International Journal of Food Design
Volume 8 Number 1
 https://doi.org/10.1386/ijfd_00053_1
Received 24 October 2022; Accepted 24 December 2022

PATRIZIA MARTI
University of Siena

SONIA MASSARI
University of Pisa

ANNAMARIA RECUPERO
University of Siena

Transformational design for food systems: Cultural, social and technological challenges[1]

ABSTRACT

Due to climate changes, resources availability and evolving markets, the food system is developing towards an articulated and complex ecology, with fast transformations occurring in food production, preparation, delivery and disposal. In this context, innovation is needed not just to ideate solutions to deal with a fast-changing system but also to accompany the change adopting a systemic long-term approach. We reflect on the transformational potential of design in the food sector enabled by digital technologies, one of the current major drivers of change. We define two levels of changes implying digital technologies, those that radically change the food system and those enabling changes within a given system. These levels are exemplified with case studies documented in literature and with students' projects showing how transformational design can help grasp the complexity of current problems, and question the current status quo by facilitating a dialogue among stakeholders to stimulate behaviour change without prescribing it. In this article we encourage a paradigm shift of design from craft activity to a holistic approach of systemic thinking where the designer assumes the role of

KEYWORDS

food system transformation
transformative design
sustainability
digital technologies
fishery ecosystems and management
food innovation

1. For this paper, Rick Schifferstein served as editor.

promoter and facilitator of change. Reflections on challenges at cultural, social and technological levels are provided in the conclusion section.

INTRODUCTION

Under today's accelerating ecological, climate, health and globalized change, dramatic changes that once happened every few centuries or millennia now occur within human lifetimes that alter community and food environments (Mattioni et al. 2020). The contemporary industrial economic model and the growing demand for food identity, linked to a rediscovery of cognitive and social sustainability in all its aspects (environment, health and social relationships), have somehow given rise to transformative cultural models where information technology and different communities of stakeholders are the true protagonists of change. This article promotes a reflection on the complex transformations occurring in the current models of food production, preparation, delivery and disposal, particularly those enabled by digital technologies.

Considering that, food transformation, as well as ecological transformations, can have important consequences for human communities through changes in the availability, quality or type of ecosystem goods and services (Millar and Stephenson 2015), the research in this field is well timed and necessary. In the past few years, a new wave of transdisciplinary research has emerged focused on food and food systems as engines for wider societal transformations. One of the reasons for the flourishing of these studies is that food has low knowledge barriers, being knowledgeable to everyone and enabling the involvement of researchers from various disciplines and stakeholders in the whole process, from material discovery to the final design. However, the community of researchers dealing with transformations related to society's most complex problems is still small.

Hebinck et al. (2021) conducted a systematic review of transformative change of urban food practices. They found that most represented transformative processes utilize participatory approaches and the creation of synergies among different stakeholders. Pereira et al. (2020) proposed the T-Lab as a 'transformative space' to discuss challenges in the local food system from a range of different perspectives, in order to co-develop transformative innovations that could feed into government planning. They adopted participatory processes bringing together change agents to generate outcomes that policymakers and planners can use to define and implement systemic interventions. These projects on urban food practices underline empowerment, social learning and social capital development as key factors in facilitating transformations. They show a clear ferment in the field, even if the principle inspiring transformative projects are still relatively underdeveloped and spread (Schäpke et al. 2017).

DESIGN FOR TRANSFORMATIONS

The general term 'transformation' is increasingly common in peer-reviewed literature. It is approached from varied perspectives (Schuurman et al. 2022) and recurs in various design approaches like in transition design (Irwin 2015; Irwin et al. 2015), design for environmentally sustainable social innovation (Jégou and Manzini 2008; Manzini 2014), design with the intent of sustainable behavioural change (Lockton et al. 2009) and design for lifestyles on a planet (Lettenmeier 2018). The term transformation knowledge is generally used

when the process of knowledge exchange is deep, constructive and meaningful and goes beyond the simple acquisition of knowledge since it supports not only critical models but above all the agency of the end user (Taylor 1998; Mezirov 2000; Simsek 2012). Early studies in organizational development (Watzlawick et al. 1974) provided a useful definition of transformation, identifying two levels of change: first order and second order. First-order change is related to adjustments and fluctuations within a given system, while second-order change implies qualitative changes to the system itself.

Burns et al. defined an approach to facilitate change within both organizations and communities called transformation design. They defined it as follows:

> *Because organisations now operate in an environment of constant change, the challenge is not how to design a response to a current issue, but how to design a means of continually responding, adapting and innovating. Transformation design seeks to leave behind not only the shape of a new solution, but the tools, skills, and organisational capacity for ongoing change.*
>
> (2006, original emphasis)

The design for transformations shifts the focus from products to multi-stakeholder ecologies and explores the social, cultural, economic and political nature of the problems following the social innovation approach. In this perspective, the transition design framework adds further layers of complexity (Irwin et al. 2013, 2015): in a long-term perspective, the design provides open-ended and speculative visions of the desired future, and while the design of radical changes in the socio-technical systems can be catalysed and directed, the outcomes cannot be accurately predicted. Thus, the single design solution (to adjust a given system or to change the system itself) is conceived as a single step in a long transition towards a future-based vision (Irwin 2015).

Dealing with ever-changing living ecosystems, the challenge is to envision possible futures and use design methods to empower the agents of change. To this end, IDEO proposes a design-driven approach to organizational change that aims at growing capabilities and tools to transform a company and its culture (Coughlan et al. 2007): the mindset, iterative process and methods of design thinking are employed to uncover innovation opportunities as well as to prototype the changes by moving from abstract ideas to role-playing, tangible and experiential solutions (Carlgren et al. 2016).

In this article, we look at the transformations of food and food systems from a designerly viewpoint. We consider two levels of changes: those that radically change the food system and those enabling changes within a given system. Both levels require a systemic design approach based on the analysis of current behaviours of different stakeholders and their continuous and constant involvement. We also focus on transformations enabled by the introduction of digital technologies considered as enablers of the changes taking place between the world of food production and the end user.

The main objective of our approach of transformational design is to go beyond a 'solutionist' view of design which is ineffective for solving complex problems. It rather aims at unpacking the complexity, questioning the status quo, favouring a dialogue to set the conditions for a behaviour change. We particularly focus on transformations enabled by digital technologies since they have the potential to radically change the current food system. In the next paragraph, we review different projects using digital technologies to enable

transformations in the food system. Different types of projects are examined from a literature analysis and selected from master's degree courses in design of two Italian universities. These projects exemplify different levels of transformation: at material level (e.g., showing disruptive use of 3D printing for growing and transforming food); at local level, showing a labelling system for food safety which can be introduced in the current food distribution chain, and at systemic level, transforming the lagoon fishery threatened by the invasion of Mnemiopsis Leidyi in a new value chain involving various stakeholders.

DIGITAL TECHNOLOGIES FOR TRANSFORMATIONS IN THE FOOD SYSTEM

In recent years, major transformations of food systems are affected by four major technological revolutions in the agri-food sector (biotechnology, nanotechnology, information and communication technologies, neurosciences and artificial intelligence [AI]), which are applied to key phases of the entire supply chain:

1. in the production of raw material;
2. in food processing (including packaging and distribution);
3. in planning and selling food (through design and marketing);
4. in consumption and
5. in post-consumption.

The food market is increasingly complex and appears progressively sensitive to issues such as the environmental impact, safety, traceability, ethical consumption and above all to the local and cultural resources of the territory. Information technology has offered 'local' products the opportunity to expand the size of their markets by addressing a greater number and type of consumers.

In this context, the development of food production is characterized by the pervasiveness of the technology it uses and the new opportunities it offers in retail. The digital technologies in fact contribute to guaranteeing food safety, the expansion of quality products linked to the place of origin, the improvement of the quality of these productions, the strengthening of the associated companies, the implementation of effective commercial promotion activities and solicitation of consumer awareness.

