Figure 3. Upprinting Food projects – 3d printing with food waste, 2019

URBAN REVOLUTION AT TIMES OF CREATIVE FOOD CYCLES

Nicola Canessa

Contemporary cities are constantly evolving and digital processes seem to have entered overwhelmingly into every activity daily life as well as into everyone's home. But how much and in which way this transition will affect positively our social and working life is still to be demonstrated. In food supply chains, whether in production, processing or disposal applications, the innovation factor related to digital processes still represents an early-stage field of investigation. Advanced research on Bio-materials derived from food-waste are a strong bet for urban environments, where product replacement can significantly reduce CO2 emissions and foster the implementation of a new raw material policy to rebalance the support bio-based strategies versus industrial material use. This paper explores some urban challenges and examples related to ICT implementation and creative methods connected to 3D printing and digital fabrication connected to food waste valorisation able to influence we live our domestic spaces.

urban farming / food-waste recycle / bio-based materials / digital innovation / 3D food printing

Figure 1. Pocket City Farm in Camperdown commons © Luisa Brimble, 2015

URBAN FARMING POTENTIAL SCENARIO: FROM SELF-PRODUCTION TO SELF-DISPOSAL

For several years now, the return to the countryside and agriculture, even by the younger generations, has led to an increasing knowledge sharing and transfer of some methods and approach of direct cultivation methods among networks of cities. Against this backdrop, food consumption and waste-related production is staggering: a third of all the food produced for urban context is disposed every year (FAO, 2011) of which about 1.3 billion tons is mostly coming from fruit and vegetables damaged during transport.

What we are talking about is not simply an increase in urban vegetable gardens, but a real urban cultural revolution that brings individual production into cities on roofs and balconies, as envisioned for Agropolis Munich (Schröder et al., 2009). Urban Agriculture alone couldn't be the only response to this dramatic trend, but it can help revolutionize the environmentally unsustainable food industry, providing evidence of thriving social practices and new methods of cultivation within "food deserts" and describing the global movement towards alternative food production. Creative Food Cycles (CFC) project tackles these challenges, trying to combine new cycles, mainly domestic ones, from food production, its distribution to the

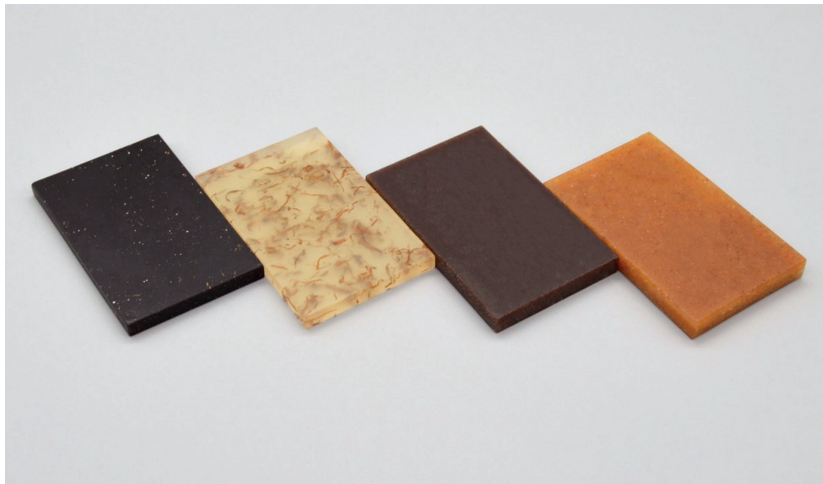

Figure 2. Chip[s]Board Parblex composite samples, 2018

reuse of food waste. In this direction it is possible to find even technologically advanced projects that work to integrate logics and new possibilities connected to food cycles. For instance, in food production large hydroponic systems have been introduced for years, in order to save soils and avoid contamination by using mineral nutrient solutions in an aqueous solvent, but what is particular interesting is the proliferation of these devices for in-house domestic structures.
Micro Smart Gardens, are becoming research objects able to fascinate both start-ups and large companies such as Ikea— which has developed indoor growing kits, nursery and sprout boxes— as piece of home furniture able to grow almost anything hydroponically, promote a new culture of care and healthy food.
With the same ease the technology enters the distribution communities. The new apps aim to give awareness about the products, to promote the exchange and solidarity consumers' groups, while new digital milieu offer social diffusion and networks of buying groups and direct cultivators to be closer to customers, promoting trade and innovative distribution. In most cases these urban agriculture practices raise from grassroots organization, associations or active citizens who wants to share experiences and emerging trends around ICT facilitated food sharing tools in urban contexts, offering at the same time alternative access to healthier food and recreational spaces able to reinforce a sense of community in the urban environ-

