The “Logic Bonbon”: A Computable Food, Or an Eatable Computer?

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ABSTRACT

This proposal presents the "Logic Bonbon," an artwork that embodies an integration of food and computation to celebrate the interconnectedness of human-food interactions within HCI. Based on the authors’ previous research exploring “alternative ways” of computation through food design, the Logic Bonbon is a liquid-centered dessert that “computes” its own flavor and presentation through hydrodynamically induced logic operations (AND, OR, and XOR), which form the basis of computation. This artwork serves as a material speculation, provoking a reimagining of the concept of "resilience" – the theme of this Art Exhibition – across the boundary between the “edible” and the “computable.” It envisions an innovative future for Human-Food Interaction (HFI) design by considering the material paradox between fragility and adaptability, ephemerality and durability, as well as palatability and computability.

CCS CONCEPTS

• : **Human-Centered Computing**; • **Interaction Design**;

KEYWORDS

Human-Food Interaction, Food design

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1 INTRODUCTION

A prevailing topic in Human-Computer Interaction (HCI) involves the endeavor to “weave together” the digital and physical domains [20, 23, 35] as interaction design has evolved into a matter of “material concern” emphasizing the material attributes of a system [29, 30, 34]. However, the material attributes are often disregarded in the context of human-food interactions [4, 8, 9, 11, 22], wherein the material affordances of food [16] are mostly underexploited. Consequently, most existing works have overlooked the potential to “celebrate the pleasurable and enjoyable experiences that people have with food” [19] derived from the food material’s properties that accentuate its aesthetic, emotional, sensual, and sociocultural aspects. Nevertheless, recent research on the integration of food and computation [12] proposed that the emergence of “material integration” could be understood as a novel approach for devising future designs in human-food interactions. Furthermore, the concept of “unconventional computing” and material computation (or embodied computing) [24, 25, 28], which are grounded in the intention to conceive “other ways to compute” [3], consider “computation” in a broader sense to step away from the concept of universality. Therefore, such concept raises a question for food as material realizations of computation: What does it mean if we design a food that is computable, or a computer that is eatable?

Within the context, we propose exhibiting our work, the “Logic Bonbon”, which is based on our research on the design of “food as computational artifact” [12, 13]. The Logic Bonbon is a liquid-centered dessert that can perform basic forms of computation, the logic operations (AND, OR, and XOR) induced by inner fluidic dynamics. This capability enables the dessert to computationally regulate its flavor and presentation in response to diners’ inputs. Such integration of food and computation allows food creators to essentially “program” the food, and the diners to initiate the “execution” of the program based on given parameters (i.e., the inputs diners operate through the choice of flavors and sequences). The computation results in different flavor combinations that the diners can then consume.

Through the exhibition, we attempt to represent a situated setting of food pavilion that encourages visitors to experience a novel computable food – which is also an eatable computer. Visitors will step into a journey at the intersection of food and computation through appreciating, creating, and playing with the Logic Bonbon through tangible pieces of the artwork as well as visual materials. It is worth noticing that due to food safety and storage issues, if we may not be able to exhibit real food for displaying and eating, we will showcase the mockups of the Logic Bonbon for visitors to play with (see the accompanied specification document for more details). Through exhibiting the artwork, we aim to demonstrate how food as a material can mediate new ways to compute, and at the same time, how complex computational concepts can be made more accessible through food as a creative medium.

Furthermore, considering the theme of this Art Exhibition – “resilience”, our artwork aims to provoke a reimagination of the conception of resilience in a broader sense within HCI. Through showcasing our artwork as a counterfactual artifact combining food and computation, we attempt to stimulate insightful discussions beyond the boundary between the “eatable” and the “computable” through the material paradox between fragility and adaptability, ephemerality and durability, as well as palatability and computability. We hope to use our artwork as a material speculation [31] to envision a new pathway to an innovative HFI futures.

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Figure 1: Right: Logic Bonbons in making; Left: a basic unit of the Logic Bonbon system.