A fundamental role is played by retail off and online (e-commerce, blockchain), which is a meeting point between supply and demand for goods and services (between developed and underdeveloped countries) and where the disparity of resources, inadequate prices and unfair economic policies only aggravate a difficult situation that is already very unbalanced. From a study conducted by Future Food Institute and Talent Garden in 2020 (Segre et al. 2020), among the components for innovation in the agri-food sector, the greatest is the digital transformation that focuses mainly on platforms, online software and mobile applications that use AI, internet of things (IoT), data processing and mechanisms inextricably linked to the sharing economy to simplify all the procedures for arriving at food, especially for the final consumer.

Other technologies like 3D printing enable food transformation and contribute to the evolution of more cost-effective food manufacturing and futuristic dining cultures. Food 3D printing has been growing rapidly in the

past few years and 3D printed food is already sold on the market, including pasta, meat, side dishes and desserts. Mixing 3D technologies and food allows not just more complex and original shapes and innovative recipes but also adaptation to specific diets. Some researchers have made a step ahead in the transformation of edible materials and food preparation practices by exploiting 3D technologies in radically new ways.

Wang et al. (2017) created shape-changing digitally fabricated food to minimize the size of packaging and the shipping costs. Their design called 'transformative appetite' produced self-wrapping caviar cannoli and self-chopped noodles to demonstrate multiple food materials interactivity through designed shape transformation upon hydration. Another example of transformational design through edible material innovation and digital fabrication technique is the Edible Growth project by Chloé Rutzerveld (2018). She combined natural growth, digital manufacturing technology and design to create food with living organisms. The project demonstrated a radically new way of using 3D printing to produce natural, healthy and sustainable food by combining natural growth, technology and design. The outcome is a radically new way of processing food and an excellent example of what we call 'transformational design' of food material. These visionary projects of radically new use of 3D printing are exemplars of transformational design aiming at a radical change in food growing and production.

Innovative technologies are also used to transform the packaging using environmentally friendly material (e.g. recycled material) and introducing smart functionalities: through the use of sensors embedded into the packaging to detect, sense and record the changes in the product environment (Yam et al. 2005; Biji et al. 2015) and through the use of augmented reality to provide information about ingredients and nutritional value, warning labels and cooking instructions to overcome the limitation of traditional packaging (see, e.g. the review by Styliaras 2021). Such innovations of the specific system of packaging enable transformation at the production and distribution level towards more sustainable models, as well as in the decision-making and consumption habits of the consumers towards their empowerment.

At a systemic level, some recent initiatives exploit the potential of digital platforms, AI systems, IoT to experiment with a circular and collaborative economy. An example is the REFLOW project (with the pilot 'Food Market 4.0 Dashboard') that promotes the transformations towards circular and regenerative cities through a systemic change of the current approach to material flows in the urban context. Specifically, the project co-designed a tracking system for fruit and vegetables, conceived as an ecosystem of physical and digital tools, to track and monitor the food flows along the chain and in the urban market, to prevent its waste. To support the transformation, the technologies serve as enabling factors to connect different actors in the value chain and inform the decision-making towards a more sustainable agri-food system.

LOCAL AND SYSTEMIC TRANSFORMATION OF THE FOOD SYSTEM: TWO STUDENT PROJECTS

In a world of increasing complexity, where transformations are necessary to meet the goal of sustainable and equitable food systems, design is becoming a vital tool for shaping future concepts and guiding the transformation. A fundamental shift in the role of design is required, from a craft activity, where the designer acts as an artisan, to a holistic approach of systemic thinking,

where the designer assumes the role of facilitator of change. In this perspective, the design practice is no longer limited to products, modes of interaction and services. It is rather used as a means to imagine possible futures, to frame the problem and to create enabling environments to activate and sustain the changes (Burns et al. 2006; Sangiorgi 2011).

The designer can act as a mediator to ease a shared ownership of the final design outcome and to empower the stakeholders as agents of change. The final consumers are no longer involved in the design process as a source of information and evaluation but as active partners in problem-framing, decision-making and drivers of change (Sangiorgi 2011; Manzini 2015). The active engagement of the stakeholders is pivotal for any transformative projects in complex systems like food, welfare and educational systems (Burns et al. 2006). In order to implement this vision, it is quintessential to train young designers in dealing with transformations, managing participatory processes with multiple stakeholders in a creative and visionary way.

In the following, we present two projects developed by master's degree students in design of two Italian universities. The projects help identify the characteristics of transformational and transformative design and the associated challenges. Both projects focus on the fish segment, which is undergoing a profound transformation due to the drop of almost 4.5 per cent of wild fish capture. The United Nations' Food and Agriculture Organization (FAO) released its latest 'State of World Fisheries and Aquaculture' report in late June 2020 outlining a 'blue transformation' that aims to make both the aquaculture and wild fisheries sectors more sustainable and productive to help feed an increasing human population.

Indeed, fishing and aquaculture represent an important source of food of high nutritional value, as well as an important source of income and employment of the local communities. Since ancient times, fish has been of primary importance in human nutrition, and the western civilization, born and developed on the coasts of the Mediterranean, is pervaded by cultural references and traditions concerning fish and fishing. Today, there is an increasing demand for fish products, given their importance for a healthy diet (see the Mediterranean diet) and this market demands led to the evolution of fishing, conservation and processing technologies and the development of aquaculture.

Unfortunately, as the FAO report (2020) points out, fishery resources continue to decline due to several factors: overfishing, pollution and degradation of marine habitats, poor management of the resources and biological invasion of non-native species. The decline of the fishery resources critically affects the small-scale producers, and the local coastal communities are vulnerable (FAO 2020). Thus, the current situation requires improving fishery and aquaculture, while safeguarding the ecosystems, reducing pollution, protecting marine biodiversity and supporting the local artisanal fishers.

The European Community started funding innovative projects to reverse this trend and push a transformation towards sea safeguard and fishery circular economy. For example, the WaSeaBi project (Waste, Seafood side-streams and Bioeconomy, 'waste, fish by-products and bioeconomy') deals with optimizing the exploitation of the seas. It demonstrates how the use of waste and trimmings to produce fish meal can help meet the ever-increasing demand for seafood. In fact, fishmeal is a sustainable and circular solution, which is obtained from small fish or from the carcasses of large fishes discarded from the production of baby food for children and for gastronomy. Today, waste begins as soon as the nets are withdrawn. Only some species are brought into

port, the others are thrown back into the sea, usually already dead. This trend continues in the processing plants, which generally aim only at the fillet. The FAO has estimated that worldwide waste, along all stages, is equal to 35 per cent of all fish and what is produced in aquaculture. Finally, waste also occurs in the definition phase of the final processed fish product.

Starting from this problem-framing, the students met some of the current challenges of sustainable fish capture, transformation and consumption by developing two original projects. Both projects identify fishermen and consumers as possible agents of change towards a more sustainable and safe fishery chain. The first project addresses biological invasions as a global challenge for the environment, the food system and the local communities, identifying artisanal fishers as main agents of a renewed and innovative fishery chain. The second project addresses food security as an urgent demand from the customers who take the role of consumers and agents of change in food security perception and implementation.

Fishers as agents of change

The 2022 Student Service Design Challenge is a global design award that celebrates, encourages and inspires the next generation of designers. It was initiated by Philips Design, as part of its mission to involve young designers in finding people-centred and future-oriented services for people and the planet. The competition invites students from all over the world to tackle a global challenge through the design of a service that disrupts the current ownership economy towards a collaborative and sustainable economy, using the mindset and tools of design thinking. A team of master's degree students in design from the University of Siena participated in the call for projects, developing research on the sustainable use of marine resources.

By performing desk and field research they discovered that the Mediterranean Sea is threatened by the invasion of Mnemiopsis Leidyi, an alien and invasive ctenophore that is considered one of the world's top 100 most invasive alien species. The Mnemiopsis Leidyi feeds on fish eggs and zooplankton; its reproduction is very fast and considerable and critically damages the marine ecosystem. Based on these insights, they framed the problem by systemically identifying a deep crisis in the local fishery as well as in the socio-economic context, requiring a transformation of the extended value chain. They inquired about how to transform the invasion of the Mnemiopsis Leidyi into an opportunity for development of the lagoon in the socio-economic context. The project aimed to create a shared socio-economic responsibility in the ecosystem through collaborative consumption, highlighting the value and quality of fishes provided to the local community and putting the artisanal work of fishermen in the spotlight as an enabler of a more sustainable model.

