Modern Environmental Science and Engineering (ISSN 2333-2581)
February 2022, Volume 8, No. 2, pp. 102-110
Doi: 10.15341/mese(2333-2581)/02.08.2022/003
Academic Star Publishing Company, 2022
www.academicstar.us

Emotionality in the Images of Design: A Biological-Evolutionary Theory

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Abstract: From the start of this century there has been a proliferation not only in the study of neurosciences and the physiology of perception/emotion, but also in its dissemination. This has resulted in countless programs, courses, etc., that pretend to help the designer, be it architectural, advertising, product, packaging or others (Ulrich, R. S. 1999) to appropriately impact the experience of the end user; tendencies such as biophilia, neuromarketing, user centered design, the influence of color in a space (Aseel AL-Ayash, Robert T. Kane, Dianne Smith, Paul Green-Armytage, 2016), or the impact on behavior and the brain when observing works of art (Kendall J. Eskine, Natalie A. Kacinik, Jesse J. Prinz, 2012), are intended to give us answers based on the neurology and physiology of perception/emotion. Nevertheless, it is hard to separate science from pseudoscience, and even to organize into a useful model the copious scientific information available. The objective is to present a theoretical model that incorporates and synthesizes the state of knowledge in this field, to facilitate its application in the diverse art and design disciplines; this will help both the creator-artist to have a better understanding of their process and comprehension of their work, as well as the designer, to be able to predict the impact their projects will have upon the audience they are directed towards. We are talking from photographers and painters, to architects and illustrators, etc. The methodology consists mainly in the exegesis — and organization of the material resulting thereof — of basic text on this field. In this talk, we present the Theory of Emotive Reactions model, that has been developing in Tijuana since the beginning of this century, we give a shallow explanation of its scientific foundations, we point out its correlation with the state of knowledge and we present the basic principles for its application in the diverse artistic and design disciplines.

Key words: design, emotion, neurosciences, perception, end user experience

1. Introduction

From the start of this century there has been a proliferation not only in the study of neurosciences and the physiology of perception/ emotion, but also in its dissemination. This has resulted in countless programs, courses, etc., that pretend to help the designer, be it architectural, advertising, product, packaging or others [1, 2] to appropriately impact the experience of the end user; tendencies such as biophilia, neuromarketing, user centered design, the influence of color in a space [3], or the impact on behavior and the brain when observing works of art [4], are intended to give us answers based on the neurology and physiology of perception/emotion. Nevertheless, it is hard to separate science from pseudoscience, and even to organize into a useful model the copious scientific information available.

The talk is put together as part of the dissemination of knowledge work by the core nucleus of research at the School for Higher Studies on the Visual Arts in Tijuana, Mexico; the three authors being doctors by the University of Guanajuato, applying the arsological protocol for research, developed at the same core of research and reflects a synthesis of the theory that is foundation to their degree thesis, as well as their subsequent research work.

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2. Material and Methods

The methodological approximation will be primarily the exegesis of texts and the hermeneutics of the state of knowledge resulting thereof; understanding our problem as one of disciplinary integrations, the exegesis of each field will be undertaken in an independent fashion, to then attempt a converging synthesis and the corresponding hermeneutics.

3. Results and Discussion

3.1 Research Question

The problem of study we pose ourselves is, is this theory proven based on disciplinary coherence with the sciences that intersect with it? The concept of "disciplinary coherence" as a fundamental methodological and epistemological aspect of the scientific method, we have already argued in several texts: doctoral thesis, articles in arbitrated journals and books. Basically, it consists in the first proof — from many — that a theoretical model must achieve to cease being a hypothesis and become a theory; this proof is its coherence with the scientific *corpus* or state of scientific knowledge; the no-contradiction with the rest of knowledge in its field nor that of other sciences. According to what is stated at the sciences journal, from the National Autonomous University of Mexico: "SCIENCE". "Critical, collective and systematic search for knowledge by using empirically based formal reasoning subject to the requirement of disciplinary coherence and experimental verifiability." [7]. That is, if by definition a theory is a hypothesis that has been proven to some extent, then the disciplinary and interdisciplinary coherence is the first and most basic level of proof, that must be followed by direct experimental verification.

