

References List

0 Project Brief

Tran, J. L. (2016). 3D-printed food. *Minn. J. Sci. & Tech.*, 17, 855.

Verganti, R. (2013). *Design driven innovation: changing the rules of competition by radically innovating what things mean*. Harvard Business Press.

Wagner, C. (2009, September). 'The Japanese way of robotics': Interacting 'naturally' with robots as a national character?. In *Robot and Human Interactive Communication, 2009. RO-MAN 2009. The 18th IEEE International Symposium on* (pp. 510-515). IEEE.

1 Approach

Verganti, R. (2013). *Design driven innovation: changing the rules of competition by radically innovating what things mean*. Harvard Business Press.

2 Technology and Meaning Deconstruction

2.1 Technology Deconstruction

Diaz, J.V., Van Bommel, K.J.C., Noort, M.W., Henket, J., Brier, P., 2014. Preparing Edible Product, Preferably Food Product Including Bakery Product, and Confectionary Product, Involves Providing Edible Powder Composition, and Subjecting Composition to Selective Laser Sintering. *Nederlandse Org Toegepast Natuurwetensch (Nede-C)*.

Godoi, F. C., Prakash, S., & Bhandari, B. R. (2016). 3d printing technologies applied for food design: Status and prospects. *Journal of Food Engineering*, 179, 44-54.

Hao, L., Seaman, O., Mellor, S., Henderson, J., Sewell, N., Sloan, M., 2010b. Extrusion Behavior of Chocolate for Additive Layer Manufacturing, *Innovative Developments in Design and Manufacturing - Advanced Research in Virtual and Rapid Prototyping*, pp. 245e250.

Lajoie, E. W., & Bridges, L. (2014). Innovation Decisions: Using the Gartner Hype Cycle. *Library Leadership & Management*, 28(4).

Lipton, J., Arnold, D., Nigl, F., Lopez, N., Cohen, D. L., Norén, N., & Lipson, H. (2010, August). Multi-material food printing with complex internal structure suitable for conventional post-processing. In *Solid Freeform Fabrication Symposium* (pp. 809-815).

Sher, D., & Tutó, X. (2015). Review of 3D food printing. *Temes de disseny*, (31), 104-117.

Wegrzyn, T.F., Golding, M., Archer, R.H., 2012. Food Layered Manufacture: a new process for constructing solid foods. *Trends Food Sci. Technol.* 27 (2), 66e72.

2.2 Meaning Deconstruction

Gibson, I., Rosen, D. W., & Stucker, B. (2010). *Additive manufacturing technologies* (Vol. 238). New York: Springer.

Verganti, R. (2013). Design driven innovation: changing the rules of competition by radically innovating what things mean. Harvard Business Press.

Raghavan, K. (2016, July 14). 5 reasons why consumer 3D printing is going the way of the dodo. Retrieved February 25, 2017, from <https://stratnel.com/2016/07/14/5-reasons-why-consumer-3d-printing-is-going-the-way-of-dodo-2/>

2.3 Cooking process

Bourne, M. (2002). Food texture and viscosity: concept and measurement. Academic press.

Lee, K. (2015, October 12). INTERVIEW: We Talk to Natural Machine's Lynette Kucsma About the Foodini 3D Food Printer. Retrieved March 2, 2017, from <http://inhabitat.com/interview-we-talk-to-natural-machines-lynette-kucsma-about-the-foodini-3d-food-printer/>

McCormick, R. (2015, May 11). Even junk food becomes food porn on Instagram. Retrieved March 5, 2017, from <http://www.theverge.com/2015/5/11/8588291/junk-food-food-porn-chef-jacques-la-merde>

Nikkei Asian Review (2017, February 18). Food taking bigger bite out of Japanese households' spending. Nikkei Asian Review. Retrieved March 2, 2017, from <http://asia.nikkei.com/Politics-Economy/Economy/Food-taking-bigger-bite-out-of-Japanese-households-spending>

Perasso, E. (2016, September 23). THE BIG DATA OF #FOODPORN TRENDS. Retrieved March 2, 2017, from <https://www.finedininglovers.com/stories/food-porn-trends-big-data/>

Schiffman, S. S., Musante, G., & Conger, J. (1978). Application of multidimensional scaling to ratings of foods for obese and normal weight individuals. *Physiology & Behavior*, 21(3), 417-422.

Sun, J., Peng, Z., Yan, L. K., Fuh, J. Y. H., & Hong, G. S. (2015). 3D food printing—An innovative way of mass customization in food fabrication. *International Journal of Bioprinting*, 1(1), 27-38.

Szczesniak, A. S., & Kahn, E. L. (1971). Consumer awareness of and attitudes to food texture. *Journal of Texture Studies*, 2(3), 280-295.

VICE Media LLC (Producer). (2016, April 13). Food Hacking: Food Perfume [Video file]. Retrieved March 10, 2017, from <https://munchies.vice.com/nl/article/food-hacking-food-perfume>

2.4 Clustering key qualities

3 Deconstructing the Context

3.1 Cultural Framework and Social Shifts

Hofstede, G. H., & Hofstede, G. (2001). Culture's consequences: Comparing values, behaviors, institutions and organizations across nations. Sage.

Hofstede, G. (2011). Dimensionalizing cultures: The Hofstede model in context. *Online readings in psychology and culture*, 2(1), 8.

Beugelsdijk, S., Maseland, R., & Hoorn, A. (2015). Are scores on Hofstede's dimensions of national culture stable over time? A cohort analysis. *Global Strategy Journal*, 5(3), 223-240.

Nikkei Asia Review. (2016, October 27). Seniors 75 and older outnumber children in Japan. Nikkei Asia Review. Retrieved March 14, 2017, from <http://asia.nikkei.com/Japan-Update/Seniors-75-and-older-outnumber-children-in-Japan?page=1>

Nikkei Asia Review. (2017, April 10). Japan's population to plummet 30% by 2065. Nikkei Asia Review. Retrieved April 17, 2017, from <http://asia.nikkei.com/Japan-Update/Japan-s-population-to-plummet-30-by-2065>

Oi, M. (2015, March 16). Who will look after Japan's elderly? BBC News. Retrieved March 5, 2017, from <http://www.bbc.com/news/world-asia-31901943>

3.2 Techno-Intimacy

The Economist. (2016, September 01). I don't. Retrieved February 26, 2017, from <http://www.economist.com/news/asia/21706321-most-japanese-want-be-married-are-finding-it-hard-i-dont>

Aoki, M. (2016, September 16). In sexless Japan, almost half of single young men and women are virgins: survey. The Japan Times. Retrieved March 5, 2017, from http://www.japantimes.co.jp/news/2016/09/16/national/social-issues/sexless-japan-almost-half-young-men-women-virgins-survey/#.WNf_WRhh2Aw

Allison, A. (2000). Permitted and prohibited desires: Mothers, comics, and censorship in Japan. Univ of California Press.

Grassmuck, V. (1990). I'm alone but not lonely: Japanese otaku-kids colonize the realm of information and media. A Tale of Sex and Crime from a Faraway Place, in www.race.u-tokyo.ac.jp.

Greenfeld, K. (1993). "The Incredibly Strange Mutant Creatures who Rule the Universe of Alienated Japanese Zombie Computer Nerds (Otaku to You)," Wired. <http://www.wired.com/wired/archive/1.01/otaku.html>

Lowry, R. (2015, September 15). Meet the Lonely Japanese Men in Love With Virtual Girlfriends. Retrieved March 26, 2017, from <http://time.com/3998563/virtual-love-japan/>

Gatebox. (2016, January 20). Gatebox. Retrieved March 19, 2017, from <http://gatebox.ai/>

McFaul, T. R. (2010). The future of truth and freedom in the global village: modernism and the challenges of the twenty-first century. Pg. 93. ABC-CLIO.

Morris, D. Z. (2016, December 18). The Creepy Virtual Assistant That Embodies Japan's Biggest Problems. Retrieved February 27, 2017, from <http://fortune.com/2016/12/18/gatebox-virtual-assistant-japan/>

Atomicrowd. (2016, December 24). Sadder Than HER, Creepier than Black Mirror: Gatebox's AI Assistant. Retrieved March 14, 2017, from <http://atomicrowd.com/gatebox-ai-assistant/>

Inagaki, K. (2017, February 1). Japan's robot chefs aim to show how far automation can go. Retrieved February 10, 2017, from <https://www.ft.com/content/9b72c5a6-d680-11e6-944b-e7eb37a6aa8e>

3.3 Diet and Health

OECD. (2014, June). Obesity Update. Retrieved February 18, 2017, from <http://www.oecd.org/health/Obesity-Update-2014.pdf>

Nobuko, I. (2014, March 5). Traditional Japanese Cooking in the Home: An Endangered Art. Retrieved March 20, 2017, from <http://www.nippon.com/en/currents/d00110/>

Marsh, S. (2016, May 17). 'Many suffer but no one talks about it': the rise of eating disorders in Japan. The Guardian. Retrieved March 20, 2017, from <https://www.theguardian.com/world/2016/may/17/many-suffer-but-no-one-talks-about-it-the-rise-of-eating-disorders-in-japan>

Sullivan, S. (2017, April 28). Wearables Aren't Dead, But They Deserve To Die. Retrieved April 29, 2017, from <https://www.fastcodesign.com/90112197/wearables-arent-dead-but-they-deserve-to-die>

3.4 Becoming a maker

Japan Trends. (2016, March 23). *Maker culture and fab lab booming in Tokyo*. Retrieved April 01, 2017, from <http://www.japanrends.com/maker-culture-spaces-fab-labs-hackerspaces-tokyo/>

3.5 Creativity Through Technology

VICE Media LLC (Producer). (2016, April 13). *Food Hacking: Recipe Network* [Video file]. Retrieved March 10, 2017, from <https://munchies.vice.com/nl/article/food-hacking-recipe-network>

Brandt, R. (2016, January 11). *Chef Watson has arrived and is ready to help you cook*. Retrieved April 01, 2017, from <https://www.ibm.com/blogs/watson/2016/01/chef-watson-has-arrived-and-is-ready-to-help-you-cook/>

3.6 Ease of Acquisition

Tokyo Metropolitan Government. (2016). *TOKYO'S HISTORY, GEOGRAPHY, AND POPULATION*. Retrieved March 29, 2017, from <http://www.metro.tokyo.jp/ENGLISH/ABOUT/HISTORY/history03.htm>

Nussey, S. (2017, April 27). *Convenience stores are part of Japan's 'social infrastructure,' but labor crunch threatening that role*. Japan Times. Retrieved April 27, 2017, from <http://www.japantimes.co.jp/news/2017/04/27/business/convenience-stores-part-japans-social-infrastructure-labor-crunch-threatening-role/#.WQcSfFKB2Aw>

Nikkei Asia Review. (2017, February 18). *Food taking bigger bite out of Japanese households' spending*. Nikkei Asia Review. Retrieved February 23, 2017, from <http://asia.nikkei.com/Politics-Economy/Economy/Food-taking-bigger-bite-out-of-Japanese-households-spending>

Harper, C. (2015) *This computer will grow your food in the future*. [Video File]. Retrieved from https://www.ted.com/talks/caleb_harper_this_computer_will_grow_your_food_in_the_future/transcript?language=en#t-213091

3.7 Quality and Value

Food Made Good. (2016, April 18). *What Makes Food Good?* [Video file]. Retrieved from https://www.youtube.com/watch?v=GrR1ZQ_FnIY&index=34&list=WL

Nikkei Asia Review. (2017, February 18). *Food taking bigger bite out of Japanese households' spending*. Nikkei Asia Review. Retrieved February 23, 2017, from <http://asia.nikkei.com/Politics-Economy/Economy/Food-taking-bigger-bite-out-of-Japanese-households-spending>

Pringle, P. (2010, July 23). *Monozukuri - Another Look At A Key Japanese Principle*. Retrieved April 20, 2017, from <http://www.japanintercultural.com/en/news/default.aspx?newsid=88>

Gelb, D. (Director). (2012). *Jiro Dreams of Sushi* [Video file]. Netflix. Retrieved April 14, 2017.

Hall, M. S. (Director). (2012). *Sushi: The Global Catch* [Motion picture].

Gelb, D. (Director). (2017). *Chef's Table: S03E04 Ivan Orkin* [Video file]. Netflix. Retrieved April 20, 2017.