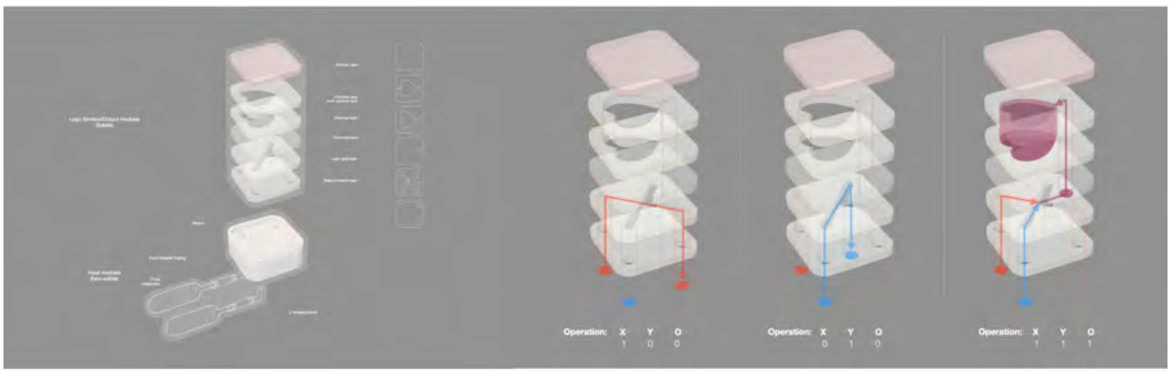

Figure 2: Schematic structure of a Logic Bonbon system, and the logic operation within a Logic Bonbon (AND gate).

2 INSPIRATION FROM RELATED WORKS

Prior works inspired us to explore the possibilities for encoding computational capabilities (including actuation and sensing) into food materials so that the food physically transforms in response to external stimuli [21, 32]. However, these works realized only "fixed" processes (i.e., a one-off change of state according to predefined behaviors), hence they are not modifiable once produced. Interestingly, prior research on "material integration" [10] envisaged a future of "cyber food" experiences by conceptualizing the notion of "food as computational artifact". Building on this, we aims to realize this concept by exploiting the food's abilities for direct realization of a computational process to facilitate dynamic "inter-actions" [34] between consumers and food.

Furthermore, prior research has exploited fluids to perform computation [1, 2, 7, 15, 18, 36], including the a hydromechanical analog computer, "Moniac" [6]; as well as fluidic devices functioning as responsive display [26], performing logic operations [5, 14, 17, 27], and accomplishing soft autonomous robots control [18, 33]. Overall, these prior works demonstrate that fluid's unique physical properties and mechanisms make it versatile materials for use in performing computation. More importantly, we note that fluids, such as soup, broth, coulis, liquor, and syrup, are all essential elements that enrich our flavor experiences. This inspired us to design and experiment with fluidic systems out of food material.

3 CREATION & FABRICATION OF THE LOGIC BONBON

We conceived the idea of the "Logic Bonbon" (Figure 1) after noting that some desserts contain a multi-flavored center and that traditional bonbons often contain a liquor or coulis center that can enrich the flavor experience. The Logic Bonbon is designed with a multi-layered structure that determines specific fluidic configurations and logic functions (Figure 2). Furthermore, we sought to create the Logic Bonbon dessert to be able to computationally configure its properties (flavor and visual presentation) in response to external diner inputs via integrated fluidic mechanisms. Therefore, a complete Logic Bonbon system consists of a set of input modules, a logic gate, and an output module (Figure 2). Figure 4 shows the cooking process of the Logic Bonbon [12].

4 INTERACTING WITH THE LOGIC BONBON

The Logic Bonbon interaction begins with the diners applying force to the flavor reservoirs. The flavor reservoirs are two pipettes filled with two different flavor inputs: "x" and "y". When a diner presses the reservoirs, the flavored liquids (inputs) will flow through the mount into a Logic Bonbon and produce different outcomes according to its logic function (Figure 2). Figure 3 demonstrates a summary of three logic operations and the possible flavor outcomes. The outcome might vary based on the timing and sequence of the

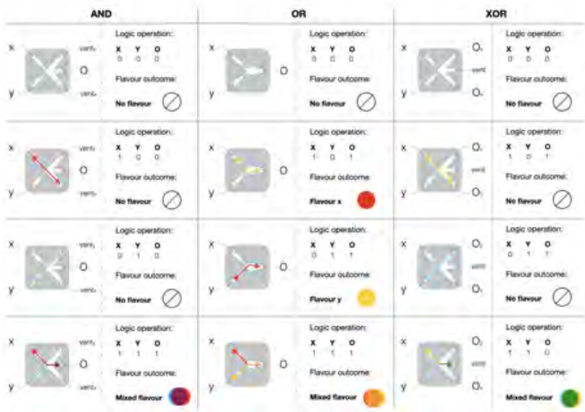

Figure 3: A summary of three logic functions the Logic Bonbon can perform and the associated flavor outcomes.