The design process

The methodology applied is Design Thinking (Plattner et al. 2009) that moves from the empathy phase, to investigate and deeply understand the context, to the ideation phase and iterative design and evaluation, by alternating divergent thinking and convergent thinking (Plattner et al. 2009; Brenner and Uebernickel 2016). During the empathize phase, the students collected relevant documentation (reports, scientific literature) and discussed with experts to understand the phenomenon of the biological invasion. To deeply understand

how this phenomenon is experienced by the actors of the fish value chain, the students visited the Venetian Lagoon and performed field observations and interviews with the local communities of fishers. This exploration of the problem led to mapping the negative impact of the Mnemiopsis Leidyi invasion at different levels: on the fishery practice, on the loss of artisanal knowledge and lagoon traditions and on the entire supply chain.

While the discussion with experts provided the students with an overview on the phenomenon of biological invasions and its impact on the marine ecosystem, the field research enabled them to understand the vulnerability of the small-scale fishers in the Venetian Lagoon, who represent the base of the fishing economy, and the way such vulnerability affects the entire local community. The fishing in the Venetian Lagoon represents an artisanal traditional practice that is very different from the industrial fishing: it involves fishing households (as opposed to commercial companies); it uses relatively small amount of capital and energy; it makes short fishing trips close to shore; it employs techniques that prevent the bycatch in order to protect their livelihood and the fish is mainly for local consumption (The Fish Project 2015; FAO 2020). This traditional sustainable practice shapes the cultural identity of the fishers and their role in the community, and it is passed down through generations. But the biological invasion of non-native species is hindering generational change.

In the define phase, the students translated the research data into design insights through the creation of stakeholder map, map of the value chain, personas representing diverse actors and How Might We questions to focus the challenge (Stickdorn et al. 2011). Then, in the ideation and development phase, the students moved from the divergent thinking to the definition of a concept, employing design methods such as the cognitive walk-through, user journey map, service blueprint and mock-ups.

The design concept

'NOCE' is a platform, run by a lagoon fisher cooperative, composed of a fish hub and an online marketplace service capable of directly connecting producers and consumers (Figure 1). Within this new value chain, different actors are involved in creating a collaborative network of lagoon fishers, restaurateurs and citizens (Figure 2). Instead of dealing with the entire process from fishing to selling, which is the current model today, the lagoon fishers bring their fish to the hub, where it is aggregated and stored in the fridges. The hub is provided with a smart scale, where fishers can weigh their catch of the day. Thanks to an IoT technology, the scale automatically provides the real-time availability for buyers through the online platform. Restaurateurs and food service owners can visualize the fish availability and order it, thanks to NOCE's marketplace.

The online platform receives and submits the orders to the hub. NOCE's employees place the order while the online platform notifies the buyer who may decide to go to the hub and collect the order (in reusable boxes) or to book the delivery service. NOCE also engages private citizens in a concept of collaborative consumption through a reward-based crowdfunding mechanism: they subscribe to a monthly or annual plan in order to support the local economy and, in return, receive monthly rewards (e.g., discounts, recipes, fish boxes).

To introduce the transformation proposed by NOCE, diverse management steps will be required to engage the key stakeholders, implement the enabling

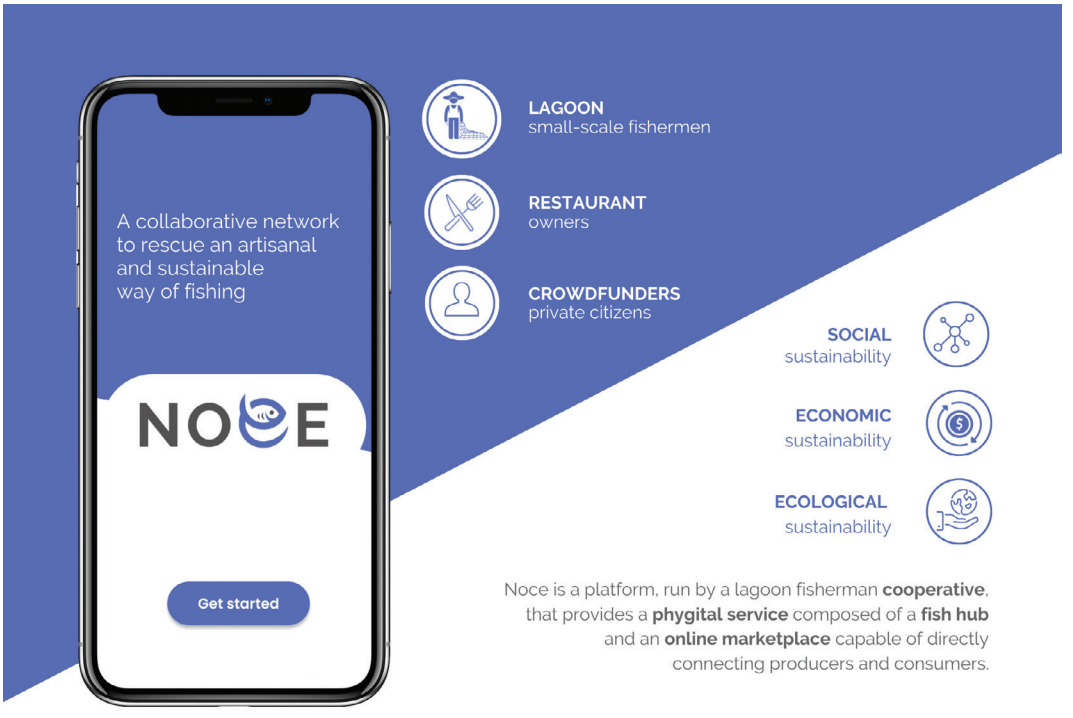

Figure 1: Hero image of the NOCE project. Courtesy of Giulia Teverini, Lisa Lazzarotto, Leonardo Bindi and Anna Caponi.

technologies and facilitate the transition from the traditional model to the NOCE model. The creation of a cooperative of fishers is one of the management step towards the transformation: instead of reinforcing the competition among the fishers that characterizes the current model, the cooperative allows them to collaborate, support each other, train the future generations, as well as create synergies with partners (e.g. with research centres to investigate the phenomenon of the biological invasions, with the local communities to develop initiatives for the preservation of the ecosystem).

The students reflected on the possible issues and negative consequences that might occur when introducing the new system: for example, the new value chain should support the quality inspection and assurance policies, and by moving from industrial food distribution networks to the short supply chain, the large numbers of intermediaries are left out. A way to deal with this issue is to transform the role of the intermediaries to become advocates of the new socio-technical system.

Fish market: Consumers as agents of change

As stated above, wild fishing is an activity in crisis due to the overexploitation of fish resources. Aquaculture (fish farming) is booming and is often invoked as the solution to procure fish in order to satisfy the growing world population. About 59.9 per cent of the main commercial fish