RamenAdventures. (2016, December 1). *Michelin Starred Ramen 2017 (Tsuta and Nakiryu)*. Retrieved April 25, 2017, from <http://www.ramenadventures.com/2016/12/michelin-starred-ramen-2017-tsuta-and.html>

Tani, S. (2016, October 12). *The secret war in Japan's sushi industry*. Nikkei Asian Review. Retrieved March 5, 2017, from <http://asia.nikkei.com/Life-Arts/Japan-Trends/The-secret-war-in-Japan-s-sushi-industry?page=1>

Wisdom, P. (2016, September 19). *Women Still Struggle to Be Taken Seriously as Sushi Chefs in Japan*. Retrieved March 28, 2017, from https://munchies.vice.com/en_us/article/women-still-struggle-to-be-taken-seriously-as-sushi-chefs-in-japan

Appendix

Appendix A:	3D FOOD Printing Initiatives	1
Appendix B:	Interviews Meaning and Interaction	4
Appendix C:	Process Visuals	
C.1	Generic 3D Printing Process	12
C.2	Cooking Process	12.5
C.3	Cooking Process Roles	13
C.4	Overview Key Qualities	14
Appendix D:	Japan Expert Interview	
D.1	Igarashi Takeo	16
D.2	Kita Yui	20
D.3	Sugawara Yoshiharu	24
D.4	Hopson, Nathan	26
Appendix E:	Hofstede's Cultural Dimensions	30
Appendix F:	Contextual Factors Overview	
Appendix G:	Cold Smoking Test	
Appendix H:	Human-Robot Collaboration in Creation Process	

Appendix A - 3D Food Printing Initiatives

Overview of 3D Food Printer Initiatives

Year	Name	Maker	Method	Material	Coordination	Commercial	Size	Comments
2009	CandyFab 6000	Mad Evil Scientist Lab	Hot Air Sintering (not laser)	Sugar	XYZ Cartesian Slider	No		
2010	Digital Fabricator Concept	MIT	FDM	Purees	XYZ Cartesian Slider	No, Research		
2010	Robotic Chef Concept	MIT	Various Operation Method	Fresh Products	XYZ Cartesian	No		
2010	Virtuoso Mixer Concept	MIT	Mixer	Liquids		No		
2010	Digital Chocolatier	MIT	FDM (sort of)	Chocolate				
2010	Food Jet	FoodJet Printing Systems	MJ (material jetting)	Liquid Based / Chocolate / Sauces / Sugar	XY Cartesian Slider	Yes, service		Gelderland
2012	Imagine 3D Printer	Essential Dynamics	FDM	Peanut butter / chocolate / cookie dough	XYZ Cartesian Slider	Yes, 3000USD		
2012	Senepro / Performance	Biozoon	FDM (?)	Chicken, Potatoes, cauliflower, pork, peas and even pasta	XY Cartesian Slider	No		
2012	Universal Paste Extruder	Richard Horne	FDM	Paste (incl edibles)	XYZ Cartesian Slider	No, opensource		
-	Food Printer Concept 3 Arm	TNO	FDM	Purees	-	No, Research		
-	Food Printer Concept 2 Arm	TNO	FDM	Purees	-	No, Research		
2014	NuFood	Doverlaid	Ink Jet in Water bassin	Gels	Scalar			
2014	Insects au Gratin	Susana Soares	FDM	Insects	XYZ Cartesian	No, Research		
2014	Gandy	3D Ventures	FDM	Sugar / Chocolates	XYZ Cartesian	Yes, kickstarter		
2014	ChefJet Pro	3D Systems	BJ (BinderJetting)	Sugar / edible ink	XYZ Cartesian Slider + PowderBed	Yes		
2014	ChocJET	ChocJET	FDM	Chocolate	XYZ Cartesian Slider	Yes, service		Amsterdam
2015	XYZ Food Printer	XYZ Printing	FDM	Purees / Cookie dough / chocolate	XYZ Cartesian Slider	Yes	150x150x200mm	Taiwan
2015	QiaoKe Food 3D Printer	3D Cloud / Becoda	FDM	Chocolate	XYZ	Yes		China
2015	ChocCreator 2.0 plus	ChocEdge	FDM	Chocolate	XYZ Cartesian Slider	Yes	185x185x50mm	
2015	Focus	3D by Flow	FDM	Plastis / edibles	XYZ Cartesian Slider	Yes, kickstarter		Maastricht, foldable
2015	Barilla Pasta Printer	TNO x Barilla	FDM	Pasta dough	XYZ Cartesian Slider	No		4 pieces per 2min
2015	CocoJet	3D Systems	FDM	Chocolate	XYZ Cartesian Slider			
2015	FOVAPaste	ORD Solutions	FDM	Frosting / Doughs /etc	XYZ Cartesian Slider	Yes		
2015	Foodini	Natural Machines	FDM	Purees	XYZ Cartesian Slider	Yes		
2016	Busochi	Team Busochi	FDM	Marzipan	XYZ Cartesian Slider	Yes, kickstarter	100x100x130mm (Junior) 150x150x150mm (Pro)	
2016	PancakeBot	PancakeBot	FDM	Batter	XY Cartesian Slider	Yes, 300USD		

Appendix B - Interviews

Meaning and Interaction

Overview of Interviewees

#1: Aaron Bislip

- Owns multiple 3D printers / Uses 3D printers for profession / Built 3D printers

#2: Moritz Theiselmann

- Uses 3D printers for profession / has unlimited access

#3: Samy Ralph Andary

- Owned a 3D printer / Uses 3D printers for profession / has unlimited access /

Interview 1: Aaron Bislip | 3D Hub owner / Architecture student

Introduction

“ My name is Aaron Bislip, I am an architecture student at TU Delft. I am also as a student assistant in helping students with 3D printing, modeling and making. Aside from the curriculum, I have a business around 3D printing. Most of what I do is, I have a 3D hub. So I get orders from people and I print what people want. I’ve been working with 3D printing for 6 years.”

Subject 1: The design process and workflow

- Can you tell about your workflow or the process steps you always have to take?

“It’s a very simple workflow. The printer is a stupid device that is offline and receives commands. Commands are sent in a G-code file, which you make on your computer. The user doesn’t do any of the slicing or creating the G-code, they only do the modeling.”

“My clients, they don’t know anything about 3D printing except that it’s a technology that they can use to get the shape they want. “I often call and talk with people. They are often not from 3D hubs but from the faculty of architecture who know I’m an expert. They look at as a tool like in the workshop. Whereas some people don’t know how to use the circular saw, you’re not allowed to use it. I think they look at it in the same way. You have an operator that knows how it works and the students or clients know how to make a model and deliver it. The operator (which is me) makes sure it is printed in the right settings, orientation, etc. When people model,

they keep some things in mind. And I specifically tell them and because it's an obvious thing. It prints with a nozzle that has a minimal thickness so they cannot go smaller."

In the case of printing for himself "I come up with an idea, sketch it really roughly and then I make it in Rhino (a 3D CAD software). Or I just skip the sketching and draw it straight away in CAD. I draw it in Rhino with minimal thicknesses and no overhangs that are too large. It's basic things that you know from experience, from lots of mistakes from the printer. After finishing the model, I export it to an .STL file, a mesh. You input that into G-code conversion software. And there are even integrated applications that you can link your printer with."

Steps: Idea > Sketch > 3D CAD > Export > Slicing > G-code > Send > Print (> Clean print bed)

"So basically only 3D modeling skills are absolutely required."

- Is the first print always the right one?

"Well, in my case, I have gained a lot of experience and have been doing it for 6 years. When I print something, 90% of the time it works and I'm happy with it. Then again, I don't make the same mistakes, I know how to make the model and I've spent my hours."

- How much work is it really to get the end result?

"If you keep the model simple and just keep to the principles, you can't fail the first time. Really."

- How do you solve those issues?

"You know when you own a printer and know how the machine works. The accessibility to this knowledge is enormous, because it's open source and because there is such a large community. You learn a lot of different things about a lot of different fields you wouldn't learn otherwise. And you also learn how the machine works. You learn how a stepper motor works, you learn how the electronics are coded. You also know what's wrong with it. And most of the time, it's your mistake."

"And the problem indicator lights. Printers still miss those problem indicators lights that cars have."

Subject 2: Meaning and relationship

- How does a 3D printer make your life better?

It makes my life WAY better. Look, you have this slave which you have no moral problems with having, that makes things for you. It makes you understand the world in a very definite way. Because it's own world view is non-existent but look at the magic it creates anyway. And you understand that this beautiful entire process is just a series of tiny processes. The motor that moves, the electronics are just sending electrons that just follow the path of least resistance that we, humans, designed because we know we can use electricity to our benefit.

Whereas my view is that I just enjoy the process and the end-result as well (which is an understanding that you can have as a human being).

Philosophical Answer:

3D printing helped me expand my knowledge incredibly. By extension, also changed my life philosophy. You understand that when you do something, something else happens for a reason. And it's consistent. You have your point of view (which is tiny), your biases, your cultural background and all that kind of stuff and that defines you. You are not defined by what reality per se is. Within the very little that you know, the most that you can do is with the knowledge you are most certain achieve the best things for yourself. Knowledge is power.

It's the extra knowledge that I gained in different subjects and you see that everything is quite simple and in terms of human understanding, very understandable. With the understanding with these very small specs of knowledge. You become certain of the correctness of that very little knowledge you have. With that very small certain knowledge, you can achieve a lot.

Everything happens for a reason, logically. Whether you understand it or not, that's a different question.

- If you were to describe your relationship with this thing as if it was your pet, how would you describe it? Needs lots of attention? Or super autonomous and reliable?

“Everything I own and is good for my life, I give a name. So printers all have names. My first 3D printer was called Stanley. And I killed Stanley and used its parts for a circuitboard for a snackbar that has a lighting fixture I made for them. I use the motors to make a few other machines with it. I think I have one of its motors still lying around somewhere. I don’t have a very emotional relationship to things at all. And more importantly, I understand that they work only because of the components that make them. Remember, Stanley is not one thing; it’s a motor, and electricity and another motor and a circuitboard that makes it work. I don’t see a reason to get attached to a series of components which get damaged and need to be changed. But I can always remake Stanley if I want to. I have all the files and components.”

“It needs a lot of attention.”

“What I also need to say about workflows, and not just 3D printers, but machines in general. When you look at machines for metal working. You have preparation, making the actual thing and then, after that, cleaning everything.

With a 3D printer, you don’t care at all. You start the print, you clean the bed every now and then. The amount of work is very much relatable to this generation. At least, that’s my observation. I never develop workflows because all my work happens behind the computer screen. In applications, when you use a tool, the previous tool goes automatically back to its place. Try doing that in real life.”

Subject 3: Everyones

- Owning a 3D printer, is this a thing for everybody? Why so, why not?

“For consumers? It is a market that is not representative of reality. It’s not that consumers want 3D printers. They don’t know where to start. It’s a “what am I going to do with a 3D printers?”.

“As a consumer, you see a black box of which you don’t understand the process and then something comes out of it, which you like.”

“It’s not the consumers but there are specific people that want it. Pretty much every architecture firm has one but don’t use it. They don’t know how to use it and it usually makes them change their workflow.”

“You need an intelligence to understand which settings you need to get the best result. That’s the challenge. And in the case of a Form1 (experience of the interviewer), is that it’s a refined product. So that it’s easy to use for the user that doesn’t understand what’s going on. There is an interface between you and the end result. That’s what many companies are going for, if they want to reach the consumer.”

“And with a regular paper printer, you have some paper formats and maybe a few different settings. But with 3D printers, you have an interface for low, medium and high quality. But you have so many variables for quality and speed. What is quality? Is it resolution? Because this won’t tell much about the mechanical properties.

“Plus you need to make sure your printer always works and never fails. So you need to engineer the machine properly and make sure there can be NO mistakes.”

“If it is well engineered and if the model is well built. And can the consumer build a good model, I don’t see why not because consumers have more time to invest in themselves.”

- Ever heard of 3D food printers? Would you think the same of these printers?

“Let me put it this way, I think that the vision is not representative of reality, that people want this in their kitchen. Often times it’s marketing and hype. And you got a crazy idea and that some people go for it and that’s what you see with this and many other Kickstarter printers coming out. And with the internet, you see a lot of unrefined products coming out.”

-

“I mean, out of practical reasons, what is it that it’s doing? You already have the food, it’s not producing the food. It’s just making it

nice for you. If you're talking about a cooking machine, perhaps that would be different. It's not even food processing I would say, it's more food drawing."

-

I think that a small business that needs automation in their workflow can definitely profit from a technology like this. I will probably for a specific part in the workflow but still very helpful.

Finishing up

- Do you have any question? No
- Can I use your name and input on my website blog? Yes
- Do you wanna stay connected? We'll have more contact

Interview 2: Moritz Theiselmann | Creative Technologist @ Random Studio

Introduction

- **Can you tell a bit about yourself; your name and occupation?**

My name is Moritz Theiselmann. Working as a creative technologist at Random Studio in Amsterdam.

- **How are you in contact with 3D printers?**

At the moment not anymore, because we had to sell our 3D printer, but there is the idea to buy a FDM-based one again. At Random studio, we used to a lot to build motor mounts and cogwheels and pulleys. We used professional printed parts for clients projects. We did prototyping and testing with our own printer and then sent everything to a supplier like Materialized to get it printed it big quantities.