Figure 4: Cooking process of the Logic Bonbon.

diner pressing the reservoirs, as well as the pressure they applied. Figure 5 demonstrates diners interacting with the Logic bonbon.

5 CONCLUSION

Taken together, through exhibiting the artwork, we wish to create a multisensorial and participatory journey for the visitors. We invite visitors to experience the artwork by tasting the actual dessert (if possible), touching the tangible pieces, assembling a Logic Bonbon system, and initiating an execution of the logic operations. By letting the visitors to taste, create, build, and play with the artwork, we wish to gain the first-person insights to answer the question we asked above, that might contribute to our future research.

6 ARTISTS

Jialin Deng is an HCI designer, researcher, and currently pursuing a Ph.D. at the Exertion Games Lab, Monash University in Melbourne, Australia. Jialin's research explores the future of comestible interfaces through designing and studying food-based computational artifacts to provoke speculations about human-food interaction futures. With a background in Fine Arts and Experience Design, Jialin's past practice lies at the intersection of media arts, visual communication, and UX design. Her works have received the first runner-up prize for the Mullen Lowe NOVA Awards (2015) and exhibited at the London Design Festival (LDF) 2015, and Open Day 2022 at Monash University. She has also been invited as a guest speaker at Living in a Material World, LDF 2015; Young People Matter, Shanghai, 2017; and TEDxGuangzhou, 2019; Dagstuhl Seminar (Eat-IT), 2022, and CHI-Melbourne, 2022. Jialin's personal website is: www.jialindeng.xyz.

Florian 'Floyd' Mueller is Professor of Future Interfaces at Monash University (Melbourne, Australia), where he leads the award-winning Exertion Games Lab. Previously, he was at RMIT, Stanford, University of Melbourne, Microsoft Research, MIT Media Lab, Fuji-Xerox Palo Alto Labs, Xerox Parc, and industrial research organization CSIRO. He featured on the top 100 human-computer interaction (HCI) researcher list and was the first Australian-based researcher to be selected to chair the CHI conference: HCI's highest-ranked publication outlet. Floyd's games have featured on the BBC, ABC, Discovery Science Channel, and in Wired magazine, and they have been played by more than 20,000 players, across three continents. Floyd is an inaugural honoree of the Australian Design Centre's Australian Design Honors and a member of the prestigious ACM SIGCHI Academy, an honorary group of leaders "who have made substantial contributions to the field of HCI".

