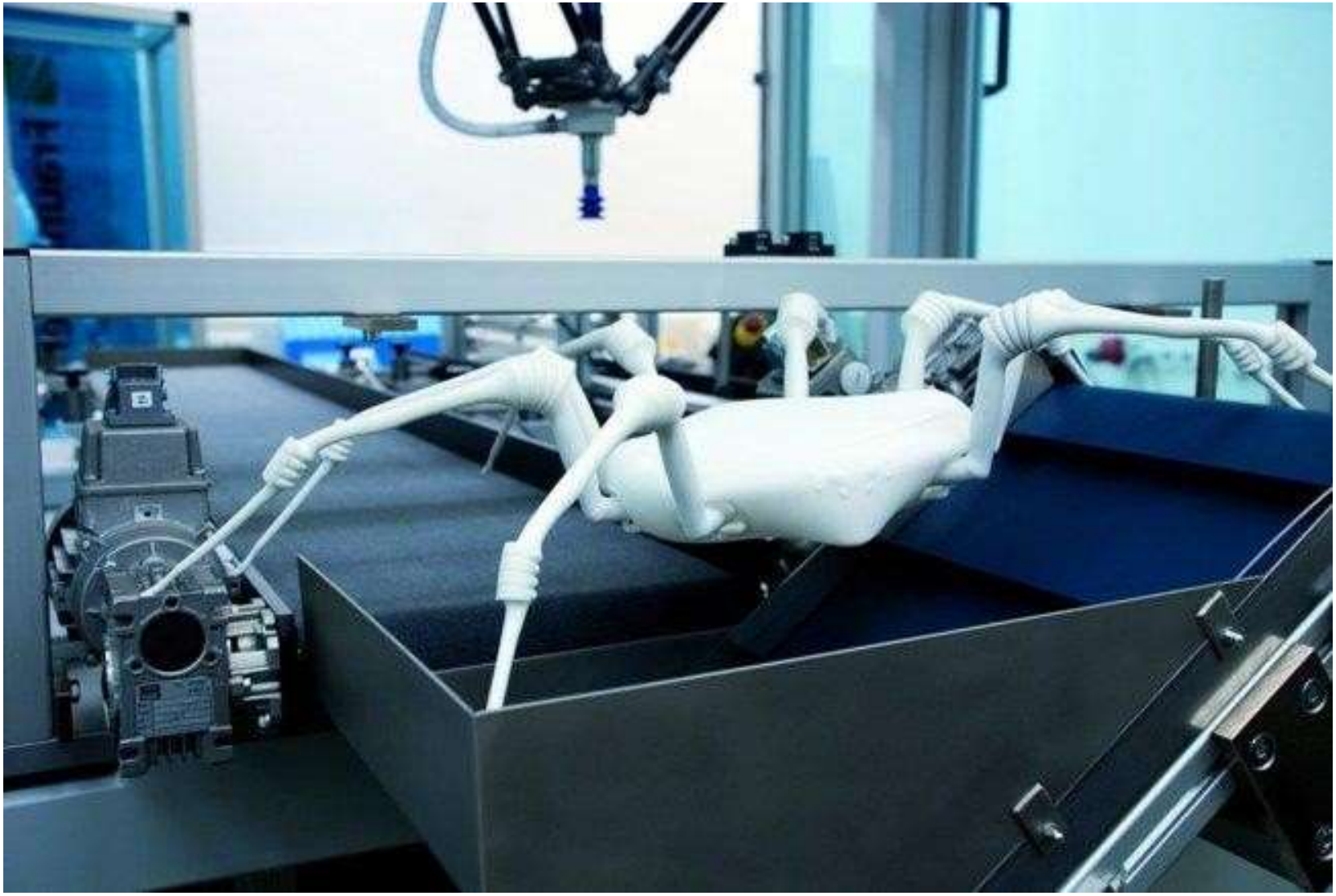
Biomimetics

Part 2

Survivor-Locating Spider

- The ability to squeeze through tight spaces and turn on a dime makes the spider an ideal model for lifesaving robots that could make their way through rubble after a disaster to locate survivors.
- Researchers at Germany's Frauenhofer Institute say this robot can be cheaply reproduced using 3D printers.



Survivor-Locating Spider

- After natural catastrophes and industrial or reactor accidents, or in fire department sorties, it can help responders, for instance by broadcasting live images or tracking down hazards or leaking gas.

Survivor-Locating Spider

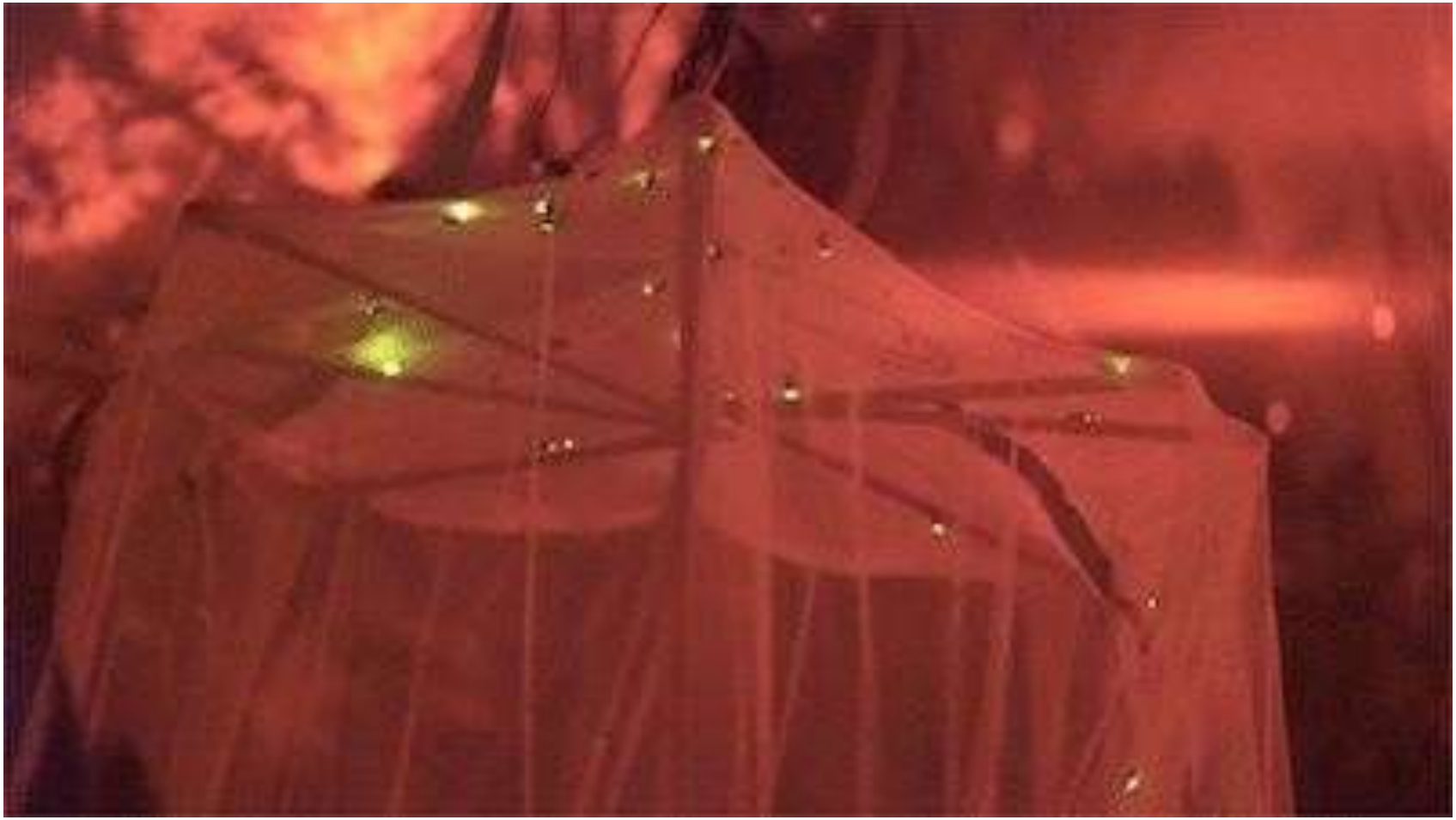
- For mobility, insect-like ability to cover varied terrain, climb surfaces and provide stability seems to work better.
- Insect eyes offer greater resolution and panoramic range for exploring places people cannot go, and the ability to quickly adapt to changing environments (or even to spy on enemies undetected).