- **What kind of printers and how often?**

Most experience I have is with the Makerbot, Ultimakers. Before this studio, it was a similar studio with installation jobs. Also at my university, we had a Makerbot.

- **How long have you been working with it?**

My first time was around 6 years ago, the first Ultimaker version.

Subject 1: The design process and workflow

- **Can you tell about your workflow or the process steps you always have to take?**

I usually don't do any normal sketches, I start immediately in 3D. If it's a functional part for a motor, I usually do it in Autodesk Fusion 360. If it's a bit more organic shaped, I use Cinema4D. **The software is free for students, freelancers and small companies. Cinema4D is obviously not free, I think around 3-4k euros.** Maybe also a student free license.

I start from designing from scratch in 3D. **It's mostly going back and forth; designing something and printing and testing it.** Especially, in the beginning with a new printer or material. They all behave a bit different. Some of them shrink more. This is especially with technical small parts. If it's an object, such as a head, sizing doesn't really matter. In the beginning it's mostly getting a feeling for the printer, material, perfect settings.

(Idea in 3D CAD > Measuring and Dimensions of CAD > Printing > Testing > Adjusting 3D CAD > (iteration cycle)

- **Is the first print always the right one?**

If you know your printer and if you're experienced enough. After a while you get a feeling for it.

- **How do you solve those issues?**

We didn't. We have the Formlab Form+. It was the first version and the problem was the maintenance. Every tiny bit of dust could harm the print so it needed constant cleaning. Also not suitable for working with multiple people. The parts needed to be cleaned all the time. Then we replaced it and then it worked for a bit and then it went wrong again. There were also other causes. I think I know what happened.

We had really good support from the company. They sent us parts for free, twice. Because I worked with it so many times and cleaned/maintained all the time, I had a good idea what was wrong all the time. But it was just painful and annoying to fix it, costing a lot of time and effort.

I also think that FDM printers are just more reliable than SLA.

Subject 2: Meaning and relationship (owning and not owning)

- **How does a 3D printer make your life better? (when using it and also when owning it)**

So I don't own a 3D printer personally. But I think that if you have one, you realize how useful it can be. If you don't have it, sometimes it doesn't really matter. When having it, you realize you can make a lot of things with it and solve little problems quite easily. Especially if you do prototyping. Totally depends what your profession is. I know that a lot of architects that use 3D printers, it's just way too much work. Easier to make with wood or paper.

I would like to own one, might be a bit costly for one person. But there are lot of cheap Kickstarters for 200-800euros. And then it depends what you're using it for and what quality you're expecting.

- **If you were to describe your relationship with this thing as if it was your pet, how would you describe it? Needs lots of attention? Or super autonomous and reliable?**

It depends on the printer. I used a Makerbot quite a lot. It took little bit of time and effort to make it work. You had to play around with it and test it. And find out what you can print, because obviously you can't print everything, you have to make sure your model is printable. I think it's just in the beginning, it takes time and after a while it gets easier and easier. Also depending on what you want to print. Highly detailed and complex takes more time and effort.

So basically it's like a dog that you have to train and get to know and after some time it's all good and familiar. And it's not like you can't use it from the beginning, it's just depends on what you want to print.

With the Formlabs (SLA) it was just too much maintenance. But the newer model apparently had all the problems solved that we were having. It's a much better product for the same price.

Subject 3: For everyone?

- **Owning a 3D printer, is this a thing for everybody? Why so, why not?**

I think it was a few years ago, that they were saying that everybody will have a printer in 2 or 3 years. And then Makerbot got bought up by a bigger company, the prices went up and it wasn't affordable for most people anymore. I think it's unrealistic. I don't think everybody has a need or wants a 3D printer. 3D printing is one thing but you also need some kind of knowledge to design the model or use open-source models.

- **Ever heard of 3D food printers (explain if not known)? Would you think the same of these printers?**

It's a bit like a NASA product. When printing a pizza, it's different materials and different nozzles. The biggest problem is probably the printing time. If you print something like a pasta, it takes like 5 minutes. But if you want to have a bowl, it'll take like 5 hours. So it definitely needs to be faster.

You already have the food, it just makes it in a different shape and nice. The material that goes in there, either in a liquid kind of substance or a filament, you can probably just eat it like this. So it's not doing something from out of nothing. It's not really interesting. With 3D printing, you have plastic (for example) and you can build something that you can use for something else. For printing food, you just print something to eat it and then it's gone. So you don't really have to bring it in a certain shape. Unless you just want to make it look nice.

I remember during my studies, we wanted to make something similar to this. The idea was to track yourself over the day with some device. It tracks your movement and the energy you burn in a day. It would connect to your printer and then prepare a dish for you (based on your data). You would come home, and there's a dish ready and you can eat it.

Finishing up

- Do you have any question?
- Can I use your name and input on my website blog?
- Do you wanna stay connected? **Yes**

Interview 3: Samy Andary | Industrial Design Engineer / Entrepreneur-Founder of Crescent Alpha

Introduction

- **Can you tell a bit about yourself; your name and occupation?**

Samy Ralph Andary, an industrial design engineer with an entrepreneurial mindset. Founder of Crescent Alpha, a startup for VR camera headsets for surgeons.

- **How are you in contact with 3D printers?**

For prototyping of my designs. First time was Bachelor thesis project, then with MSc subjects and then thesis. That was one month full on printing, cleaning, processing. And after graduating, I've been working with it for months at the workspace in Amsterdam, having 3 different printers at my command.

- **What kind of printers and how often?**

Using Ultimakers and Lulzbot (better for flexible materials).

- **How long have you been working with it?**

3-4 years ago.

Subject 1: The design process and workflow

- Can you tell about your workflow or the process steps you always have to take?

The beautiful thing about 3D printing for me is iteration. My work flow definitely changed using 3D printers. At first, it was prototyping with foam, clay or something else and printing my final design (because it was accurate). Now, it's immediately printing the first attempt, checking the dimensions and performance, considering adjustments and immediately print the second version. I just skip the foam, wood (i still love using clay) nowadays.

Point being, print it, check it, what can we do better and print again. **And when designing multiple parts, you redesign the first part in CAD while turning on the print for the second part. So the printer is always on and thus effectively using your time, instead of waiting on it.**

Basically, it's a shortcut in my workflow. The iteration cycle just gets really tiny and fast.

When I had access to a printer in the lab, it was from 8am till 9pm. But it was just too limited for my way of working. So I rented one, 25 bucks a day, and it was printing 10 days straight.

- Is the first print always the right one?

No. It's always exploring how the material will behave when you propose at certain mechanism or fitting.

And there are also things you get that you didn't anticipate on. For example, the fill-in texture, I appreciate that.

But no, often the print does not come out the way you hoped/wanted it to. (shows example) This band, I made a hole for a pin hinge, however the material flowed more than I thought and basically clogged the hole for the pin. Cura (slicer software) does not give any feedback on the properties on the material. It only slices the model.

And that is 3D printing in general. You only know how the material behaves when it comes out of the printer. Printers are basically stupid. And the newer models do they sensors to know which material is in there and camera's to check the progress and stuff.

- How do you solve those issues?

It's just constantly figuring out in that iterative process what goes wrong and adjusting the model to it. That's really it.

Subject 2: Meaning and relationship (owning and not owning)

- How does a 3D printer make your life better? (when using it and also when owning it)

Obviously depends on what you do. So for me as a designer and entrepreneur. **It bridges the gap between digital and analogue.** If you can make a beautiful 3D render, that's awesome. But I can't do that. I can make the model. So I can print it, make the actual real life photo and then give it to the customer and let him or her play with it. And of course, you can make these kind of models using different methods or tools, but that's usually time consuming. And, it's additive manufacturing instead of subtractive, using only the material you need. A more effective use of material.

As for owning one as opposed to just having access to one, it really depends per person. For me, I use it very frequently and I still wouldn't want to own one. It's makes a lot of noise and the noise itself isn't really pleasant. Those motors (3 of them) just make all kinds of sounds non-stop for hours.

At my home where 3 designers live, there is a 3D printer and it's collecting dust. Nobody uses it. In my opinion, it still doesn't have a place in the home. You can think of so many little problems you can solve around the house. So then, you have the tool but only one input material (which limits almost everything). It is as much work (if not more) to go through the entire process of 3D printing then ordering the replacement part (if available).

And then, even when you're a maker, you still don't want to own it, only have access to it. Even if it's just around the corner. And that's something I did hear, that supermarkets should/will have to change their entire interior for an experience where you have a

storage shop for raw materials and set of 3D printers operated by an expert that has knowledge and a database. That person doesn't have to buy materials because he already has those available. The same thing could happen to food.

- **If you were to describe your relationship with this thing as if it was your pet, how would you describe it? Needs lots of attention? Or super autonomous and reliable?**

I think it's an aquarium, not even the fishes but the tank itself. There are beautiful things in there, but then you have to really go there and look at it. You're not going to stare at your aquarium every single day. But once in a while, you just want to enjoy the beauty of an aquarium. Once in a while, you have to clean the glasses, maybe even full clean up. It's really not that much care. You don't have to maintain it everyday nor are you going to use it.

Subject 3: For everyone?

- **Owning a 3D printer, is this a thing for everybody? Why so, why not?**

Not now. I'm doubting it on short term but definitely on long term.

- **Ever heard of 3D food printers (explain if not known)? Would you think the same of these printers?**

Almost everybody has a 2D printer at home. But I think that's going to decrease because we're becoming so much more digital, as far as documents and whatnot. 3D printers (regardless what kind) take so much space, you just need a lot of space.

Where I see the printer, is the in-between moments. I don't see it as the three main meals. But it would be so convenient if there would be a constant supply of fresh crunchy veggie cookies (or something healthy). Almost as if you have a coffee maker, tea pot and a snack 3D printer.

It doesn't cook anything right? I think it should either cook or heat up (because that's just nice). You can also drink lukewarm water with a teabag in it — but we don't do that for a reason. As far as I'm concerned (and especially in a maker space such as here) with an open shared kitchen, that would be ideal.

I think that consumers wouldn't go through the whole process of making CAD files. It would be menus, just buying recipes and menu's online.

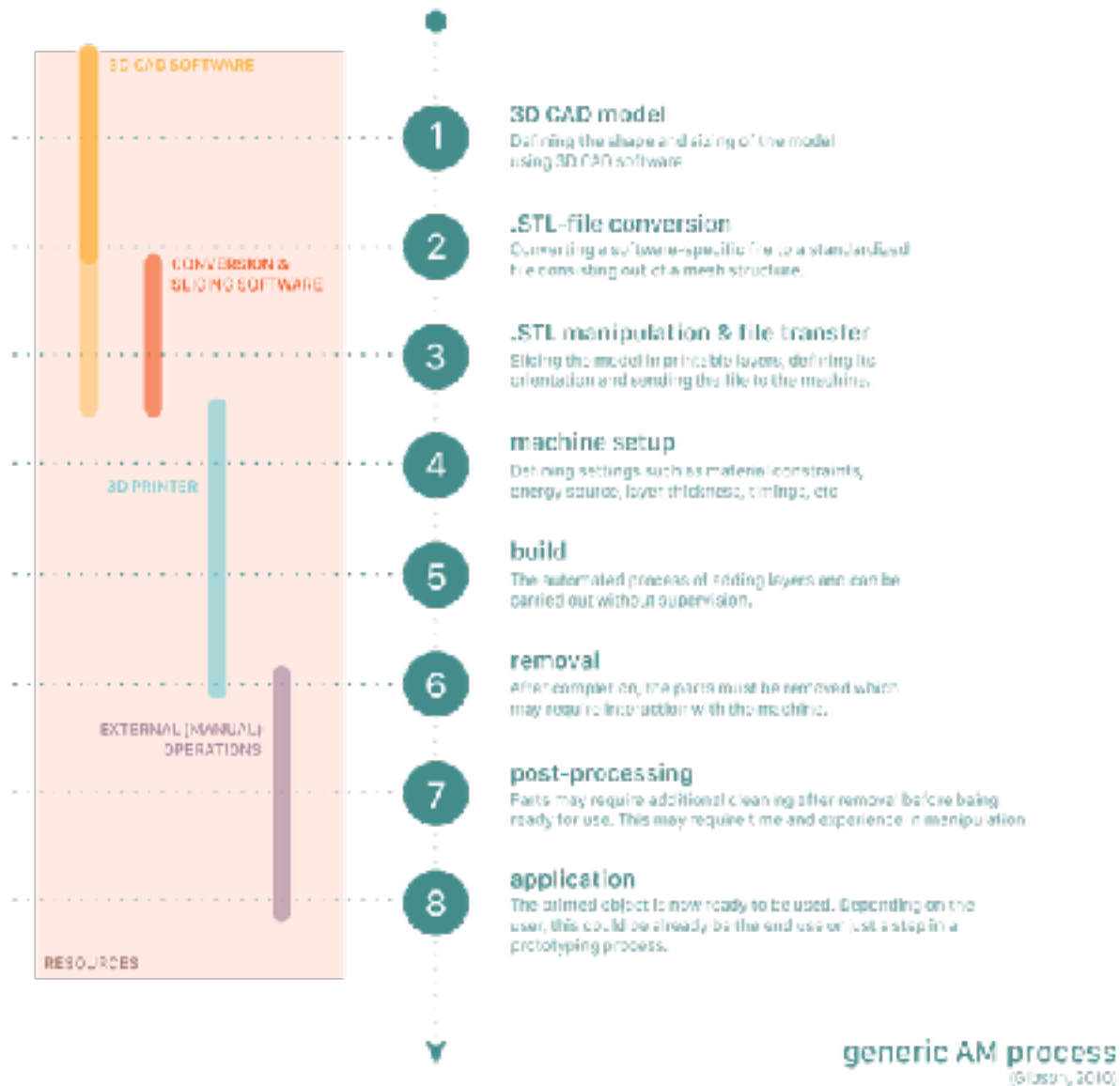
In my opinion, food printers are a given. It's going to happen. But my question is, who is the first person that is going to adopt this technology? Are those the chefs? I would seriously consider the co-maker space, so the kitchen in a shared space of makers (entrepreneurs and makers and such). They would say: "ah cool, we can make our own snacks everyday?". Or maybe just elderly home? Just pure for ease of use.

