Design for Emergencies

The Contribution of Design Culture in Emergencies

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Abstract. The recent health crisis and the phenomena linked to environmental upheavals have aroused great interest in the theme of emergency and the need to systematise it.

The "Design for Emergency", not yet well defined and in continuous evolution within the scientific discipline of Design, is today at the centre of the cultural debate to find a more precise definition, limits and possibilities, good practices and necessary interdisciplinary relations.

After an initial introduction to the topic, the essay intends to define and discuss, through selected case studies, the design's contribution within critical contexts, through the reinterpretation of two terms, the "cycle" and the "wave", discussed in the essay "Designing in the Post-COVID Era" (2021) by M. Bianchini, P. Bolzan and S. Maffei [1].

The two terms, used by the authors to describe a range of phenomena, would influence differently the actions, methods and design strategies aimed at developing innovative and effective solutions and products to cope with emergency conditions.

Keywords: Design for emergency · cycle and wave · Industrial Design · protection and safety · Design-driven process

1 Emergency and Its Dichotomy Within the Project Culture

In normal when we refer to the term 'emergency', first situations that come into mind may be those due to unforeseen circumstances related to human safety such as accidents, floods, seismic events, avalanches, etc.

Today, between the climate change impacts and pandemics, social conflicts and wars, emergency seems to be an increasingly common element in people's lives, with which they are learning to coexist with.

Starting from its definition [2], emergency mainly has two meanings. Firstly, that of 'emergence; protrusion', identifying itself as a fact or phenomenon with particular relevance that emerges and must be understood as a potential threat for a system. Secondly, that by ' unforeseen circumstance', referring instead as a crisis or dangerous situation that must be tackled promptly and resolutely.

F. Zanella et al. (Eds.): Design! OPEN 2022, SSDI 37, pp. 263–272, 2024.
https://doi.org/10.1007/978-3-031-49811-4_25

These two definitions expand meaning, indicating both a normal danger situation recognised within everyday life, and an unforeseen situation that disrupts it for an indefinite time period, with the likelihood that something will generate damage out of the ordinary, putting human safety at risk [3].

In some regions, moreover, "what we consider an emergency is instead an everyday event" [4]. There are countries who have learnt to live with critical and complex situations that, if transferred to other non-risk areas, can be considered tragedies, suddenly upsetting their equilibrium.

For Maria A. Sbordone [5], the emergency reflects a short-circuit in the system, i.e. the result of various circumstances "not foreseeable by the dominant modernist logic"; a criticality sedimentation and accumulation that make an area fragile, consequently exposed with the probability that something at some point will "break", generating a events chain that propagate, overwhelming the region, profoundly changing its meaning. From the "unexpected convergence impact of human activities on ecosystems, testifying to a time never allowed for the sustainable remedial measures implementation" [5], to the widespread social, political, and economic conflicts that have emerged since the turn of the century.

Emergencies that endanger the safety of human beings, therefore, no longer concern only sudden phenomena more or less foreseen related to their safety; to these are added those that will generate in the future more lasting and burdensome states of emergency for: the planet, the environment and society, attributable to anthropic action to related forms of natural rebellion.

From these reflections derive design forms that investigate future emergency needs, reinterpreting the risk that arises from them, and then proposing solutions aimed above all at extreme survival conditions.

For years, design has been working on increasingly critical issues to safeguard the humans wellbeing and the environment, with all its scientific and digital support for monitoring, but even, today it cannot predict when an unexpected event will occur that will trigger a radical change in a normal state and what kind of impact it will produce, thus reducing the design 'veracity' relative to the above-mentioned futuristic solutions.

Design, operating within an experienced or experimental emergency scenario, plays an essential role both in responding to real needs [6] and in undertaking concrete, emergency-specific solutions that take into account people's needs, values, social and environmental resources, helping to reduce the impact on ecosystems in crisis/collapse.