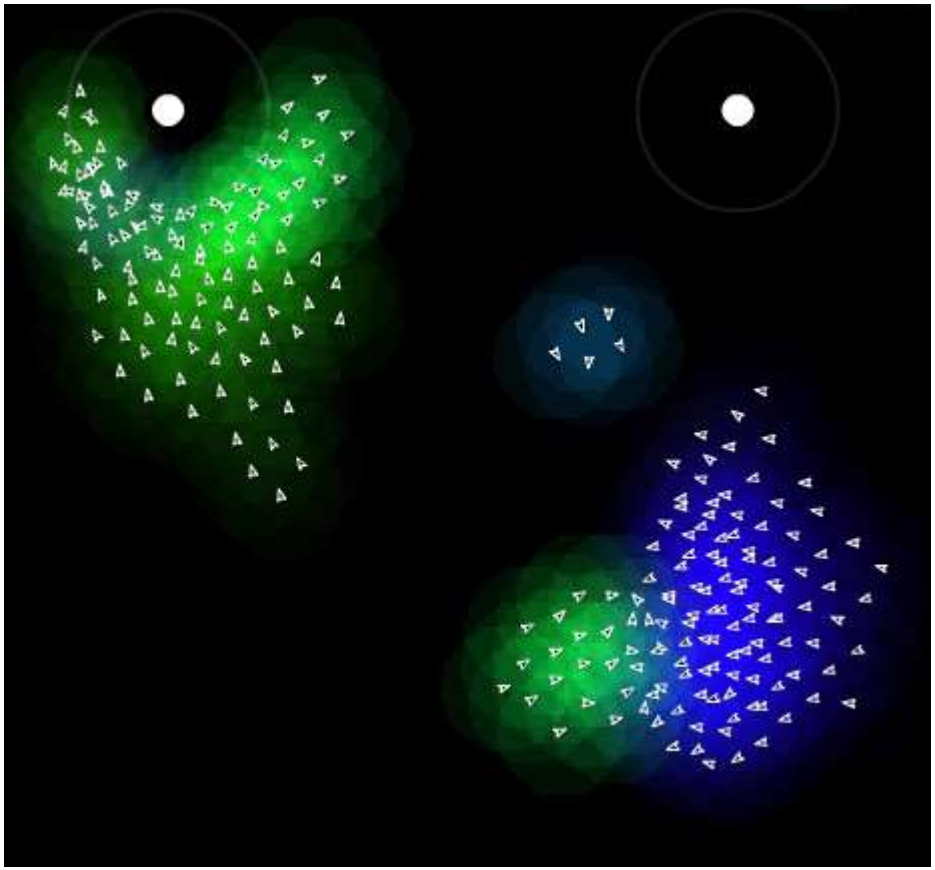
Biomimicry Heliotrope Follows the Movements of the Sun

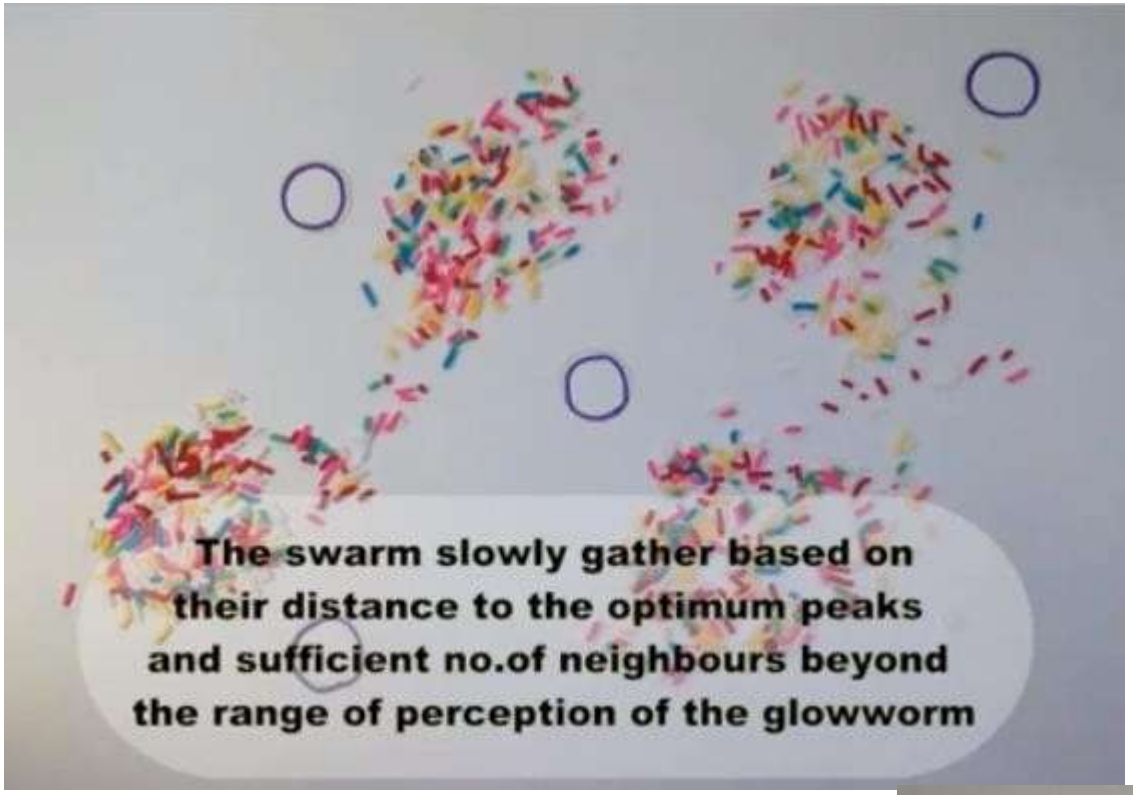
- Sunflowers turn themselves throughout the day to follow the movement of the sun.
- This lighting device by designer Jonathan Ota copies that phenomenon with silvery artificial flowers with LED light bulbs in the center.
- Powered by solar panels, the flowers are fitted with tiny pistons that use evaporation of alcohol to move the petals, closing them up during the day and opening them at night.