ment (Canannes, Marocchino, 2018). This happens in some cities where vacancy become a resource or abandoned plots are transformed into social farms or collective vegetable gardens. Sometimes this happens spontaneously after winning a municipal public announcement as happened for the Pocket City Farms opened in Sydney in 2016.
These initiatives manage to support themselves through crowdfunding campaigns, public/private support or in most of the case through direct sales of food grown locally, by creating small networks of facilities, such as farmers markets, social tables or small restaurants to empower the community through real micro economies, while offering multi-functional programmes of amenities.

Digital transition and advanced technology represent a significant added-values which has entered into these realities, not necessarily to transform the organizational structures, but to enhance communication, visibility and the transferability/replicability of processes enhanced by online communities, especially when foster public/private associations, new job opportunities and community engagement.
However, there are probably three factors that have influenced this renaissance of urban farming, transforming it from a niche of socio-environmental activism to a structural component of urban and planning agendas (Parham, 2018). The first is undoubtedly a significant perception of the uncertainties related to climate change and the diffuse effects on different regional productions. Secondly, the renewed demand of food security and safety according to new paradigm of higher nutritional values, healthy lifestyles and diets, organic and Zero Km products. The third is the freedom of networking and sharing practices linked both to the management of open spaces in the metropolitan dimension, as well as the necessity of direct traceability of food cycles and supply chains.
A particular link to ICT implementation and food cycles is represented by the ongoing research of food cycles impacts in the waste management process, exemplified by the motto "From waste to resource". Technologies to produce new materials from food waste are now available to start-ups and creative industries and soon be able to enter our domestic spaces, considering that of the billion tonnes of solid waste produced by cities annually, it is estimated that 47% is organic and mostly food waste. (Newman, Cepeda-Marquez 2018)
Considering the global market pressure and soil-contamination trends, the advantage of using food waste as a raw material, instead of low-quality agricultural produce, will improve the reorganization of food cycles, in particular connected to a more democratic access to secure and healthier food. Producing locally on regional-based supply chain a significant reduction in costs will be possible, avoid-

ing complex food processing with OGN and preservatives, long stocking periods in refrigerators and international shipping to supply great distributors and supermarkets. In parallel, a significant reduction in packaging and food-waste treatment will open possibility of new investment, research and development for creative food-industries, contributing to towards a Green New Deal transition (Archer & Hamerschlag, 2020), advocated as significant challenge for territorial justice and our urban future.

NEW BIO-BASED DESIGN PRODUCTS FROM FOOD-WASTE RECYCLE

Advanced research on Bio-materials derived from food-waste are indeed a strong bet for urban environments and new possibilities for domestic economies also in Europe, where product replacement can significantly reduce CO2 emissions and foster the implementation of a new raw material policy to rebalance the support bio-based strategies versus industrial material use. (EC, 2020) In the bio-plastics sector, brand leaders have expressed interest in long-term shift to using bio-plastics and biopolymers for their product packaging. In addition, bio-plastics are being increasingly used in more durable applications such as home appliance, cosmetics, furniture, children's toys and building materials. This new life cycle applied to food-waste is a real technological evolution, because can sensitively influence policymakers, local authorities, companies and active urban society to define new value chains towards circular economy.
In the last years, SMEs and creative industries already experimented processes for the transformation of food-waste into new packaging, as in the case of Scoby , designed by Roza Janusz, as a high-performing and home compostable bio-plastic membrane, made out a fermentation process from bacteria and yeast. In the same field, Lucy Hughes introduced a translucent, stronger than low-density polyethylene (LDPE) and flexible bio-composted film, obtained from fish scales and skin waste: MarinaTex . Similar experiments have been conducted by Margarita Talep with algae, in order to test possible solutions to the accumulation of plastic waste in marine environments, which persist not only in sea surface waters but also affect natural cycles. Similar approach to organic waste is currently under development by ARUP in order to provide industry with cheap, low-carbon materials and further application to building sector (e.g. pigments, insulation, carpets, acoustic treatments and interior finishes). Some of the applied food-waste materials proposed are: peanut shells, which can be used to produce low-cost partition boards that are resistant to moisture and fire; rice, whose husks can be turned to ash and mixed with cement to reduce need for fillers; bananas, whose fruits and leaves