REFERENCES

[1] Andrew Adamatzky, 2016, On Half-Adders Based on Fusion of Signal Carriers: Excitation, Fluidics, and Electricity. *Complex Syst.*, 25(3).
[2] Andrew Adamatzky, 2019, A brief history of liquid computers. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 374(1774): pp. 20180372. DOI: 10.1098/rstb.2018.0372.
[3] Andrew Adamatzky, 2021. *Handbook of Unconventional Computing*. Handbook of Unconventional Computing.
[4] Ferran Altarriba Bertran, Danielle Wilde, Ernő Berezvay, and Katherine Isbister. 2019, Playful Human-Food Interaction Research: State of the Art and Future Directions. In *Proceedings of the Annual Symposium on Computer-Human Interaction in Play*, Barcelona, Spain, Association for Computing Machinery, New York, NY, USA. 225–237. DOI: 10.1145/3311350.3347155.
[5] C.A. Belsterling, 1971. *Fluidic Systems Design*. Wiley-Interscience.
[6] C. Bissell, 2007, Historical perspectives - The Moniac A Hydromechanical Analog Computer of the 1950s. *IEEE Control Systems Magazine*, 27(1): pp. 69-74. DOI: 10.1109/MCS.2007.284511.
[7] Paulo Blikstein. *Programmable Water–Computation is not just about electronics.* Retrieved January 2020, from: http://www.blikstein.com/paulo/projects/project_water.html.
[8] Rob Comber, Eva Ganglbauer, Jaz Choi, Jettie Hoonhout, Yvonne Rogers, Kenton O'Hara, and Julie Maitland, 2012, Food and interaction design: Designing for food in everyday life. *Conference on Human Factors in Computing Systems - Proceedings*. DOI: 10.1145/2212776.2212716.
[9] Rob Comber, Jaz Choi, Jettie Hoonhout, and Kenton O'Hara, 2014, Designing for human–food interaction: An introduction to the special issue on 'food and interaction design'. *International Journal of Human-Computer Studies*, 72: pp. 181-184. DOI: 10.1016/j.ijhcs.2013.09.001.
[10] Jialin Deng, Patrick Olivier, and Florian Mueller. 2021, Design of Cyber Food: Beginning to Understand Food as Computational Artifact. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems,* Yokohama, Japan, Association for Computing Machinery, New York, NY, USA. Article 293. DOI: https://doi.org/10.1145/3411763.3451687.
[11] Jialin Deng, Yan Wang, Carlos Velasco, Ferran Altarriba Bertran, Rob Comber, Marianna Obrist, Katherine Isbister, Charles Spence, and Florian Mueller. 2021, The Future of Human-Food Interaction. In *CHI Conference on Human Factors in Computing Systems Extended Abstracts (CHI '21),* Yokohama, Japan, ACM, New York, NY, USA. DOI: 10.1145/3411763.3441312.
[12] Jialin Deng, Patrick Olivier, Josh Andres, Kirsten Ellis, Ryan Wee, and Florian Mueller. 2022, Logic Bonbon: Exploring Food as Computational Artifact. In *CHI Conference on Human Factors in Computing Systems (CHI'22),* New Orleans, LA, USA, ACM, New York, NY, USA. 21 pages. DOI: https://doi.org/10.1145/3491102.3501926.

Figure 5: Interacting with the Logic bonbon.

[13] Jialin Deng, Patrick Olivier, and Florian 'Floyd' Mueller, 2023, Exploring tasty fluidics for designing food as computational artifact. *International Journal of Gastronomy and Food Science*, 31: pp. 100630. DOI: https://doi.org/10.1016/j.ijgfs.2022.100630.

[14] G.W.A. Dummer and J.M. Robertson, 2013. *Fluidic Components and Equipment 1968–9: Pergamon Electronics Data Series*. Elsevier Science.

[15] Nazek El-Atab, Javier Chavarrio Canas, and Muhammad M. Hussain, 2020, Pressure-Driven Two-Input 3D Microfluidic Logic Gates. *Advanced Science*, 7(2): pp. 1903027. DOI: https://doi.org/10.1002/advs.201903027.

[16] Tom H. Fisher, 2004, What We Touch, Touches Us: Materials, Affects, and Affordances. *Design Issues*, 20(4): pp. 20-31. DOI: 10.1162/0747936042312066.

[17] K. Foster and G.A. Parker, 1970. *Fluidics: Components and Circuits*. Wiley-Interscience.

[18] M. Garrad, G. Soter, A. T. Conn, H. Hauser, and J. Rossiter, 2019, A soft matter computer for soft robots. *Science Robotics*, 4(33): pp. eaaw6060. DOI: 10.1126/scirobotics.aaw6060.

[19] Andrea Grimes and Richard Harper. 2008, Celebratory technology: new directions for food research in HCI. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '08)*, Florence, Italy, Association for Computing Machinery, New York, NY, USA. 467–476. DOI: 10.1145/1357054.1357130.

[20] Hiroshi Ishii, Daniel Leithinger, Lining Yao, Sean Follmer, and Jifei Ou. 2015. Vision-Driven: Beyond Tangible Bits, Towards Radical Atoms. *In Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems (CHI EA '15), Seoul, Republic of Korea.* Association for Computing Machinery, New York, NY, USA. 2495–2496. DOI: 10.1145/2702613.2721936.

[21] Viirj Kan, Judith Amores, Chikara Inamura, Yujie Hong, Dhruv Jain, and Hiroshi Ishii. 2014, Food as Prototype for Radical Atoms. In *In submission to MAS 834: Tangible Interfaces final project report.*

[22] Rohit Khot, Florian Mueller, and Damon Young, 2019, Human-Food Interaction. *Foundations and Trends®in Human-Computer Interaction*, 12: pp. 238-415. DOI: 10.1561/1100000074.