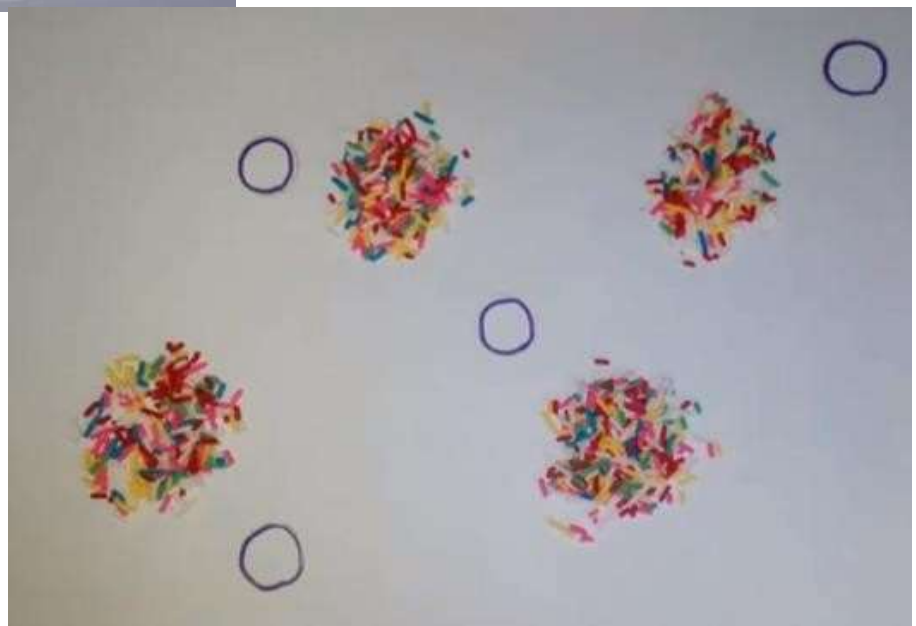
Nature based algorithms-swarm intelligence of glow worm

- Nature-inspired algorithms are among the most powerful algorithms for optimization
- High-quality clustering techniques are required for the effective analysis of the growing data.
- Clustering is a common data mining technique used to analyze homogeneous data instance groups based on their specifications.

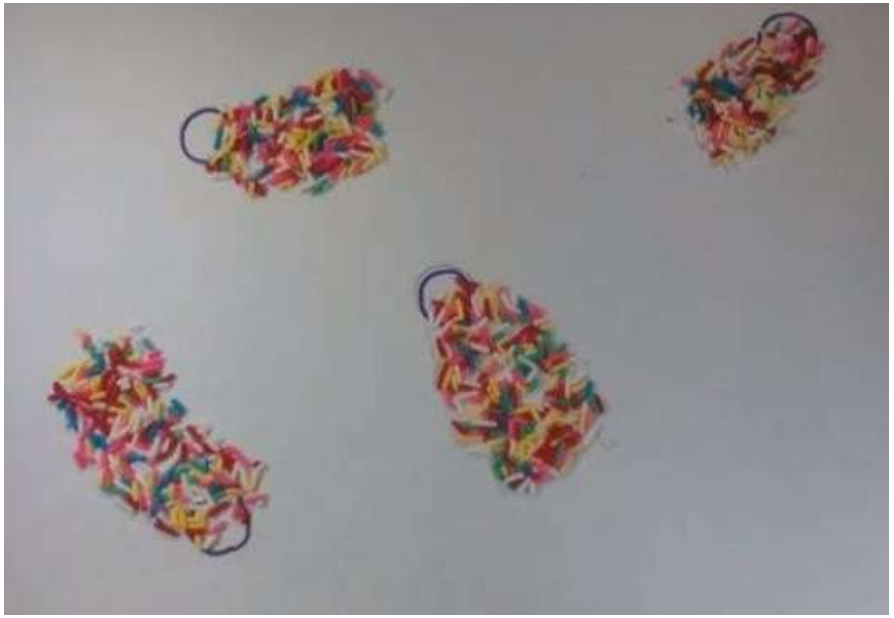





The swarm slowly gather based on
their distance to the optimum peaks
and sufficient no.of neighbours beyond
the range of perception of the glowworm




The swarm slowly go to their
optimum peak




Finally, the swarm has been clustered
into their optimum solution

Nature based algorithms-swarm intelligence of glow worm

- The clustering based nature-inspired optimization algorithms have the ability to find better solutions for clustering analysis problems.
- Glowworm Swarm Optimization (GSO) is a recent nature-inspired optimization algorithm that simulates the behavior of the lighting worms.
- GSO algorithm is useful for a simultaneous search of multiple solutions, having different or equal objective function values.

Swarm intelligence

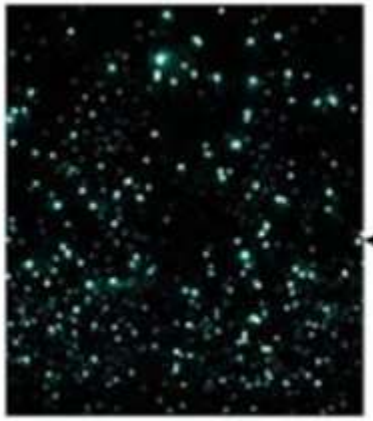
- Swarm intelligence (SI) is a type of artificial intelligence, based on the collective behavior of decentralized, self- organized systems.
- It focuses on the study of the collective behavior that is made up of a population of simple agents interacting locally with one another and with their environment.
- The main idea: This algorithm is derived from natural glowworm's activities in the night, the glowworm exercise in group, they interact with each other by one's luciferin.
- If the glowworm emits more light, it can attracts more glowworms towards it.

Nature based algorithms-swarm intelligence of glow worm

- Two fundamental functions of such flashes are to attract mating partners
- We know that the light intensity at a particular distance ‘r’ from the light source obeys the inverse square law
- The air absorbs light which becomes weaker and weaker as the distance increases
- The flashing light can be formulated in such a way that it is associated with the objective function

- Attractiveness is proportional to their brightness, thus for any two flashing fireflies, the less brighter one will move towards the brighter one.
- If there is no brighter one than a particular firefly, it will move randomly
- The brightness of a firefly is affected or determined by the landscape of the objective function.
- For a maximization problem, the brightness can simply be proportional to the value of the objective function


Start
Initialization of glowworms position and local decision range
Evaluate glowworms fitness
For each iteration, t
For each glowworm, i
Update glowworms luciferin value
Update movement of glowworm by using probabilistic mechanism
Update glowworms decision range by using neighborhood range update rule
Is termination criteria met ?
NO
YES
End