3.2 Hypothesis

We start from the hypothesis that, the first proof of a theoretical model is that of "coherence" with the body of intersecting sciences; therefore, our methodology consists fundamentally in the exegesis — and organization of the material resulting thereof — of the basic texts from this field in relation to the model discussed hereat.

3.3 Objectives

3.3.1 General

Our general objective is to present a theoretical model that incorporates and synthesizes the state of knowledge on this subject, to facilitate its application at the diverse disciplines of art and design; which will help both the artist-creator to have a better understanding of their process and comprehension of their works, as will the designer, to be able to forecast the impact that their projects will have upon the audience they are directed towards. We are talking from photographers and painters, to architects and illustrators, etc.

3.3.2 Specific

For a better organization of the work, we undertake our subject and general objective divided into the following specific objectives:

1) Determine the biology (evolutionary theory) of the mechanisms of perception, processing and response to the environment's information.
2) Determine the processes of neurology of perception-emotion, that determine the experience of the audience before the works of art and design.
3) Determine the conditions of the physiology of perception (vision, audition, etc.) that determine the information coded in the work of art or design, to which the brain can have access.
4) Determine the physics (optics, acoustics, etc.) that determine the information that is possible to encode in the work of art or design.

3.4 Development

Our approximation hereat is interdisciplinary; this tendency to the integration of knowledges in the study

of fields that, like art and design, had been isolated in that safehouse called "the humanities", is not a personal whim, it is the natural result of the state of knowledge. Indeed, if the beginning of the XXth century was the realm of specialization, the end of the XXth century found itself faced with the need of disciplinary integration as it dealt with complex phenomena. Speaking about the specialists that work in a bubble, oblivious to the implications that other disciplines had upon their work, James Gleick tells us: "[...] all those scientists and many more, convinced that the components of their disciplines were different, accepted as a logical thing that the complex systems, consisting of millions of those components, had to be different as well. Now well, that has changed in our time. In twenty years, physicists, mathematics, biologists and astronomers have been stablishing variant, substitutive, ideas. Simple systems cause complex behavior. Complicated systems cause simple behavior. And, more importantly, the laws of complexity have a universal validity, and they don't concern themselves with the details of the atoms that constitute a system." [8].

The pertinence of incorporating the most recent advances in the biological and physical sciences to the study of art and design, might have escaped the attention of the "theoreticians" of art and design, but has become ever more evident from the point of view of these sciences, the same that view such enterprise as something increasingly more viable, as David Hubel argues: "The relation between art and science nowadays would only be a vague and fictitious dream if neurobiology was a subject so abstract and so highly evolved as for it to be out of reach for someone not deeply trained in science and mathematics. Fortunately, our science is not so abstruse, in the way that relativity or quantum mechanics are." [9]. This vision is shared by researchers from many fields, such as neuroscience, anthropology, etc.

3.5 Physics

We must start by remembering that physics defines the playing field where the phenomena of perception, representation and reception that constitute the complex phenomenon called art or that of design will occur. Most of the proposals about art and design from the XXth century and earlier, suffer from a lack of coherence with contemporary physics. That is, any theory about art, its nature, production, reception and effects, must derive from a worldview that corresponds with the state of physical knowledge. "Science treated facts, grey, blurry, as if they were, as it actually happens in mathematics, black or white. Nevertheless, no one had ever shown a fact of the world that was true or false at a 100 per 100. It was stated that they were, that is all." [10]. Here lies the difference between the phenomena of the world, diffuse and blurry, and the "things", those molds where the conscious human brain inserts the phenomena to simplify and stabilize them.

The main issue to consider, is the current vision of the universe as a continuum where non-local waves interact, whose fleeting interactions determine the current state of reality in any concrete place and time. "Nature creates trends and patterns. Some will be orderly in space and disorderly in time, others viceversa. There are fractal patterns, that exhibit in different scales structures similar to themselves. Others produce stable or oscillating states." [8]. The new way to understand the objects in the material world Are these trends and patterns, these configurations in their fleeting and changing interactions are not the stable and concrete "things" in which we used to believe. Under this vision, the notion of 'thing' as some concrete object, with defined and stable properties, vanishes. "Each thing flows regularly towards nothing. The atoms at the tips of our fingers go round and round until they become atoms of air. There are atoms from the fingers and atoms that are not from the fingers. And then, there are atoms in the middle, that to some extent are at the same time atoms of the fingers and atoms of the air, and to some extent are neither." [10].

