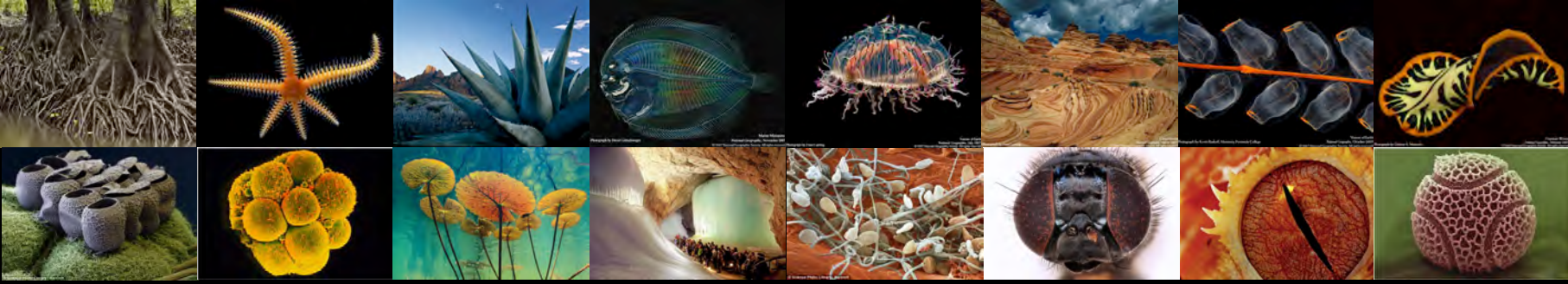
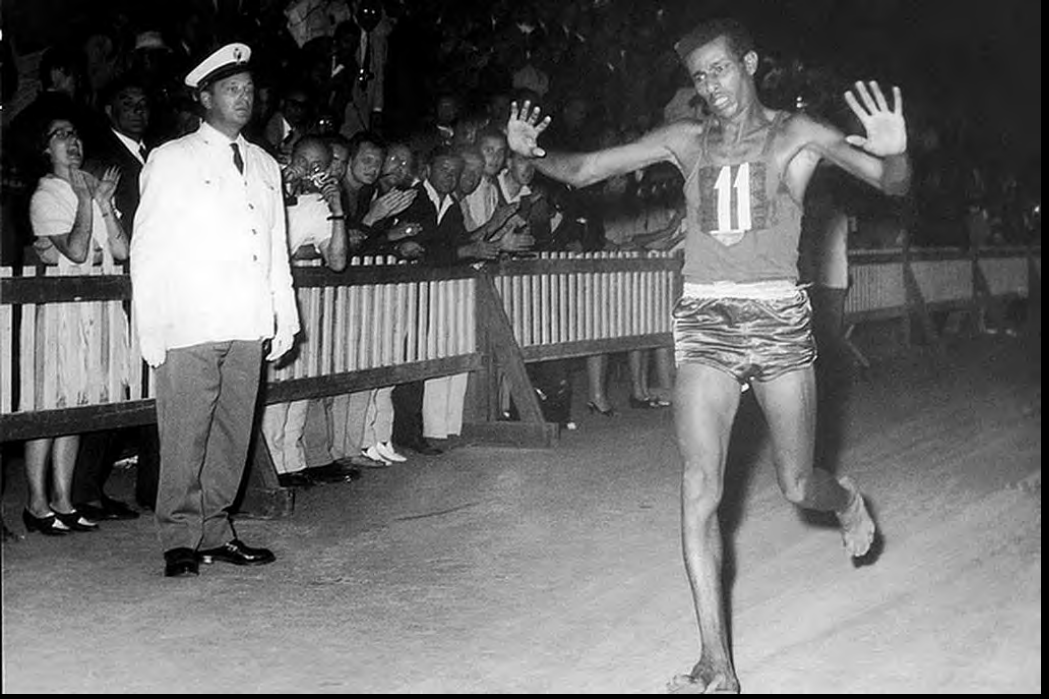


Nature & Architecture

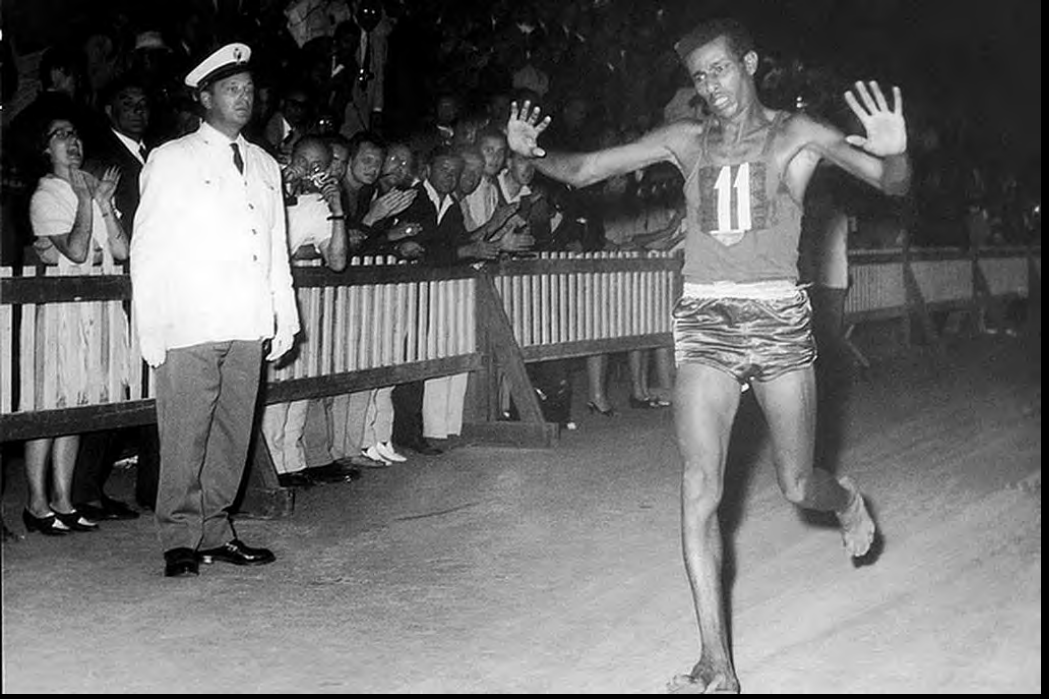
Structure, Function & Aesthetics in Nature
Source of Inspiration for Architectural Design and Technology

The UIA GGWI (Great Green Wall Initiative): Interactive Webinar, 26th March 2022
Nikolaos TSINIKAS, Professor Emeritus, School of Architecture, Aristotle University of Thessaloniki (A.U.Th.), Greece



Abebe Bekila, Marathon, Rome Olympics, 1960
World record barefeet!

Bob Beamon, USA,
long jump 8.90m., +55cm,
Mexico Olympics, 1968

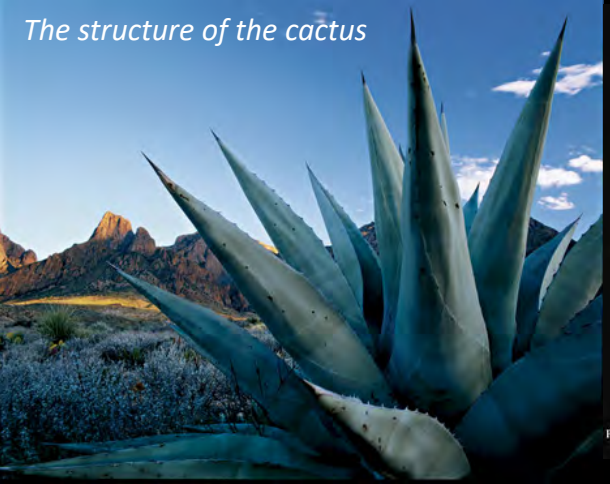


Abebe Bekila, Marathon, Rome Olympics, 1960
World record barefeet!
Altitude in Addis Abeba is 2.355m. Less air to breathe!

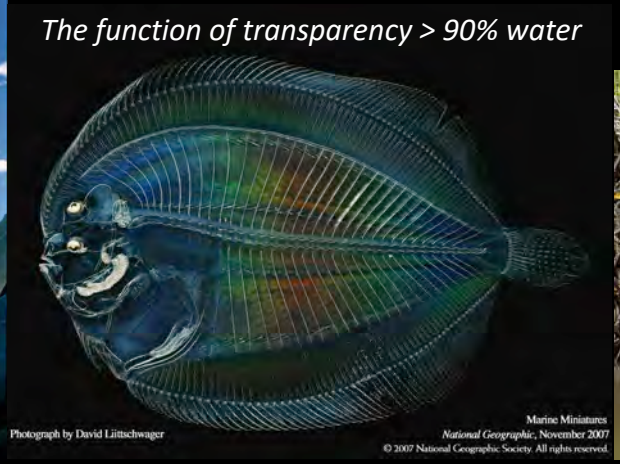
form follows function in biology
to survive spieces must adapt to the environment

Bob Beamon, USA,
long jump 8.90m., +55cm,
Mexico Olympics, 1968
Altitude Mexico 2.250m.
Less gravity force!