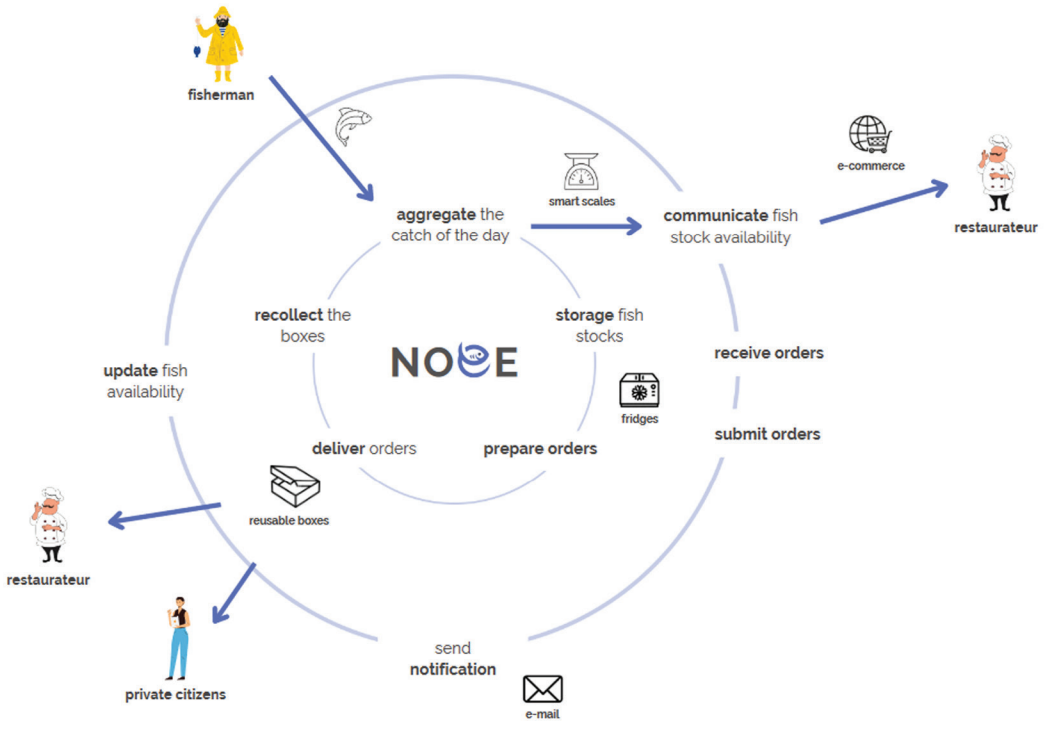

Figure 2: Visual map showing the actors and tools involved in the NOCE collaborative system. Courtesy of Giulia Teverini, Lisa Lazzarotto, Leonardo Bindi and Anna Caponi.

species monitored by FAO are currently fished at biologically sustainable levels, while 33.1 per cent are fished at biologically unsustainable levels. The obvious consequences of overfishing, illegal fishing and destructive fishing practices require the implementation of science-based management plans to restore stocks and reduce the amount of fish that is discarded or disposed of after catch. In addition to this scenario, in 2020, in conjunction with the first lockdowns due to the COVID-19 pandemic and the increase of online purchases (delivery and e-commerce), big retailers recorded a significant loss in turnover due to the decrease of consumer demand for fish. Inspired by these data, a project was developed in the master's degree in systems design at ISIA Roma Design, with the aim of understanding the relationship between the final consumer and the fish supply chain and identifying potential drivers of change to activate in the retails and blockchain systems for achieving the Sustainable Development Goal 14 of the UN Agenda (refer SDGs) 'Life below water'.

In the food industry, there is often the risk of running into a wall of false myths to dispel that can easily mislead consumers in their daily choices. Today, the focus of food consumer protection activity has been based on *ex-post* resolution of any conflict situation between consumer/user and company, a legal and adversarial approach that can be implemented only after the consumer has suffered a damage or a contraction of their rights. Without prejudice to the fact that this type of activity is and will be indispensable, it is necessary to

offer consumers a better defence of their rights by intervening *ex ante*, seeking to resolve any type of problem in advance.

Based on these insights and in order to make this qualitative shift, the students have framed the problem systematically, identifying the evident growth of a new model of consumer, who must be more aware of their food choices and their consequences. The consumer must evolve from a passive consumer of the consumerist era to a consumer actor (more active for system change) in the market of the new consumerist era. Through desk and field research, the students discovered that consumers nowadays seek and demand more quality, reflecting irrepressible values, expectations, ethical and social demands. Globally, there are numerous ways and tools (mostly labels) to provide information on allergens, food labelling, food hygiene, food security, origins up to cases of diseases caused by food. But the proliferation of numerous acronyms, scales, indices, scores (such as the recent nutriscore tool) and the consequent excessive fragmentation of items have fostered the reverse process, particularly in recent years, with the weakening of education in the consumer, and the consequent weak awareness and agency in purchasing choices.

The student's project aimed to create an alternative tool, starting from the fish market, to share scientific content behind food safety with the consumer and help consumers make informed decisions about their daily food choices. Moreover, the student's project aims at empowering the consumers about their choices and the direct and indirect consequences on his life of others, but also to transform the distribution system that today favours the logic of extreme low-cost, nurturing empathic mechanisms to reshape the consumer–producer relationship of food sensitively, redefining the quality of the product/service offered and purchased. The research also highlighted an evident lack of knowledge not only on the fish product but also on the whole fish supply chain.

The design process

The project development process followed the design thinking approach (Plattner et al. 2009; IDEO 2011; Brenner and Uebernickel 2016). During the inspiration phase, data were collected with desk analysis and a series of interviews with experts and stakeholders in the fish market sector. The research project involved national and global data collection and involved numerous industry experts (retailers, nutritionists, agronomists, food producers), as well as field observations.

To fully understand consumers, their needs and buying style in the fish market, the ethnographic research phase was crucial. Several qualitative methodologies were applied, such as a multiple-choice questionnaire to allow participants to express their views in an informed way and the 'fly on the wall' method (Martin and Hanington 2012), to observe how the user naturally interacts during the purchasing phase (at the supermarket, at the open market, through apps and e-commerce). In this phase, it was important to compare data with other thesis students in the Department of Economics who conducted questionnaires and field interviews in the fish consumption sector in the pre- and post-pandemic periods. Finally, the method of unstructured interviews was also applied, in which users were able to express themselves freely and identify their values and main drivers in the buying process through guided storytelling.

In the problem definition phase, user profiling and analysis of different food distribution methods allowed for the grouping of different 'iconic

personas' of purchase. At this stage, major gaps in consumer knowledge about seafood products were identified, as well as drivers by which consumers can activate changes in the seafood market system. Critical consumption and socially and environmentally sustainable practices to drive new processes and production logics fuelled the ideation phase. In the ideation phase, the new labelling system was designed as a system and then also designed using attractive graphics that were easily accessible to all types of consumers. The naming of the labelling system also required careful analysis and design: the Ethical, Quality, Origin and Seasonality (EQOS) name and logotype arose from the need to identify a unique and recognizable name regardless of language. Starting from the idea that one label alone is not enough, and it is necessary to educate the consumer by introducing different dimensions, the acronym chosen results from the combination of the following four words: Ethical, Quality, Origin and Seasonality. In the testing phase, stakeholders and experts (chefs, retailing experts, nutritionists and sustainable marketing experts) were interviewed to validate, improve and finalize the concept.

The design concept

EQOS is a labelling system for the fresh food chain that aims to revolutionize the way of selling fresh food, starting from the case of the fish market. The main goal of EQOS is not only to involve consumers in the buying process, but also to empower them as agents of change to determine a greater impact when, together with the local community, they decide to affect the food system by activating healthier and more sustainable purchasing decisions for the planet. The project proposes a new labelling system to provide consumers with crucial information such as the ethical state of food (e.g., good animal husbandry, biodynamic agriculture and fair trade partnerships), seasonality and origin of the product, so that they can make informed and fair choices. Armstrong et al. (2019) demonstrated that positive ethical information can increase consumer expectations of a product. This research was taken as a reference point to define ethical quality. Since expectations of nutrition, taste and quality can influence consumer purchase decisions (Furst et al. 1996), companies might usefully communicate ethical information (e.g., that products are sustainably produced) when marketing their products. In turn, this may increase consumer expectations of their products, resulting in increased sales of ethical foods.