Furthermore, the notion of "identity", that served as foundation for the reasoning of the last century vanishes and is substituted by typicality; an issue that we could see coming since the moment typicality was found in fingerprints at the end of the XIXth century and was used as a method for identification by the Argentinian policeman Juan Vucetich. This means that, before art, in nature there are no "things", concrete and identical entities, there is no a=a from human logic and not art, nor language, could arise by taking "things" as reference or model. Whereas binary logic, identity and the concept of objects as "concrete things" rules the human worldview, in nature what defines the world is typicality, the object understood as interaction between fleeting states of the world and the subject's perception; as well as fuzzy logic.

3.6 Physiology

Regrettably, the study of physiology of perception is very limited; particularly, insofar as the formal organization of the perceived information and its translation into emotional responses and associations. From amongst all perceptual aspects, the most studied is that of sight; reason why we will limit ourselves to said aspect in this occasion, taking advantage of its advances, as Hubel points out: "Over the last fifty years, our knowledge about how the brain interprets the information it receives from the eyes, has taken great strides, mostly because, for the first time, we have had the tools to make the right questions. Amongst these tools there are the microelectrodes, that allows us to listen to the activity of the individual cells in the brain; electronic devices that allows us to amplify and record these signals; and new techniques of neuroanatomy, that make it possible to know how the cells are interconnected." [9]. Two of the best introductory texts to the global physiology of perception — visual, particularly — are those of Harvey Richard Schiffman [11] and of Margaret Livingstone [9]. These texts collect the sum of most of current knowledge about the physiology of perception, particularly of those aspects that determine what the audiences of art and design can or cannot perceive in a visual configuration.

According to the state of knowledge in this field, visual perception is, as anticipated by Arnheim, an active processing of information, a construction of a model of reality from the received visual information, and not the passive reception of "images of things": "In any event, if the purely sensory reflection of things and events from the outside world were to occupy the mind in their raw state, that information would be of little use. The infinite spectacle of ever new particulars would stimulate us but not instruct us. Nothing that we could learn about an individual thing is of use unless we find generality in the particular." [12] Indeed, the brain does not receive images of things from the eye, because it would need in turn to have eyes to see those images; as Livingstone explains: "The fallacy is the idea that, when we see something, a little representation of it is transmitted to the brain to be seen by a little man. The fact is, of course, that there is no little man in the brain to look at that or any other image. The function of the visual system is really to convert patterns of light into useful information for the organism." [9] This takes us to the understanding — that should have been obvious — that in the works of visual arts or design there are no persons, nor things, or animals; there are only clues that the eye transmits to the brain for it to, using its previous experiences, imagines what we are seeing.

But this does not mean that, as it was argued in the last century, that "each person sees something completely different and unique in the work of art"; the mechanisms of subconscious interpretation in the brain are a specific and typical set for all human beings, not arbitrary. These mechanisms have not yet been entirely explored by science, but we can note a clear coherence between the three or four psychological rules from Arnheim [12]: expectation, structural simplicity, typicality, continuity, and the thirty something computational rules identified by Hoffman [14].

Another limit to the arbitrariness that used to be attributed to the perception of art, is the fact that we

have two visual systems with clearly differentiated functions; a primitive system, shared with most mammals, of monochrome perception and adapted to the perception of space and interpretation of movement [9]. Whilst the other one is a more modern visual system, shared only with apes, capable of distinguishing colors and adapted to identifying objects (Fig. 1) [9].

From here it follows that the audience's experience facing the work of visual art is strongly mediated by the natural mechanisms of perception and interpretation and the visual information. Most of the color theory that has been taught at the art and design schools, is denied or, at least, adjusted by this knowledge about the perceptual mechanisms of vision.

Fig. 1 Universe of diffuse and fluctuating objects, according to modern physics. Cuanalo, oil/canvas, 1.2 m × 1.5 m, 2010.