The structure of the cactus



The function of transparency > 90% water



Beauty of the roots (anchorage & water)

form - follows - function

Vitruvius said, every building must be:

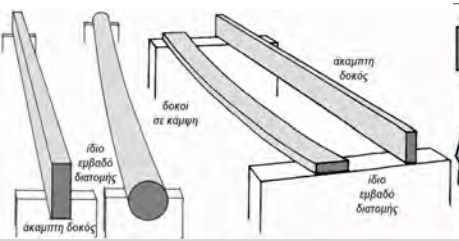
strong, useful, beautiful

structure, function, aesthetics

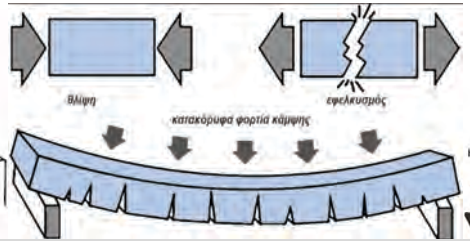
consider nature as structures

use them as source of inspiration for

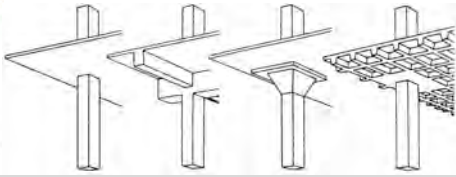
architectural design - synthesis



right position of beams in relation to their section



distortion of beam under loads, cracks, up-compression, down-tension



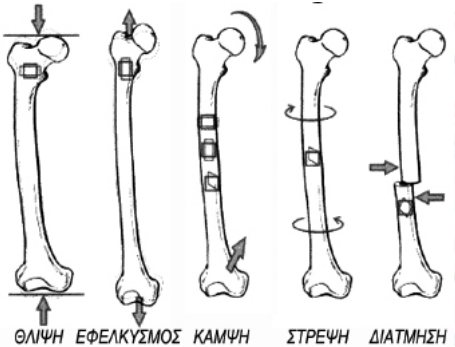
smooth transfer of loads

Distribution of Loads in Structural Elements

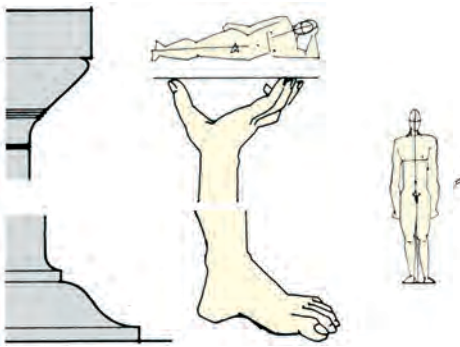
beams, columns-pillars, cables-wires

vector active structural elements
small section compared with their length

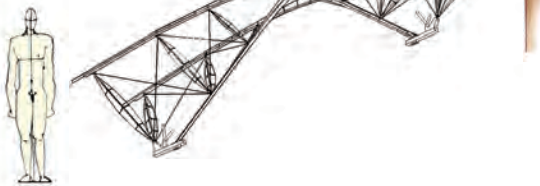
tension
compression *bending* *torsion* *shear*



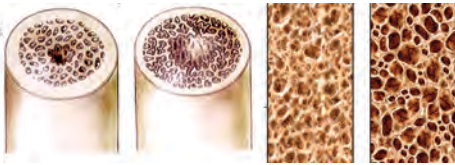
transfer of loads on a pillar hand & foot

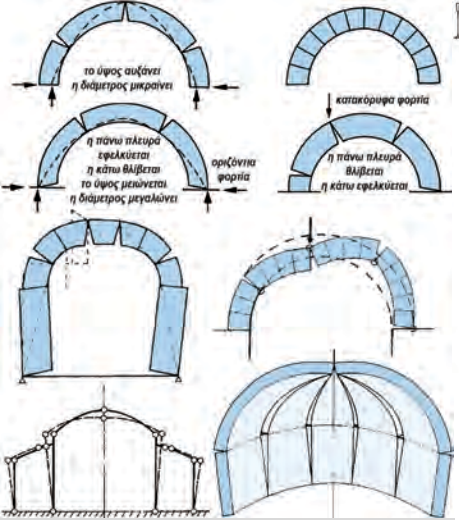


design to enhance strength under compression



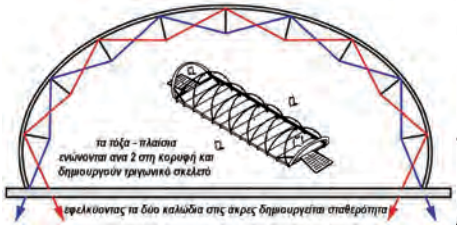
healthy bone and osteoporosis



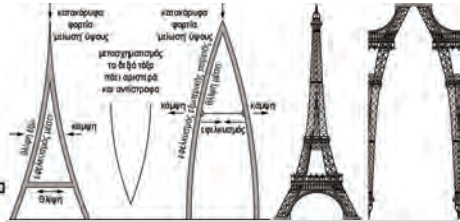


deformation of 'hole-body' arches and domes under horizontal or vertical pressure loads

'Pabellon del futuro', Expo 92, arch. MBM, eng. Peter Rice.



'MOMI' tent, 1991. arch, Future Systems, eng, Peter Rice.



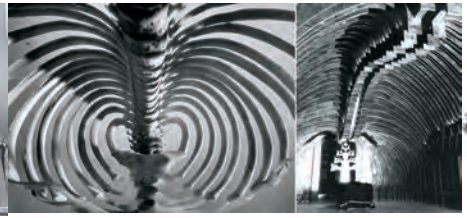
the 'converse' shape of Eiffel tower in Paris from 'curved' to 'concave' arch from beam (compression) to wire (tension)

arches

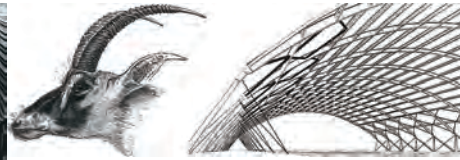
distribution of loads in arches

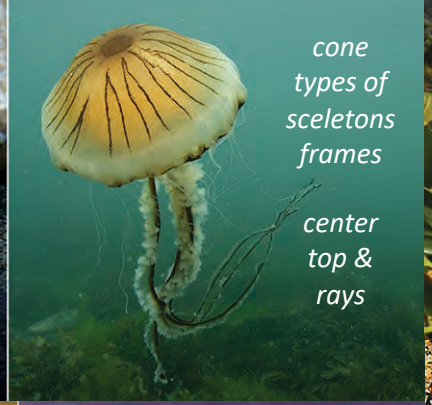
Gateway, Eero Saarinen, 1965, St. Louis

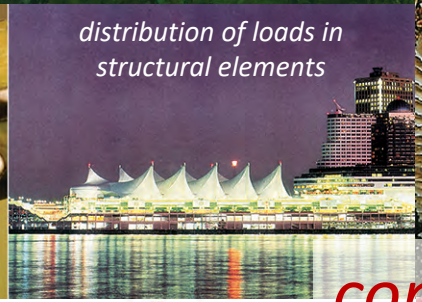
Farkasret Mortuary, Imre Makovecz, Budapest, 1975



Stockley Park W2 Building, Peter Foggo.