Swarm of Glowworms

Glowworm

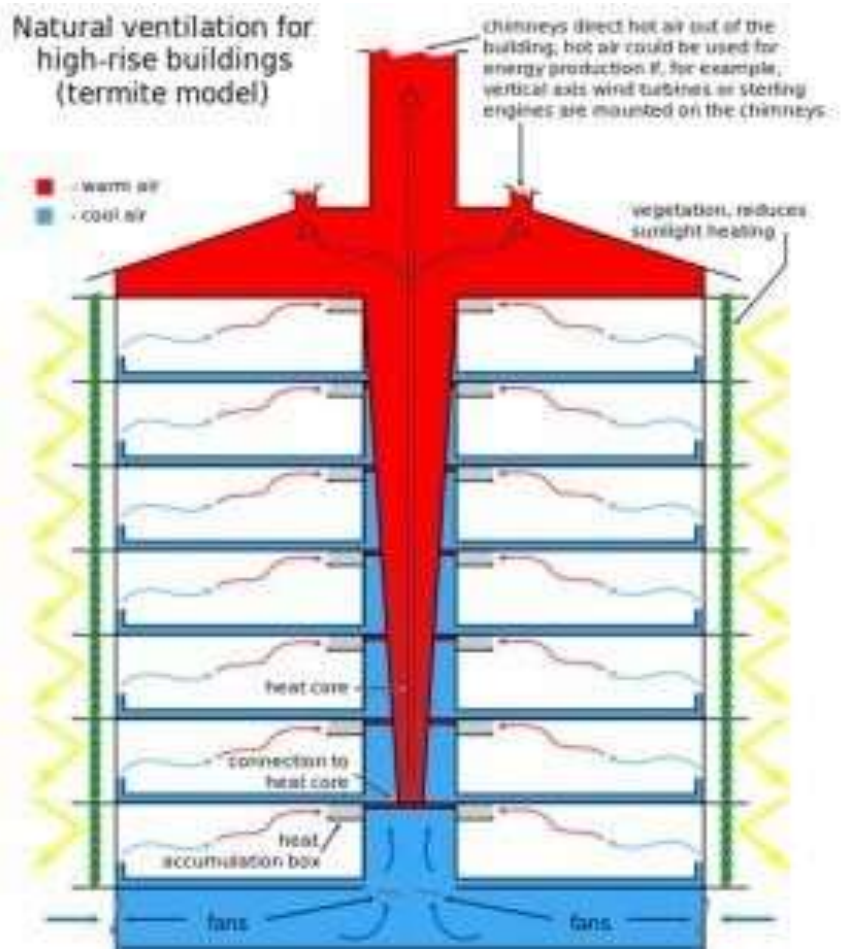
Solution

Nature based algorithms-swarm intelligence of glow worm

- Applications:
  - Dispatching system of public transport
  - Multimodal Function with collective robotics
  - Chasing Multiple Mobile signal Sources
    Rolling bearing fault diagnosis method

Biomimetic architecture- Termite Mound

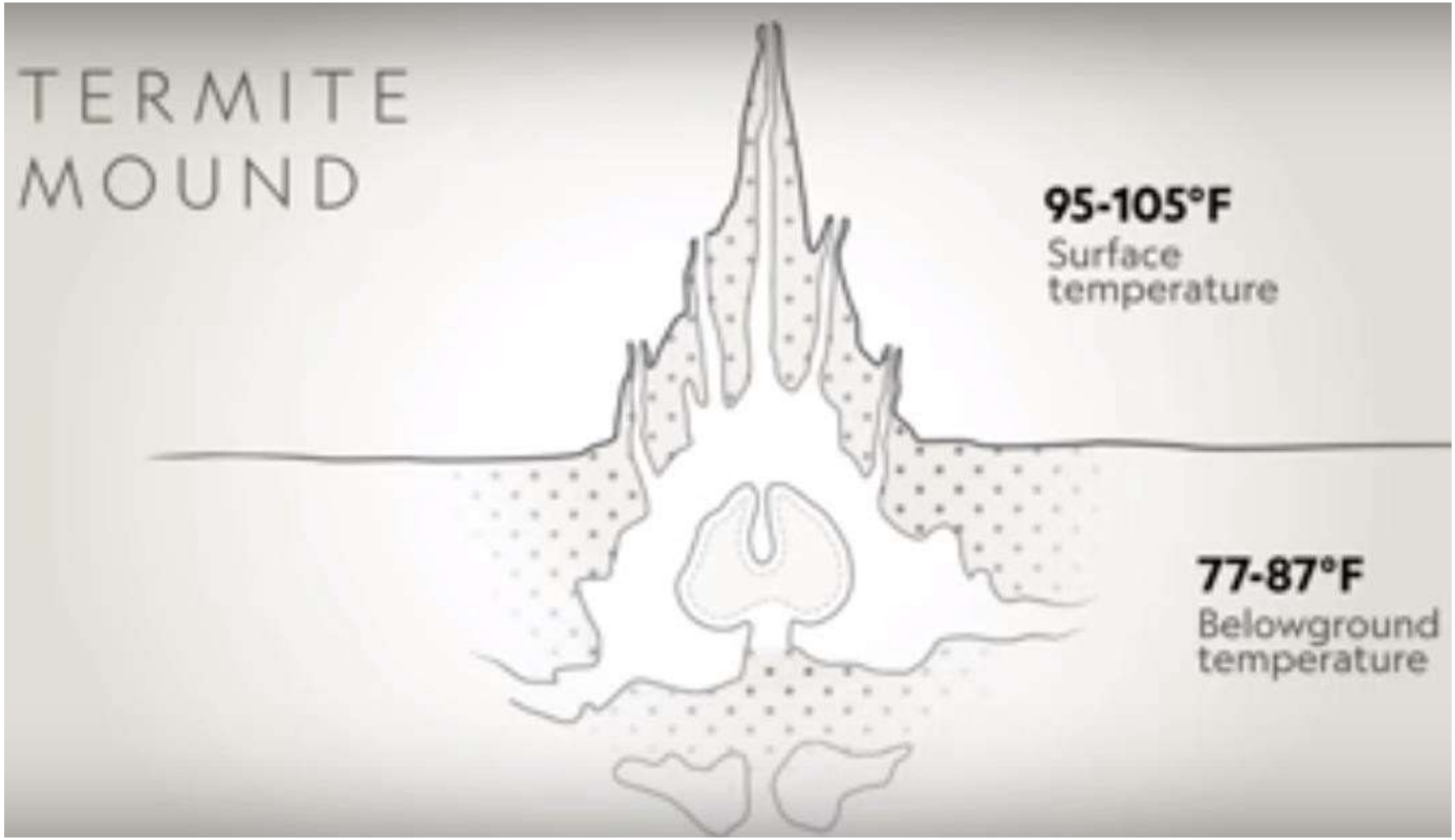
- **Thermoregulation through shape**



Termite mounds

- Termite mounds are huge structures – many growing to a height of 4 or 5 metres – which host colonies of millions of termites.
- Especially in hot climates, where air and ground temperatures are around 40ºC, an engineering (or *termite*) solution is required to vent the inside heat.

