DAISY.WORLD

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DAISY.WORLD
Scientific context

The idea and title, or rather the quote, come from the development of the GAIA theory (or GAIA hypothesis) in the '60s/'70s of the last century. The formulation of the GAIA theory was an expression of a gradual change in the scientific view of the world towards the end of the last century – especially ideas about what we are: LIFE.
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It was one piece in the puzzle of the ongoing paradigm shift in our understanding of science and ourselves towards complexity, thinking in terms of networks and holistic scientific observation.

The GAIA theory is a new interpretative model in the interdisciplinary field of Life Sciences.
It is the scientific foundation of and inspiration for a new ecological understanding of our world.

The starting point for this project was my realisation of permanently changing environmental conditions. Our world is always drifting.

GAIA

The British atmospheric chemist, James Lovelock, and the American molecular biologist, Lynn Margulis, two of the most inspiring scientists in the new discipline of Life Sciences, developed the GAIA theory based on each of their specific areas.
They discovered and gathered a wide range of data to support the hypothesis that the complex microbial networks in our biosphere should be viewed from a higher perspective as a single, self-regulating, living organism – a superorganism.
They later expanded their definition of the geophysiological system GAIA[1] to include the entirety of all organic/biological elements (life forms) created in reciprocal co-evolutionary change and their inorganic/geophysical conditions (the atmosphere, oceans, layers of earth).

The most important aspect of this new way of looking at things, seeing the Earth as one single, huge organism, was the question of self-regulating mechanisms. (Do such mechanisms exist in and of themselves; what are their effects?)

According to generally accepted theory, life has the capacity for homeostasis. This means that a living organism has the ability to regulate and stabilise its internal physical state so that its cycle of internal essential biological processes can be optimally maintained when external conditions change.
= Control over its internal life.

The idea of homeostatic behaviour in the higher level of organisation in GAIA, transferred to all levels of the internal parts of the superorganism, the level of its internal organs and cells,[2] in this sense to the planet's individual populations and species and therefore also in terms of human beings – is a controversial scientific idea!

Thus, if the internal organs and cells control their own existence and environments within a superordinate control mechanism, then that would mean:
Living populations/species do not just control themselves, but also their surrounding dead geophysical conditions.
Life would therefore have not merely colonised an unchanging dead planet (it would not just be sitting on top of it, so to speak), rather it would have shaped the appearance of the previously dead planet significantly to its own advantage.
= Terraforming by life itself.

Finally, one would have to conclude: both components, dead and living matter in the lower level of organisation, together form a living thing on the higher level: GAIA.
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The idea of a living Earth is much more popular today than it was in the twentieth century:[3] every earthly life form, every species or symbiotic community, including human society, is a part or a particle like an organ or a cell in the larger organism that is our planet Earth.

Almost everyone has heard of this theory. And yet we seem to really want to suppress this knowledge with our old, misunderstood experience of our dominant position in nature. The human categories 'domination' and 'superiority' are deceptive, wishful ideas.

There are no hierarchies in the networks of life – only equal connections in all directions.
Each component is dependent on all the others and contributes to the survival of all the others. If you move one component in this network it has a knock-on effect on all the others.
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In GAIA's network, the 'higher', highly specialised life forms only play a cursory role – perhaps comparable to a very rare cactus flower, which only blooms under very specific conditions.
Measured in the dimensions of Earth's history, these curious flowers of evolution with a tendency to autonomisation have rarely survived for a very long time.[4]

Only those life forms that remain a part of the organism and benefit it have the right to stay. Proliferation in the system is halted by homeostatic compensatory adjustments. Life forms that proliferate unchecked undermine their own foundations for living.

Everyone should be aware of this, especially in our times, since climatic equilibrium is changing to our own detriment. Climate is just one aspect of the overall geophysiological network – in that sense also one of GAIA's faces.

DAISYWORLD

In his research on our planet's self-regulating mechanisms, James Lovelock set up a computer simulation called DAISYWORLD. It is a mathematical model for a simplified ecosystem.

Working with his scientific team, James Lovelock programmed a real-time simulation – a virtual model of our real world with its cosmic, geophysical and biological parameters. However, his model only has two life forms, two populations of flowers: black and white daisies = DAISYWORLD.

The programme, the artificial ecosystem, works completely autonomously, independently of external influences or any interference by the scientists.