The information described in Figure 3 is displayed through a scale, a gradient that can be improved but also worsened. The design of the 'circle stamp' in the label contains a concentric grid, the versatility of which allows the three parameters of ethical quality to be represented in a simple way: (1) C means Certain, safe, like a hug; (2) F means Fair, the balance not quite achieved by the product; a product may achieve a fair level but not have the various factors balanced and (3) Q means Questionable, for a product with questionable ethical quality, highlighted by the stylized magnifying glass, which prompts the consumer to ask questions (and/or prefer other products). The use of colours has been implemented on these three icons to define different scales of origin (regional, national, continental and international) and the consistency with the four seasonalities (it is an inclusive label because even colour-blind people can access the information easily). The designed labelling system becomes a triggering agent of change: on the one hand, it educates the consumer who will gradually become more and more educated on the fish supply chain; on the

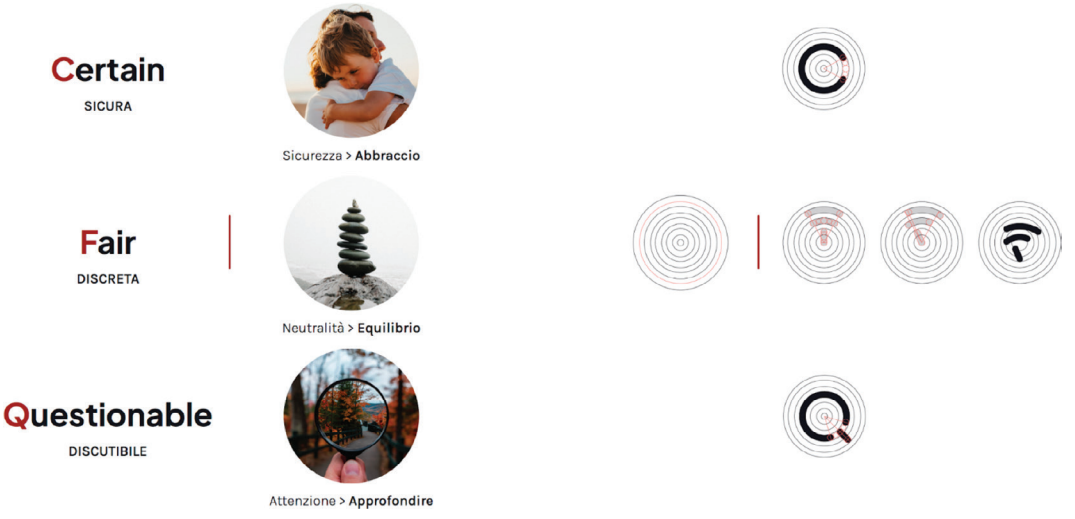

Figure 3: EQOS new labelling scale. Courtesy of Nicola Bovenzi.

other hand, it guides retailers to choose more credible and sustainable food producers and suppliers.

The advantage of EQOS is its flexibility. It is designed to be applied by the same food retailer in different ways; the label is complementary to the ones in use and can be used for both physical and digital channels. From pre-packaged fresh food to the fish market, from the app as search filters to the website, EQOS is designed to solve the different needs and purchasing methods of consumers, thanks to its representation of information: simple but intuitive (see Figure 4). In fact, this labelling system is perfectly suited to all the information on the food supply chain reported by blockchain technology, the pivot for a more united and transparent food supply chain.

EQOS is also a tool for food retailers to direct them to build new businesses and unique customer experiences. The research project includes an envisioned 'fish-retail of the future', which functions as an interactive installation, developed according to the principles of retail-tainment (the concept of adding entertainment and experiences to the retail mix as shown in Figure 5) and customer-centricity omni-channel, thus fulfilling the needs of customers both in a dynamic and interactive way.

The consequences and impact that this new labelling system could generate rely on the definition and use of a real common 'language' that can also be easily transferred to the catering sector (e.g., in menus of restaurants) or to other food sectors, to highlight the characteristics and uniqueness of food. Monitoring and traceability help meet the growing consumer demand for food safety, establish responsibilities along the entire supply chain (from raw material to product sold) and provide a means of fair competitiveness and sustainable rationalization of production systems, as well as a system for the enhancement of local and quality agri-food productions. A critical point of the project is in the reliability of information: less critical is mapping and reporting origin and seasonality but more difficult is tracking ethical quality. Forms

Figure 4: A sample of EQOS applied to an Italian label. Courtesy of Nicola Bovenzi.

of monitoring and assessments, as well as evaluation tools for the indicators proposed in EQOS, need more detailed analysis and research, especially in the transition phase from concept to prototype, and in the application of the system to the real market.

During the validation with experts, it was emphasized that the innovation is in the labelling as a tool for relationship and interaction among stakeholders, even before being a tracking tool. The transformation that the student's concept envisions is in the systemic role that this labelling could have in fostering critical thinking in readers and thus in transforming the relationships between different stakeholders in the agri-food supply chain (particularly in the fish sector). The Future of Fish project mentioned many challenges in the fish market labelling process. EQOS concretely addresses one of them: interoperability. Indeed, today organizations tend to adopt the system that works best for their internal needs; EQOS is designed to easily communicate with other systems adopted by trading partners or companies further up or down the supply chain.

From the experts' comments, it appears that this alternative labelling could support the idea of the supermarket of the future, as suggested by the 'ville du quart heure' concept (Paris, ideal post-pandemic concept), which involves a short and very short supply chain, a real reduction of space occupied by supermarkets in cities in favour of a 'dynamic fish market' and phygital that keep up with the demands of generation Z and beyond. The risk in giving the

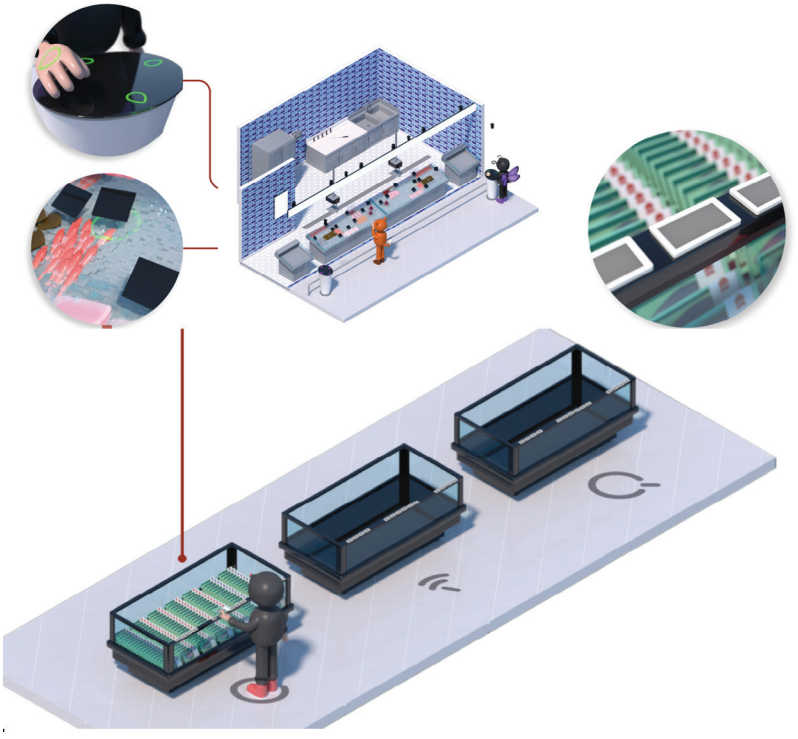

Figure 5: Simulations of retail-tainment shopping experience with EQOS application. Courtesy of Nicola Bovenzi.

supermarket a role as a certifying unit could impact positively in the choices of the food industry but, on the other hand, implications of marketing, customer trust and a consequent competition among retailers could bring the consumer back to a position of passivity and difficulty in purchasing choice.

The ability to implement this alternative label also could be affected by the future penetration of blockchain. Blockchain may prove to be a strategic lever in the food supply chain for the reduction of food waste and for greater awareness of what is consumed, since higher quality products positively impact consumers' health and their quality of life. Presenting consumers with 'true' information about the origin of a food can be a lever against competitors, even if the consumer then stops at the first perceptual level: that is, the fact that the company adopts a blockchain traceability system, perceived as truthful and secure in itself, rather than actually going to read the data contained therein.

DISCUSSION

The two projects address the challenges of sustainable fishing, in a context where the overexploitation of fish resources and illegal fishing, combined with the pollution of the marine ecosystem, and the increasing market demand, hinder the access to healthy, secure and affordable food (FAO 2020). The NOCE project proposes a radical change in dealing with the invasion of the

Mnemiopsis Leidyi in the Mediterranean by transforming the ecological threat into an opportunity for sustainable business. Through the design of the NOCE value chain, the Mnemiopsis Leidyi moves from being a waste product to being a valuable edible food that provides a source of revenue for the fishers. Moreover, the fishing of the Mnemiopsis Leidyi can serve as a collective action performed by the fishers, the restaurateurs and the citizens to reduce the invasion in the Venetian Lagoon and to restore the ecosystem. The EQOS project proposes a transformation within a given system to exploit a new labelling system for educating the consumers and empowering the retailers as credible and sustainable providers.