[23] David Lakatos and Hiroshi Ishii. 2012. Towards Radical Atoms—Form-giving to transformable materials. *In Proceedings of the 2012 IEEE 3rd International Conference on Cognitive Infocommunications (CogInfoCom), Kosice, Slovakia.* IEEE. 37-40. DOI: 10.1109/CogInfoCom.2012.6422023.

[24] Bruce J. MacLennan, EMBODIED COMPUTATION: APPLYING THE PHYSICS OF COMPUTATION TO ARTIFICIAL MORPHOGENESIS, in Handbook of Unconventional Computing (pp. 1-30). DOI: https://dx.doi.org/10.1142/s0129626412400130.

[25] Bruce J. MacLennan, Mapping the Territory of Computation Including Embodied Computation, in Handbook of Unconventional Computing (pp. 1-30). DOI: https://dx.doi.org/10.1142/9789811235726_0001.

[26] Hila Mor, Tianyu Yu, Ken Nakagaki, Benjamin Harvey Miller, Yichen Jia, and Hiroshi Ishii. 2020, Venous Materials: Towards Interactive Fluidic Mechanisms. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems (CHI '20),* Honolulu, HI, USA, Association for Computing Machinery, New York, NY, USA. 1–14. DOI: https://doi.org/10.1145/3313831.3376129.

[27] Karl N. Reid, 1969, Fluidic Devices and Their Steady-State Characteristics. *SAE Transactions*, 78: pp. 1934-1942.

[28] Susan Stepney, Samuel L. Braunstein, John A. Clark, Andy Tyrrell, Andrew Adamatzky, Robert E. Smith, Tom Addis, Colin Johnson, Jonathan Timmis, Peter Welch, Robin Milner, and Derek Partridge, 2005, Journeys in non-classical computation I: A grand challenge for computing research. *International Journal of Parallel, Emergent and Distributed Systems*, 20(1): pp. 5-19. DOI: 10.1080/17445760500033291.

[29] Anna Vallgårda and Johan Redström. 2007, Computational composites. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '07)*, San Jose, California, USA, Association for Computing Machinery, New York, NY, USA. 513–522. DOI: 10.1145/1240624.1240706.

[30] Anna Vallgårda and Tomas Sokoler. 2009, A material focus: exploring properties of computational composites. In *CHI '09 Extended Abstracts on Human Factors in Computing Systems (CHI EA '09),* Boston, MA, USA, Association for Computing Machinery, New York, NY, USA. 4147–4152. DOI: 10.1145/1520340.1520631.

[31] Ron Wakkary, William Odom, Sabrina Hauser, Garnet Hertz, and Henry Lin. 2015. Material speculation: actual artifacts for critical inquiry. *In Proceedings of the Aarhus Conference on Critical Alternatives,* DOI: 10.7146/AAHCC.V1I1.21299.

[32] Wen Wang, Lining Yao, Teng Zhang, Chin-Yi Cheng, Daniel Levine, and Hiroshi Ishii. 2017. Transformative appetite: shape-changing food transforms from 2D to 3D by water interaction through cooking. *In Proceedings of the the 2017 CHI Conference on Human Factors in Computing Systems,* 6123-6132. DOI: 10.1145/3025453.3026019.

[33] Michael Wehner, Ryan L. Truby, Daniel J. Fitzgerald, Bobak Mosadegh, George M. Whitesides, Jennifer A. Lewis, and Robert J. Wood, 2016, An integrated design and fabrication strategy for entirely soft, autonomous robots. *Nature*, 536(7617): pp. 451-455. DOI: 10.1038/nature19100.

[34] M. Wiberg, 2018. The Materiality of Interaction: Notes on the Materials of Interaction Design. MIT Press.

[35] Mikael Wiberg and Erica Reyna Robles, 2010, Computational Compositions: Aesthetics, Materials, and Interaction Design. *International Journal of Design* [Online] 4:2. DOI: http://www.ijdesign.org/index.php/IJDesign/article/view/757/301

[36] Qiongdi Zhang, Ming Zhang, Lyas Djeghlaf, Jeanne Bataille, Jean Gamby, Anne-Marie Haghiri-Gosnet, and Antoine Pallandre, 2017, Logic digital fluidic in miniaturized functional devices: Perspective to the next generation of microfluidic lab-on-chips. *ELECTROPHORESIS*, 38(7): pp. 953-976. DOI: https://doi.org/10.1002/elps.201600429.