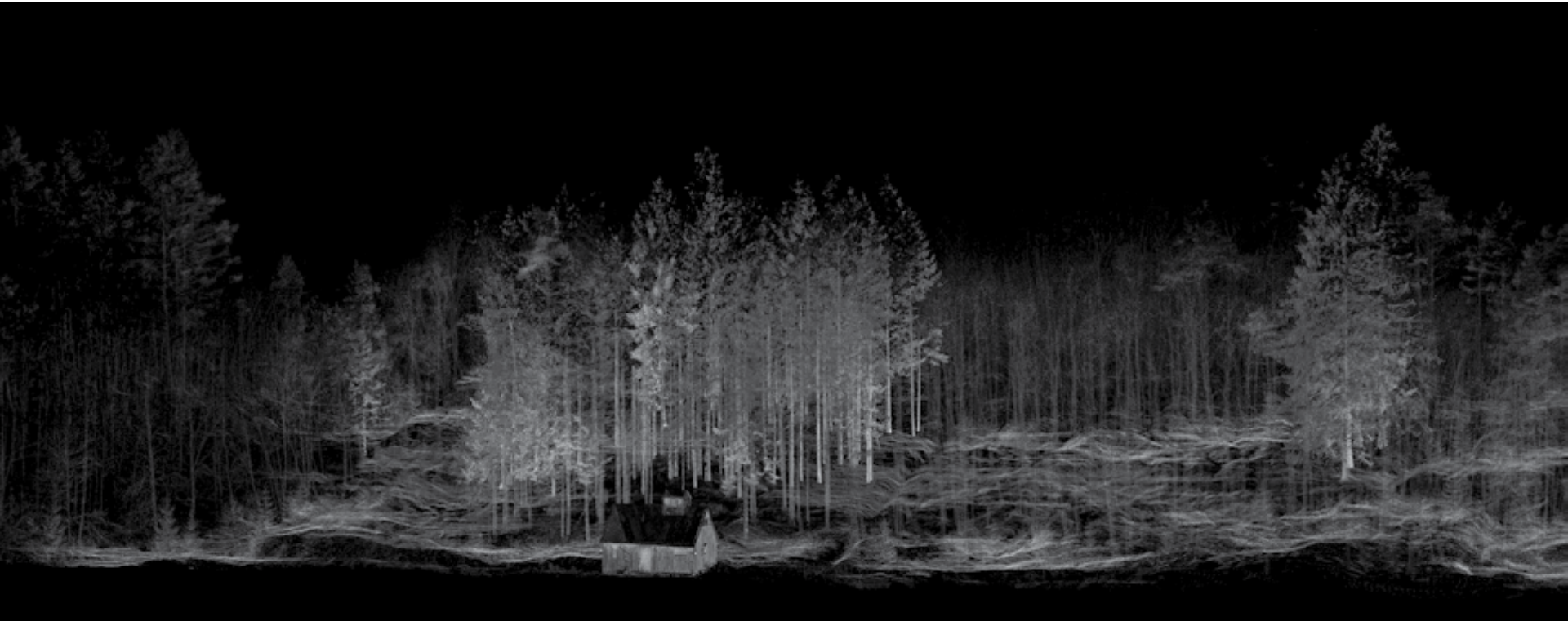
Use of naturally bend  
timber elements  
Grossmann 2004