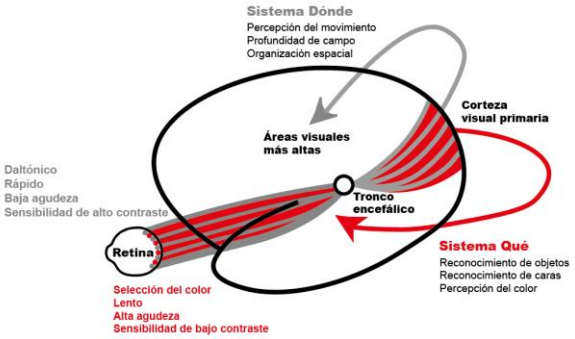

Fig. 2 The primate visual system, composed by the What (tan) system and the Where (blue) system. Livingstone, 2002.

3.7 Neurology

The user's experience is definitively determined by the architecture and functions of their brain. And although representation has made it possible for the arbitrary and conventional coding of concepts and precepts — conscious thought — it is also true that these are coded in the very same "networks" of neural connections, with the same mechanisms that biological intelligence — unconscious or subconscious perception/reaction. There have been no other, more evolutionarily recent, mechanisms detected that could allow a human brain to process the works of art or design in any other way. That is, our evolutionary relationship with the artificial is so recent that we have not developed mechanisms other than the ones we already had to deal with life in the wild.

We know, for example, that the integration of visual information is progressive and iterative, from the retina itself, passing through the nervous cells in the eye, over to the different levels of integration in the visual cortex and only at the very end integrating both signals: "what + where", with conscious thought. Livingstone explains to us how the process of perception has a structure of hierarchical integration that can be interrupted at any stage if the brain determines an appropriate response and that only involves the conscious aspects in the "higher" areas, at the end of the process: "Although neurobiologists do not yet comprehend consciousness or the sense of self, it is generally accepted that they must be mostly a consequence of activity in these higher association areas." [9]. This means that the incidence of the conceptual ideas and memories of the conscious, about the user 's experience before the work of art or design, is minor and, many times, the brain 'finds' its response to the image way before arriving at this level of integration. This reinforces the notion that the audience's response to art and design, even if truly individual and unique, is also highly typical and the differences are minor.

Another aspect of neurology that directly affects the audience's experience, is that of the so called "mirror neurons" or, better said, that of empathy. As explained by Rizzolatti and Sinigaglia; at the neuronal level, doing and "watching doing" are intimately connected in a form of biological intelligence underlying conscious human intelligence: "...above all, the brain that acts are a brain that understands. It is about, as we shall later see, a pragmatic, preconceptual and pre linguistic comprehension." [13]. This mechanism associates the perception of the movements of "others" with the emotionality and intentionality of the perceiving subject. This derives from the fact, first, that all bodily movement is nothing but the spatial representation of a "neural pathway"; second, that emotions are movement themselves and; third, that intentions define the "neural pathway" for a movement from its "preparation", that is, from the subtle initial movements that prepare the body to execute a determined action. The mechanism consists in groups of neurons that are activated in a very similar way when we execute a particular movement, than when we see it being executed by others. This allows for the recognition of the movement and, therefore, of the emotion and intention behind the movement. Note that, by movement, we are referring even to the micro movements of facial expression or, even, to the symptoms that betray the change of emotional state such as, for example, the acceleration of breathing, etc.

3.8 Biology

The general theoretical foundation of all behaviors, both instinctive as well as learned, with a transgenerational distribution is, necessarily, evolutionary theory. In the context of millions of years of evolution, guided by principles directly related to survival, the impact of recent conditions — a few tens of thousands of years of human civilization — is minimal. Therefore, the experience of the spectator before a work of art or design does not escape this condition and is defined, mostly, by said evolutionary aspects.

It should be remembered that the essential evolutionary function of the brain is that of predicting future effects from current environmental conditions upon the individual — in reference to the eventual transmission of their genes — for the purpose of executing actions conducive to the survival of their genes. As Donald Hoffman explains: "You are a genius at vision, as you are a genius at language, it is innate, wired in a secure fashion in your brain under the influence of your genes." [14]. Also, it is necessary to remember that both the mechanisms of the environment' s sensory perception and information, as a behavioral emotional response, are basic tools of the brain to fulfill this function; that is, when we speak about "decision making" in the brain, we are speaking about binomials of perception-emotion. "[...] the eye itself does not see apples and waterfalls; instead, it has around 130 million of photoreceptors, and each one of them sees only one thing: how many photons of light it just captured [...] There are not, on the eye's photoreceptors, delicious apples nor dazzling waterfalls. There is only an astounding set of numbers, without obvious meaning… With ingenious detective and theoretical work, your brain interprets a jumble of numbers as a coherent world, and that interpretation is what you see — the best theory that your brain was able to put together" [15]

