3D Food Printing = Spider-Man Masks Now, Mars Later: BNEF Q&A

June 16, 2021

The day may come when making a hamburger is as simple as flicking a switch, according to Anirudh Agarwal, founder of Singapore-based Anrich3D, a 3D food printing company.

3D food printing is about much more than convenience, said Agarwal. Using 3D printers to compose a meal tailored to the specific nutritional needs of an individual represents an opportunity to reduce waste, improve diets and could ultimately herald a new age of food production best-suited for missions to the Moon and Mars.

“Personalized nutrition information and apps are everywhere but the hardest part about getting a healthy meal is executing or implementing that into an actual meal,” Agarwal said in an interview with BloombergNEF. “It is possible to do a lot more personalization with 3D printing than with anything else.”

Agarwal’s platform uses vegetables like spinach, carrots, and potato ground up into a paste, which is then poured into a baking syringe and extruded into layers to make 3D shapes. The platform has been used to make whimsical shapes such as a Spider-Man mask or the Superman logo to encourage fussy toddlers to eat their vegetables.

On a more serious note, Agarwal says 3D printers can be used to produce alternative meats. The ability to precisely control multiple ingredients to an individual’s nutritional needs makes the platform applicable to hospitals and care homes. Along with customizing nutrition, 3D food printing could also boost sustainability efforts by, for example, using produce that would normally be rejected on aesthetic grounds. Biodegradable packaging may also be possible, Agarwal said.

“A growing number of companies are looking to bring 3D printing innovations to food production,” BNEF Analyst and Consumer Specialist Hugh Bromley said. “This is being championed by alternative meat producers, who see 3D printing as a way to give plant-based and lab-grown meats the texture of real meat.”

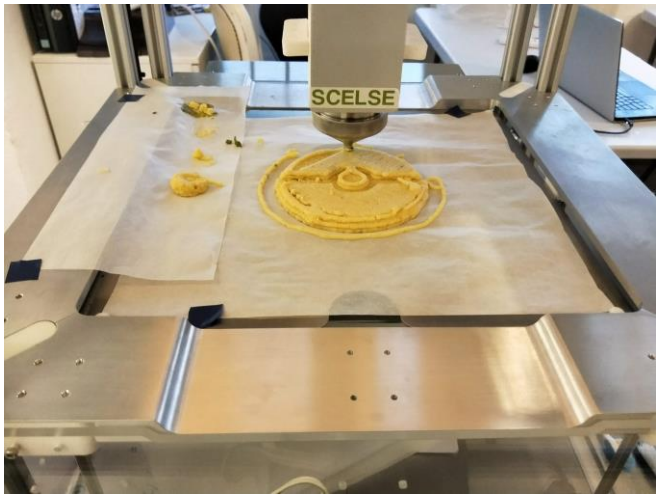
Anirudh Agarwal, founder of Singapore-based Anrich3D.

Anrich3D is a spinoff of the Nanyang Technological University in Singapore established in collaboration with NTU and the AllSpice Institute, a hospitality and culinary arts institute established in 2009. Agarwal spoke to BNEF in early June. The following transcript has been edited for length and clarity.

Q: Where did the idea for Anrich3D come from?

A: I started looking into how I could make healthier choices. It turns out you literally are what you eat. I found that there are many apps and services and equations out there. If you have enough information you can always optimize for whatever is mathematically the best possible thing for you to eat. But it’s not humanly possible to always do the calculations or record all the data. Machines are a lot better at doing calculations and measurements.

Personalized nutrition information and apps are everywhere but the hardest part about getting a healthy meal is executing or implementing that into an actual meal. I specialize in manufacturing technology and automation. I see that 3D printing is the most flexible manufacturing technology and it is possible to do a lot more personalization with 3D printing than with anything else. That's why I thought that if we use 3D printing, especially multi-material 3D printing where we control the amount of every ingredient, you can get a fully balanced meal with as many ingredients as you want and it will be mathematically optimized for you.



Anrich3D uses extruders to deposit layers of food paste in three dimensions.

Q: How does 3D printing of food work?

A: 2D printing is depositing a layer of ink on a surface in two dimensions -- length and breadth. 3D printing is stacking multiple layers of material in the third dimension – height -- to make physical objects. We grind up vegetables like spinach, carrots, and potato into a paste, fill it in a baking syringe and extrude it out layer-wise to make 3D shapes. With multiple extruders, we can control the amount of every paste and create shapes which have a balanced dietary profile. After printing, the items are usually baked to make them hard enough to scrape from the baking paper. However, the printed food can be eaten in the soft form as well. For some pastes like chocolate or jelly-based items, we refrigerate after printing to make them hard and easy to transport or move.

Q: What are the challenges?

A: Most 3D printing technical support is made for plastic printers. There are some challenges modifying and designing for food printing. We need to fine-tune food paste recipes to make sure they print smoothly and consistently and are viscous enough to hold their own weight for multiple layers but fluid enough to come out of a small nozzle without any damage. At first, we thought public perception would be an issue but the response to 3D printed food samples has been very positive.

Q: I understand why machines are better at measuring, but what are the advantages of 3D printing food instead of traditional preparation methods?