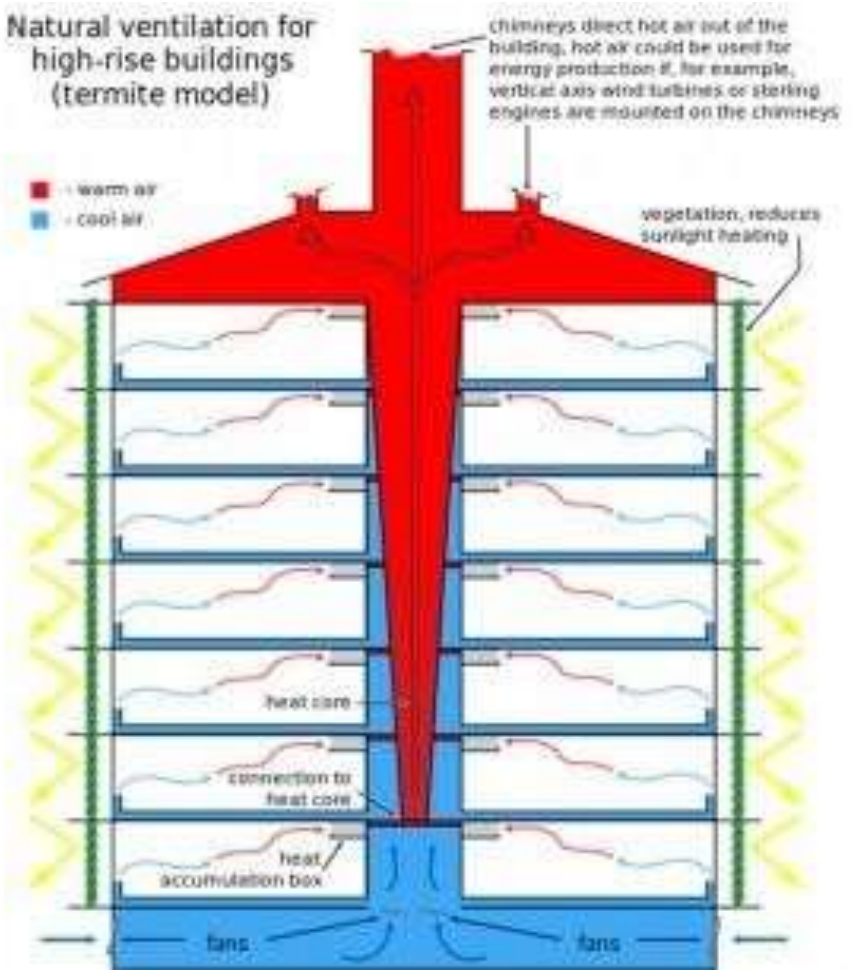
- In order to achieve this, termites insulate the walls of the mound – which receive most of the sun's rays – from the inner chambers.
- Moreover, these are built vertically over a large hall-like area under the ground.
- The cold air in this chamber is sucked up by the hot air streams which tend to rise through convection.



Tiny holes cover the entire mound. These holes help the gases pass through freely