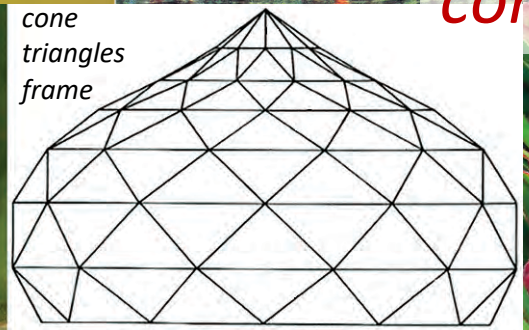


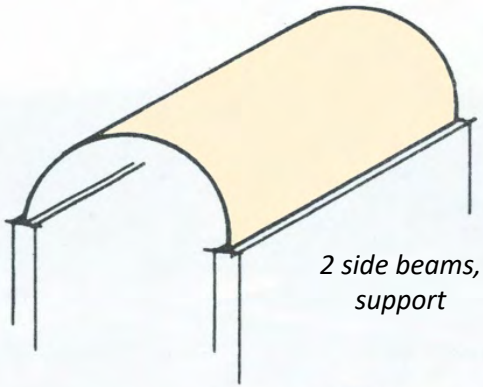

cone
types of
sceletons
frames
center
top &
rays


distribution of loads in
structural elements

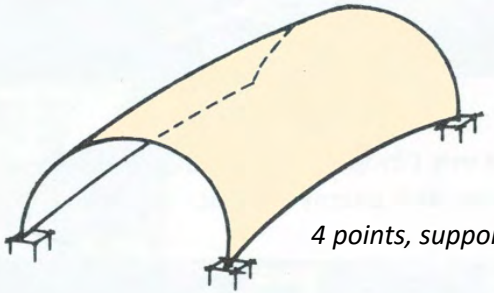
cones


cone
voronoi
frame
dome of
spongilla
fly

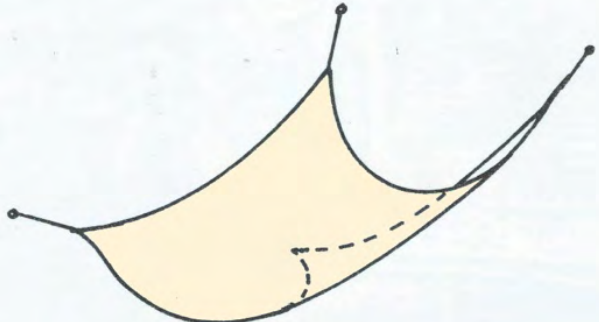

cone
triangles
frame

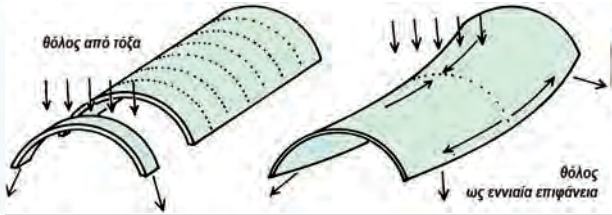


2 side beams, support

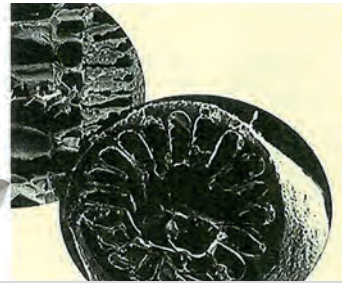


4 points, support





vault under pressure forces
forces on individual arches
surface active

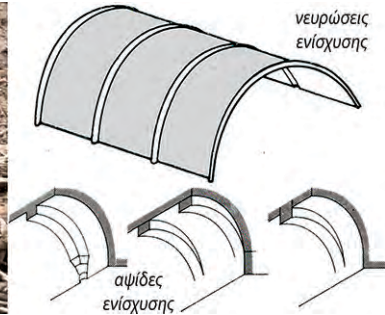


bones of a hedgehog with extra ring layer for extra endurance during fall

vaults, semi-hemi-cylinders

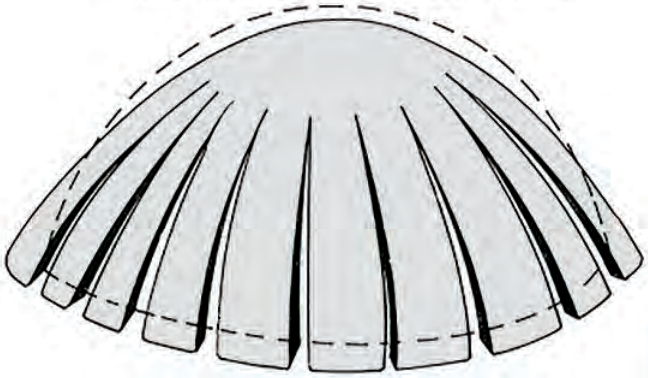
arched bridge in Zagoria, Greece

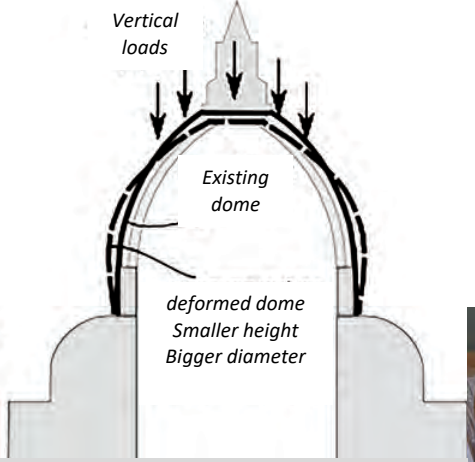
9zone armadillo, extra supporting arches in Romanic temples



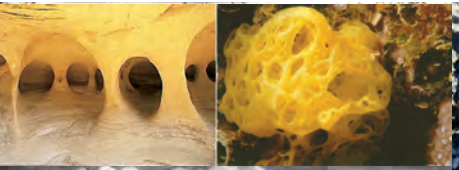
domes, cupolas

deformation of a dome under pressure forces
reduction of height, increase of the diameter of the ring and cracks.



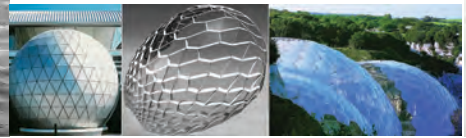


If the ring on the base is strong, then the diameter increases on a higher point.



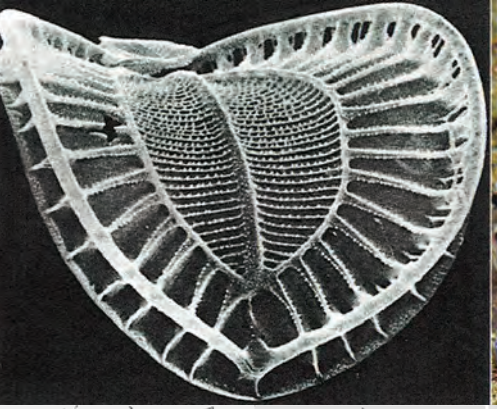
pre-historic shelter - igloos

Ball House, Dresden, 1928

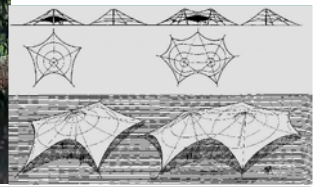


Dalian Shell, China, 2009

first inflated dome in 1948 with diameter of 15m

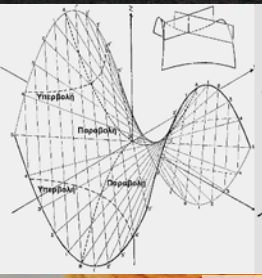


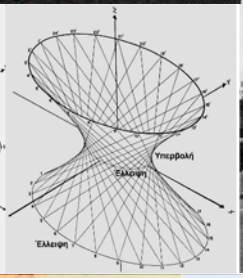
Hyperbolic paraboloid

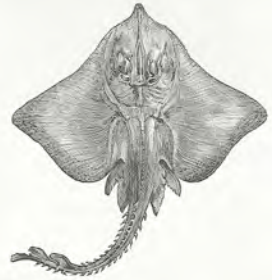


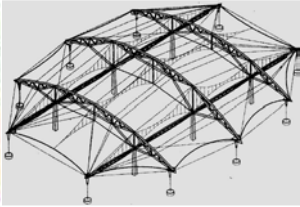
tents

double curvature surfaces, surface - active



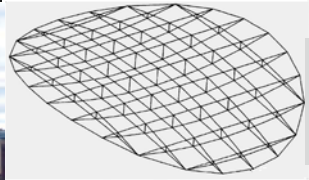






Bat Weather Lately

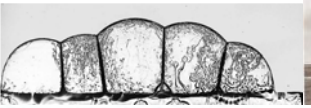
FOLLOWING THE TRAIL of Joseph Banks in Australia, photographer Cary Wolinsky hoped to find the furry fruit bats the British botanist described in his journal. "We looked six places for these bats. I wanted to shoot them from below, flying, with the sun shining through their wings." As he moved into position under the tree-roosting creatures, some suddenly took to the sky. "You know what bats do when frightened?" asks Cary. "I felt a warm rain, smelling oddly like the New York City subway."



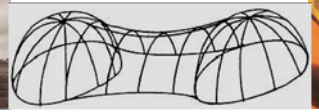
form finding inspiration from nature

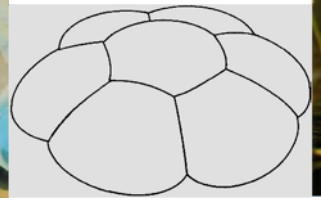
tensile membranes

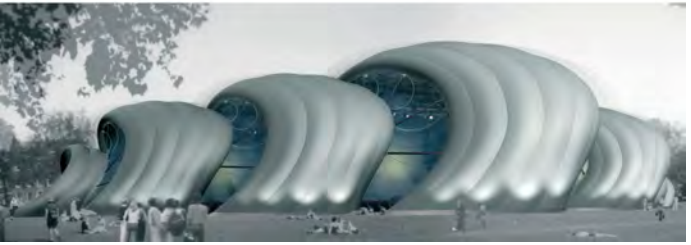
inflatable - pneumatic structures

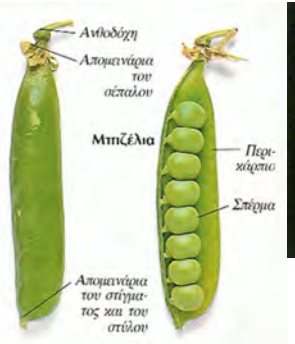


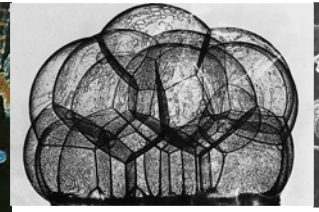
form from suction (de-pressure)