2 Cycles and Waves: A Considered Overview on Strategies Applied by Design for Emergency

Emergency appears to be associated with "a complex phenomenon composed by elements that influence each other, which in turn influence the generic system behaviour" [7] consequently manifesting different regimes of conduct, based on the perturbation undergone. This gives rise to phenomena that express themselves more frequently, sporadic ones with a greater impact or those that we have forgotten about over time or that seem far away from us. There are also emergencies that disrupt an area and then reoccur over time, becoming habitual, until they are further disrupted by a small variation (butterfly effect) that could amplify the effects.

Therefore, starting from the territorial reactions and responses to the variety of emergency phenomena, specific project needs emerge to help people endure or overcome adverse conditions, trying to mitigate their consequences and protect them from dangers.

In order to offer a reasoned systematisation about strategies applied by Industrial Design in emergencies, it is necessary to recognise that urgent critical phenomena are composed by a plurality of actors and but multiple logics that cannot be separated [4] or decontextualized. Instead, it is necessary to focus on the common aspects that characterise emergencies, namely: time, which marks their continuity and duration; impact, which encompasses all the alterations and transformations produced; and scale, as the extension of the emergency.

In the essay "Designing in the Post-COVID Era. Transition Artifacts for Distributed Futures', in Distributed Design Platform, the authors M. Bianchini, P. Bolzan and S. Maffei, describe phenomena whose sudden and underestimated flows affect the environment, society, economy, technology and innovation, through the concept of 'waves'. The latter stresses the affected community by modifying its biological, economic and production cycles, making it vulnerable [1].

However, it is interesting to reread the above cycles from an emergency perspective, giving them a connotation contrary to the 'waves' concept.

In this way, it is possible to systematise emergency phenomena according to previously identified parameters (time, impact, scale) in relation to their periodicity and amplitude, under the reworked 'cycle' and 'wave' concepts.

In this contribution, therefore, 'cycle' will be used to describe all those emergent phenomena, of natural or anthropogenic origin, that are repeated over time, relatively short in duration, with minor impact and scalarity.

The 'wave', on the other hand, will turn out to have the same connotation as described above, within which all those phenomena that disrupt the territory for an indefinite period of time, with a greater impact and scale than the 'cycle', will fall.

This reinterpretation of the two terms, is a useful reading tool through which to systematise and catalogue case studies, such as products, processes and strategies, described below, with which design is expressed in critical situations in order to safeguard human beings and their environment. Conversely, we could read the same concepts as phenomena that influence differently the design actions, methods and strategies, aimed at developing innovative and effective solutions and products to deal with emergency conditions.

2.1 Strategies and Products in Response to Cyclical Emergencies

Over time, humans have learnt to understand all those emergency phenomena that tend to recur due to a risk within the territory or as an unfortunate result of circumstances caused by anthropic factors. The same is true for more endemic critical phenomena that are peculiar to other territories, which we understand through consumption of images and information transmitted by (globally connected) technological devices, making us increasingly aware and participants in an interconnected system [3].

We could cite, for example, the chronic emergencies in developing countries, or the needs experienced by those who have been forced to move and live at the mercy of events since the earliest times. All these phenomena, natural and otherwise, more or

less foreseen, with minor impacts on the environment, society, the economy, repeating themselves over time, could be classified under the concept called 'cycle'.

Through their evolution, humans have learnt to know them, modify them and live with them, managing the risks and organising the resulting needs in advance.

Within the 'cycle', design discipline proposes preventive solutions that are useful in everyday life, guarantee safety and protection should the same emergency conditions recur: be it sporting mishaps or sudden foreseeable disasters, for example.

We could mention, for example, life-saving furniture that can be placed within high-risk contexts and 'activate' in case of an earthquake; backpacks that become protection during avalanches; garments that can be transformed into shelters; etc.

Otherwise emergency products are available in compact kits to be kept 'at hand'. Kits can be found for practising emergency manoeuvres, guaranteeing the minimum necessities of life, signalling devices up to more specialised ones for use during conflicts.