Finishing up

- Do you have any question?
- Can I use your name and input on my website blog?
- Do you wanna stay connected? **Yes**

Appendix C.1

Generic 3D Printing Process



Appendix C.3

Cooking Process Roles

TYPE OF USERS
based on involvement in cooking process

	recipe creation	meal preparation	meal consumption
characteristics	focus on creativity and innovation / using both knowledge of food and technology	functional knowledge of the technology / where it will fit in time and productivity	social experience / instant gratification / fun when you have an idea that
meaning of technology	Enabling the experimental side in the creation process by speeding up the iteration cycle and providing freedom in the app	Speeding up the workflow and decreasing the labor through automation	A novel technology that produces interesting/culinary dishes
relevant key qualities	Convenient / Personal and meaningful / Unique value / Evokes excitement / Complexity in presentation	Time efficiency / Some cooking skill / Unsupervised / Instant gratification / Unsupervised / no recipe watching required	Quarantine focus / Waste reduction / Novelty of technology
shortcomings	Shift in expertise / Accessibility to software / Need for more functionality beside shopping	Production line functionality / Frequent volume / Need for more functionality beside shopping	Taste / Some uniform recipe / Possible negative processed food associations

Appendix C.4

Overview Key Qualities

After deconstructing the technology and meaning, 26 key qualities have been identified that characterize 3D food printing:

1. Complexity in Composition (layered)
2. 1:1 Replication
3. Zero Cooking Skill
4. Shift in Skill Set
5. Instant Sharing
6. Connectivity / IoT
7. Quantified Food
8. Geometry Freedom and Manipulation
9. Waste Reduction
10. Unsupervised Operation/Autonomy
11. Mobility (free from kitchen)
12. Physical Required Volume
13. Isolated operating area
14. (Steep) Learning Curve
15. One Uniform Texture
16. Alternative Ingredients
17. Form complexity vs Nutritional value
18. Involvement in the entire process
19. Requires post-processing
20. Made by Robot, not human
21. Texture - improvement and innovation
22. Evokes experimentation
23. 24/7 Working hour
24. Increasing complexity, steady labor
25. Accessibility to software
26. Access to computation power

APPENDIX D - JAPAN EXPERTS

List of experts:

1. Takeo Igarashi (Professor Computer graphics @ Tokyo University)
2. Yui Kita (PhD @ Tokyo University)
3. Yoshiharu Sugawara (GK Dynamics President) - Informal talk about the subject
4. Nathan Hopson (Professor Nagoya Uni / Historian)
5. ~~Kyo Shimizu (Spatial Designer @ GK Kyoto) - Informal talk about the subject - Cancelled~~
6. ~~Kentaro Fukuchi (Professor Mathematics @ Tokyo University) (interview) - Cancelled~~
7. ~~Eric Hamilton (CEO @ Tech Company in Tokyo) - Cancelled~~

APPENDIX D.1

Takeo Igarashi (Professor Computer graphics @ Tokyo University)

Information

Name: Takeo Igarashi

Expertise area: Human interaction and computer graphics

Reason for seeking consultancy: Insights on 3D modeling software for non-designers

Type of contact: **Interview** (semi structured) / Discussion / Email / Chat

Insights/Highlights:

“This way you can just draw 2D strokes and get 3D models. With traditional software, this would be tedious to design, but here you can just quickly draw something and then get something. This is quickly for simple design and is used for communication.”

“I do not believe is efficient for just saving time. Usually we buy devices because it makes us do something that is not possible without it.”

“So in the case of using simplified 3D modeling software, the shapes are extremely basic. So in the case of cooking, I would just use hands which is faster. Because otherwise you have to design in the computer, send the data to the printer and so on. So it would make sense with plastic or metal.”

“If the software is too generic, the general purpose becomes difficult. But if you have a very specific target shape, it becomes easier. So if you specialize for a certain kind of shape, the specialized software we develop can make it easier and maybe make it worth doing because it cannot be done by hand.”

“The question is how you leverage computational power.”

“When talking about communication, people text everyday but not so much drawing. Taking into account that drawing 3D is even more complex than 2D, the current situation of 2D drawing already shows that it’s not an everyday thing.”

Results

Introduction

Hi, my name is Randy Kadarman, an industrial design master student at the TU Delft, The Netherlands. Right now, I am graduating on 3D food printing. The goal of the project is to design a 3D food printer for the Japanese society. I chose Japan because it has a long history in food aesthetics and relationship with robotics.

I am researching for whom the food printers are suited now (cooking enthusiasts or regular consumers) and in the future (5-10years) and which additional functionality is needed (how much of the cooking is being done by the machine). Right now, the food is only being shaped, but I expect people will want to have a better experience with cooked food of different textures. And it is only suited for people with 3d modeling skills and who can put time and effort in it.

I saw your work on teddy, sketch-based 3D modeling. And with 3D food printing, a big part of the process is the modeling part. I want to know the future of 3D modeling and how it can be accessible for consumers and if they would have time or desire to work their food like that.

- Can you tell a bit about yourself; your name and occupation?
- Can you tell about what you are working on at the moment?
- Do you have a relationship with food? Can you tell me more about that?

Takeo Igarashi, professor Computer Science here at University of Tokyo . My expertise is in Human interaction and computer graphics. In the computer graphics part, I have been working on Geometric modeling, so 3D modeling and also animations and so on. Originally I worked only on virtual 3D graphics, but lately, also more into physical stuff. So not just creating 3D graphics, but developing systems for designing physical objects such as a plush toy or clothing. I don't have a direct relationship with food, but my collaborators do have many projects in that area.

Subject 1 - Teddy

- Please tell me a bit about the Teddy software. How does it exactly work and what is needed to make it work?
- For whom do you think this is mostly useful? For a designer/student or perhaps maybe also for the regular consumer or maybe only for programmers? and why?
- What other technology or hardware would be needed to make the food network useful for normal people?
- Where is this software being used for now?

So basically you just sketch something and when you finished drawing, the computer generates a 3D model so you can see it from the top. This way you can just draw 2D strokes and get 3D models. With traditional software, this would be tedious to design, but here you can just quickly draw something and then get something.

So the goal of this software is not to replace professional 3D software, like animation product company or car or product design. This is the exact opposite. This is quickly for simple design and is used for communication. For example, you and I are talking right now about a 3D concept and when you have paper it's hard to communicate, so this tool is perfect for this application. Or perhaps in biology class explaining how bacteria looks like and showing the details in there. Or perhaps by a doctor who's explaining the problems of the patient and how to treat it. Actually high school teachers use this in a real class for geography when showing a mountain. My favorite example is the contour lines. You can draw the mountain from the side and give the different heights, the computer makes a 3D model and shows the height lines seen from above. This way the students can understand really well how those geographic maps work. So again, as I said, this is not designed for professional careful design for products and graphics. This is a communication tool.

This was used in a couple of commercial 3D modeling software and also games. You can draw your own character, like a pokemon character and then fight and everything. So games, 3D modeling and some smartphone apps.

And it's already available on your phones. And as 3D printing is getting popular nowadays, this is also sold and used as software for 3D printing.

Subject 2 - Level of Involvement

So when preparing food, you have three roles: the chef who makes the recipe, the cook who prepares the food in the kitchen (mostly a person have both roles of chef and cook) and the consumer who eats the food. I am researching how people are still involved in cooking and creativity.

- First, a simple question: How often do you cook yourself? And do you have enough time to cook? Why is that?

- Are you more a chef and make your own recipes or more a consumer? How do you think this is changing?
- Do you think people will have time for making their own created recipes in 3d models and meals? Why?
- How will new technology fit inside a person's house? or will it have to be in a cafe or restaurant or office?

I cook everyday and most of the times I have enough time to cook. As for the workload, it depends on how far the technology is. But in theory, if I have more technology and machines in the kitchen, it takes more time to prepare and more time to wash it. So in Japan, you usually have a rice cooker, maybe a coffee machine and maybe some other devices. And of course, it also takes space in the kitchen. I do not believe is efficient for just saving time. Usually we buy devices because it makes us do something that is not possible without it. So in the case of using low threshold 3D modeling software, the shapes are extremely basic. So in the case of cooking, I would just use hands which is faster. Because otherwise you have to design in the computer, send the data to the printer and so on.

So I think that software such as Teddy are not per se suited for food or soft material. If you want to print hard material, like plastic, you cannot do such a thing by hand. So it would make sense with plastic or metal.

So the thought behind Teddy is this: modeling clay using hands is very easy. But in the computer using a mouse it can be really difficult, that why we developed this software. But if you have your hands and the material, it is much easier that way.

So if you design software specifically designed for constructing complicated shapes, then we can definitely develop easy-to-use software for this kind of complicated shapes. The most important concept behind this software is: If the software is too generic, the general purpose becomes difficult. But if you have a very specific target shape, it becomes easier. So that is an important lesson to learn. In this case, the software of Teddy is specifically designed for stuffed animals, which now becomes easier. So if you specialize for a certain kind of shape, the specialized software we develop can make it easier and maybe make it worth doing because it cannot be done by hand.

The question is how you leverage computational power.

So this one is a software for designing your own custom paper airplane. The thing is that designing a custom paper airplane is very difficult. If it's poorly designed, it does not fly, it just falls. And with the consideration of interaction between air and material and gravity is very difficult. But the computer can run simulations. So this software lets you sketch a shape of an airplane and the system continuously runs flight simulations. Which gives real-time feedback on the performance of your custom design. We also implemented an automatic optimization button which automatically optimizes your shape for flying. Yet again, this is not possible with hand. Computational power of the computer is essential for this. After designing you can send the data to the laser cutter and then build the airplane.

Future of 3D modeling

- How do you see the future of 3D modeling? Is everybody going to use it on a daily base?
- Will children learn it from elementary school? Should they?
- What is your ideal vision on 3D modeling?

It depends really on how often you need 3D model representation in your daily life. And that would not be everyday I think. As I said, when you have discussions or meeting about a 3D model, then it would be necessary and helpful. But otherwise, probably not everyday for everybody.

When talking about communication, people text everyday but not so much drawing. Taking into account that drawing 3D is even more complex than 2D, the current situation of 2D drawing already shows that it's not an everyday thing.

Subject 3 - Future of Food

The other subject is the future of food. I am working on a vision of the future of 3D food printing. And I would like to

- What would be your ideal relationship with technology and cooking?

- Are we still going to cook ourselves? Which part of the cooking should be done by machine?
- Japanese Food is very traditional and has a strict rules when it is about cooking and using ingredients. How do you think new technology and new recipes are going to fit in the Japanese culture?

Of course, a combination of cooking and being cooked for. Sometimes I just want to eat, but sometimes I want to cook because it is a fun activity. The same is with autonomous cars, right? Sometimes you want to drive yourself and sometimes you just want to get there. So obviously it depends per situation and per people. So both ways, a hybrid.

As for the Japanese culture, I think that using new technology or ingredients are welcome if they are of high quality. Even in traditional sushi restaurants, they use technology and everything.

Finishing up

"I think we've been through all the questions I needed to ask you. Thank you so much."

- Do you have any question?
- Can I use your name and input on my website blog?
- Do you wanna stay connected and be updated with designs?

"Thank you so much for your time, your insights definitely helped me out here."

APPENDIX D.2

Yui Kita (PhD @ Tokyo University)

Information

Name: Yui Kita

Expertise area: Computer science — creation using computers

Reason for seeking consultancy: Using computational power for human creativity and experience in digital/food project

Type of contact: **Interview (semi structured)** / ~~Discussion~~ / ~~Email~~ / ~~Chat~~

Insights / Highlights

And following these recipes, I am creating recipes. This means that my creativity is limited to the vocabulary I have. And so I try to create new recipes, not from brain but from the computer. But the process I use is the same.