The two projects go beyond the design of a response to a current issue (Burns et al. 2006). Rather, they enlarge the perspective towards a systemic approach to frame the problem (e.g., how the biological invasion of the non-native marine species affects the entire community) and to consider the consequences of the proposed transformations on the individual, community, organizational and societal levels. This way, the focus of attention shifts from the individual 'user' to an enlarged community of stakeholders and natural systems who have a primary role in driving the transformation (Meroni 2007). Moreover, the process leading to the concepts of NOCE and EQOS highlights the need for educating the future designers to act as mediators of the behavioural, cultural and organizational changes and to adopt a systemic view of the problem (considering both the possible barriers and the enabling factors), which can favour the transition towards the food transformation.

The two projects question the status quo and propose modification of traditional practices, attitudes, values, roles and tools along the entire fish supply chain. By introducing digital technologies (e.g., the NOCE marketplace, the EQOS labels), the practices of collecting, packing, distributing and buying fish are transformed. These innovations pose new challenges related to the acceptance, adoption and appropriation by the stakeholders. Both solutions and behaviour changes must be considered and designed together to favour the transition.

For example, the NOCE project requires awareness of fishers and consumers about threats and opportunities and an open-minded attitude to change some cultural practices. During the field research, the students found out that the traditional lagoon fishing is based on silversides and crayfish, and thus the fishers perceive the Mnemiopsis Leidyi not only as a waste product but also as a threat that reduces the most important fished species. However, they are not aware of the potential benefits of eating species like jellyfish and insects while consumers are reluctant to eat these species due to personal, cultural and social concerns (the so-called food neophobia) (Giordano et al. 2018). The students envisioned a possible solution to the invasion of the Mnemiopsis Leidyi, requiring not just technology but a mind shift from considering Mnemiopsis Leidyi as a threat into seeing it as a business opportunity for fishers and an edible food that can offer prospect for creative food alternatives to chefs and consumers.

The transformation of the traditional food system also requires new relationships based on mutual commitment and trust among the different actors of the value chain. This challenge is specifically pointed out by the EQOS project since the new labelling system relies on the trustworthy and secure collection, storage and distribution of the fish. In this case, the labels offer a tangible means to support this trustworthy supply

chain (from the raw material to the product sold in retail). To be implemented, this system requires creating synergies among the diverse stakeholders. Participatory design practices are pivotal to activate such synergies (Hebinck et al. 2021).

When moving from the design concept to the implementation and deployment, it is fundamental to anticipate the changes in the power dynamics (Avelino and Rotmans 2011), which can be directed towards cooperation and synergies, even if they cannot be fully predicted. Other challenges regard the setting up of the enabling factors to pursue the expected changes: for example, the rules and agreements at institutional level that are needed to support the new socio-technical systems, which tend to be self-reinforcing and resistant to change (Avelino and Rotmans 2011; Abson et al. 2017).

The two student projects help highlight the need to educate future designers to adopt a systemic perspective beyond defining new functions. First, the designer should deeply understand the context and the diverse perspectives of the stakeholders. For example, the student of the EQOS project identified diverse consumers' demands related to food quality and safety, while the students of the NOCE project empathized with the lagoon fishers threatened by the invasion of the Mnemiopsis Leidyi. The field research performed through observations, interviews and questionnaires enabled the students to frame the problem and to map the diverse needs, concerns and demands of various stakeholders. Within an iterative process, the problem-framing was dynamic and incremental. Indeed, one of the key characteristics of the transformation design is the definition and redefinition of the brief involving the stakeholders in the formulation of the right problem to tackle (Burns et al. 2006). Then, using visual maps, prototyping techniques and evaluation methods the students designed solutions which represent new socio-technical systems to empower fishers, consumers and other key actors in the value chain. The proposed solutions are based on new services that not only may contribute to solve a local problem but can also stimulate the emergence of a more collaborative and sustainable economy (Sangiorgi 2011).

To better understand the possible barriers and negative consequences (at individual, social, economic, environmental and policy levels), which might occur when introducing both radical changes and transformations into a given system, pilot actions in the operational environment can be useful to enable the stakeholders to try out, critique and improve the proposed solutions. The scientific literature about the dynamics of acceptance and adoption of new systems in the food sector (see, e.g. Giordano et al. 2018) can support the estimation of the enabling and hindering factors. However, iterative field testing is needed to identify (and design for) the peculiar context-related factors.

The involvement of the stakeholders in the transformation design project requires skills to enable the participants to take part in the decision-making and envisioning of the solutions (Burns et al. 2006). When employing participatory design techniques, designers bring their expertise in methods and theories, while people contribute with their knowledge of community historical, economic, social and cultural dynamics (Ozanne and Anderson 2010). Moreover, co-designing with key actors can produce a cascade effect to engage the wider community around the main stakeholders in the transformation process (Sangiorgi 2011; Manzini 2015).

The challenge of educating young designers on transformational design is not limited to teach theories, methods and tools to envision new solutions.

Students should be educated to vehicle the value of the proposed changes, taking into account the possible resistances in communities and organizations towards radical changes (Sangiorgi 2011), covering cultural, social, economic and policy factors affecting the transformations (Irwin et al. 2015). To this end, the education of the future designers can take advantage from the combination of lectures, reading, discussion and hands-on activities to stimulate systemic and holistic thinking, with theoretical frameworks from different disciplines (e.g., the theories of change from psychology and political science), as proposed by the course in transition design at the Carnegie Mellon University.

CONCLUSIVE REMARKS

This article focuses on transformational design in the food system with a specific emphasis on the use of digital technologies as an enabler of two levels of transformations occurring within an existing system or transforming the system. Digital solutions can address and solve the problem of accessibility to food and food security that underlies the imbalance in the production and distribution of food resources, the cause and consequence of world hunger and inequalities.

By transformational design we mean an iterative, incremental, collaborative and creative process producing 'knowledge for action' (Grunwald 2004), that is knowledge that can help design coherent and integrative strategies and adopt a systemic approach which considers the system at large and as a whole. It is a generative approach supporting the goal of grasping the complexity of current problems and questioning the current status quo.

In this article we focus on the potential of transformational design using digital technologies as an accelerator of the transformations taking place between the world of food production and the end user. From the analysis of the existing literature and two student projects, we identified some fundamental steps that must be taken to implement transformational design.

The first step concerns a deep understanding of the context, analysing the current behaviour, rules, attitudes, values and practices that are intended to be transformed. To achieve a deep knowledge, the designer needs 'to grasp and feel' the context consulting experts to get insights and to empathize with people directly experiencing or indirectly having a role in the system to transform. Walk-throughs, interviews, observation concerning the current status can help define whether certain aspects of behaviour address individual habits, environmental conditions, sociocultural practices and policies. This helps acquire a systemic view on the problem and identifies the potential enablers and actors of change. For this, the designer is required to develop certain sensitivity and to be open-minded.

Once the current behaviour is understood and described, the designer can move on to the transforming behaviour part of the design approach. They can start exploring possible solutions to achieve the desired transformation of behaviour, by involving stakeholders in explorative and generative practices such as role-playing, brainstorming and design for point of view (Brown 2019). The collaboration and dialogue with stakeholders are also essential to question the designers' beliefs and assumptions that profoundly influence the design decisions towards a shared common ground (Irwin et al. 2015). Moreover, we believe that in contrast to current persuasive technologies, which address behaviour transformation solely from prescription and nudges,

transformation of behaviour can also be achieved through a deep involvement of stakeholders who become the main agents for change.

Designing for transformation requires validation in context as well as a systemic approach. This means iterative design, prototyping and evaluation in context. This process allows stakeholders to see their ideas materialized and open to adjustments and redefinition. Prototypes in this context help try out a solution and envision the implication of a transformed behaviour.

Transformational design has also an ethical dimension. The impact that this approach could reach goes further than changing behaviour towards building inclusive and sustainable food markets and safeguarding supply chains and enabling sustainable production of foods by identifying, adapting, piloting and scaling technologies with local partners and in collaboration with primary stakeholders including local governments and policy-makers. We believe that transformational design can contribute to a shift towards healthier and more sustainable behaviours, applying strategies such as participation, empowerment, education and communication to achieve collective goals (Abson et al. 2014; Rauschmayer et al. 2015). With the case studies presented in this article and the analysis of the state of the art in transformation design, we hope to inspire design thinking towards a systematic thinking, which can stimulate behaviour change without prescribing it. The unsustainable patterns of production and consumption in which we live today cannot be adequately resolved with single design solutions or one-off policy measures. On the contrary, we believe that transformational design can provide a lens to abandon a short-term 'solutionist' approach, which is not suitable for solving complex problems like the ones ongoing in the food system, contributing to unpack the complexity by questioning what we are doing and why and envisaging new long-term socio-technical systems.