Figure 4. Upprinting Food prototypes – 3d printing food topping with food waste, 2019

can make rugged textiles due to high-strength fibers; potato peels, which can be pressed and dried to create a low-weight, eco-friendly alternative to single-use materials like MDF and chipboard, as tested with Chip[s]Board project, excellent for digital fabrication process and performances.
What all these researches have in common is the sharing experimental methods to ameliorate rising levels of waste and shortfalls of raw material, as well as to be characterized by a strong communicative and visual approach, shown through events and social campaign to share knowledge to wider audience, trying to influence both industrial and domestic economies with creative spirit. A particular audience target is represented by younger generation and students, who are the most sensitive towards new technologies, creative design approach, as well as to current environmental issues, but also show particular interest to experiment direct sustainable strategies to recycle commonly unusable waste domestic products.

With particular reference to young creatives and designers, Creative Food Cycles explores the role of ICT implementation and creative methods connected to urban food productions and food waste valorisation, as shown in Food Interaction Cat-

Figure 5. Upprinting Food – Karpendonkse Hoeve Logo, 2020

alogue (Markoupoulou et al., 2019). A database on existing international practices, which puts together unconventional results, co-design actions and start-ups experimentations on how creative recycling methods applied to food waste can be valuable marketing resources for industrial design sector, as applied for new clothing materials derived from orange peels (Santonocito, Arena, 2019) or pineapple leaves (Hijosa, 2019).

What is particular interesting in relation to ICT and new fabrication techniques is the similarities to Fab-Lab philosophy, to produce locally through open-source platforms, enhancing equal access to sustainability in a globally connected networks of cities. CFC projects' database represents "new seeds" of shared-knowledge that need to be tested and upscaled on a higher level of production, distribution and consumption to understand the real performances in a concluded life cycle thinking vision. Through smaller prototypes, which can be replicated at home with a simple 3D printer, is it possible to give new values and meanings to daily food waste, by composting the portion which cannot be recycled, while creating new healthy habits such as the direct cultivation of a rooftop or backyard community garden. This is the way in which urban agriculture and smart-technologies can be combined to promote a real food revolution in our supply chains and consumption logics. (Cockrall-King, 2012)

POST-PANDEMIC HOUSES: 3D FOOD PRINTING AND CREATIVE PROCESSES

Especially today, after the dramatic consequences of COVID outbreak, through the rediscovery of self-sufficient habits and prolonged individuality due to social distancing, the digital transition and the role of social media to connect people are seen not anymore as the only way to enhance human social relations and dialogue. During our forced confinement at home, the unexpressed potential of our domestic spaces to host small self-sufficient practices, such as the cultivation of a kitchen garden, or self-composting and recycling techniques, could have been associated with creative intuition and smart devices, sometimes just for leisure.
However, most of the cases as skilled "survivalists" we stocked up on toilet paper, detergents, tomato puree and yeast for baking, filling our homes with a large amount of bulky materials. We ordered objects through e-commerce online platforms, filling our storage rooms with cartons or plastic to dispose of, and finally cooking a large amount of canned food, often complaining about the lack of quality choice at supermarkets and great distributors. Probably the blessing in disguise, while coping with the pandemic, is represented by the opportunities offered to transform our daily domestic rituals of "serial wasters" in wiser consumers, reducing consumption levels, adopting healthy diets and correct disposal habits, and maybe implementing creative invention and recycling.
The real novelty can lie also in the ability to create new objects and materials enriched by artisanal or digital fabrication work, a sharing practices to promote social engagement and civic associationism. In these regards, ICT will certainly bring great progress on the ease of transformation of digital communities, which should be inspired by open-source platforms and principles like the ones adopted by Fab-city network and 3D printer communities where exchange of tools, software, methods, hints and "recipes" are the normality. In fact, today we are in a condition where 3D printing methods can represent a new milestone for innovative homemade food processing. After having experimented printing with plastic polymers, concrete and steel, the new frontier is represented by digital gastronomy and customized food fabrication. Different from robotics-based food manufacturing technologies designed to automate manual processes for mass production, 3D food printing integrates 3DP and digital gastronomy technique to manufacture food products with customization in shape, colour, flavour, texture and even nutrition. This introduces artistic capabilities to fine dining, and extend customization capabilities to industrial culinary sector. For instance, the Italian bio-engineer Giuseppe Scionti founder of Novameat , has invented the "world's first" 3D-printed