Branch as structural  
element  
Kirk, 1994



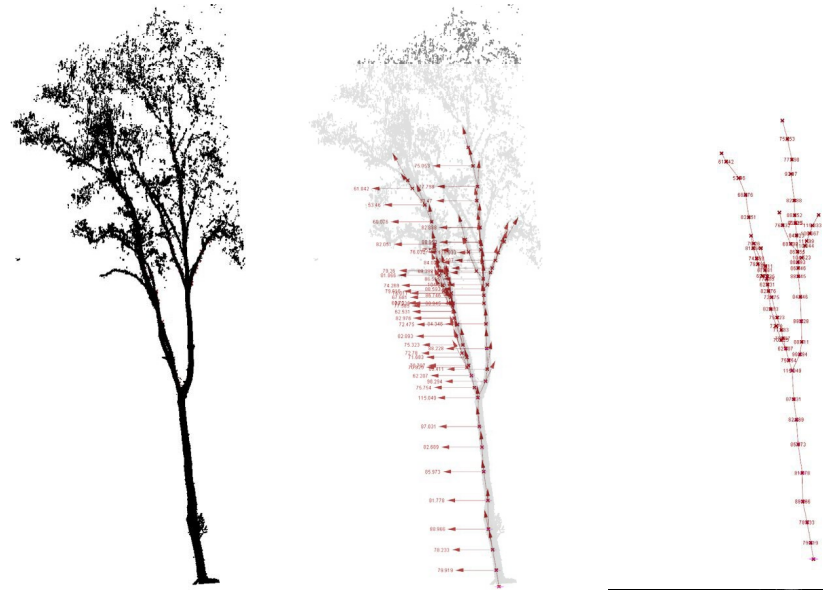
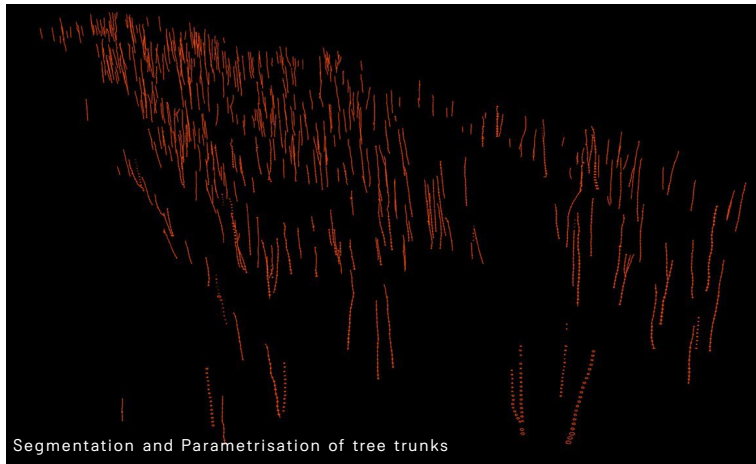
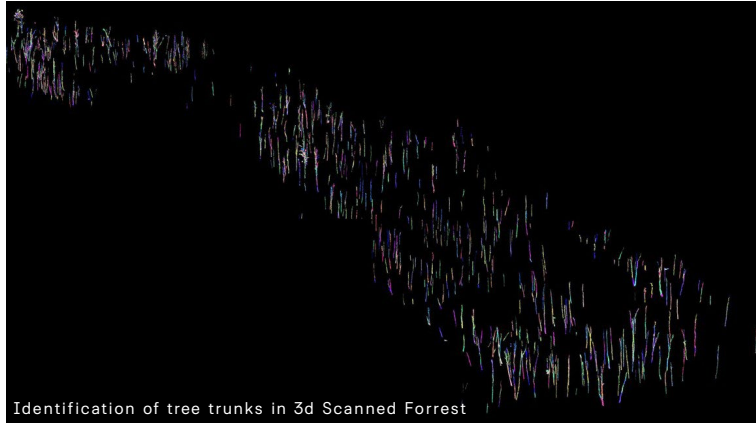
# FORREST AS RESSOURCE



Design with found wood / Per Kristian Hanson / CITA.STUDIO 2014



# FORREST AS RESSOURCE



Design with found wood / Per Kristian Hanson / CITA.STUDIO 2014

# FORREST AS RESSOURCE

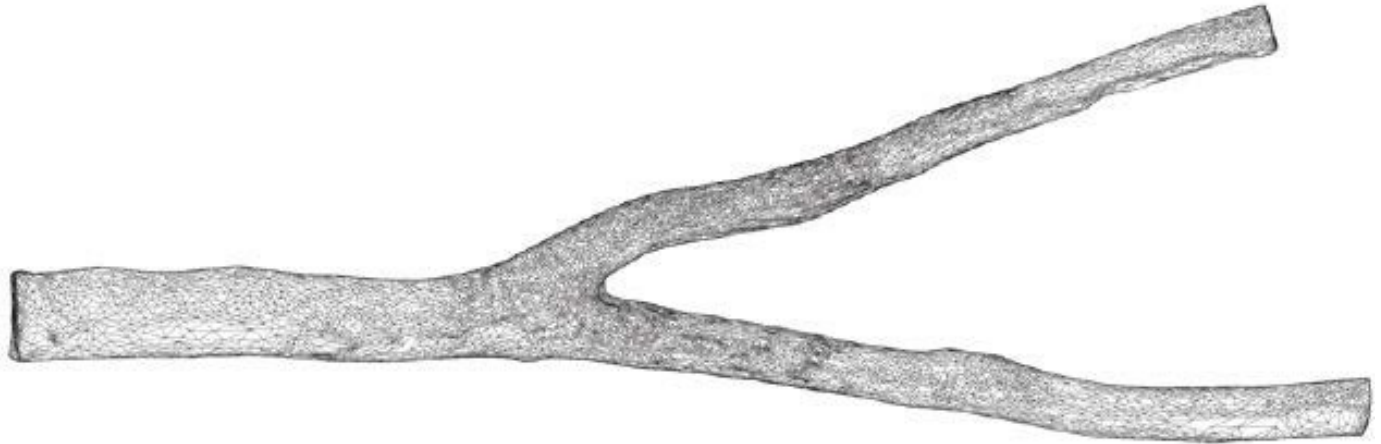


## Hooke Park - AA

Mollica, Z., & Self, M. (2016). Tree Fork Truss - Geometric Strategies for Exploiting Inherent Material Form. In S. Adriaenssens, F. Gramazio, M. Kohler, A. Menges, & M. Paily (Eds.), *Advances in Architectural Geometry 2016* (pp. 138-153). ETH Zürich.



# FORREST AS RESSOURCE



Fork 08\_D02 scan mesh



# FORREST AS RESSOURCE



# FORREST AS RESSOURCE