The two cases adopt Design Thinking as a mindset, a process and a set of tools to address wicked problems towards transformations. Within the design thinking framework, IDEO conceptualized five building blocks to facilitate the transformations in schools and educational settings by leveraging on the relationship between educators and learners (Diefenthaler et al. 2017; Teachers Guild x School Retool 2020). Notably, during their project works, the students recognized in those building blocks the role of design in the transformational process:

1. Trust – relationships grounded in trust and mutual commitment;
2. Belonging – in fair and inclusive systems which see, know and value each person and equitably share the power;
3. Resilience – to adapt to challenging situations, changing needs and long-term visions;
4. Evidence – to support the individual and collective capacity to create change, through field experimentation and impact evaluation;
5. Collaboration – not just as a way to work together, rather as a means to change the power structures and create distributed power and leadership.

We agree with the call for the close collaboration among experts who have so far been contributing mostly from within the boundaries of their respective disciplines (e.g., environmental science, sociology, economics, engineering) (Gaziulusoy and Oztekin 2019) and with the attempt to hybridize the design education with diverse theoretical frameworks and perspectives so as to train the future designers to work in transdisciplinary teams (Irwin et al. 2015). The

design case is a powerful educational tool to engage the students with open-ended projects working on the local scale but to address a global challenge, focusing on the current problems but with a long-term vision of the dynamic future (Irwin et al. 2015).

ACKNOWLEDGEMENT

Special thanks to Nicola Bovenzi (MA student from ISIA Roma design school), who developed the project EQOS, and to Giulia Teverini, Lisa Lazzarotto, Leonardo Bindi and Anna Caponi (MA students from the University of Siena), who developed the NOCE project.

REFERENCES

Abson, D. J., Fischer, J., Leventon, J., Newig, J., Schomerus, T., Vilsmaier, U. and Lang, D. J. (2017), 'Leverage points for sustainability transformation', *Ambio*, 46:1, pp. 30–39, https://doi.org/10.1007/s13280-016-0800-y.

Abson, D. J., Von Wehrden, H., Baumgärtner, S., Fischer, J., Hanspach, J., Härdtle, W., Heinrichs, H., Klein, A. M., Lang, D. J., Martens, P. and Walmsley, D. (2014), 'Ecosystem services as a boundary object for sustainability', *Ecological Economics*, 103, pp. 29–37, https://doi.org/10.1016/j.ecolecon.2014.04.012.

Armstrong, B., Meskin, A. and Blundell-Birtill, P. (2019), 'Delicious but immoral? Ethical information influences consumer expectations and experience of food', *Frontiers in Psychology*, 10:843, pp. 1–11, https://doi.org/10.3389/fpsyg.2019.00843.

Avelino, F. (2017), 'Power in sustainability transitions: Analysing power and (dis)empowerment in transformative change towards sustainability', *Environmental Policy and Governance*, 27:6, pp. 505–20, https://doi.org/10.1002/eet.1777.

Avelino, F. and Rotmans, J. (2011), 'A dynamic conceptualization of power for sustainability research', *Journal of Cleaner Production*, 19:8, pp. 796–804, https://doi.org/10.1016/j.jclepro.2010.11.012.

Biji, K. B., Ravishankar, C. N., Mohan, C. O. and Gopal, T. S. (2015), 'Smart packaging systems for food applications: A review', *Journal of Food Science and Technology*, 52:10, pp. 6125–35, https://doi.org/10.1007/s13197-015-1766-7.

Brenner, W. and Uebernickel, F. (2016), *Design Thinking for Innovation: Research and Practice*, Cham: Springer.

Brown, T. (2019), *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation*, New York: HarperCollins Publishers.

Burns, C., Cottam, H., Vanstone, C. and Winhall, J. (2006), *RED Paper 02: Transformation Design*, London: Design Council.

Carlgren, L., Rauth, I. and Elmquist, M. (2016), 'Framing design thinking: The concept in idea and enactment', *Creativity and Innovation Management*, 25:1, pp. 38–57, https://doi.org/10.1111/caim.12153.

Coughlan, P., Suri, J. F. and Canales, K. (2007), 'Prototypes as (design) tools for behavioral and organizational change: A design-based approach to help organizations change work behaviors', *The Journal of Applied Behavioral Science*, 43:1, pp. 122–34, https://doi.org/10.1177/0021886306297722.

Diefenthaler, A., Moorhead, L., Speicher, S., Bear, C. and Cerminaro, D. (2017), *Thinking & Acting like a Designer: How Design Thinking Supports Innovation in K–12 Education*, Doha and Riverdale, CA: Wise & IDEO.

The Fish Project (2015), 'Artisanal fisheries', The Fish Project, http://thefish-project.weebly.com/artisanal-fisheries.html. Accessed 12 December 2022.
Food and Agriculture Organization of the United Nations (FAO) (2020), *State of World Fisheries and Aquaculture*, Rome: FAO, https://www.fao.org/documents/card/en/c/ca9229en/. Accessed 22 September 2022.
Furst, T., Connors, M., Bisogni, C. A., Sobal, J. and Falk, L. W. (1996), 'Food choice: A conceptual model of the process', *Appetite*, 26:3, pp. 247–66, https://doi.org/10.1006/appe.1996.0019.
Future of Fish (2020), 'The Future of Fish project', https://www.futureoffish.org/. Accessed 12 December 2022.
Gaziulusoy, I. and Erdoğan Öztekin, E. (2019), 'Design for sustainability transitions: Origins, attitudes and future directions', *Sustainability*, 11:1, https://doi.org/10.3390/su11133601.
Giordano, S., Clodoveo, M. L., De Gennaro, B. and Corbo, F. (2018), 'Factors determining neophobia and neophilia with regard to new technologies applied to the food sector: A systematic review', *International Journal of Gastronomy and Food Science*, 11, pp. 1–19, https://doi.org/10.1016/j.ijgfs.2017.10.001.
Grunwald, A. (2004), 'Strategic knowledge for sustainable development: The need for reflexivity and learning at the interface between science and society', *International Journal of Foresight and Innovation Policy*, 1:1&2, pp. 150–67, https://doi.org/10.1504/IJFIP.2004.004619.
Hebinck, A., Selomane, O., Veen, E., de Vrieze, A., Hasnain, S., Sellberg, M., Sovovà, L., Thompson, K., Vervoort, J. and Wood, A. (2021), 'Exploring the transformative potential of urban food', *npj urban sustainability*, 1:3, pp. 1–9, https://doi.org/10.1038/s42949-021-00041-x.
IDEO (2011), *Design Thinking for Educators*, Riverdale, CA: IDEO.
Irwin, T. (2015), 'Transition design: A proposal for a new area of design practice, study, and research', *Design and Culture*, 7:2, pp. 229–46, https://doi.org/10.1080/17547075.2015.1051829.
Irwin, T., Kossoff, G. and Tonkinwise, C. (2015), 'Transition design provocation', *Design Philosophy Papers*, 13:1, pp. 3–11, https://doi.org/10.1080/14487136.2015.1085688.
Irwin, T., Tonkinwise, C. and Kossoff, G. (2013), 'Transition design: Re-conceptualizing whole lifestyles', *Head, Heart, Hand: AIGA Design Conference*, Minneapolis, MN, USA, 10–12 October.
Jégou, F. and Manzini, E. (2008), *Collaborative Services: Social Innovation and Design for Sustainability*, vol. 1, Milan: Polidesign.
Lettenmeier, M. (2018), *A Sustainable Level of Material Footprint: Benchmark for Designing One-Planet Lifestyles*, Espoo: Aalto University.
Lockton, D., Harrison, D. and Stanton, N. A. (2009), *Design for Behaviour Change: The Design with Intent Toolkit v. 0.9*, London: Brunel University.
Manzini, E. (2014), 'Making things happen: Social innovation and design', *Design Issues*, 30:1, pp. 57–66, https://doi.org/10.1162/DESI_a_00248.
Manzini, E. (2015), *Design, When Everybody Designs: An Introduction to Design for Social Innovation*, Boston, MA: MIT Press.
Martin, B. and Hanington, B. (2012), *Universal Methods of Design: 100 Ways to Research Complex Problems, Develop Innovative Ideas, and Design Effective Solutions*, Beverly, MA: Rockport Publishers.
Mattioni, D., Loconto, A. M. and Brunori, G. (2020), 'Healthy diets and the retail food environment: A sociological approach', *Health & Place*, 61, pp. 1–9, https://doi.org/10.1016/j.healthplace.2019.102244.