It is understandable then that the evolutionary function of the brain is not to know — much less understand — the world around us, but to take effective actions for the survival of the genes, in response to the ever changing conditions of the environment. For the same reason, the function of the visual system is not to give the brain tons of superfluous information — which is the most part of the information present in our environment — but rather only that which is pertinent for survival. In reference to the little circular window — in our visual field — within which, exclusively, we see sharply, Hoffman explains: "Only within this little

window, your sensory interface builds a detailed report of fitness rewards. This crucial report is formatted as the shape, color, texture, movement and identity of a physical object. You create an adequate object — your description of rewards — with a glance. You destroy it and create another with your next glance. Your extended visual field guides your eyes to place attention where there are vital rewards to be reported." [15].

Now well, in spite of the fact that, as Hoffman points out, there is no necessary correspondence between our conscious model — image — of the world and the real morphology of it, it is necessary that the information the brain obtains and the response it gives said information has a positive correlation to the effects of the world over the survival of the genes. "The world of physical reality does not consist of meaningful things. The world of environmental reality, as we have been trying to describe it, does. If what we perceive were the entities of physics and mathematics, the meaning would have to be imposed upon them. But if what we perceive are the entities of environmental science, their meanings could be discovered." [9]. That is, the brain's adaptation and its physiology must correspond to the nature of the environment in function of the effect of the latter on the individual, as pointed out by James Gibson in his theory of "affordances". "Perhaps the composition and configuration of surfaces *constitutes* what they afford. If so, to perceive them is to perceive what they afford. This is a radical hypothesis, since it implies that the 'values' and 'meanings' of things in the environment can be directly perceived. Moreover, *this* would explain the sense in which values and meanings are external to the perceiver." [16]

Independently of the differences we might have with this latest author, we definitely agree that the sensory information surfaces communicate to the brain constitute, in most cases, precisely what said surfaces "afford" the individual in terms of possibility — of damages or benefits — the opposite being an anomaly; otherwise, the perception-emotion mechanisms would be useless to deal with the environment in an effective manner. And this correlation is evolutionarily so relevant as to dominate the individual's aesthetic experience — perception/emotion — facing their environment, as well as facing any configuration that art or design might offer them.

3.9 Theory of Emotive Reactions (TER)

The TER model [5] is a synthesis of the state of knowledge on the biology of behavior and perception. Its core concept is that of "typicality" as the foundation of biological intelligence and, at the same time, as opposed to "identity" as the foundation of rational intelligence. In its short form it states: "To any typical individual of a given species, to each typical configuration perceived, corresponds a typical emotive reaction in function of the consequences that typically follow said perception." This model explains the "instincts" — with the exception of the so-called "survival instinct" — in function of the physiological — mostly neurologico — mechanisms of perception, processing and response to information in the environment. And, as for most "human" phenomena, these biologic mechanisms will be the foundation upon which conscious thinking acts, derived from and conditioned by emotions; the concept of emotion understood as a biologic mechanism. "In this sense, it is true that all emotions are relational, by their own nature, not because experiences evoque them, but because their function is to correlate perception with action, in function of the expected consequences. And it is true that they are fleeting, although not necessarily in terms of seconds, but in spans of time that make biological sense and that are variable depending on the kind of emotion." [5].

This applies not only to information about the natural ecosystem, but also to all interactions with the artificial, be it the urban environment, a work of art or design, because there do not exist any other alternative mechanisms that have emerged from evolution to process these new phenomena. As explained by Leon,

for the case of photography: "What does this have to do with photography? This means that, for example, that the way in which the visual elements or formal parameters of photography (lighting, colors, framing, point of view, geometric or irregular shapes) are organized, has a very specific impact on how we feel; the same visual elements, in the same photography, organized and placed in other way, tend to generate another kind of specific emotive reaction to this new configuration." [17].