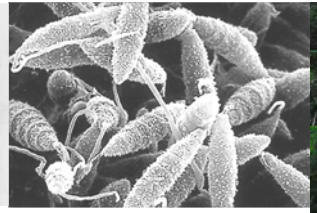






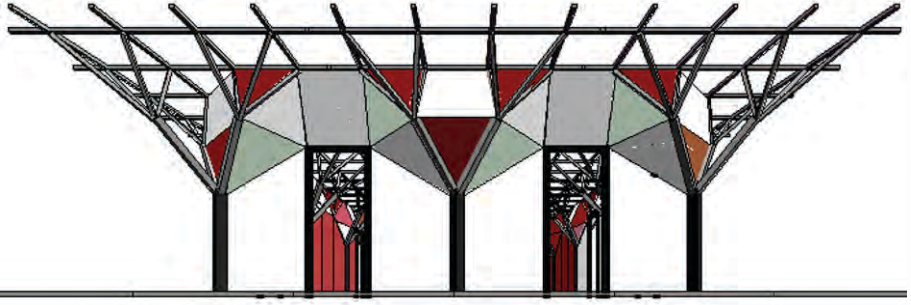




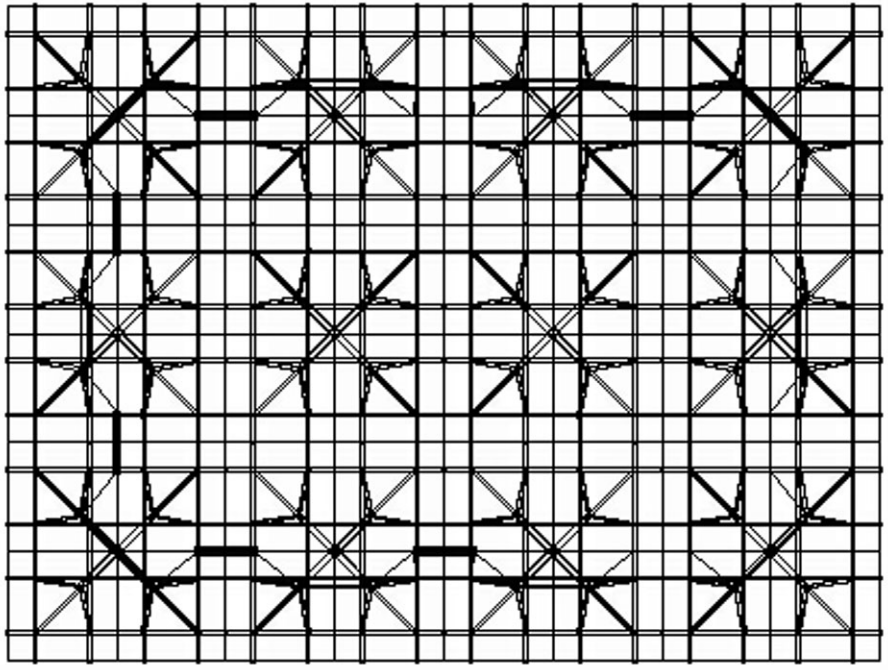


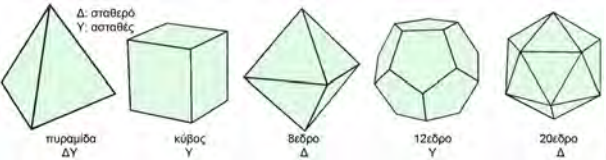
deriving form from pressure – 1,2 inside – 1,0 outside
form from suction (de-pressure)
air pillows – air tubes – air halls

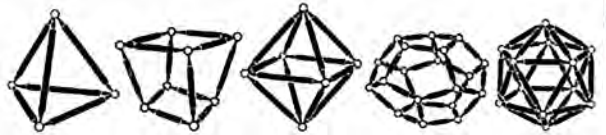
trees as smart structural elements



Coffee bar in Papanikolaou Hospital, Thesaloniki, Greece, 2003
arch. Nikos Tsinikas & Fani Vavili

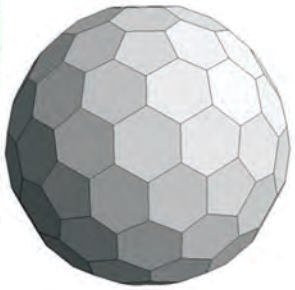




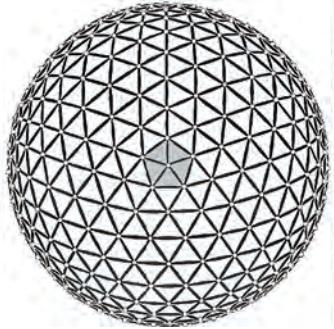


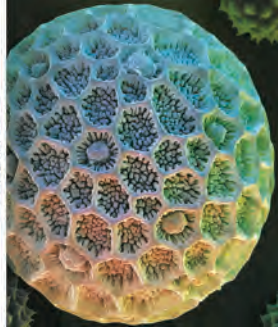
stable *unstable* *stable* *unstable* *stable*

surface-active & vector-active



geodesic dome, truncated icosahedron with 20 hexagons-hexahedrons and 12 pentagons-pentahedrons

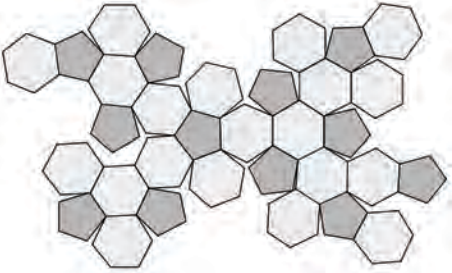




radiolaria

geodesic domes

20 hexagons - 12 pentagons



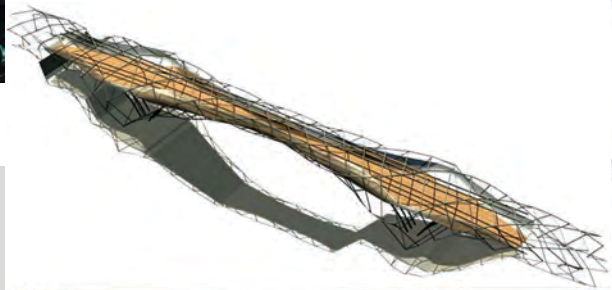
Elevation pattern of a truncated icosahedron

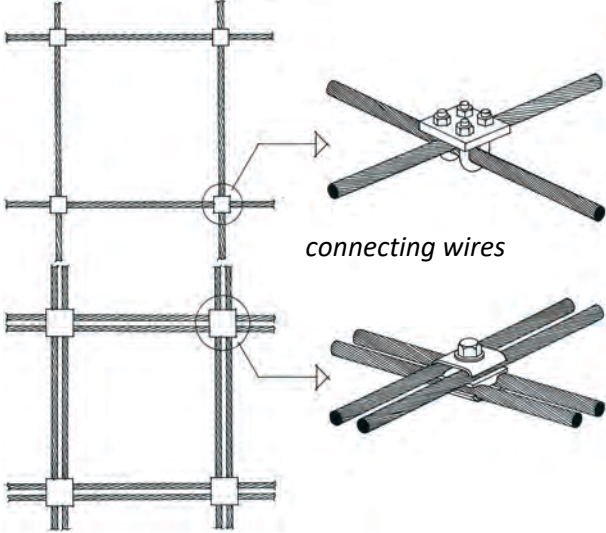
bee eyes (650X), wasp nest, ananas

wired surfaces

birdcage, Munich Zoo
Frei Otto, Buro Happold, 1980

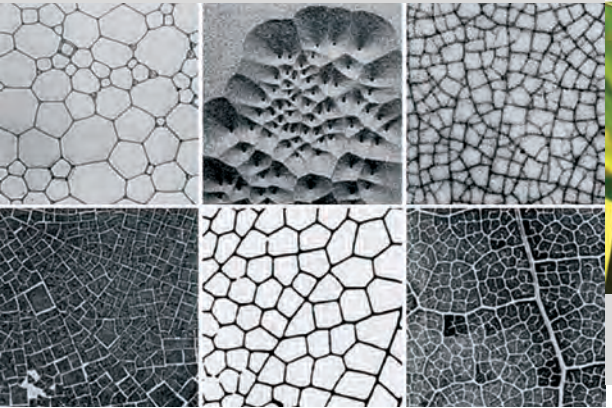
Preston river bridge, 2008, Sjölander da Cruz Architects.