This is a summary of what happened: the black flowers are able to grow and spread while it is still too cold for the white flowers. They form a dark carpet across the planet and spread from the equator to the polar caps. The dark carpet absorbs energy from the sun and increasingly heats up the atmosphere. Gradually it starts to get too hot for the black flowers. The carpet of flowers develops holes near the equator, the population migrates towards the two polar caps or shrinks. Now the white flowers can take over the terrain and spread. Their white surface reflects the sunlight; they are better able to deal with the heat. As the white flowers spread, the atmosphere cools down.

The populations change depending on changes to the external conditions. When it gets hotter, the white flowers grow and form a protective shield. When it gets colder, the black flowers form an absorbing carpet.
Lovelock's experiments have shown: the more complex many populations are, with different requirements of their living environment, the stronger the self-regulating effect.
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The result is both astounding and revealing. The populations and symbiotic communities grow and spread across the Earth or shrink and die out.
Life is permanently drifting.
It is subject to constant changes, caused by changing external conditions.
However, the growth/spreading and shrinking/extinction have a fundamental effect on the climate. Everything is a condition of everything else, is linked to each other in feedback loops and only as a whole forms the ecosystem.

One can see that the way the different populations grow corresponding to every external change and vice versa, how the populations absorbs the harmful effects. The alternation between blooming and dying stabilises precisely those climatic conditions that are necessary for the survival of all the populations overall.[5]
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The DAISYWORLD experiment revealed the autonomous self-regulating character of the web of life and its mechanisms in a simple way.
It shows us clearly how life is capable of resisting both external and internal harmful influences and to rebalance itself without the intervention of a higher power.
Life does not need a “protective hand”, nor a “creator”, to constitute and later sustain itself as a self-organising endeavour of the forces of the universe.

The DAISYWORLD experiment gives us an understanding of the drifting that occurs in symbiotic communities as a fundamental condition of a living, self-sustaining ecosystem.
However, it also illustrates to us how fragile this dynamic balance is. It reacts very sensitively to every change, inside or outside the system (also those caused by humans).

In this sense, the moral consequence of this knowledge is: a foresighted awareness of ecological relationships and a conscious, sustainable obligation to take care of nature.
The art project DAISY.WORLD seeks to contribute to people learning about this.

Note 1)
Geophysiological (not geophysical), taken from Biology and Medicine, since it is a living system; The physiology of the Earth (coined by J. Lovelock) – the study of the physical and biochemical processes in the planetary organism, the Earth – viewed as all of the biological processes working together, from the molecular to the organic functional level of the biosphere (from this perspective, the organs are the large geophysical, biological entities such as rain forests, ocean currents, deserts, polar caps, the ozone layer, etc.).

Note 2)
Cells – in reference to biological body cells (red and white blood cells, nerve cells, muscle cells etc.) – structurally distinct units of function on the level of (what are known as) individuals – on a higher functional level as in cell biology acting as complex tissue structures.

Note 3)
...even if often only in its mystically romanticised, personified forms as an omnipresent deity (e.g. the film AVATAR) not as a scientific, causal principle.

Note 4)
The history of human culture in the higher sense begins with the Neolithic Period around 10,000 years ago. The human (Homo) species' cultural practices date back around 80,000 years for making art (The Grotte de Pigeons, Morocco) and 400,000 years for religion (the first burial rituals). The first members or our species were born around 2.5 million years ago (Homo rudolfensis).
GAIA is more than a thousand times our age, around 3.6 billion years old.
Our planet, as a dead, geophysical formation, came into existence around 4.5 billion years ago.

Note 5)
As might be expected, these self-regulating mechanisms only work within certain existential limits for these external conditions – "the window of life". When these limits are passed, the system collapses and the entire organism dies.

DAISY.WORLD
Technical realisation

The flower populations of the DAISY.WORLD installation are orange and blue.[1]
The public art installation should be installed vertically on an urban structure or building, which should have a large, flat surface and be clearly visible from a distance within its urban surroundings. It may have curves and angles.[2]
Some options would be towers, the façades of buildings, walls or large-scale bridge elements. It should give the impression that the building has been taken over by an artificial landscape of flowers.

TECHNICAL MATRIX

The design should be realised using a technical matrix, which will be projected onto the surface of the building like a second skin. This consists of the following components:

1. Supporting structure
This can be a solid, standing structure (e.g. a standard scaffolding structure) or a hanging, web-like steel cable structure (lighter and more transparent) attached to the building. The supporting structure provides a stable platform for the functional hardware components without damaging or impairing their function.[3]
Furthermore, it must be possible to access each intersecting point manually to carry out maintenance or adjustments.