The typicality of the spectator's experience is defined, therefore, by the evolutionary mechanisms of perception-emotion and the association of the resulting emotion with the conceptual theme of the work interpreted according to the cultural competency of the spectator and, in turn, the resulting response "colored" by the ideology and the relevant emotional experiences of the same. In the visual, for example, the emotional identity of the represented spaces or environments, will be assigned by the spectator in a typical way, in function of the evolutionary response selected for similar spaces or environments in nature throughout millions of years of evolutionary history. That is, the represented space will appear to us as cheerful, scary, depressing etc., in function of the "correct" evolutionary answer that our ancestors would have had facing a similar experience in nature. "In general semiological terms, our polychrome visual system is adapted to interpret natural configurations — and now also the artificials, by similarity — that potentially fall in the following categories: Human identity-emotion; potentially dangerous/edible animals; potentially dangerous/edible objects; opportunities and dangers of the environment; organic vs inorganic." [5].

As much will happen to the identity attributed to objects; they will seem dangerous, tasty, mysterious, etc., in function of the emotive reaction developed by our ancestors when faced with similar configurations and evolutionarily selected for because of results. This is independent of the conventional interpretation that the figures might have. "In short, color vision is a 'chemical analyzer', more than an instrument for embellishing our perception of the world. As almost everything else in our body, it evolved in response to survival needs and not as a 'plus' to appreciate the beauty of the world." [5].

4. Conclusion

Our work produces as conclusion the fact that, unlike all the others we have notice of, the Theory of Emotive Reactions (TER) is theoretical model coherent with the state of knowledge and susceptible to be corroborated scientificly, that is, by means of experiments conducted by independent third parties.

According to this model for the user experience, the receiver of art and design, although it is never identical, is indeed typical and, therefore, predictable and modifiable by using the TER.

There is a high percentage — yet to be precisely determined — of this experience, that is defined by the perception-emotion apparatus, derived from our evolutionary history; another portion is defined by the conventions common to all the members of a culture — included those derived from language or ideology, for example; and only a minimal percentage from the experience and corresponding reaction that is unpredictable, since it derives from the arbitrary of personal experience for each member of the public, of their linguistic incompetence and other similar factors. (Table 1).

Therefore, we can conclude that, in principle, the Theory of Emotive Reactions is a theoretical instrument useful for explaining, guiding and predicting the reception of art and design by the audience; same that is, of course, subject to constant verification, criticism and improvement to the end of increasingly refining the certainty of its predictions (Fig. 2). But that, for now, passes the test of coherence with the physical and biological foundations of the process; even though, of course, it still needs extensive verification from experimental observations.

Table 1 Theory of emotive reactions: Typical natural configurations and typical ancestral responses.

Natural configuration	Emotive reaction	Biological meaning	Visual system	Factor
Forest fire	Anxiety- flee	Prejudicial	What	Low general contrast and high and distributed local contrast: tone, saturation and color temperature.
Electric storm	Anxiety- flee	Prejudicial	What	General darkness, high local tonal contrast, desaturated, cold colors.
Pray	catch	Benefic	Where	Erratic transversal movement
Cave or refuge	Safety- stay calm	Benefic	What	Warm, desaturated colors; low tonal contrast.
Imminent storm	Anxiety-seek shelter	Prejudicial	Where	Low tonal contrast with homogeneous distribution of tones
Camp Fire	Safety-stay calm	Benefic	What	General darkness, high local tonal contrast, warm saturated colors.
Exit	Relief– exit	Benefic	Where	High local tonal contrast, gradually increasing.
Poisonous	Anxiety- reject	Prejudicial	What	Geometric patterns, precise edges, saturated warm colors, high tonal contrast.

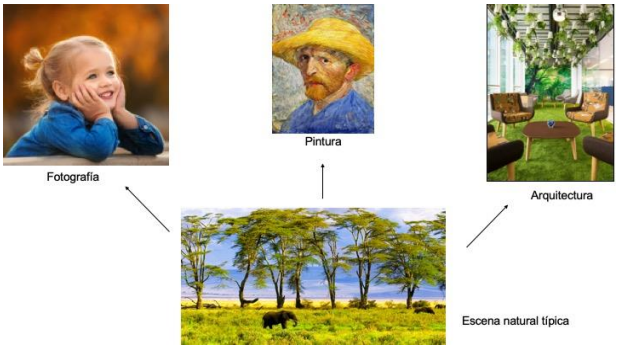

Fig. 3 Typical visual configuration: Sunny day.

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