meat-free steak made from vegetable proteins, which mimics the texture of real beef or chiken. In similar way, the project Upprinting Food aims to use the 3D print technology to recover the food that would be wasted and make it consumable and appetizing again, by blending and combining the different ingredients in purees. The prints are then baked and dehydrated for crunch and longevity. Using current advancements in biotechnology the startup Genecis is currently applying machine learning processed and microbial engineering to convert food waste into PHAs. A fully biodegradable form of plastic, PHAs can be used to make more sustainable toys, medical devices and 3D printer filament. PHAs —scientifically known as polyhydroxyalkanoates— are polymers produced by bacteria which have various benefits over other forms of bio-plastics. They can be developed into a thermoplastic, to be turned easily into different products. Moreover, unlike many other forms of bio-plastics, the PHA won't spoil the recycling process. PHAs fully degrade in the environment within one year, and under 10 years in water. Whereas synthetic plastics can take more than a hundred years to degrade in similar environments.

These experimentations are very reminiscent of science fiction movies, but they make us understand how it is possible to manipulate food and food waste to obtain something else. Surely it will take some time, before something could be launched on the market for big productions, but it is already interesting to see the different research and development trends in industrial design sector related to food.
The current scenario gives us a significant pictures of direct cultivation and ICT-assisted method for urban farming often born spontaneously and community driven; in parallel, innovative start-ups produce, transform, deliver food ecologically, showing a large amount of case studies able to influence directly our domestic spaces; finally the presence of larger consumer groups and targeted audience open to environmental sensitivity, quality of food production and reduction of waste disposal underlines the desire to a rising consensus towards circular economy and sustainable development goals.
These three topics together represent a key-outputs of Creative Food Cycles projects and a future research perspective that would be worthy to be investigated. What is missing (for now) is the change of scale and a cluster of industries intended to invest in new digital infrastructures and fabrication supply chain able to push forward this change in the urban society.

BIBLIOGRAPHY

Archer L., Hamerschlag K. (2020). "Green New Deal Must Transform Our Food System to Save Our Climate". In: Friends of the Earth International Blog. Available online at: https://foe.org/blog/green-new-deal-must-transform-food-system-save-climate/ [Accessed 07.06.2020]

Canannes Y., Marocchino C. (2018) Integrating food into urban planning. UCL Press, London

Cockrall-King, J. (2012) Food and City: Urban Agriculture and food revolution, Prometheus Book, New York

EC (2020) Bio-based economy in Europe: state of play and future potential. DG Research and Innovation. Directorate Bio-technology, Brusseles. Available online at: https://ec.europa.eu/research/consultations/bioeconomy/bio-based-economy-for-europe-part2.pdf [Accessed 14.06.2020]

FAO (2011) Global Food Losses and Food Waste: extent, causes and prevention. Interpack International Congress 2011 Düsseldorf, Germany. Available online at: http://www.fao.org/3/a-i2697e.pdf [Accessed 03.05.2020]

Hijosa. C (2019) "Pinatex". In: Markoupoulou A., Farinea C., Ciccone F., Marengo M. eds. (2019) Food Interactions Catalogue. Collection of Best Practices. IAAC Press, Barcelona, pp.208-211.

Markoupoulou A., Farinea C., Ciccone F., Marengo M. eds. (2019) Food Interactions Catalogue. Collection of Best Practices. IAAC Press, Barcelona. Available online at: https://creativefoodcycles.org/food-interactions-catalogue/ [Accessed 20.06.2020]

Newman D., Cepeda-Marquez R. (2018) Global Food Waste management: an implementation guide for cities. World Biogas association. Sustainable Bankside Edition, London

Parham S. (2015) Food and Urbanism: The convivial city and a sustainable future. Bloomsbury, London

Santonocito A.; Arena E. (2019) "Orange Fiber". In: Markoupoulou A., Farinea C., Ciccone F., Marengo M. eds. (2019) Food Interactions Catalogue. Collection of Best Practices. IAAC Press, Barcelona, pp.224-227.

Schröder J., Baldauf. T., Deerenberg M., Otto F., Weigert K. (2009) Agropolis Munich. Available online at: http://www.agropolis-muenchen.de/index_en.html [Accessed 18.05.2020]