Over time, these products have become increasingly specific in relation to the potential risk to be incurred in an area (e.g. flood risk, seismic risk, fire, etc.). In flood-prone areas, for example, ready-made mobile barriers have been designed[1]. In Israel, on the other hand, chemical and biological attacks are so commonplace that the population is equipped with specific masks[2] and houses are built with bunkers and functional furniture to safeguard people's lives [4].

Often conceived to cope with short or long critical situations, the emergency kit must be designed in a methodical manner, convey information, provide a sense of security, promote awareness and calm apprehension, as it plays an important role in helping oneself and one's loved ones in critical phases until help arrives, with the aim of minimising errors, including those due to negative emotions that may arise from a traumatic situation.

Through constant observation of needs in critical contexts, design is able to provide increasingly high-performance life-saving products, both on the basis of new knowledge about the phenomenon and survival needs, and thanks also to developments in science and technology, enabling the wearer to protect himself and perform his role safely.

One could mention workwear, which is becoming more and more high-performance: chef's uniforms that are easily torn off in the event of a fire[3], or uniforms for firefighters that provide precious extra life seconds during a fire, thanks to a special fibre that can absorb heat[4].

All this through a design process that is, however, expressed in a time relatively 'far' from the emergency.

The design process for cyclic events is not stressed by the urgency to provide immediate answers, for human and environmental safety, as there are already products on the market that act as a safety measure and manage the consequences and effects of a known event.

[1] Boxwall: Mobile, self-anchoring protective barrier against flooding. Designer: Sigur Melin.

[2] See the project Bezalel Research & Development, Bezalel Academy of Art and Design (Israel, est. 1906). Bardas Protective System.

[3] See 'fast Chef jacket' with quick opening in case of fire by the company Toma.

[4] The latest uniforms for firefighters are made from a special fibre called Nomex® by the company DuPont™.

In order to be able to develop appropriate and increasingly up-to-date responses, as in the examples cited above, there is a need to: constantly monitor and study cyclical phenomena; recognise the difficulties of others; interpret needs; and engage with stakeholders such as experts and production systems. But in order to be able to offer a more efficient performance product, based on new knowledge about a phenomenon and scientific-technological developments, one needs time above all.

Time in fact makes it possible: on the one hand to elaborate proposals, make considerations, discuss with the actors involved in the design process, develop prototypes and carry out tests on them; on the other hand, it offers the possibility of drawing on long production chains - in which several actors are included in the product realisation - which supply resources and materials useful for the final product realisation, but which require logistics that take into account the distances between factories.

To conclude, it could be argued that the design process in the 'cycle' benefits from observing existing solutions applied in an emergency (state of the art) and from the long run, to develop new devices that increase the probability of survival should the emergency reoccur.

2.2 Strategies and Products in Response to Wave Emergencies

Anthropogenic actions are generating cause-effect dynamics that over time tend to accumulate, scale and accelerate beyond the capacity of human control and intervention, weakening territories and creating new and unpredictable emergencies, which propagate in different forms both globally and locally [5].

All these major events that are beyond the ordinary, with impacts on human and anthropic ecosystems and in terms of overload, can be systematised under the concept of 'wave'.

'Wave' phenomena stress communities because they modify their economic and production, making them vulnerable, but also because they require costly investments in preparation to defend or protect themselves, or else they catch them unprepared [1], putting their resilience under strain, sometimes creating irreversible situations that are incompatible with their lives, so much so that they are forced to fight for their survival.

The project world's response for such events consists in implementing relatively quick, empirical solutions, taking advantage of readily available resources, dictated by the emergency type, in order to prevent the damage resulting from the event. Based on the duration of an event triggering the emergency, however, two types of 'wave' phenomena can be distinguished, which in turn influence design responses differently.

In the first case, the short-term event that arises may be new to the territory or more far-reaching than previous ones. New needs therefore emerge and, consequently, the requirement for new instruments to be able to deal with changed risks in the territory to face the reappearance of the emergency phenomenon.