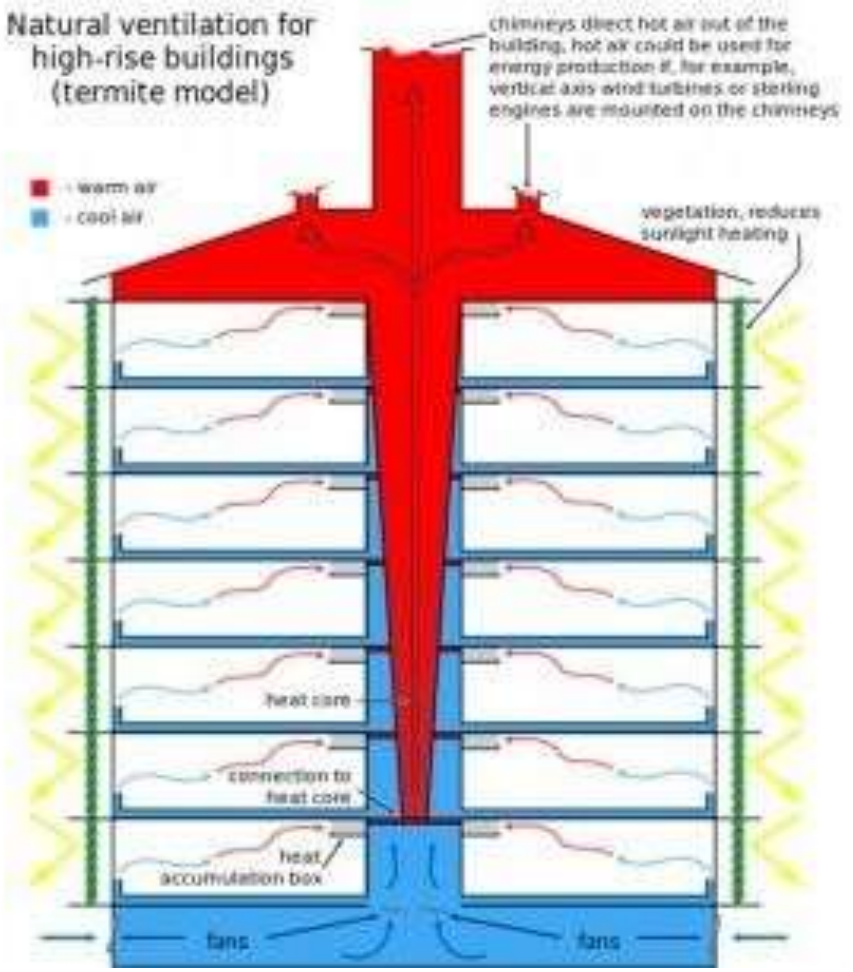
Biomimetic architecture- Termite Mound

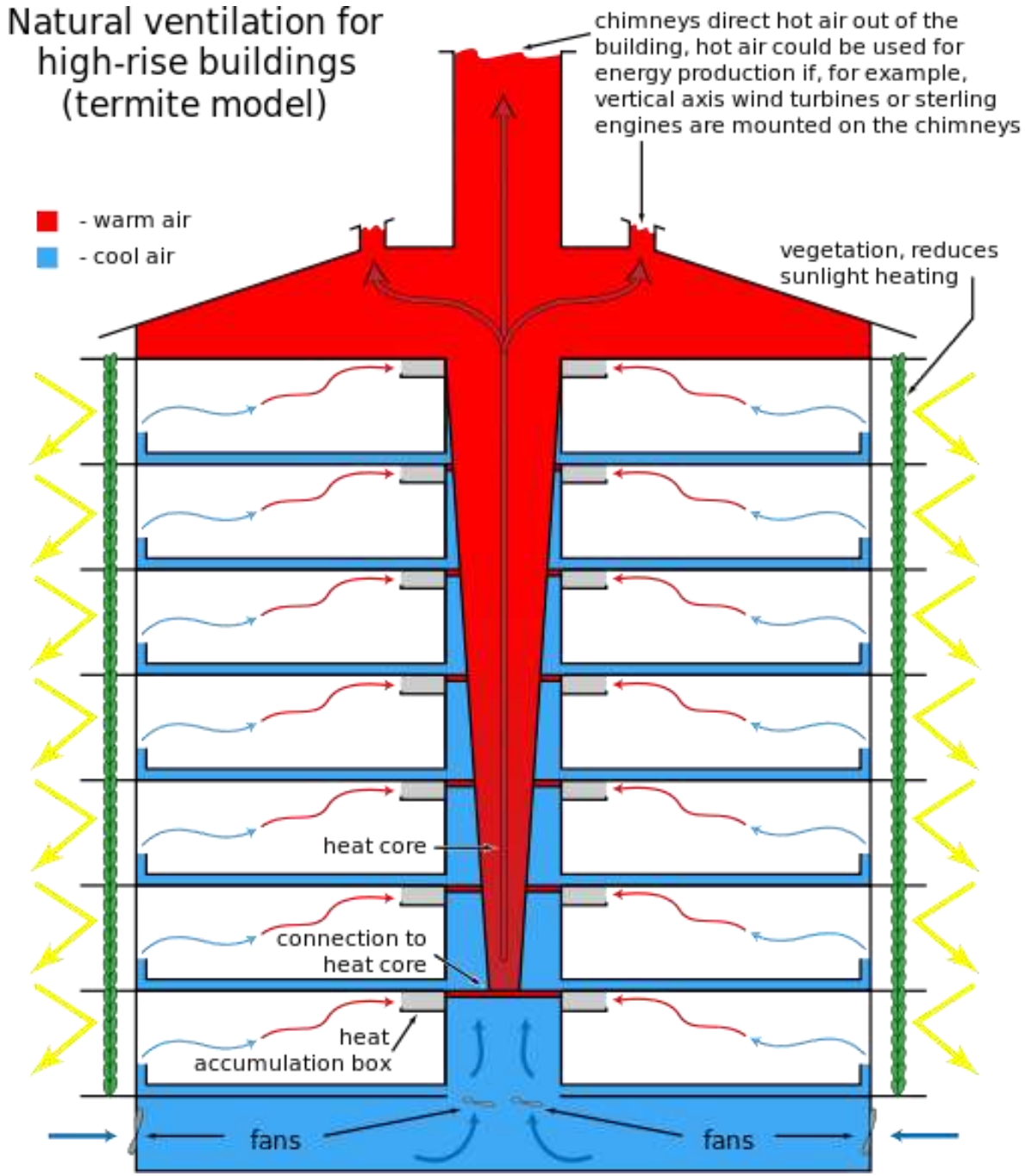
- An exceptional example of a biomimetic building is the Eastgate Centre in Zimbabwe.
- This is a shopping centre which uses a **heat venting system similar to that used in termite mounds**.



Biomimetic architecture- Termite Mound

- This building saves close to 70% of the energy that would have been consumed had it been built along more traditional architectural patterns.




Natural ventilation for high-rise buildings (termite model)
chimneys direct hot air out of the building, hot air could be used for energy production if, for example, vertical axis wind turbines or sterling engines are mounted on the chimneys
- warm air
- cool air
vegetation, reduces sunlight heating
heat core
connection to heat core
heat accumulation box
fans
fans

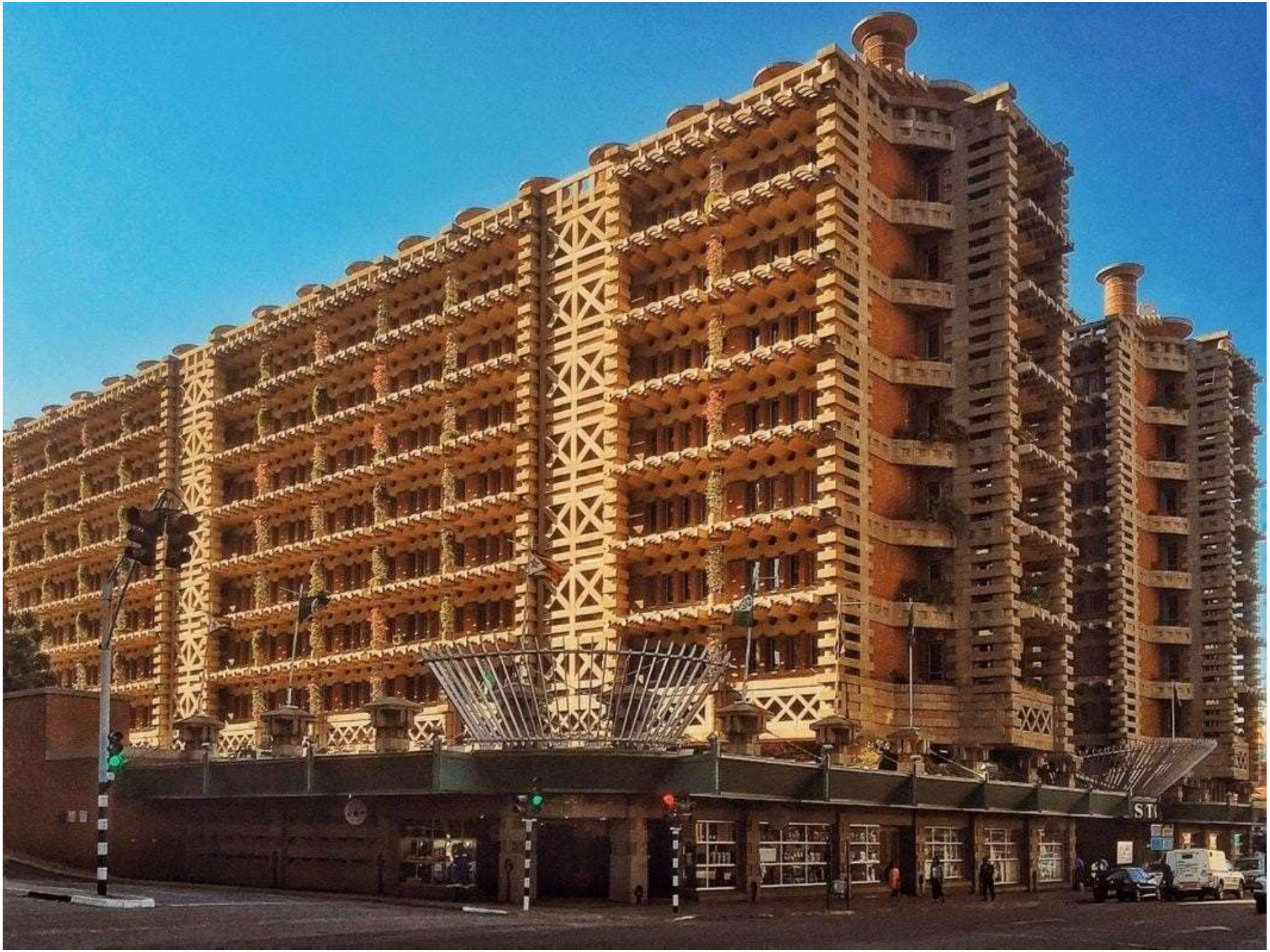
Biomimetic architecture- Termite Mound

- East Gate centre building is made up of concrete and slabs.
- These materials have high thermal mass. They can absorb lot of heat without changing temperature.
- Exterior of building is prickly like cactus.
- Small windows minimize heat absorption
- Extended overhangs provide extra shade

Biomimetic architecture- Termite Mound

- In the night, inside the building, low power fans pull in cool air from outside and disperse it throughout the floors
- Concrete wall absorbs the cool air and circulates it.
- In the morning, warm air is taken up by shafts and sent outside through chimneys.
- Uses 35% less energy