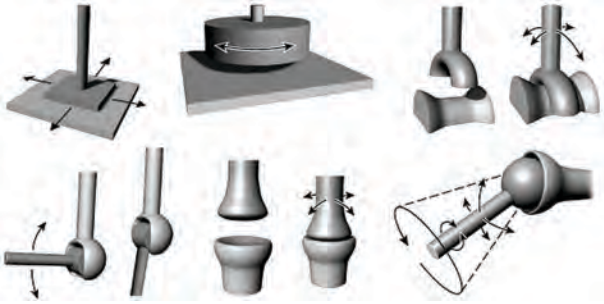
connecting wires

bubbles, moving sand, porcelain cracks, zelatine cracks, dragonfly feather, maple leaf



bridge from ants to make way from ane leaf to another

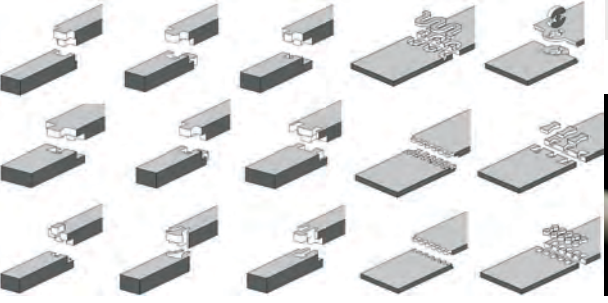
dome of spongilla fly
egg yolk (500X) - wireframe

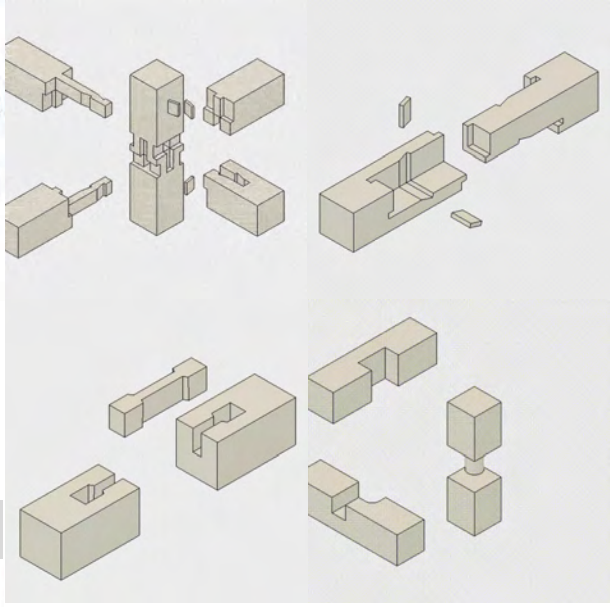


joints - assembly connections

joints - assembly connections,
shock absorbers & anti-vibration mechanisms
in nature & technology

joints that are similar to the head bones

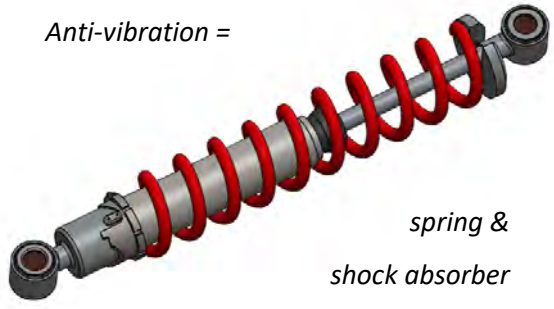




joints, holding fingers & zipper

Woodpecker has 'elastic' materials in his head between his beak and skull.
chimpanzee has lots of leaves and branches in his 'soft' 'anti-shock' bed

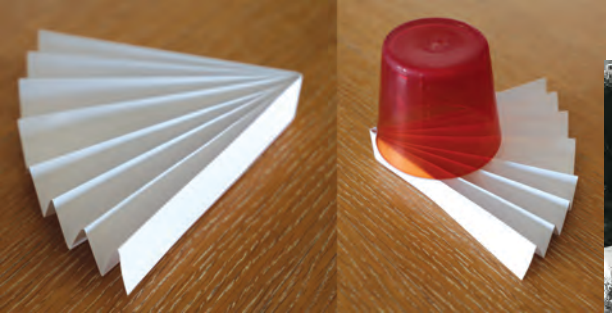
Anti-vibration =



spring &

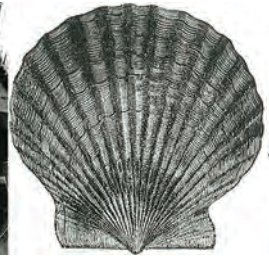
shock absorber

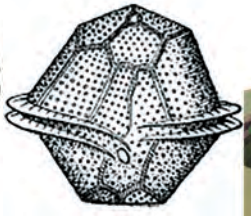
Nature as a Source of Inspiration to increase the strength of structures



Strength of folded paper

School, Gratz, Gunther Domening 1977





voronoi, 'radiolarian, Litharacnium'

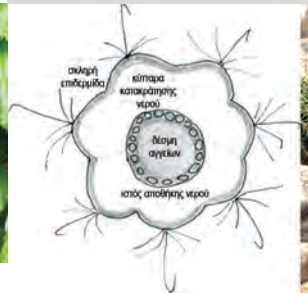
'jolly green giant' των MVRDV, 2004, London

folded & folding structures

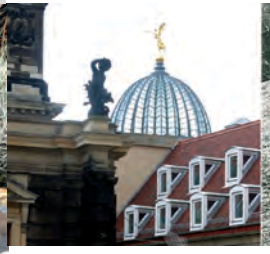
City hall, Rancho Mirage, 'mask of batman'

Carpinus betulus, plant

Cactus as folded structure. Echinocactus grusonii

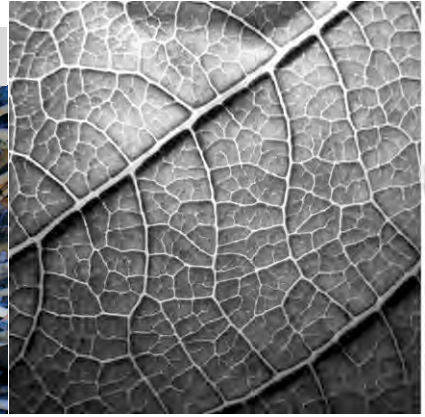


Lemon squizer dome Dresden

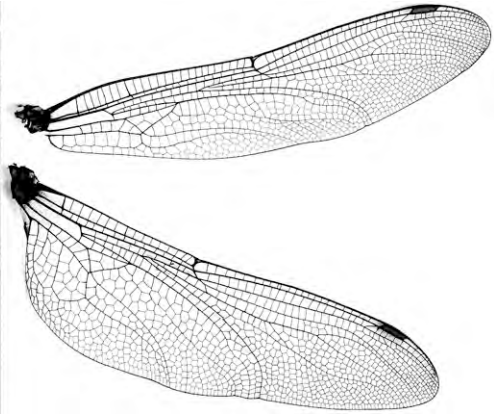


Folding shell emergency

ribs in bamboo and seawater worms



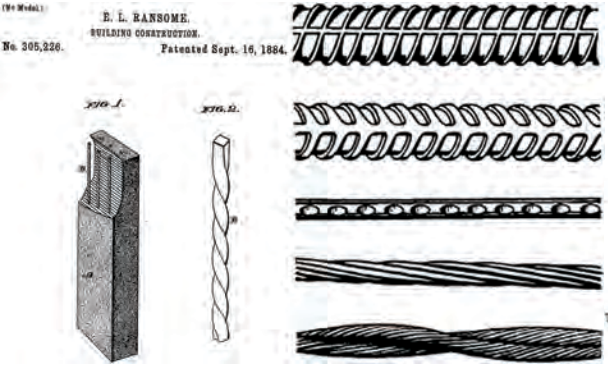
Leaf.
Voronoi pattern, central axis



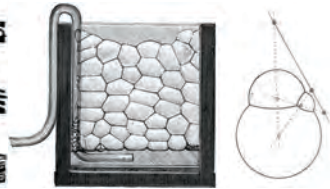
Dragonfly feather. Axis on top, enhance sections on top.