2. Pneumatic system
The pneumatic system is the energy source for the movement of the installation.
At each intersection of the technical matrix, air pressure can be released via a system of tubes and controllable outlet valves. There is always a certain amount of pressure, provided by a compressor with a pressure control tank/mechanism. The compressor should be positioned a little to the side. It only starts up to balance out a drop in pressure.[4]

3. Effectors/flower heads/kinetic pixels
There is a pneumatic effector at each intersection of the technical matrix, i.e. at each outlet valve in the pneumatic system in the form of an artificial blossom object (see drawings).
This is a capsule-like object with an opening to allow air in (an inlet valve) and an air-release opening, which also has a controllable valve.
The flower heads also have star-shaped openings, in which there are inflatable rubber tubes with rounded ends.
The tube capsules are hard-wearing, weather-resistant, translucently coloured (should be lit up from inside) and have a high elasticity.[5]

They form an airtight seal in the cell-shaped objects and can expand to form long rubber arms as when the inlet valve opens and air enters. They shrink back to their original capsule shapes when the outlet valve opens and the air can escape again.

4. Data network
The data network exchanges information between the sensor system, the computer simulation and the effector matrix. Information about changing environmental parameters is fed into the computer simulation. Information about growth or shrinking is sent to each point in the real flower matrix by the virtual simulation. A bus system controls the inlet and outlet valves in the matrix.

5. Sensor system
A network of sensors records current values for specific environmental factors essential for life. The values measured are interpolated onto the positions that have not been measured between the sensors in the network. Each position is thus assigned its own value. The sensors also record other events.

Sensor system => data network => computer simulation => data network => effectors

CONTROL

The effectors, i.e. the artificial flower landscape, can be controlled via only two stimuli:
1. Open air-inlet valve / inflation / blooming / growth / spreading
2. Open air-outlet valve / deflation / wilting / dying / shrinking

The technical matrix is a hardware structure comparable to a computer screen.[6]
Each flower head is a binary pixel and can take on one of either of the states described above:
1. ON / growth
2. OFF / dying

The public art installation is controlled via an interactive real-time computer simulation just like in Lovelock's experiment.[7]
The programme analyses each point in series in the virtual coordinate system in certain time intervals according to a defined "window of life", i.e. existential environmental parameters, as well as the mathematical growth/shrinking rules for the current growth values for each point/pixel.

A. Basic existential conditions/window of life

Various environmental conditions that can be recorded by the sensors have been specifically selected as exemplary conditions (e.g. temperature, light, air humidity/rain, wind, etc.; the simulation is a simplified model). An upper and a lower limit necessary for survival are defined for each environmental condition and species. All the environmental parameters measured must fall within the window of life for each species in order to initiate the stimulus for growth. If even one factor necessary for life is missing, life cannot develop. The more optimal the conditions are, the higher the growth values and the more abundant the spread.

B. Influences/growth and shrinking rules

These are made up of:
A - Logical conditions/events
B - Natural environmental conditions taken into account
(via the sensors)
C - Hypothetical environmental conditions similar to those in nature
(without sensors, only programmed)
D - Conditions inherent to the system similar to natural conditions/
types of behaviour

Using the growth/shrinking rules, positive or negative growth coefficients (pos./neg. GCs) are determined; these influence the pixel's growth and correspond to both advantageous and harmful environmental factors.

pos. GC = factor > 1 = growth value increases = better growth conditions
neg. GC = factor < 1 = growth value decreases = worse growth conditions

C. Growth and shrinking stimulus / trigger point

There is a defined critical growth value that determines the binary state of the pixel. This critical value defines the average growth environment, in which the population would begin to develop naturally – defined as 1.

If the growth value is determined to be higher than 1 in any of the cycles, this means ON for that pixel, if it is less than 1, this means OFF.
Each time, the programme compares the previous value with the current one and, if it has changed, sends a positive (growth) or negative (shrinking) stimulus to the corresponding valve of the real flower network.
The programme carries out its growth calculations for both populations, since at each point in the technical matrix there are two flower heads – one orange-coloured one and one blue. Each field in the coordinate system can be occupied by either of the two species.

There are four theoretical possibilities for the pixel field:

1. OFF - neither of the two species can exist
2. ORANGE - the orange-coloured flower grows
3. BLUE - the blue flower grows
4. ORANGE or BLUE - both species could exist, but only one will prevail
(depending on the rule for each case)

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Once the programme has started up, the installation works completely autonomously without further human intervention. As a system, the installation is linked to its environment and together with it forms a superordinate closed system.
The flower landscapes' growth develops its own dynamic, which can no longer be understood by us observing from the outside.