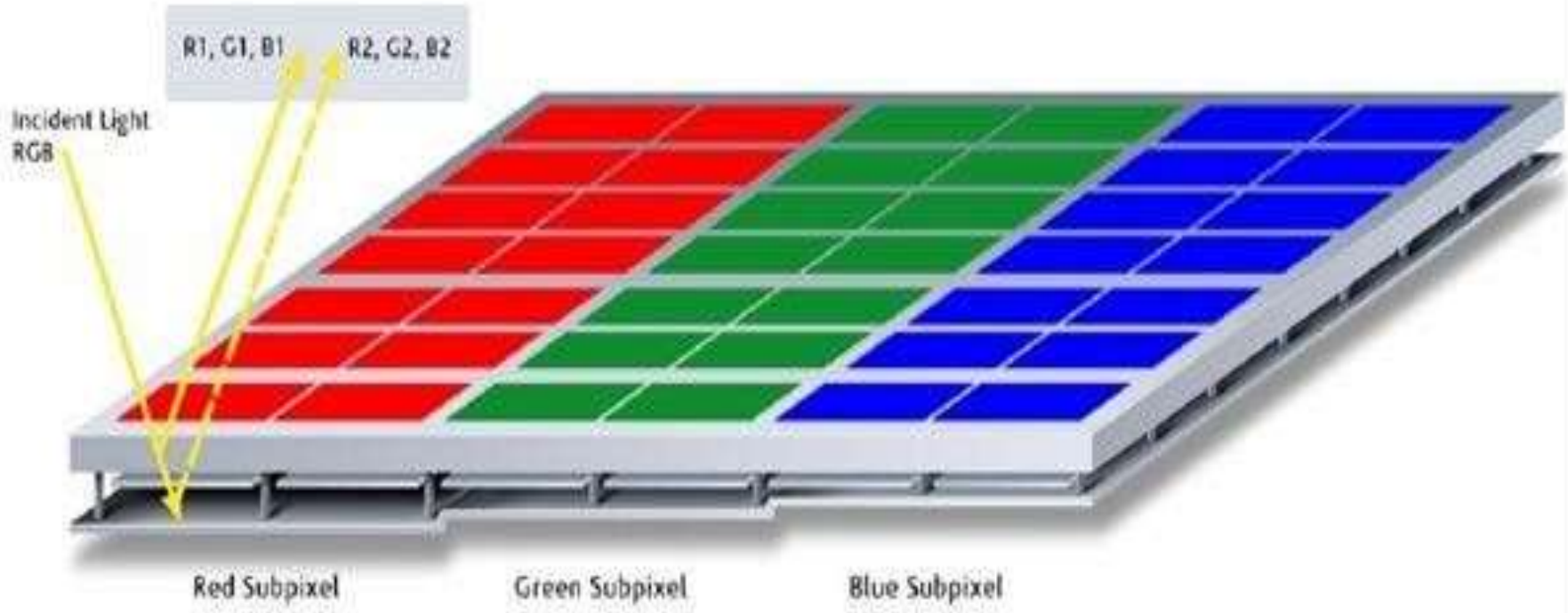
BIOMIMICRY

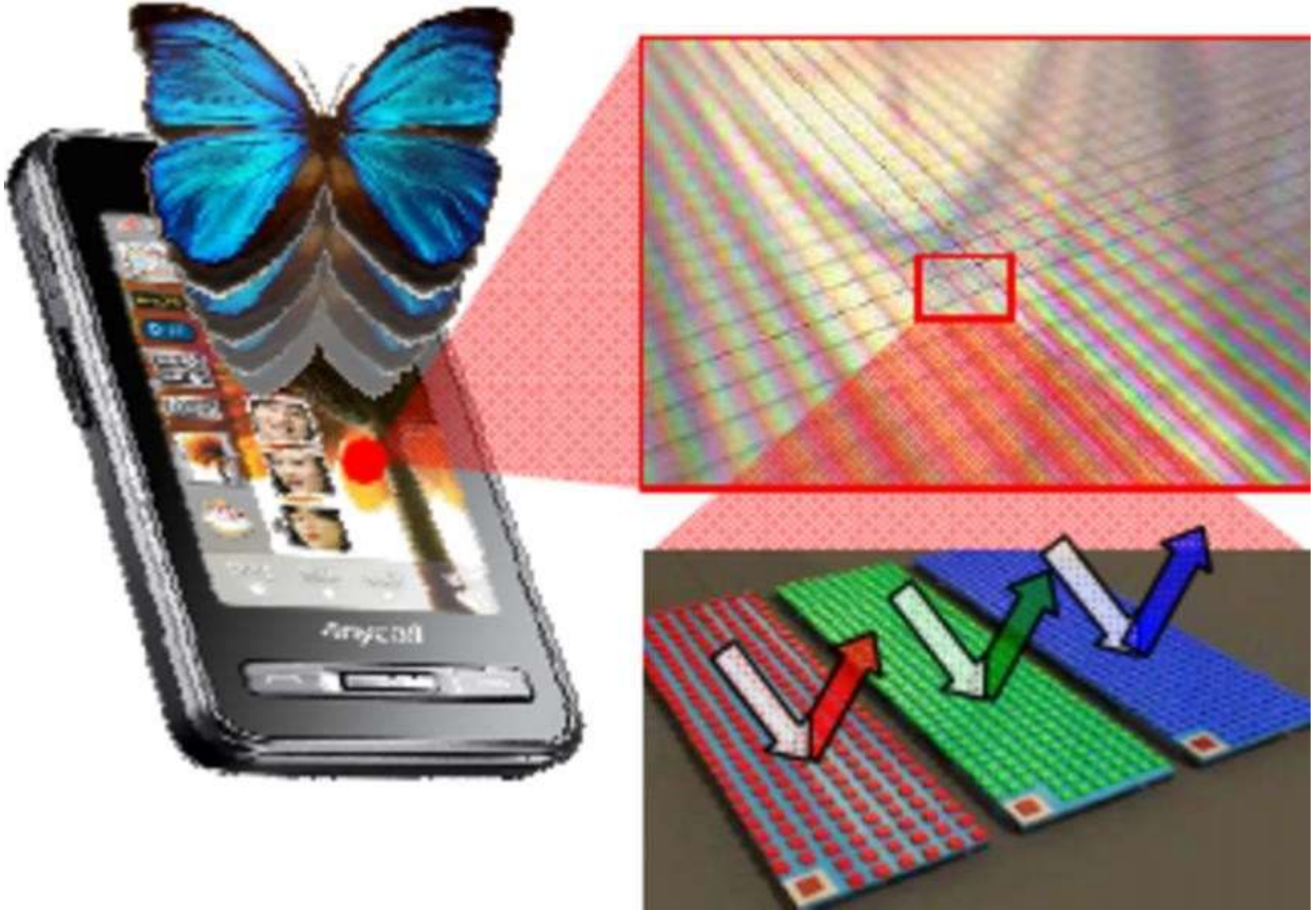


Bioinspired photonic crystals

- A butterfly’s wings are one of nature’s most remarkable materials.
- These tiny but complex structures reflect light in such a way that specific wavelengths interfere with each other to create intensely vivid colors one could only find in nature.

- By carefully studying this process, engineers at **Qualcomm** have been able to mimic this effect, allowing them to develop a system that produces colored electronic screens that are extremely efficient and can be viewed under any light conditions.