Reinforcement of concrete with ribs on the wires to improve adhesive welding through the increase of common surface between wires and cement and improve anchorage

ribs

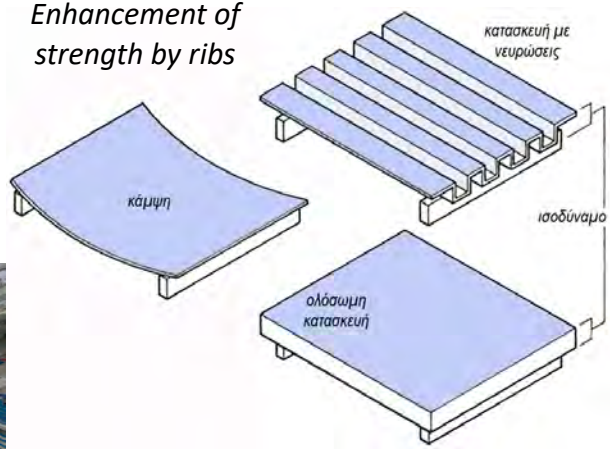


bubbles angle 120°
Boys, 1959

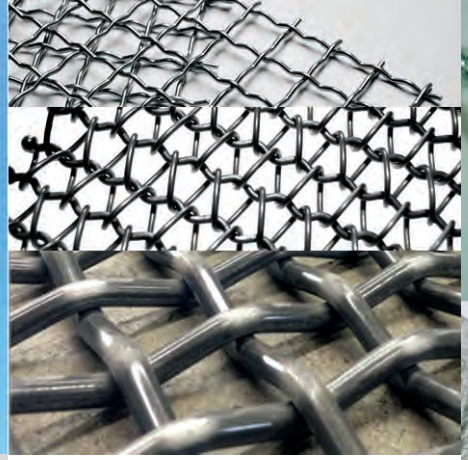


'watercube'
Beijing, 2008

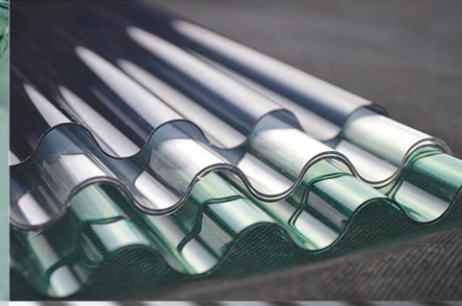
Enhancement of strength by ribs

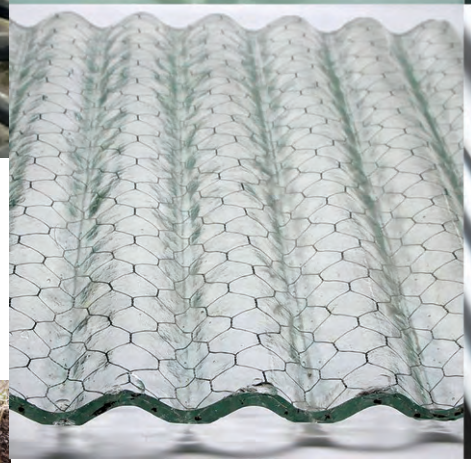


corrugated wires in bungee jumping



corrugated wire mesh



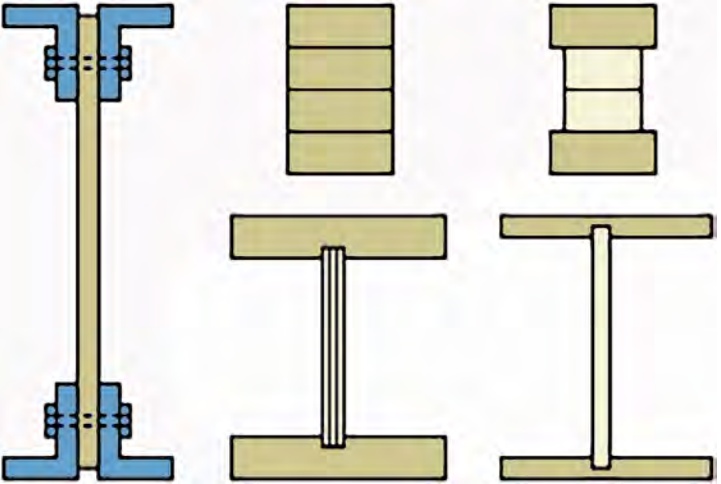


Corrugated form, structural panels. Reinforced plastic panel with corrugated chicken wire glass.

Bridges with natural cables. Kakum, Ghana & Q'eswachaka, Peru

ripples, elasticity

ways to enhance the strength of structures
geometry design of structural elements

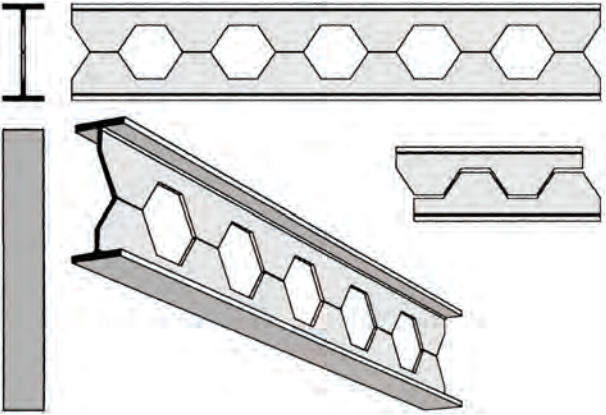


Double T beams
4 corners and 1 plate
Layers of structural wood with special profile sections

Double T beams from wood

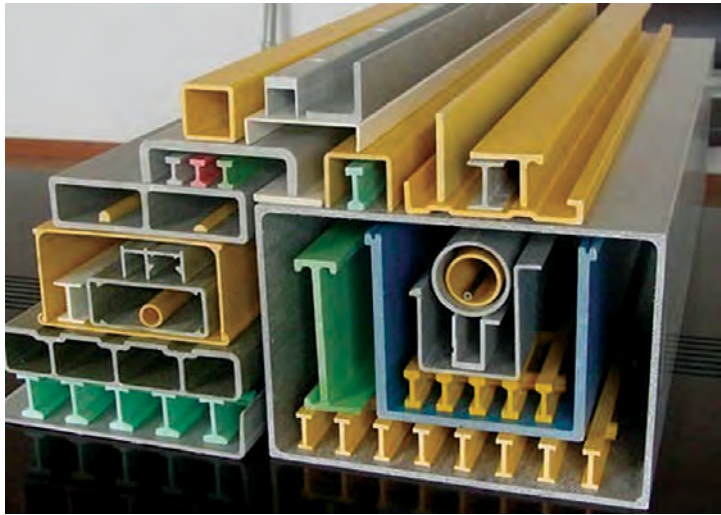
special profile sections

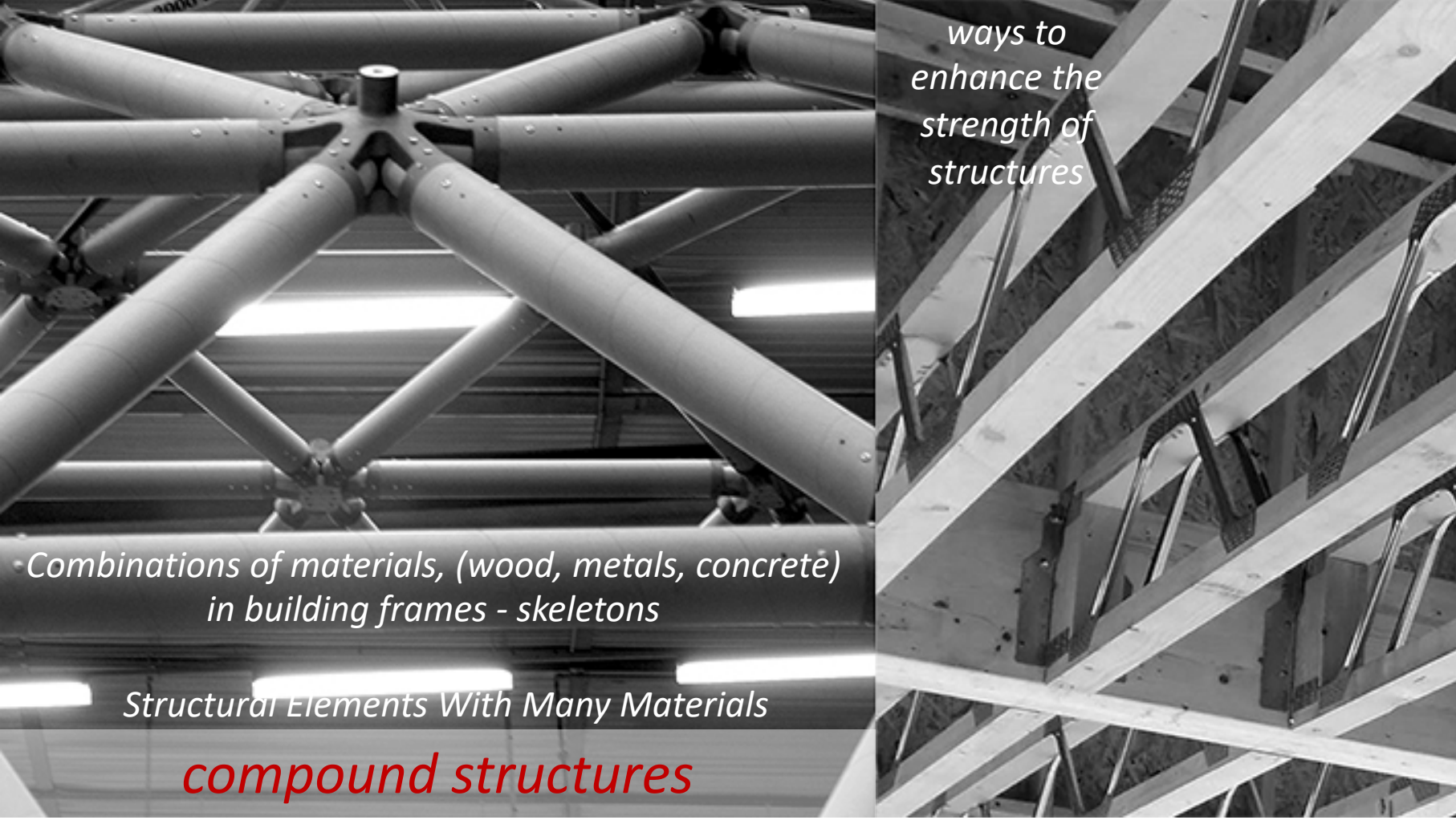
ways to enhance the strength of structures - geometry design of structural elements