A: If you want to talk about having the precise amount of every ingredient, then it's possible to do it without 3D printing. But if you are talking about a real meal, any sort of food with any structure whatsoever, especially with multiple ingredients, there is absolutely no other way to make something like this without 3D printing.

Q: What are the data inputs based on? I would imagine things like blood tests, sleeping patterns, heart rate. Is it a case of these data points prescribing what goes into a meal?

A: People are very particular about the nutritional apps they trust. Since there are also so many services out there, we thought we'd make a general tool that everybody can use as a platform. Based on whatever nutritional advice you want to use, you just use our 3D printing platform to implement that into the meals. So, depending on what goes in – if it's a traditional app it takes BMI [body mass index] and your exercise and sleep habits – all we need would be the amounts of every ingredient and the configuration you want it to be in.

Q: What is the road to commercialization?

A: Regardless of what research grants or government grants we get, the first few steps in development are going to be the same. We are applying for research grants for hospitals and care facilities which would be the most critical market – the most life and death situation where the need is most intense. Then we have the

schools and childcare market where we can look into how we can get healthy ingredients in fun shapes to get the kids to eat more healthy. Then we have the hotel/restaurant/caterer market. There it's more about having something novel, something fancy, something personalized, especially for the higher end.

Q: What kind of interest are you seeing from the hospital and care home sector?

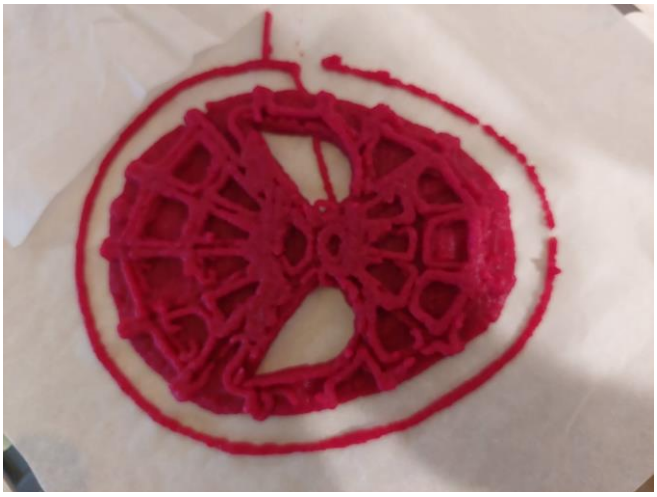
A: In the beginning of the project, we had some conversations with some care facilities and hospitals. Now we have letters of intent from AMKH [Ang Mo Kio-Thye Hua Kwan Hospital] and SCH [SingHealth Community Hospital]. Those are the ones that have shown interest to these kinds of trials where we evaluate how much benefit we get from providing personalized nutrition as preventative healthcare, and how much reduction we get in the total time of stay and how much reduction there is in the risk of getting some complication that arises from poor nutrition.

Q: Are there sustainability benefits to 3D printing of food?

A: There are a few aspects to sustainability. The first is food waste reduction. As part of the preparation, we need to make the food into a paste. You can use produce that gets rejected for cosmetic reasons. We can use that because in paste form it doesn't matter. Paste is also continuous. Most normal things like apples, broccoli etc. all come in discrete pieces. When you talk about personalization and have more precise amounts, there are fewer rounding up errors. Instead of using two apples you can use one point three and have the remaining used in the next batch. In traditional preparation we also cut off the ends and have different ways in which we discard parts of the food. We can maybe reduce that as well. Once we have personalization on a large-enough scale we should be able to predict how much food will be required and we can work with grocery stores and even the farmers to make sure the production line is more streamlined to ensure we have as little waste as possible. The second is reducing the carbon footprint. Food 3D printing is an important part of some of the ways to make alternative meats, which are being developed to reduce carbon emissions. The third is circular design, which we can implement as we design the machine from scratch. The fourth is biodegradable complex multi-material packaging, which can be 3D printed.

Q: I'm trying to envision what actually ends up on my plate.

A: As of now we've made things that are similar to cookies or sandwiches. We have layers of dough, and then we have layers of vegetables or meat inside and then we cover it with another layer of dough. Because it is 3D printing, the dough can be woven throughout. I've printed the face of Spider-Man and Ironman and the logos of Batman and Superman. For now we made simple shapes but as we get more feedback and ideas we can do more and more complex shapes.



A 3D printed Spider-Man mask produced from food paste by Anrich3D.

Q: What is the future of 3D food printing?

A: Even with the current technology, when fully implemented, we can optimize health and improve productivity. In the future, we can dry the food to make it into a powder such that it can be made into a paste by adding water. Since most food is mostly water, food can be transported at much lower weight and volume and maybe even a longer shelf life. Just mix with water at the destination and produce fresh food on the spot, which is especially useful in disaster relief. Since the same pastes can be used to make different things, there is even more flexibility in how the rations are used to produce the food on the spot as needed. Reduced weight and volume on top of

individual personalization are most important in space missions. Going a step further, if we can directly produce the powders through chemical processes, we can skip the step of having to grow the food in the new environment before settling. If that works, we can speed up colonization of Mars and the Moon even further.

For more BNEF research on alternative meats, see *Alternative Proteins: Fake It Till You Make It* (web | terminal).

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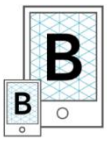

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