I think in the early stages, let's say 5 years, it's for professional chefs in fine dining. Maybe in 20 years, a lot of people can use it. I think in this timespan of 20 years, hobby is the most important keyword in our lives.

In addition to this software, you need a machine that can assemble the ingredients, such as a 3D food printer.

One of the hardest problems in using computational power in cuisine is that we do not have a method to manipulate the physical and chemical components of the recipes. I am using the computer for the data but I need myself to do the work and do the cooking.

If you want cutting-edge creativity, you need to experiment a lot and so you need a machine.

AI is a very strong and powerful tool. But the thing is, letting an AI do everything is (sometimes) not the best answer. The AI will not be able to determine whether it's good or bad, in the end we (the people) need to taste it ourselves.

And since we do not have a machine to manipulate things, a computer is much more beneficial, logical and efficient to do the thinking (the first part) and the other part we can better do ourselves.

But most people do not enjoy cooking. Back in the days, we also made our own clothes. But not anymore, because we are specialized to maximize our productivity. We don't have to and I think we should not even do it.

Some people say it is better to cook at home because it's healthier or cheaper. But actually, it's not. It's very expensive to cook at home. Maybe, it'll be okay if you would cook for the entire family. But if you're living on yourself, cooking at home is very expensive, takes a lot of time and you have a lot of left-overs.

So you are more specialized in whatever you have to do. It's really a productivity thing. As a hobby, it is different.

...it's more assembling and to fulfill the need to achieve something by yourself. In the end, you can do the aesthetics and plating by yourself, so that is the part of your satisfaction.

And I even have a box for delivery and I tell them that if I don't respond in three calls, they can put the food package in my box. So functionally, this delivery box of mine is turned into a 3D food printer, a very high quality printer.

I visited a lot of restaurants, I asked a lot of chefs, and they say that the main factor of dining is economic.

Results

Introduction

Hi, my name is Randy Kadarman, an industrial design master student at the TU Delft, The Netherlands. Right now, I am graduating on 3D food printing. The goal of the project is to design a 3D food printer for the Japanese society. I chose Japan because it has a long history in food aesthetics and relationship with robotics.

I contacted you because I saw your work on Food Hacking of the recipe network. It was very interesting and inspiring to see processing power used to enhance making food. I wanted to talk to you because I need research validation and inspiration for design.

I am researching for whom the food printers are suited now (cooking enthusiasts or regular consumers) and in the future (5-10years) and which additional functionality is needed (how much of the cooking is being done by the machine). Right now, the food is only being shaped, but I expect people will want to have a better experience with cooked food of different textures. And it is only suited for people with 3d modeling skills and who can put time and effort in it.

- Can you tell a bit about yourself; your name and occupation?
- Can you tell about what you are working on at the moment?
- Do you have a relationship with food? Can you tell me more about that?

My name is Yui Kita, a PhD student at Rekimoto Laboratory. This laboratory is part of the faculty called Applied Computer Science, which means that our goal is to think about the new way of using technology in human culture or activities, such as sports, cooking and other leisure activities. Instead of making computers faster. And in that field, my specialty is focused on creation using computers.

My work is called Chef's Hippocampus. The Hippocampus is a part of the brain that stores working memory. And actually, I love cooking. In the process of cooking, I have generated a lot of my own recipes. I have realized that in the process I am thinking of all kinds of recipes I have seen before. And following these recipes, I am creating recipes. This means that my creativity is limited to the vocabulary I have. And on the other hand, I am a PhD student in Computer Science and I have a lot of databases that include super interesting combinations of food. (It even has ingredients such as 7Up) And so I try to create new recipes, not from brain but from the computer. But the process I use is the same.

Subject 1 - Food Network

- Please tell me a bit about the food network. How does it exactly work and what is needed to make it work?
- For whom do you think this is mostly useful? For a chef or perhaps maybe also for the regular consumer or maybe only for programmers? and why?
- What other technology or hardware would be needed to make the food network useful for normal people?
- How do you look at implementing also properties (textures/temperatures/smell/taste) and maybe even cooking methods (grilling/steaming) into the network? (or is the input not suited for this?)

So it's actually really simple. I have two hypotheses in my project. The first is that if two ingredients share a lot of recipes, then these two ingredients are close in terms of taste. The second hypothesis is that the recipes that we have now have been sophisticated over thousands of years. Which means they are good recipes with good taste. What I did was to create a graph of nodes and links.

Each node represents an ingredient and each link represents the similarity of the ingredients. If you create recipes, some popular ingredients like water and salt could be a hub of that network. And if you point out two different ingredients from two different recipes, you can see how close they are to each other.

I think in the early stages, let's say 5 years, it's for professional chefs in fine dining. Maybe in 20 years, a lot of people can use it. I think in this timespan of 20 years, hobby is the most important keyword in our lives. Because the AI will do a lot of the work (if not everything). People will get a lot of free time that we originally used to work. So this is the scenario where the AI could be the alternative of a worker. So people will focus more on hobby's and creativity.

In addition to this software, you need a machine that can assemble the ingredients, such as a 3D food printer.

One of the hardest problems in using computational power in cuisine is that we do not have a method to manipulate the physical and chemical components of the recipes. I am using data but I need myself to do the work and to cook. The computer only makes the data and I am doing the assembling. Maybe it can be a human if you enjoy cooking. If you want cutting-edge creativity, you need to experiment a lot and so you need a machine. **(thought from Randy: "It will be able to generate thousands and millions of results, but unless they are actually tested/simulated, it will remain only passive data.")**

As for using more than just ingredients, so properties and methods and volumes, the Chef AI from IBM's Watson does this. It does not only generate and combine ingredients, but also the cooking methods. Actually, the method is very delicate. If you change a bit of the method, the entire recipe will change. If you burn it, or heat it, or mix it, it's more delicate. This is actually more a design issue. AI is a very strong and powerful tool. But the thing is, letting an AI do everything is (sometimes) not the best answer. The AI will not be able to determine whether it's good or bad, in the end we (the people) need to taste it ourselves. But also, in the process of cooking, we need to gather the ingredients, think about the method and do the cooking ourselves. These are the kind of three steps. And since we do not have a machine to manipulate things, a computer is much more beneficial, logical and efficient to do the thinking (the first part) and the other part we can better do ourselves.

Shows a poster of a previous project

This is a previous project called programmable food. So if you look at a computer from the outside, it's only a machine to manipulate the state of the memory of the machine. It can change whatever it shows on the screen in real time. Now what if we manipulate the taste of the food. This project actually failed because it was really hard to attach hardware to cutlery. The cutlery have a very delicate state; if you would change this curve, the taste would change. This also happens when you change the material, or the shape, the color, etc. So if you want to apply computational power to cuisine, you should apply it to data.

Subject 2 - Level of Involvement

So when preparing food, you have three roles: the chef who makes the recipe, the cook who prepares the food in the kitchen (mostly a person have both roles of chef and cook) and the consumer who eats the food. I am researching how people are still involved in cooking and creativity.

- First, a simple question: How often do you cook yourself? And do you have enough time to cook? Why is that?
- Are you more a chef and make your own recipes or more a consumer? How do you think this is changing?
- Do you think people will have time for making their own created recipes and meals? Why?
- I did research and it seems that people are cooking less and less. Will new technology make it easier for people to become more creative and hopefully cook more or only just have more creative food experiences?
- How will new technology fit inside a person's house? or will it have to be in a cafe or restaurant or office?

I myself cook almost every day. I like baking crepes late at night or like 3AM in the morning or something. I don't eat it. I eat it the next morning. I cook for myself because I enjoy it. So for dinner and also late at night, not per se for eating. But most people do not enjoy cooking. And this is not just cooking, other things for example our clothes. Back in the days, we also made our own clothes. But not anymore, because we are specialized to maximize our productivity. We don't have to and I think we should not even do it.

Some people say it is better to cook at home because it's healthier or cheaper. But actually, it's not. It's very expensive to cook at home. Maybe, it'll be okay if you would cook for the entire family. But if you're living on yourself, cooking at home is very expensive, takes a lot of time and you have a lot of left-overs. Sometimes, people maybe bring bento's for lunch. But I don't think that's cost efficient. In my case, when you're a PhD student, you have to write your papers. So you are more specialized in whatever you have to do. It's really a productivity thing. As a hobby, it is different.

Have you heard of Blue Apron? It's a very interesting service in the US. They deliver food, but only half-cooked for a one-person meal. You as a consumer have to make the other half. It's usually only baking or cooking. So if you don't have a lot of skills, you can still have a feeling of "I have cooked this meal". That style is a bit different from conventional cooking, it's more assembling and to fulfill the need to achieve something by yourself. — In the end, you can do the aesthetics and plating by yourself, so that is the part of your satisfaction —

It would be very interesting if I would have a 3D printer at home, and when I arrive home it would start printing so I can eat after I take a shower or something. But actually, everything became a cost thing, that's the problem. So if the purpose of 3D food printers is just for eating or eating healthy, then I will just buy a bento (boxed food) instead of this. Or do you know UberEats? I have been using UberEats so many times. Do you know Ootoya (大戸屋)? It is a Japanese restaurant and they serve good Japanese style meal sets (定食/ていしょく). For a very low price. And the meal includes vegetables, meat and rice, it's healthy and balanced. And using UberEats, I can just push one button to get it to my house. And I even have a box for delivery and I tell them that if I don't respond in three calls, they can put the food package in my box. So functionally, this delivery box of mine is turned into a 3D food printer, a very high quality printer. So actually, you don't need to own a 3D printer and have it in your house to enjoy the benefits of instant on-demand food for low price. Unless you want to make the complex shapes yourself or if you've invested in the industry. So if you're fascinated by the results, you can buy it if you can.

So if you want to do 3D printing, you should do something only a 3D printer can do. A very important aspect is texture. Also, maybe using different materials for each layer.

One thing I heard from a professional chef is that when you cut an ingredient, you have to cut exactly the same size. Every slice should be exactly the same thickness. And the difference in size has a big impact on the taste.

Subject 3 - Future of Food

The other subject is the future of food. I am working on a vision of the future of 3D food printing. And I would like to

- How do you see the future of food?
- What would be your ideal relationship with technology and cooking?
- Are we still going to cook ourselves? Which part of the cooking should be done by machine?
- Japanese Food is very traditional and has a strict rules when it is about cooking and using ingredients. How do you think new technology and new recipes are going to fit in the Japanese culture?

Well, if I have free Ootoya everyday, that would be great. But I think it would be a combination of cooking and using robots. If I have time, I would be cooking, but not for eating but to fulfill the achievement. For the daily basis, I will use Ootoya on UberEats. And I think it can be free. It's kind of an economical issue. I visited a lot of restaurants, I asked a lot of chefs, and they say that the main factor of dining is economic.

As for tradition in recipes, it's the same as when we have startups. For example snapchat, maybe early adopters will use it but most people will think, "who will want to use this?". There is an app called "Yo" and it's a message app that only sends the word "Yo" without any other words or images or emoji's. This app actually became a great phenomena. As seen in the startup scenes, Yo eventually faded away. Sometimes it's a bigger, sometimes a smaller wave that fades away. If it's something that lasts, it's a revolution. And this can also be seen in kitchen technology and trends. — that was cool, what's new? —

I think kitchens have different domains. For example, we have a lot of shared kitchens in Japan. So there are kitchen classes, just like English class. If I pay a fee, I can get a course. These people enjoy cooking, can practice here and are able to experiment. If food printing is really expensive, maybe for now because of the early stages, maybe it can be shared in the class if there is enough

interest and if people want to create new recipes. And then maybe, people will want to try 3D food printing to try to make new stuff. It's only a few people in the course that would then buy the product.

Finishing up

"I think we've been through all the questions I needed to ask you. Thank you so much."

- Do you have any question?

- Can I use your name and input on my website blog?

- Do you wanna stay connected and be updated with designs?

"Thank you so much for your time, your insights definitely helped me out here."

I have been working at TAKRAM for visualizing data about the population. And one of the most important things I've learned is how to communicate with society and a lot of people. I am a PhD student in this laboratory, so I am kind of isolated from society or industry. Some academic people sometimes say very dreamy things. Of course, if you can realize it in society, that is great. But society is more complex and irrational, sometimes not efficient. So we know to know the very deep insights of the domains we're tackling. In the cuisine, we have to look at the very same area the chefs are looking — meaning kitchen, restaurant. If I have this kind of problem, I will work in the restaurant to get the insights.

Yes, of course, I would love to be stayed updated.