Double T beams
And way of construction
Cutting along the length and welding.
Creation of hexagon holes for pipes
Improving the height of the beam
Reducing its weight
Improving its strength

Plastic structural elements (beams or pillars)
With increased strength due to geometry design of the sections



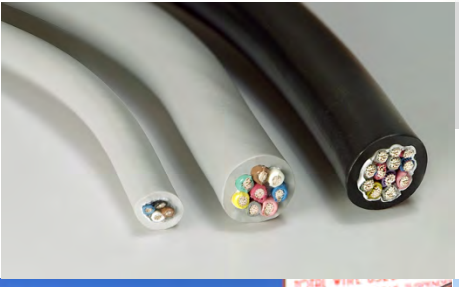


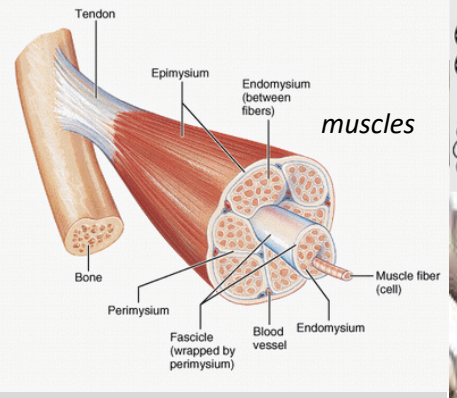
ways to enhance the strength of structures

Combinations of materials, (wood, metals, concrete) in building frames - skeletons

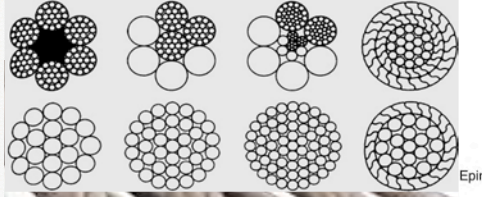
Structural Elements With Many Materials

compound structures

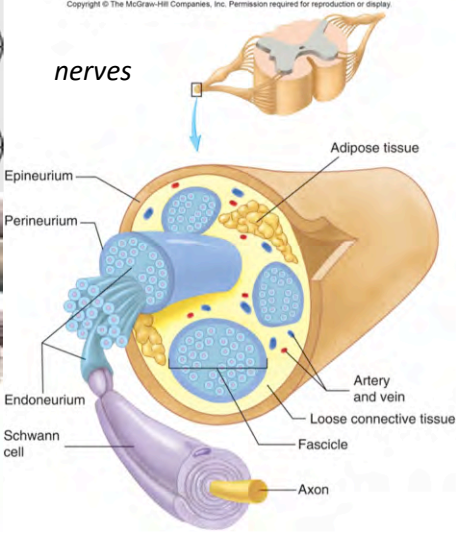




ropes, muscles, metal cables nerves, multi-strand cables, multicore wires

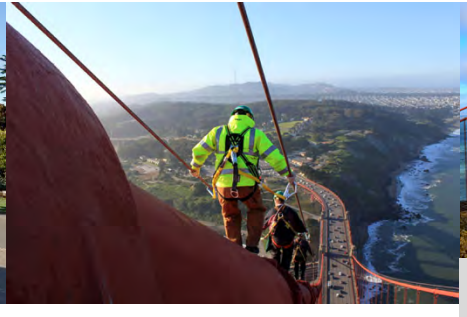


multicore cables



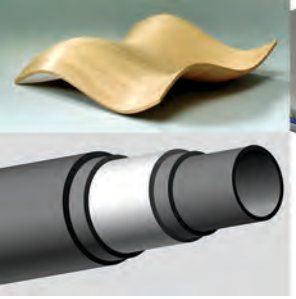
construction & building elements with many materials, multicore cables

multicore cables

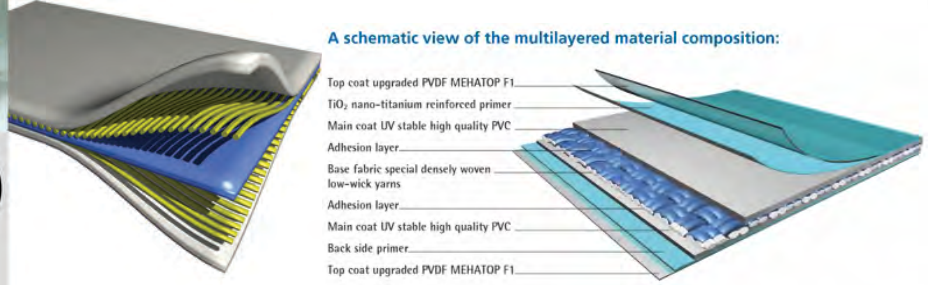


Golden Gate Bridge, San Francisco, 1280m, 1933

ways to enhance the strength of structures

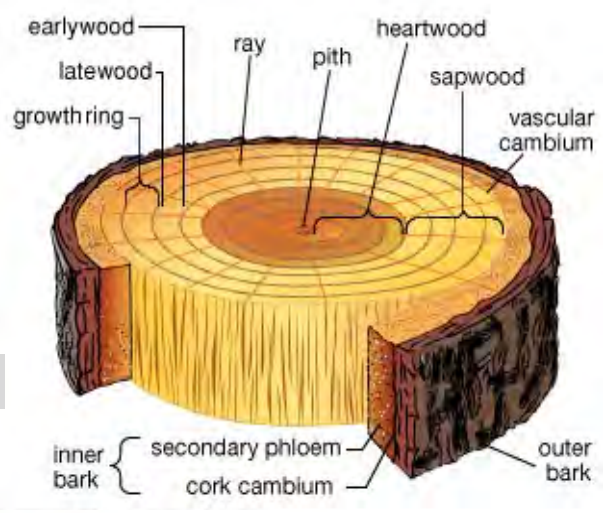


Multilayered structural materials.
Aluminium pipe with insulation layers,
Wood 'veneer' and 'ciment.wikibis'.



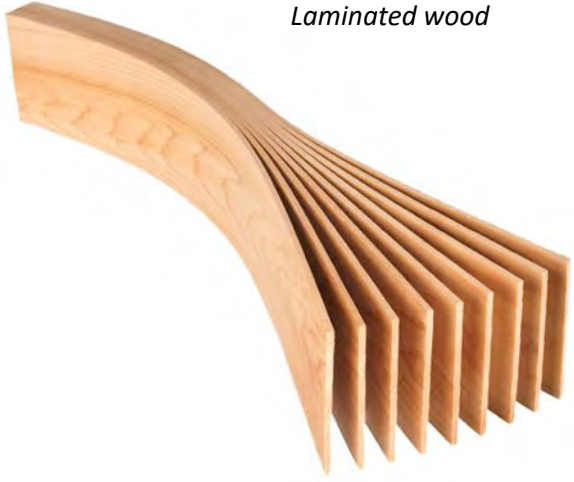
Multilayered material for tensile membranes