Meroni, A. (ed.) (2007), *Creative Communities: People Inventing Sustainable Ways of Living*, Milan: Edizioni Polidesign.

Mezirov, J. (2000), *Learning as Transformation: Critical Perspectives on a Theory in Progress*, San Francisco, CA: Jossey-Bass.

Millar, C. I. and Stephenson, N. L. (2015), 'Temperate forest health in an era of emerging megadisturbance', *Science*, 349:6250, pp. 823–26, https://doi.org/10.1126/science.aaa9933.

Ozanne, J. L. and Anderson, L. (2010), 'Community action research', *Journal of Public Policy & Marketing*, 29:1, pp. 123–37, https://doi.org/10.1509/jppm.29.1.123.

Pereira, L., Drimie, S., Zgambo, O. and Bigg, R. (2020), 'Planning for change: Transformation labs for an alternative food system in Cape Town, South Africa', *Urban Transformations*, 2:13, pp. 1–26, https://doi.org/10.1186/s42854-020-00016-8.

Plattner, H., Meinel, C. and Weinberg, U. (2009), *Design-Thinking*, Landsberg am Lech: Mi-Fachverlag.

Politecnico di Milano (n.d.), 'REFLOW project', https://www.neb.polimi.it/reflow-co-creating-circular-and-regenerative-resource-flows-in-cities/. Accessed 12 December 2022.

Rauschmayer, F., Bauler, T. and Schäpke, N. (2015), 'Towards a thick understanding of sustainability transitions: Linking transition management, capabilities and social practices', *Ecological Economics*, 109, pp. 211–21, https://doi.org/10.1016/j.ecolecon.2014.11.018.

Rutzerveld, C. (2018), 'Edible Growth', https://www.chloerutzerveld.com/edible-growth. Accessed 12 December 2022.

Sangiorgi, D. (2011), 'Transformative services and transformation design', *International Journal of Design*, 5:2, pp. 29–40.

Schäpke, N., Omann, I., Wittmayer, J., van Steenbergen, F. and Mock, M. (2017), 'Linking transitions to sustainability: A study of the societal effects of transition management', *Sustainability*, 9:5, pp. 1–36, https://doi.org/10.3390/su9050737.

Schuurman, G. W., Cole, D. N., Cravens, A. E., Covington, S., Crausbay, S. D., Hoffman, C. H., Lawrence, D. J., Magness, D. R., Morton, J. M., Nelson, E. A. and O'Malley, R. (2022), 'Navigating ecological transformation: Resist–accept–direct as a path to a new resource management paradigm', *BioScience*, 72:1, pp. 16–29, https://doi.org/10.1093/biosci/biab067.

Segre, N., D'Antino, A. and Leveau, M. (2020), *The State of Global Foodtech Report 2020*, Milan: Talent Garden, https://talentgarden.org/en/guides/foodtech-report/. Accessed 22 September 2022.

Simsek, A. (2012), 'Transformational learning', in N. M. Seel (ed.), *Encyclopedia of the Sciences of Learning*, Boston, MA: Springer, pp. 3341–43, https://doi.org/10.1007/978-1-4419-1428-6_373.

Stickdorn, M., Schneider, J., Andrews, K. and Lawrence, A. (2011), *This Is Service Design Thinking: Basics, Tools, Cases*, Hoboken, NJ: Wiley.

Styliaras, G. D. (2021), 'Augmented reality in food promotion and analysis: Review and potentials', *Digital*, 1:4, pp. 216–40, https://doi.org/10.3390/digital1040016.

Taylor, E. W. (1998), *The Theory and Practice of Transformative Learning: A Critical Review*, Columbus, OH: The Ohio State University.

Teachers Guild x School Retool (2020), 'The case for belief', Teachers Guild x School Retool, https://drive.google.com/file/d/1YAGeDwfMMR2s8gwvS3zzSzXdnuAZuO4U/view. Accessed 12 December 2022.

Wang, W., Yao, L., Zhang, T., Cheng, C. Y., Levine, D. and Ishii, H. (2017), 'Transformative appetite: Shape changing food transforms from 2D to 3D by water interaction through cooking', in *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, Denver, CO, USA, 6–11 May, New York: ACM, pp. 6123–32, ttps://doi.org/10.1145/3025453.3026019.
WaSeaBi project (n.d.), https://www.waseabi.eu/. Accessed 22 September 2022.
Watzlawick, P., Weakland, J. H. and Fisch, R. (1974), *Change: Principles of Problem Formation and Problem Resolution*, New York: Norton.
Yam, K. L., Takhistov, P. T. and Miltz, J. (2005), 'Intelligent packaging: Concepts and applications', *Journal of Food Science*, 70:1, pp. R1–R10, https://doi.org/10.1111/j.1365-2621.2005.tb09052.x.

SUGGESTED CITATION

Marti, Patrizia, Massari, Sonia and Recupero, Annamaria (2023), 'Transformational design for food systems: Cultural, social and technological challenges', *International Journal of Food Design*, Special Issue: 'Designing Digital Technologies for Sustainable Transformations of Food Systems', 8:1, pp. 109–32, https://doi.org/10.1386/ijfd_00053_1

CONTRIBUTOR DETAILS

Patrizia Marti is an associate professor in the Department of Social, Political and Cognitive Science, University of Siena, where she teaches experience design and design thinking. She is the director of Santa Chiara Fab Lab, a digital manufacturing laboratory, specializing in innovation and research projects. From 2013 to 2017 she was appointed part-time full professor in the Department of Industrial Design, Eindhoven University of Technology. She has an interdisciplinary background in philosophy, design and computing and a Ph.D. in aesthetics of interaction design. Her research interests include tangible and embodied interaction, human–food interaction, human–robot interaction and societal impacts of new technologies.

Contact: Department of Social Political and Cognitive Sciences, University of Siena, Via Roma, 56 53100, Siena, Italy.
E-mail: marti@unisi.it

https://orcid.org/0000-0002-2448-8747

Dr Sonia Massari has more than twenty years of experience as an educator, researcher, consultant and designer in the fields of human–food interaction design, sustainability education, design thinking and co-creative methods for innovative agri-food systems. She is a research fellow at the Department of Agricultural, Food and Agro-Environmental Sciences, University of Pisa; academic director at the Future Food Academy (FFI) and senior consultant at the Barilla Foundation (Skilled Erasmus+ Project). She is the co-founder of the FORK – Food Design Organization, an international non-profit organization dedicated to food+design, a faculty member and a visiting professor in several European universities. She recently edited the book *Trans-Disciplinary Case Studies on Design for Food and Sustainability* (2021) published by Elsevier.

Contact: Department of Agricultural, Food and Agro-Environmental Sciences, University of Pisa, Via Borghetto 80, 56124, Pisa, Italy.
E-mail: sonia.massari@agr.unipi.it

https://orcid.org/0000-0003-1471-1199

Dr Annamaria Recupero, Ph.D. in psychology, is a junior researcher (RTD-A) in the Department of Social, Political and Cognitive Sciences, University of Siena. She collaborates with the Santa Chiara Fab Lab in research projects applying design thinking and co-design methods in diverse domains, including cultural heritage, accessibility and healthcare. Her research interests deal with the psycho-social processes involved in the interaction with digital technologies and services.

Contact: Department of Social Political and Cognitive Sciences, University of Siena, Via Roma, 56 53100, Siena, Italy.
E-mail: annamaria.recupero@unisi.it

https://orcid.org/0000-0003-2686-4010