APPENDIX D.3

Yoshiharu Sugawara (Company President @ GK Dynamics)

Information

Expertise area: Designer

Expert's background information: Major in Economics / Car Design

Reason for seeking consultancy:

Type of contact: ~~Interview / Discussion / Email~~ / **Informal Chat**

Insights / Highlights

Sweets are very popular here. From cake, to "mochi" (rice flour cake) to chocolate. Especially when people give "omiyage" when they've returned from a business trip or just as a 'thank you'. And this is definitely something that is done very often"

As for the alternative ingredients, I think that could be very interesting. Especially if they are very healthy and cheap.

They usually live alone and have a hard time traveling because of their bodies. So having an application at home that can make them food is probably a good thing.

What I'm aiming at is that this lifestyle in Tokyo is the reason why people don't grow fat. It took me a few months before my body became fit again to handle these commutes.

Results:

"I can understand that automated meals can be very convenient. Although I am not certain what the current performance of a 3D printer is at the moment." *Randy explains and shows the capabilities and results* "If it will only make shapes, it will only work in sweets. Sweets are very popular here. From cake, to "mochi" (rice flour cake) to chocolate. Especially when people give "omiyage" when they've returned from a business trip or just as a 'thank you'. And this is definitely something that is done very often"

* omiyage = a small souvenir brought from a (business) trip, usually in the form of savory snacks or sweets that are a local specialty.

"As for the alternative ingredients, I think that could be very interesting. Especially if they are very healthy and cheap. Actually, bugs are not that strange. I ate a lot of them actually. grasshoppers in soy sauce and bee larva's. But I think it's really just a thing that you would eat at your grandparents or in my case, my parents, somewhere on the country side. You probably wouldn't see it being popular in the city. I'm pretty sure it was mostly eaten during war time, when the food was scarce."

"I think this can be very helpful for elderly. Elderly are still increasing in numbers, and its really starting to get difficult to take care of them. These people usually live farther away from the center and the density of resources. They usually live alone and have a hard time traveling because of their bodies. So having an application at home that can make them food is probably a good thing."

"When I lived in America, I had a car and basically only took roughly 50 steps — It was from my doorstep to my car and from the car to the office. That was for a few years. When I came back in Tokyo in 2015, my commutes were extremely exhausting. I live around 1.5 hours away from the GK office. This meant walking to my neighborhood station, stand in the train because usually it's packed, take the transfer, maybe stand and wait on the platform, stand more and then walk to the station. What I'm aiming at is that this lifestyle in Tokyo is the reason why people don't grow fat. It took me a few months before my body became fit again to handle these commutes."

APPENDIX D.4

NATHAN HOPSON (Professor History of Japanese Culture/Food @ Nagoya University)

Information

Name: Nathan Hopson

Expertise area: Japanese History and Food culture

Reason for seeking aid: State and development in nutritional needs and Japanese food culture

Type of contact: Interview / Discussion / **Email** / Chat

Insights / Highlights

There can be little doubt that eating habits are changing, and that consumption of stereotypically "Western" foods like beef and bread, etc., is higher than it was a century or more ago.

The corollary to this is that per capita rice consumption is decreasing. (And while rice consumption is falling, wheat consumption is apparently not really rising significantly)

Even though almost 99% of elementary and about 85% of middle school students get free milk at school daily, dairy consumption is remarkably low

I can say with some confidence that breakfast is the most Westernized (bread-ified) meal of the day on average.

There are also compelling questions about whether or not dietary diversification is

- a) good because it means more access to a variety of nutritious foods
- b) bad because it means more access to junk foods
- c) bad because it destroys culinary culture and homogenizes the world
- d) some mix of the above

Many people seem to believe that traditional Japanese dietary culture is in crisis, besieged by a barrage of Western junk.

Simultaneously, many in Japan are proud that they have the best longevity rates in the world for women and the total population, and that men are in the top five or ten.

It also reflects better healthcare; deaths from cardiovascular disease are near all-time modern lows in Japan, about 1/3 of the US by comparison (OECD, Japan Times)

there is definitely a place for introducing the 3D food printer in this larger context, especially if it allows people to easily create aesthetically pleasing, artistic, nutritious dishes.

On the other hand, the kitchen remains (a) gendered and (b) low-tech, other than the rice cooker. Part of this has to do with space -- there isn't any room for gadgets -- part with a handcrafting culture, part with education, and part with gender (if men had to cook more, it would be easier).

...there would be no place to put it. If I had more space, there are many other things I would like to have before that. A dishwashing machine would be #1.

Even if the 3D printer was the size of a food processor, I don't have space for one of those either

...most Japanese apartment kitchens (homes may be different) don't even have enough outlets to support much more than a rice cooker and microwave.

Content Log:

3月13日2017年 - EMAIL FROM RANDY

Dear Randy,

Thanks for clarifying.

I appreciate your interest in conversing with historians and anthropologists.

One of the reasons I became interested in the history of science is that there's not enough dialogue between science/tech fields and the humanities.

The question of dietary change in Japan is complex.

There can be little doubt that eating habits are changing, and that consumption of stereotypically "Western" foods like beef and bread, etc., is higher than it was a century or more ago. The corollary to this is that per capita rice consumption is decreasing. On the other hand, neither is a new trend. Rice consumption in particular started dropping off in the 1960s, and has steadily fallen since then. (And while rice consumption is falling, wheat consumption is apparently not really rising significantly, which I didn't realize) (Food Agency). Less rice follows the pattern everywhere: affluent consumers don't eat as much rice. That's one reason the top per capita rice consuming nations are Bangladesh, Laos, and Cambodia (FAO), and Japan is at #50, only consuming twice as much as Americans. Sure, Japanese beef consumption is up, but it's about 1/2 of the figure for the Netherlands and closer to 1/3 when compared to the US (Wikipedia, referencing FAO). Even though almost 99% of elementary and about 85% of middle school students get free milk at school daily, dairy consumption is remarkably low (Japan Dairy Council). Etc., etc.

From what I know both as a historian and as a long-time resident of Japan, I can say with some confidence that breakfast is the most Westernized (bread-ified) meal of the day on average. But even so, many of even my twentysomething students have rice for breakfast pretty regularly.

Articles on this: RocketNews, Japan Times...

The hybridization of the Japanese national diet in fact began before WWII, first in military mess halls and popular urban eateries, but gradually in the home as well. Wartime austerity and shortages put a stop to this for a while, but as soon as Japan's economy began to recover, the diet increased in variety as well.

There are also compelling questions about whether or not dietary diversification is

- a) good because it means more access to a variety of nutritious foods
- b) bad because it means more access to junk foods
- c) bad because it destroys culinary culture and homogenizes the world
- d) some mix of the above

Many people seem to believe that traditional Japanese dietary culture is in crisis, besieged by a barrage of Western junk. Simultaneously, many in Japan are proud that they have the best longevity rates in the world for women and the total population, and that men are in the top five or ten.

This perhaps speaks to the larger truth that we feel threats to culture, nation, person, family, community, etc., entirely out of proportion to the actual numbers -- think about current politics...

* It also reflects better healthcare; deaths from cardiovascular disease are near all-time modern lows in Japan, about 1/3 of the US by comparison (OECD, Japan Times)

I would be delighted to stay in touch. If you have questions, the more specific the better (for both of us, I think).

In the meantime, some useful reading might include:

- Cwiertka, Katarzyna. *Modern Japanese Cuisine: Food, Power and National Identity*. Reaktion, 2006.
- Rath, Eric C, and Stephanie Assmann, eds. *Japanese Foodways, Past and Present*. University of Illinois Press, 2010.
- Ishige, Naomichi. *The History and Culture of Japanese Food*. Routledge, 2011.
- Kushner, Barak. *Slurp! A Social and Culinary History of Ramen, Japan's Favorite Noodle Soup*. Global Oriental, 2012.

There are many excellent articles out there, too, but that covers some of the more important books on Japanese food that have come out in English in the last decade or so.

Best of luck,

N

3月18日2017年 - EMAIL FROM RANDY

Dear Nathan,

Thank you so much for your elaborated response from. I've been meaning to reply to you earlier but I have been caught up with more project management than actual research.

Interesting numbers on the decline in rice consumption yet no equal increase in wheat consumption. Either their meal composition is completely changing or the population is just eating less per capita. Could it be that the decline in population and birth rate plays a significant role in this (and the grow of elderly that just eat less than the average human)?

If there is indeed a correlation between the decline in rice consumption and population, I believe the rice decline would not stagnate.

As for the diversification of diet, I certainly believe it is a mixture of all the points you just mentioned. I do think that the urban environments (and with its high working hours and living costs) make the population fall for junk foods easier and faster. I think it's not realistic to maintain a strong culinary culture (which requires high craftsmanship, especially in Japan - 10 years training for a sushi chef??!) when people are put under these working and living conditions. In my opinion, as long as there is no such offering that combines the convenience and price-value of the food and the culinary culture (that isn't regarded as junk food such as the convenience store bento's), the trend of homogenization will remain as it is.

I really appreciated your comment that perhaps that the threat to the national culinary culture is completely out of proportion.

Fast forwarding in my process, I am trying to define the purpose of a food printer by finding a need (that may or may not exist yet) for the future population in Japan. The question is whether the purpose will fulfill a need in nutrition or perhaps a need in conserving heritage by innovating on it. After research and our discussions so far, I am convinced that a shortage in nutrition or a rise in cardiovascular diseases will not be the case in the near future. I am thinking innovating food using new technology must focus on improving the quality of life (social domain e.g. more spare time to spend with others). Or perhaps indeed enable to people to cook traditional meals with the help of technology and thus conserving the cultural heritage. A bit out of the research mode and already into solution-finding mode, any thoughts on this?

3月21日2017年 - EMAIL FROM NATHAN

Dear Randy,

Quickly, as I am traveling now for a few days at the end of my stay in Europe before returning to Japan next week, a response.

I think that there is definitely a place for introducing the 3D food printer in this larger context, especially if it allows people to easily create aesthetically pleasing, artistic, nutritious dishes. Japanese food culture is highly focused on a visual aesthetic, Japan also suffers from many of the same anxieties about food that plague the so-called "developed economies" more generally, and people are generally positive about (most) technological innovation. On the other hand, the kitchen remains (a) gendered and (b) low-tech, other than the rice cooker. Part of this has to do with space -- there isn't any room for gadgets -- part with a handcrafting culture, part with education, and part with gender (if men had to cook more, it would be easier).

The problem of space is perhaps most important for thinking about how to introduce a 3D printer into Japanese life. I have, by Japanese standards, a spacious apartment. But I know that I would never buy a 3D printer because there would be no place to put it. If I had more space, there are many other things I would like to have before that. A dishwashing machine would be #1. Even if the 3D printer was the size of a food processor, I don't have space for one of those either -- and, I just remembered, most Japanese apartment kitchens (homes may be different) don't even have enough outlets to support much more than a rice cooker and microwave.

APPENDIX E

Hofstede's Cultural Dimensions

- Power distance @ 54/100

Power Distance is defined as the extent to which the less powerful members of institutions and organizations within a country expect and accept that power is distributed unequally. With an intermediate score of 54, it explains that even though hierarchy plays an important role, Japan has always been a meritocratic society. In the Japanese education, everyone is equal and can become successful if 'he' works hard enough. Unfortunately, the influence of gender-roles are not taken into account. In this case, it is a hierarchy among emphasized on men, not women.

- Individualism @ 46/100

Individualism shows the degree of interdependence a society maintains among its members. With a score of 46, Japan is considered collectivistic by Westerners yet individualistic by other Asian countries. The Japanese society shows many characteristics of a collectivistic society: such as putting harmony of group above the expression of individual opinions and people having a strong sense of shame for losing face. However, the power distance discussed how the Japanese society focused on the success on the individual, although the individualism is scored low.

- Masculinity @ 95/100

Masculine stand for competition, achievement and success. Femininity stand for caring for others and quality of life. In combination with the relatively-low individualism rate, the behavior does not come out as assertive and competitive, but rather humble and preserved. It is about working hard and gaining success, not for the self, but for the group (company/society). Referring back to the high power distance, the environment encourages success through labor instead of predetermined position of family names and such. In kindergarten, children compete on sports day for their groups. Another form of Masculinity is the drive for excellence and perfection in their material production (物作り/monozukuri) and in material services (hotels and restaurants) and presentation (gift wrapping and food presentation) in every aspect of life.

- Uncertainty Avoidance @ 92/100

The dimension Uncertainty Avoidance suggests the way a society deals with the unknown future: the extent to which the members of a culture feel threatened by ambiguous or unknown situations and have created beliefs and institutions that try to avoid these is reflected in the score on Uncertainty Avoidance. The high score of 92 is often attributed to fact that the country is constantly threatened by environmental threats such as volcano's, earthquakes, tsunamis, typhoons.

All actions in Japan are prescribed for maximum predictability. From cradle to grave, life is highly ritualized and expressed in ceremonies. At weddings, funerals and other important social events, what people wear and how people should behave are prescribed in great detail in etiquette books. The same counts for food; established recipes has to be made according to a fixed set of rules.