ways to enhance the strength of structures



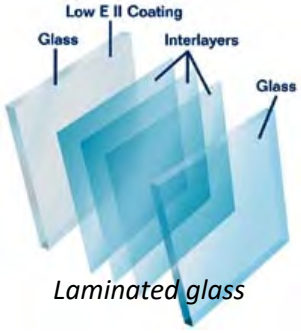
multilayered structures

Laminated wood

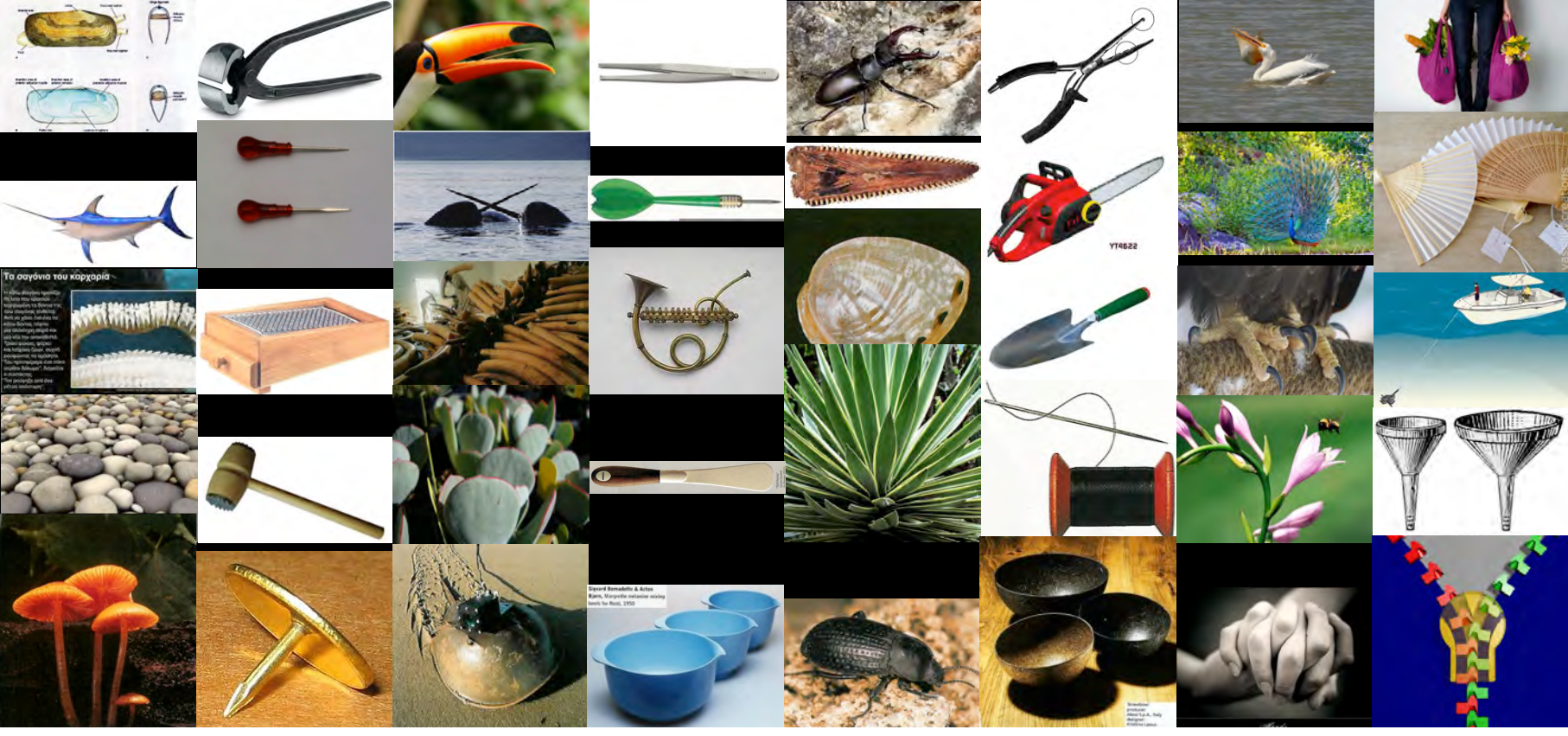


Layers – Onion - Cabbage

Presner Todd
hypercities city layers

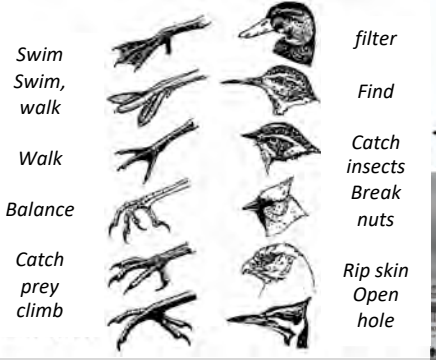


Laminated glass



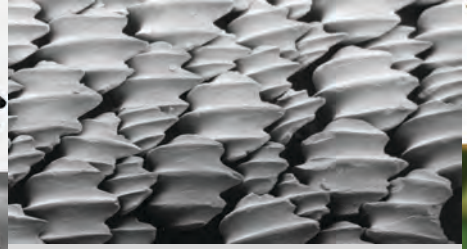
nature as a source of inspiration for tools & mechanisms

Use, properties: Shear, Penetration, Grip, Tightening, Opening and closing, Picking, Hinges, Cutting, Chopping, Grinding, Assembly, Storage, Fans, Anchoring, Aerodynamic, Antishock absorbers

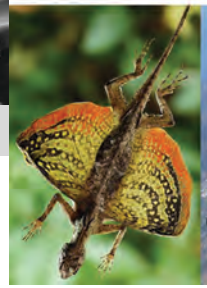


Evolution of foot shapes and beaks from different birds in different environments.

hydro-aero-dynamics



shark's scales

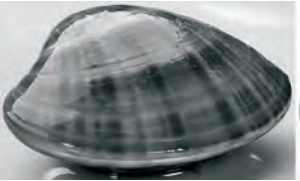


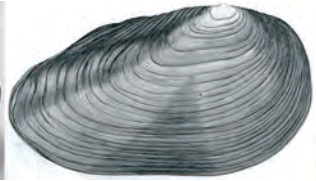
Leonardo, flying lizard, flying man

genotype > environment > > phenotype

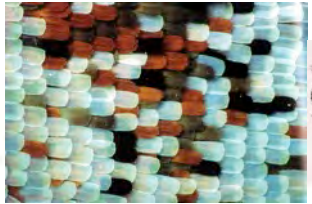
imitation of physical property, form from use, function

hydrodynamic shape, 'slipper' does not tip over easily





pangolin, butterfly's scales



skate & aeroplane

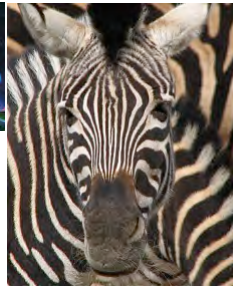
Stealth insects
Invisible to predators

stealth village in an island in Greece
invisible to pirates

stealth boat, car, jet
invisible to radars

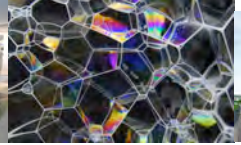
Camouflage - Stealth architecture

defence – attack, mimesis, hiding, optical illusion, blur, Stealth Architecture, Super-flattness



boat, Z. Hadid

Toyo Ito, Bone Structure inside out

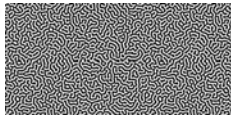


Voronoi façade

Richard Rogers Mallorca

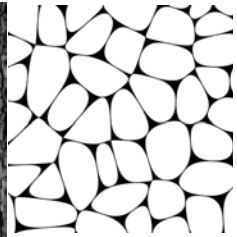
Marrakech Morocco

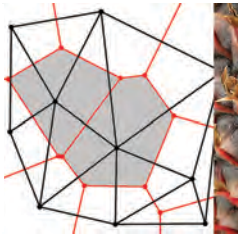
Cities & Complexity, Batty, 2005



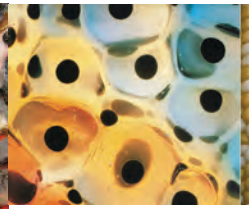
Reaction-diffusion, blur-sharpen,

Zanzivar & pine bark





Voronoi & ananas



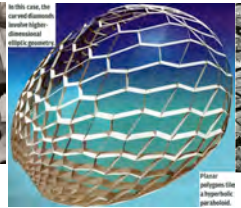
'voronoi', frog eggs 13X & corn

'voronoi' patterns

osteoporosis

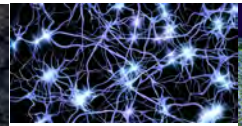
Bone Structure inside out

Heliptical dome



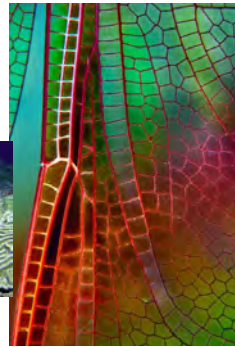
mud

Brain synapses

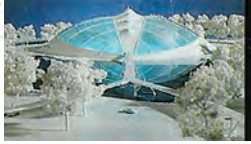


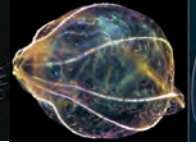
Brain Coral

Dragonfly wing

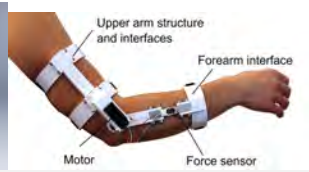












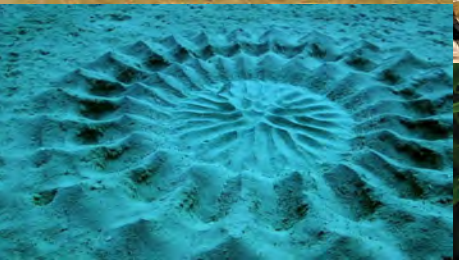
exoskeleton - bone structures

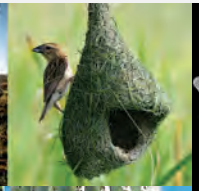
life at the bottom of the sea

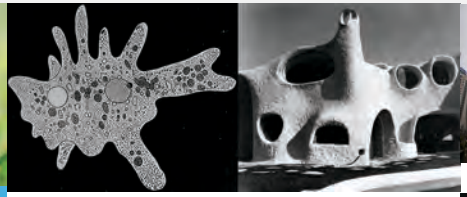
nature as the ultimate source of inspiration in architecture

the architects of nature

microcosmos




Richard Rogers *&* *Norman Foster*

by Eva Jiricna

Thessaloniki From Above From My Heart …

Thank You For Listening!

The UIA GGWI
(Great Green Wall Initiative):
Interactive Webinar
26th March 2022

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