Note 1)
Brightly coloured attention-grabbing effect as an urban eye-catcher, complementary colours (the largest possible colour contrast)
DAISY.WORLD is an entertaining art installation in public space. The colours Lovelock originally chose, black and white, are not as suitable.
Lovelock's experiment was about studying real geophysical, biological mechanisms (the population-dependent ice-albedo feedback process in the radiation budget of planets, i.e. climatic effects).
The DAISY.WORLD art project is a simplified and easy to understand model of ecological relationships for the public.
Its aim is to educate people and raise awareness. As a counterweight to an outdated and misunderstood anthropocentrism (which in turn replaced the theocentric world view), its purpose is to help to spread a new ecological worldview.
Note 2)
The surface of the building should not have any small spatial structures that would break up the overall surface (protrusions, bay windows, cantilevers, gaps or cavities, technical fixtures).

Note 3)
Since the installation is only temporary, reduced visibility of the outside from inside the building and vice versa will have to be tolerated. It should still be possible to open and close the windows, however.
If necessary, the supporting structure could be left out if the installation's hardware can be fixed directly onto the building without any disadvantages (if there is already a superimposed structure, e.g. shading elements, scaffolding for advertising, open coverings).

Note 4)
Compressed air need only be provided to individual flowers in intervals of seconds to minutes. Although the actual requirement is very low, the extensive system must be permanently pressurised. Loss of pressure must be equalised.

The growth of the flower populations on the building's surface happens very slowly, but faster than in the real world. The simulation must be programmed, i.e. the trigger values of the environmental parameters measured must be carefully adjusted and manipulated so that the result is an overall movement that is striking and fascinating for members of the public – not too fast, but without completely stopping for a longer period of time, which would be counterproductive.
Passersby will only notice the changes if they take a second look – the flowers appear not to be moving, however they are constantly, almost imperceptibly changing, just like in nature itself. Permanent drift – like the tides, sunset, moonrise and the appearance of the stars, etc.

Note 5)
A big challenge is the right material with the most effective form and optimal qualities. The material that will most likely meet all the requirements is a special silicone rubber. Qualities of materials must be compared and optimised, special mixtures could possibly be commissioned and tested (I have enquired with various chemicals companies).
Work with the Deutschen Institut für Kautschuktechnologie e.V. in Hannover, and possibly with the technical department of Wacker Chemie AG in Munich – extrusion of tubes with various mixed materials and materials tests are necessary.
Requirements:
- *UV-resistant (natural rubber starts to disintegrate in sunlight)*
- *Temperature resistance from around -20°C to 40°C*
- *Tear resistance*
- *Resistant to wind, rain and snow*
- *Highly elastic*
- *Low additional shrinkage (there is no material that fully reverts back into its original shape)*
- *A good ratio between the lengthwise and widthwise expansion of the tube, one-dimensional expansion/stretching only lengthwise if possible*
- *The material must be easily dyeable, with strong a colour effect, also when stretched*
- *Translucence, must be possible to light up the tubes from inside*

(See drawings and calculations)

Note 6)
Screens, digital advertising walls or conventional media façades are two-dimensional light media. Three-dimensional effects are only illusions and are not real.
The DAISY.WORLD installation uses new media technology that goes beyond a flat illusion. The medium actually physically grows out of the surface. The installation controls the three-dimensional movement of real objects.

Note 7)
The interaction is between the real natural environment and the virtual, autonomous computer programme on the one hand and between the programme and the real, artificial flower world on the other. I use the term 'interactive' in the sense that it is usually used nowadays.

However, in a narrower sense, it is only a “reactive” system, since the simulation only has the option to react by doing something in the artificial flower world.
A true interaction would be the case if activity in the flower world could also in turn have an effect on the real environment.
Our ecosystem is a real interaction between the populations and their environment.
The interaction ultimately always stabilises the system (a living system) – even if it sometimes appears to be tipped off balance, as is the case today.
Today’s imbalance has two possible consequences: A) The destructive element in the network ceases its behaviour that is damaging to the system. B) The destructive element is damned to extinction. Throughout its long history, the ecosystem as a whole has survived far worse catastrophes than the proliferation of the human species in the last hundred years (see also: "The Fatal Gene", p. X).