- Long Term Orientation @ 88/100

This dimension describes how every society has to maintain some links with its own past while dealing with the challenges of the present and future. The focus lies in investing in the future, instead of enjoying benefit now. Companies make decisions based on maintaining a healthy relationship with clients. They are not expected to turn profit every quarter, but to serve stakeholders and society for many generations to come.

- Indulgence @ 42/100

This dimension shows the extent to which people try to control their desires and impulses, based on the way they were raised. Relatively weak control is called "Indulgence" and relatively strong control is called "Restraint". With an intermediate score of 42, Japan is considered the latter. Restrained societies do not emphasize on leisure time and control the desire gratification. People with this orientation have the perception that their actions are restrained by social norms and feel that indulging themselves is somewhat wrong. This concurs with the low score on individualism. With their strong connection towards the group, the self cannot enjoy exclusively from the group.

This does not imply that everyone in a given society is programmed in the same way; there are considerable differences between individuals. These statements about just one culture on the level of "values" do not describe "reality"; such statements are generalizations and give a broader sense of understanding.

APPENDIX F

Overview of Contextual Insights

01 Cultural shifts

Disappearing Gender Role in Kitchen

And whereas the kitchen remains gendered, this role will have to find its replacement in the form of either more simplified and time-saving cooking or another party/person.

Increasing Single households

Living and eating alone suggests a rising need in personalization and individualization of products.

Scarcity in Living space

The limitations in space will refrain consumers from purchasing new appliances that have not proven their worth in daily use yet.

Increasing Elderly Population: the elderly population will create a enormous need in both personalized or supplemented nutrition. (due to increase of elderly population)

Shortage of Caretakers: Due to the shortage of caretakers, the solution will most likely lie in robotics and automation. (due to increase of elderly population)

Less cooking at home: less balanced meals at home and due to more westernized diets and higher prices of food.

02 Techno-Intimacy

Role of Intimacy: On a higher level of intimacy where food is being prepared by a partner/parent as an act of love, this interaction can be replicated by having an A.I. controlling the 3D printer or letting the user help out as if 'cooking together'.

Companionship / battling loneliness

A lowered level of intimacy could still take form as a friendly companion — targeting elderly living alone or children. With intimacy being high, it is more likely to target the product towards the home environment (rather than accessibility in restaurants/stores) and therefor satisfying the user's ownership over the device.

Robotics Entertainment

More and more acceptance/implementation due to need for automation.

Anthropomorphized

Although robotics are all about efficiency and saving costs, it is also about entertainment. We can automate that but it doesn't look cool, so let's make a humanoid robot do it — they have souls, so make it look like it. (try to find one commercial robot in Japan that does not have a face).

03 Diet and Health

Obesity is not the problem. It's the pressure for preventing obesity

As quantified food is often associated with controlling weight, obesity is currently not posing a threat as this is being kept in check by social pressure, cultural traits and an active lifestyle.

Need for transparency in Food intake

The pressure of staying thin remains high. 3D food printers could relieve a part of the stress by giving the consumers more control and insight over their food intake. Definitely a need for transparency in food.

Need for eco system of measuring data and knowledge for actionable steps.

Going deeper into food data, the next property to measure is the amount of nutrients (proteins, vitamins, minerals). As mentioned earlier, tracking this data will only be meaningful if the goal is 1) measurable (goal and variables) and 2) clear and closed I/O system. It has no value to measure if these conditions aren't met.

'Healthy' Elderly

The rising elderly population poses a need for a healthy diet through an offering of sufficient nutrients. However, the goal of being 'healthy' or 'fit' is too ambiguous as this is dependent on too many variables; diet merely being one of them. If the issue of skin degeneration were to be tackled, the design can focus on the amount of vitamin D and measure the results in terms of skin flexibility or such.

What about mental health?

Physical health and capabilities (athletes or medicals) are being covered as potential areas for 3D printing but what about mental health and capabilities where the goal is concentration or productivity or perhaps even happiness? Countries like Japan and South Korea are infamous for their overworking hours and suicides in corporate life.

04 Becoming a Maker

Instant gratification

Especially since consumers are more driven through **instant-gratification**, the application should focus on a effective effort-reward ratio.

Upcoming accessibility in maker spaces

Becoming a maker is easier than ever as resources are highly accessible to consumers in the form of shared maker spaces and low-level software. Especially since maker spaces attract customers through events and various facilities.

When simple, use hands

If the complexity of the design and composition is too simple, it defeats the purpose of using a printer. In this case, it's for production/productivity or inability to produce food. Kids or disabled or elderly or extremely busy people could be a potential target.

05 Creativity Through Technology

Optimization and Upscaling (Interpretation)

speed and scale up the process so that it is profitable in a cafe or restaurant. In this case, the food printer will have to be part of an automated production line.

Novelty (Interpretation)

Printing is also part of entertainment and therefore needs to be visible to the consumer.

Digitizing food

It is quantified but also open to computational power and manipulation using robotics.

Sophisticating the recipes

— composition, ratio, aesthetics — still need to be done by the human. And using the 3D printers as simulation/ prototyping device, this could dramatically enhance the sophistication of innovative or recipes using alternative ingredients.

06 Product Acquirement

Food is everywhere, (almost) non-stop, all kinds of food.

This counts for the city center. Outside of the city, the convenience stores are still around the corner.

Quality and time saving = not enough

Due to high availability and offering, leveraging the current quality and time-saving aspect is not competitive enough.

Less traditional cooking at home, knowledge on cooking is failing

Although the traditional cuisine is not necessarily disappearing, it is the general know-how of cooking at home that is at stake.

Bigger gap between the consumer and the food — the ingredients, its origin and process.

This phenomenon will only be reinforced when applications such as 3D food printing will be used in the process. It is almost impossible to visually determine anything about it due to its processed form.

Alternative ingredients

Prediction of loss in biodiversity and the effect of the greenhouse gasses call for the use of alternative ingredients, such as insects which also contain a high level of nutrients.

Lack of substitutes

However, due to the lack appealing substitutes, sushi experts can only advice to simply eat less. Uncertainty avoidance, not open for new stuff, except if it something completely different.

07 Value and Quality

Choosing Food

Quality of food is dependent on physical, emotional and intellectual aspect. The decision-making shows that quality is only one of the drivers, along with convenience and affordability taking the upper hand as food prices in Japan continue to rise.

Texture

Uniformity in texture may pose a problem, dishes such as tofu have the same uniformity and are part of a collection of dishes. In such a teishoku meal set, the variety in texture is spread across the different dishes instead of being concentrated into one dish.

Shokunin / Craftsman

Using a 3D food printer for precision in the meal preparation would defeat the purpose of their years of training. And with a declining interest of life-time craftsmanship commitment, craftsmen will start to thin out which makes the act even more valuable.

Innovation

The application is interesting for culinary artists as they are focused on innovation as well as craftsmanship. The role of the food printer would lie in the experimentation phase to test out the new recipes. The established dishes would still be made by the craftsman himself/herself.

APPENDIX G

Clustering Contextual Factors

1. Dependency on services

1. Rise of (non-junk) Food Delivery (*trend*)
2. 24/7 availability of convenience stores (*state*)
3. 24/7 availability of drink/snack automats (*state*)
4. 24/7 availability of chain restaurants (*state*)

2. Increased Rationality in decision making

1. Rising prices in food and groceries (*development*)
2. Choosing pre-made food over home-cooking (*trend*)
3. Less traditional Japanese cooking at home (*trend*)

3. Disconnecting / Isolation of Food Preparation

1. *washoku* is not disappearing but migrates out of home (*trend*)
2. Loss in cooking knowledge (*trend*)
3. Widening gap between consumer and food's origin (*trend*)

4. Control and goal orientation

1. Food tracking app (*trend*)
2. Rise of wearables / sports trackers (*trend*)

5. Preventing obesity through lifestyle conditions

1. Nutritional balance in *washoku* (*state*)
2. Small meal portions (*state*)
3. Education in school lunches (*state*)
4. Active lifestyle through commuting (*state*)
5. Expensive/scarce parking spaces discourages cars in city center (*state*)

6. Confrontation & Struggle with society

1. High collectivism in society (*state*)
2. Suppress own desires to retain harmony in society (*state*)
3. Social pressure on obesity (*state*)
4. Pressure of size 'free' clothing (*state*)
5. Medical screening through work/school (*state*)
6. Metabo Law limiting waist sizes (*state*)

7. Main activity area: Outside of home

1. Scarcity in living space (state)
 1. High living costs
2. Well-maintained public toilets and bath houses (state)
3. Public spaces as working/study space (state)
4. Long commuting hours to work/school
5. Low theft rate

8. Building artificial intimacy

1. Shintoism: Objects have souls (state)
2. Rising implementation of Robots in commercial services (trend)
3. 2D/3D romantic partner simulators (trend)
4. Possibility to pay for desired social interaction (trend)

9. Robots replacing humans (vs robots enhancing humans)

1. Automation replacing jobs (development)
2. Generic Humanoid robot replicating human motions (trend)
 1. As opposed to task-specific robots
3. Antropomorphized robots (trend)
 1. (no commercial robots without a face)

10. Interaction with Robots

1. Entertainment during waiting
2. Providing information (as humanoid robot)
3. Mobile device A.I. assistance

11. Struggle with Care for elderly (vs elderly taking care of themselves)

1. Population composition: More elderly than children (development)
2. High life expectancy (state)
3. Shortage in caretakers (state)
4. Resistance to immigrant caretakers (principle)
5. Children unable to take care of parents due to geographical difference (state)
6. High percentage of single-holds (state)

12. Accessibility to novel activities

1. Instant gratification (state)
2. Rise of maker-spaces (trend)
3. Availability of Information through Internet (development)
4. Professional applications made accessible for consumer (trend)
5. Steep learning curve in 3D modeling (principle)

13. Desire for immersion and Escapism

1. Cafe's with hyper-specific themes and services (trend)
2. Rise of VR/AR technology (trend)
3. Isolation through mobile phones (trend)

14. Commitment of the older generation (authenticity and craftsmanship)

1. Perfecting skills in food preparation
2. Years of training acknowledged as quality
3. Being responsible for well-being of your client
4. Years of apprenticeship before becoming master

15. Fixed traditional recipes (vs innovation in recipe)

1. Fixed method of sushi preparation
2. Freedom in recipe for Ramen

16. New generation is unwilling to commit

1. instant-grat 3-month Sushi chef training (state)
 1. Not acknowledged in Japan, intended for work abroad
2. Unwilling to commit to responsibilities (trend)
3. Instant gratification (development)

17. Need for sustainable food solutions/substitutions

1. Global demand for sushi/fish is rapidly increasing (trend)
 1. Blue Fin Tuna on the verge of extinction
2. Supply of fish, mostly tuna, is dramatically falling (development)
3. 70% of food in Japan is already imported (state)
4. Lack of fish substitutes (states)

18. Enhancing through AI / used in Food

1. Using computational power to think about food e.g. IBM Watson (trend)
2. Food Hackers (trend)

19. Lacking human intimacy

1. Declining marriage rate (development)
2. Declining birth rate (development)
3. Young people have lowered interest in relationship (trend)
4. Avoiding responsibility and consequences of marriage/relationship (trend)
5. Young people having a hard time to meet potential partners (trend)

APPENDIX G

Cold Smoking Tests

Experiment 01 – Scent Identification using Cold Smoking Method

Goal

This experiment tested the effects on scent manipulation using cold smoking methods. This experiment was a quick test to check 1) impact on food flavor and the effects on aroma diffusion from the dish when the cover is unveiled. And also to investigate its potential in the service. Furthermore, 2) whether the users could identify the scent and make associations with it

Outline Part 1

The food that was smoked were shortly cooked biological chestnut mushrooms with salt and olive oil. The wood used for the smoking was Oak wood.

The mushrooms were divided in three groups: 1) control group, 2) smoked for 5 minutes, 3) smoked for 15minutes.

This part focused on:

- Whether the smoke will adhere fully
- If the flavor is distinct enough to identify

Results Part 1



Left to right: 10min group, 5min group and zero group.

1. Flavors significantly adhered already after 5minutes. Superficial yet present flavor.
2. No differences in taste between 5 and 15 group.
3. If the concept of food poems requires to also have an external cloud of smoke as visual effect and individually smelling the smoke, the smoke needs to be blown by a constant stream. In this case, the smoke stuck to the glass and did not pass the user's nose.

Outline Part 2

The second part let the set of 4 participants try the smoked food in order to identify the scent.

Using Cherry Wood, 4 ingredients have been smoked:

1) mushrooms (smoke complementing the earth tone), 2) Red Beets, 3) fried banana's and 4) little pancakes.

As the first two ingredients were pure and complemented the earth tones, the latter two were processed and cooked products, unfamiliar to the relationship with smoke.