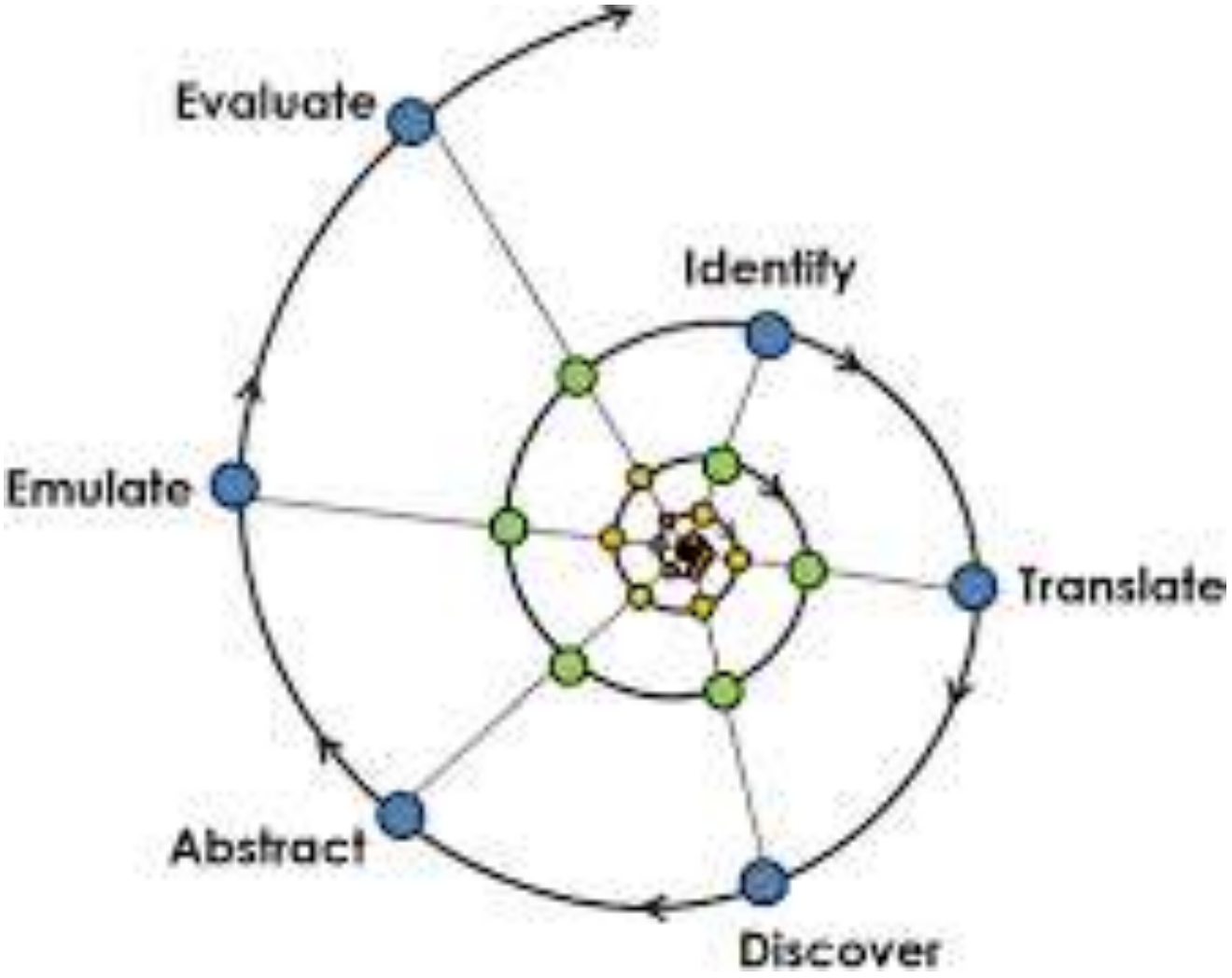

R1, G1, B1
R2, G2, B2
Incident Light
RGB
Red Subpixel
Green Subpixel
Blue Subpixel

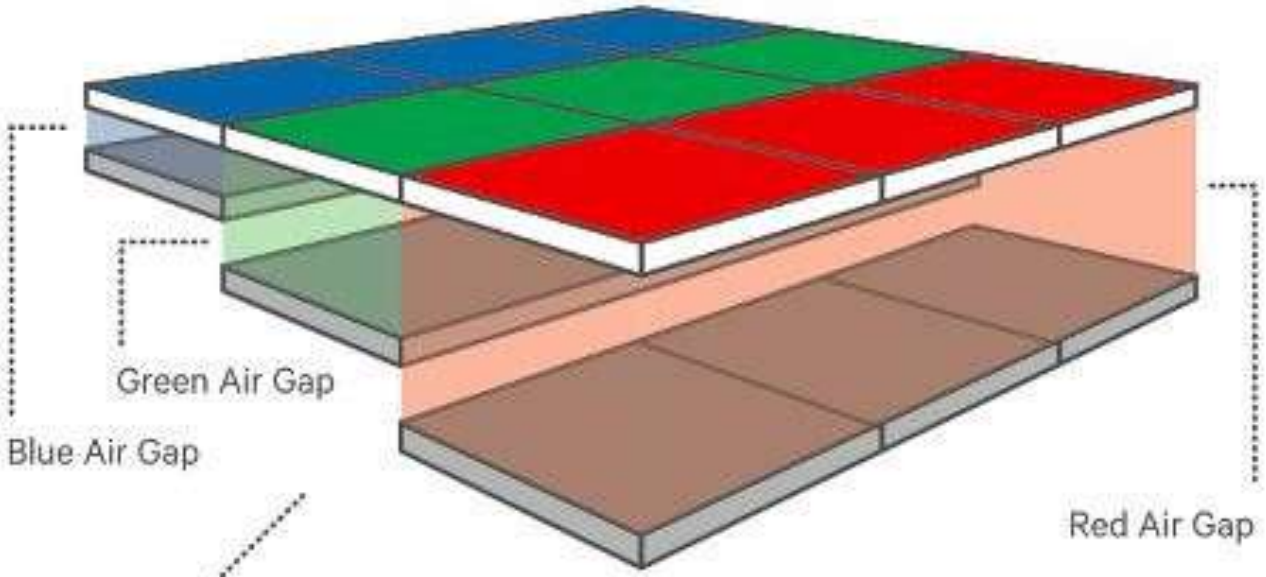


Bioinspired photonic crystals

- Donna Sgro, an Australian fashion designer has created three dresses from a fabric called Morphotex, a pigment-free and dye-free textile developed by Tejin Fibres Limited in Japan.
- This iridescent blue material draws its colour from optical interference based on the way fibres of different thickness and structure are inter-woven .

- Peacock feathers contain nanometer-scale protein structures that break up incoming light waves, recombine and reflect them as rich, vibrant colors.
- Scientists at the University of Michigan think they have a technology that emulates this process to display pictures without chemicals or electrical power.
- Eventually, the technology could replace the displays now used on smartphones, tablets, and computer screens, with strikingly high definition.


Evaluate
Identify
Emulate
Translate
Abstract
Discover



PIXEL
COLOR
DISPLAYED

COLOR
SELECTION
EXAMPLES