For example, the skyscrapers parachute's introduction was a consequence of the attack on the twin towers on 11 September 2001, which found the United States unprepared against the terrorist risk. After that event, the design world took action to provide security for citizens so that the fear of tall buildings would not turn into a phobia [4] as well as to safeguard human lives. Or, causes of climate change have led to an urgent

need to support fire brigades with new equipment in order to assist them in search and rescue operations following more violent floods[5].

Quite a different condition is manifested when the effects caused by a longer-lasting 'wave' involve more: society with its structures, its services, its assets. Within this context, needs increase exponentially with respect to the capacity of a system to elaborate responses [9].

Design therefore has to prepare immediate and viable solutions in emergencies, while studying the phenomena, within a changing context, which may influence the needs as well as the responses themselves.

In 2014, the world witnessed the worst Ebola epidemic. The disease affected health workers in particular because it was so highly infectious and difficult to defend against, putting pressure on the already fragile health systems, which were also ill-equipped and forced to work in harsh climates.

In this case, designers, universities and companies took immediate action, prioritising an emerging need and working together to create a bioinspired protective suit[6] that was designed to reduce the risk for transmission during the undressing phase by coming off without the wearer having contact with the outside: as they had found that this phase was one of the main vehicles for transmission of the virus.

During a war, however, an important tool for medics and rescuers to help save lives is the tourniquet, which is essential for tamponading wounds in the limbs or extremities of the body until arrival at the designated medical centres. But during the clash between Israel and Palestine in the Gaza Strip, a simple medical device such as this could be unavailable due to: import constraints or gaps in the supply chain; shipments into the area intercepted and denied entry; disruption of traditional production means due to electricity shortages, all brought about by the conflict itself. The Canadian company Glia, in response to an urgent request from the Gaza Ministry of Health, collaborating with paramedics, hospitals and ministries, created a tourniquet that could be developed using a rapid and portable manufacturing process, executed in-house and tested directly in the field on trauma patients.

From an operational point of view, it was determined that the tourniquet should be 3D printed using solar energy and made open source, allowing anyone with access to a printer and electricity to produce tourniquets within the region, eliminating the transportation concept for the final product.

This solution is still being applied today in the war in Ukraine. Thanks to the sharing of the digital model via online platforms, anyone with a 3D printer can find the parameters for their own self-production, helping the affected community.

When territories are disrupted by a 'wave' phenomenon, the risk is to see the production chains for many goods come to a stop. A production model based on long supply chains (as may be the case for the 'cycle'), which sees the goods production spread over several countries or even continents, is difficult to manage in the aftermath of a disaster. In fact, logistical times are not compatible with the reactivity required in an emergency, and

[5] See Trident, a project by designer Dominic Siguang Ma, in collaboration with local American firefighters and rescue specialists.

[6] Personal Protective Equipment prototype for Ebola. Johns Hopkins University.

any damage suffered could compromise the entire supply chain, affecting the production of other related geographical regions.

In such a situation, the design, with its strategic capabilities, was able to implement resilience strategies towards the community supporting urgent needs due to a disaster or facilitating a return to normalcy and preserving a region's economy in great difficulty.

It does this by, on the one hand, proposing very simple but effective solutions due to their low level in terms of implementation and dissemination complexity[7]. On the other hand, by reconverting companies' internal processes to support them in the emergency phase, reorganising the production and distribution system through the identification of viable solutions, shaping innovation paths consistent with the resilience needs imposed by the crisis[8]. Resilience is nothing more than a form of rapid adaptation to the shock event, which occurs within a changing context.

All this has been made possible through the adoption, over the years, of digital tools as well as cad/cam software and technologies that allow design to simulate and explore countless formal solutions at the design stage that industrial processes cannot provide, and to be environmentally and economically efficient at the prototyping stage, thanks to the flexibility of Additive Manufacturing[9].

But even though these advances have made design more and more efficient, during an emergency design is further stressed to respond to crises, collaborating with different skills to combine knowledge and resources in order to support the community and make it resilient to phenomena.