All ingredients were smoked for 10minutes — each ingredient had their zero group to compare.

Results Part 2

Participants were clearly confused as they could not identify the different smells.



In the case of the mushrooms, the flavor was complementing and added an extra layer to the experience. However, no comment was given on any associations.

In the case of the red beet, the smoked flavor sparked a sense of confusion as this scent was normally not found in relationship with this ingredient. One participant mentioned that it reminded her of Christmas and the Christmas markets as this smoke is used for the food that is sold on these occasions (German bratwursts and such). Other participants were confused as they did not know how to describe the relationship.

In the case of the latter two, not only was it confusing as the scent of the processed products mixed with the smoke, but the taste was also experienced as unpleasant.

Conclusion

- Needs to be further tested.
- Cold Smoking is mostly connected to the combustion of wood and will therefore always carry a more earthy tone. This is why this method will most likely always complement natural ground products such as vegetables or meats.
- Vice versa, this will make the method unpleasant, although provoking, for sweet and fresh-flavored ingredients.
- As it is based on combustion, it will always have a heavy and filling flavor to it.
- Needs to be tested with wood flavor can be overruled with other sorts of aroma's such as fruits.
- Combustion might not be a safe method in a fully automated environment for 3D food printers.

APPENDIX H

User Test: Human-Robot collaboration in creation process

Communication with Design Interface

Goal

The goal of this user test is to simulate the act of designing without the users actively designing the piece themselves and explore key aspects of the user experience of creating food poetry.

The concept of creating food poems goes through three stages: 1) *Poetry* — turning a thought or memory into an abstract narrative, 2) *Recipe crafting* — turning the narrative into an edible piece that embodies the memory, and 3) *Modeling* — turning the recipe into a 3D model that can be converted into a CAM file as digital instructions for the printer.

Since this act demands a seamless communication method between human and software, it is necessary to explore the interaction methods between the two. The user is asked to convey an narrative usually communicated in human language whereas the software has to interpret this information to generate a relevant design.

Ultimately, the test seeks insights in the following aspects:

- Type of Communication language
 - implicit/explicit — using descriptions or straight forward by keyword input
 - formal/informal — treating as human or as non-human

- high-low frequency — responsiveness in input/output / agility in designing.
- Level of direct control on design and process (directly or indirectly handling)
 - Level of ownership over design

This test is primarily for exploration and does aims to answer any hypothesis

The Concept

In the first half, the participants will experience themselves to go through to entire process of translating the memory or thought into a concept for a food poem, in the form of a sketch with various properties noted. This half will create an awareness of the amount of work and various thought processes that are required during the creation. Since this kind of creation process is an integration of various art fields, the participants will be guided through each of the steps. The second half will attempt to simulate the creation process using an artificial intelligence with human-level cognitive abilities as the dominant design agent, as described in the interaction vision. Since the AI is on par with a human, it is possible to communicate with them on a non-formal level and 'discuss' the design rather than giving instructions through a user interface. To document this interaction, the user (human) and AI (simulated by a human) will write down their interaction as if they were texting. This way, the second half will fully focus on shifting the dominance and control in designing to the software side. Paper is used as output screen when the AI will generate design concepts for the recipes. The human user will receive a colored pen to indicate any action within the design interface that they want to execute themselves (e.g. selecting/moving actions). This will identify the level of control that the users wishes to have. Since this is dependent per person, this aspect should be tested on designers and also non-designers.

This test will examine the user experience as the user is offered a less demanding and indirect way of designing.

Outline

PHASE 01 - INTRODUCTION

- Recap of project
- Vision presentation and the WHAT WHY HOW
- Interaction vision

Phase 02 WARMING UP (20min)

- Instructions for phase 02
- Closing eyes and imagining their memory
- Guiding through associating steps
- Design phase

Discussion of Phase 02

- presentation of concepts and general feedback

Phase 03 COMMUNICATING WITH THE ARTIST (30min)

- instructions for phase 03
- Pairing up, choosing target person and memory
- Final instructions + game rules

Discussion of Phase 03

- presentation of concepts and detailed feedback

The test — summarized and evaluated

Test group information: A total of 5 persons were available for the test. These were either student of employee of the industrial design faculty. Two of the participants had background in food science. During the second part of the test, the facilitator himself participated in the session. The first part consisted of 5 participants creating their own food poem based on the predetermined theme and guidance of the facilitator. The second part consisted of 3 pairs (where the facilitator was playing as AI with a participant). The test went according to plan and no unexpected difficulties presented themselves.

The experience of communicating with the AI was simulated as two people sitting right next to each other and created an interaction that was still regarded as a human-to-human interaction. Although that interaction was desired, the role playing into human-robot relation was sometimes regarded as comical and humorous and not taking the session as serious as desired.

Biased by the instructions in the presentation. Because the users knew about the workflow of the AI, they would make the shortcut and do them a favor of thinking for them. However, it is only a sign that the human users still want to have a certain amount of control.

Results and Insights

4. Matter: The essence of the message itself

1. *Observation*

Multiple users indicated that, during the memory selection phase, they wanted to 'show' a dish that they had during that moment since the receiver was not present at that time. This was the reason to share the flavors and experience with them.

2. *Interpretation*

In this case, the users wanted to convey the experience of the dish by sending a representing aspect. However, the entire experience was most likely influenced by various contextual factors of that day (the view, smell, sounds, etc).

3. *Insight*

The user will still need to confirm whether the chosen ingredient(s) will match with intended association. It is needed to figure out how to integrate a feedback loop and whether this is truly necessary.

5. Matter: Recalling the memory themselves

1. *Observation*

Participants had trouble remembering other aspects than the visuals. Therefore having a hard time imagining smells, flavors and such.

2. *Interpretation*

This matter posed two issues: 1) the memory being vague and 2) not being able to recall other than visual aspects. Recalling memories and reproducing them is mainly done through words or renderings (level depends per user). Visual aspects are deconstruct-able in components and can

be reproduced (e.g. red rooftop, black bumpy road, high green trees, etc). However, smells and taste are hard to imagine in the mind as these cannot be reproduced instantly. In other words, smells/tastes primarily work in a one-way direction, triggering memory but not reproducible out of it.

3. *Insights*

Suggestions for input formats could be digital images, as visual recognition technology could extract more information than the user would communicate through words. Even extracting color palettes could already give direction to the kind of desired atmosphere.

If users wish to directly select scents/flavors as input data, they will need access to reference material, almost a scent/taste library, at the moment of creating the recipe.

6. **Matter: Input of direct keywords – unconscious high level of control**

1. *Observation*

Users directly used “Cool Breeze, Salty, Lobster” keywords as their input

2. *Interpretation*

The software filter and produces keywords from the input of the user. In this case, the user already knew the thinking process and took the liberty to create own keywords rather than telling the story. This abstraction step led to superficial and generic keywords which will limit the spectrum (and creativity) of the recipe. Although biased by information presented in the keynote, this type of behavior is most likely to be expected since it requires the least amount of typing.

Having a group of design-related participants, they are taught to think for themselves and outside the scope of the client. However, it seems that as soon as the designers turn into clients themselves, they fall in that same behavior of being specific and their own idea instead of telling the designer what to achieve.

3. *Insight*

As own created keywords are mostly top-of-the-hat associations, these need to be used as a based but not as characterizing element. Software should be able to determine how generic input is and be able to request for more input if not satisfied. Basically, evoking more detailed information by asking more in-depth questions rather than open request of “tell me about your [event]”.

7. **Matter: Pausing during session**

1. *Observation*

During the talk with the AI, one pair, although humorously intended, wrote “Hi, are you still there...?” several times as the other side did not respond.

2. *Interpretation*

Since this is a conversation-based interaction, replies are expected within a certain timespan. Is it up to the human user to always initiate and having the AI only reply?

3. *Insight*

Allowing the users to get back at it when they have time. Communication on human level,

simulated as if in the presence of each other. However, the time-out is definitely possible and also desirable during these types of sessions. It will match to interaction vision of “On your own pace”

8. Matter: Need for precision in properties and preparation methods

1. *Observation*

One of the participants asked for further specifications and the AI replied “(Fresh green 5% and Light Yolk Yellow 20%)”. One participants suggested for sliders when requesting a level of sweetness/salty, which could also be used for colors and such. Other examples were focused on preparation methods such as “Sea-water boiled lobster”, “minced mint topping”.

2. *Interpretation*

The participant intended to have more precision / control over the dish and was replied with percentages as if the colors could be manipulated instantly. The issues is whether this customization can be realized as the ingredients are more or less fixed when it comes to colors. In addition, participants showed a need in understanding in how taste/smells will be presented through preparation.

3. *Insight*

Implementing high level of control and customization will have to be realized in real life, which could make the process far more complex. Furthermore, controlling aspects such as color or even texture and taste/scent intensity can only be verified if that dish is printed as tryout. In other words, offering more tools and options will only stimulate more trying out. Although this will create more ownership, the act will become time-consuming and less of a casual way of messaging.

4. *Insight*

There needs to be a way to convey smells/tastes/tactility from within the interface. Although it can be described through words, is there a better way to convey this? Rating level of sweetness through sliders might prove to be unnecessary as the user cannot determine its level. In other words, it would be more or less binary, a spectrum wouldn't have much use.

9. Matter: Casual communication language with AI

1. *Observation*

“I would like to make something. Would you help me?” shows a requesting behavior.

“I want to make her something...” / “Hey Robot, the topic is...” shows that the user already assumes the functionality. It skips the formality which isn't really necessary in the first place. But It does create a more human-to-human interaction.

When confirming a suggestion, the answer is never “Yes”, but follows a more natural way such as “I Love it!” or “Sure, I'm looking forward to it”.

2. *Interpretation*

Formality creates a notion of another external party. Ownership is regarded as low to none, as the

AI is seen as that external party. The effect is strengthened by using casual and ambiguous answers for confirmation that deviate from “yes/no”.

3. **Insight — ownership through relationship**

Using casual communication to shape the relationship with the AI. What if the AI could be made into a personal designer? Learning based on your own history in search request and such. Learning about your color palette and aesthetic preferences? If your designer is your “student”, would it then result in more ownership and designed-to-your-taste proposal? How to ‘teach’ your AI for that part? In essence, would the AI have enough information with only a few descriptions/ messages provided in one single conversation? Only references to ingredients but not necessarily to any aesthetics aspects. However, learning means providing data which could be limited due to privacy issues. The real question is how to teach an AI about you outside of the conversation. Perhaps an Pinterest/Tumblr-like functionality but then in edible poetry? Liking what other people are creating? Is this a functionality you want to add?

Insight — Offering control over ...

On which part should the user be able to provide their opinion? Perhaps the knowledge on food combinations isn’t necessarily a strong quality as it is hard to imagine. Visual aesthetics is definitely something whether the user can see in a split second if he or she likes it or not. So only have strong influence in the last part of the “art of plating”. The question is whether the AI is able to generate something suiting and tasty 100/100.

10. Matter: Generated Symbolism — Uncovering the thinking process

1. Observation:
Participants requested for an explanation why a certain shapes is a certain shape. In other words, the associations with the design decisions.
2. Interpretation
Basically, users want to understand the symbolism behind the poetry. Most likely if it is graspable within the human mind — this is all about syncing the level of abstraction and finding that fine line between too representative and too abstract.
3. **Insight — the thinking process**
As these keywords are the real input for associations and design of the poem, a thinking process can be traced between the final design and the initial input. Perhaps the users would like the see the thinking steps the AI went through in order to have control over that?

11. Matter: Making changes — Selecting favorite elements and commenting

1. Observation
When satisfied with a certain element of the poem, one of the user selected and commented: “I like the bubbles”
2. Interpretation
Since this type of interface tries to merge human language and human-computer interfaces into

one, several questions arise: Is the AI able to link the word “bubbles” to the designated “body”. But how to select, refer and change? Basically, what is the ‘human syntax’ of controlling the AI?

3. **Insight — Human-Computer Syntax**

What is needed to execute a command? Do we need to have a rule of [object] + [action] + [specification] in order to make it function properly? Perhaps the AI should request missing information if certain parts of the syntax is missing. However, the question is how would the AI know what is missing?

12. **Matter: Conventional forms of the ingredients**

1. *Observation*

As participants were asked to shape their recipe, two of them used natural shapes of the actual ingredient (slice of orange, fish tail and a leaf) as topping.

2. *Interpretation*

Shapes such as “fish tails” and “leaves” still dominate the aesthetic to convey the nature of the ingredient. However, these forms do not come out of the printer unless deliberately designed in 3D. In this case, the participants were most likely not aware of the processed substance that goes into the printer as well as the possibility of deviating from the known forms of food.

3. *Insight — Available Data*

As the AI would design the poems, this would not necessarily be a problem. The only condition is that the data on the substances’ properties are known when generating the model. The complexity increases when the software does not only design custom shapes but also has to run simulations on each structure to test its integrity post-printing.

Conclusion