Ezio Manzini, who in 2015 published 'Design, When Everybody Designs. An Introduction to Design for Social Innovation', describes communities as social actors who,

[7] In countries with a war-torn past, hidden landmines pose a silent and hidden threat. Demining such territories is a very expensive, time-consuming process that is done by hand by people who risk their lives, hampering communities that are just beginning to recover. Mine Kafon, by designer Massoud Hassani, is a project to bring cheap and easy-to-make mine detonators into Afghan minefields and promoted on the kickstarter site in 9 days. Spherical in shape and wind-powered, it is light enough to be propelled by the wind but heavy enough to detonate mines as it rolls. Consisting in bamboo stems with biodegradable plastic discs, it is made from locally produced recyclable materials and the construction is modular so that only damaged parts are replaced.

[8] Some examples: Gruppo Miroglio, an Italian company operating in the fashion industry, started producing in its factories cotton masks for sanitary use to cope with the Covid19 emergency. Or the Bc Boncar company in Busto Arsizio, specialised in luxury packaging, started the production of masks for customers, suppliers and prisons using the fabric bags used for their luxury products.

[9] To support the shortage of medical supplies for Covid-19 prevention and safety caused by the high demand rate, the additive manufacturing industry demonstrated that 3D printing could be used to enable the nasal swabs production and personal protective equipment for healthcare workers. 3D printing specialist SLA Formlabs collaborated with the University of South Florida (USF), Tampa General Hospital and New York's Northwell Health hospital system to develop nasopharyngeal swabs that could be quickly produced and sent to sold-out locations. Materials testing, printing parameters and designs, carried out in a matter of days, helped to find an optimal solution. The latest clinically validated swab uses an intricate lattice design to collect the virus sample while balancing patient comfort with the ability to collect a reliable and sufficient sample.

thanks to design's potential, are able to deploy design skills to define and realise their life strategies at different scales, constituting interesting social innovation for sustainability, fostering change in a fast-paced world with deep changes.

Being fast, however, does not only mean processing an intuition quickly, but also making sure that it is possible to realise that idea as economically as possible for the planet, taking into account the kind of emergency and its long-term effects.

3 Conclusions

The recent health crisis, as well as phenomena related to environmental and social upheavals, for example, have raised a great deal of interest in the emergency topic.

The Design for Emergency discipline, as yet undefined and constantly evolving, is at the centre of the cultural debate towards its more precise definition, exploring limits and possibilities; where not only the specific in-depth study on good practices, but also the necessary interdisciplinary confrontation will be decisive.

Therefore, in front an ever-changing planetary horizon, to be approached with caution, it is necessary to start systematising the strategies already applied by design in critical contexts, in order to build a synthesis framework to help us understand where, and in what way, design can be more efficient and promising, should unpredictable future emergencies catch it unprepared.

The reworked 'cycle' and 'wave' concepts, through reasoned case studies, seem to provide a useful key through which to discuss and organise these responses.

While the 'cycle' encompasses all the preventive and increasingly reasoned elaborations to known phenomena, the 'wave' stresses the design world to try to give extemporaneous, empirical and practicable solutions to a changing context that generates urgencies at a faster speed than the ability to elaborate answers.

'Wave' phenomena therefore appear as the most interesting to observe and where design can play a substantial role for helping restore an area to as normal a condition as possible. Through transparent and shared strategies and methods, it facilitates social cohesion and collaboration, bringing about circular scenarios, laying the foundations for the creation of a new economic model based on resilient communities.

A concept already explored in the 1970s by John T. Lyle, a professor at the University of California Cal State Polytechnic, who proposed a student class to think of a self-sufficient community, whose activities were based on their locally available renewable resources, similar to natural processes in which the material for the development of the living beings is sourced locally.

Science and technology are disciplines with which design will increasingly collaborate to create new materials, strategies and resilient solutions that allow trauma to be overcome in a positive way, becoming in the future indispensable to help people return in a situation as normal as possible and in tune with natural processes.

The emergency should therefore no longer be seen as something that creates vulnerability, but rather accepted as a natural change process, as well as an opportunity to try to introduce permanent long-term measures that celebrate the opportunities offered by the local territorial network, implementing restorative measures linked to sustainability.

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