3D Food printing
Creating shapes and textures

March 2015
Daniel van der Linden
3D printing (Rapid Manufacturing)

3D printing allows the layer-wise building of a structure directly from a 3D computer drawing using computer-controlled additive fabrication techniques without human intervention.

3D printing is a collective term for a large number of different technologies, each based on different principles and materials.
Why print food?

**Personalized food & well being**
- ingredients, composition, flavors, shapes, size
- health/medical, lifestyle, (dis)likes

**Design freedom & new foods**
- innovative shapes, textures, flavors, etc.
- new product concepts, fun!

**Alternative ingredients**
- proteins from algae, grass, lupine seeds, beet leaf, insects
- create tasty, structured foods

**Flexible, decentralized production**
- freshly prepared food where you want it
- local, efficient production

**Convenience**
- freshly prepared food when you want it
- “personal chef + microwave”

**Social experience**
- social media supported recipes and cooking
- “pre and post fun”, communities
Where print food?

**Large food companies**
(centralized)
- food concept development
- mass production
- printed food
- personalized / on demand

**Food service industry**
(centralized or local)
- catering / restaurants
- sport & health centers
  (personalized: design, comp.)

**Retailers**
(centralized or local)
- supermarkets, etc.
- printing for consumers

**Small food companies**
(local)
- patisseries / bakers
- chocolate copy shop
  (design)

**Home**
(local)
- personalized food
  (design, composition)
Food printers – on sale (soon?)

Choc Creator 2.0 - image: ChocEdge
Foodini - image: Natural Machines
ChefJet - image: 3D Systems
PancakeBot - image: PancakeBot
Foodform3D - image: RIG
Candy - image: 3DVentures
Technologies – FDM
Early food products printed @ TNO
Technologies – PBP
Technologies – SLS
THE ESSENTIAL DIGITAL COOKBOOK  SECTION 6 - SAVOURY SNACKS

SPICE BYTES

Curry Cube, Paprika Pyramid, Cinnamon Cylinder, Pepernoot Pentagon
Early food products printed @ TNO
Materials types for food printing

- **FDM**: Purees, gels, molten materials, doughs
- **PBP**: Powders + “Liquids” / molten materials
- **SLS**: Powders

Wide range of materials are theoretically suitable.

...BUT, not all materials and formulations are directly suitable.

Materials, processes, and equipment must be matched, tuned, and/or adapted:
- **Material and recipe adaptation/reformulation**
- **Process parameter tuning**
- **Equipment modification**
How to 3D print food
From idea to 3D printed shape
New food products: not straightforward

material and process parameters
Formulation + process optimization

**Formulation 1**
- 20%  |  80%
- 40%  |  60%

**Formulation 2**
- 20%  |  80%
- 40%  |  60%

**Formulation ##**
- 20%  |  80%
- 40%  |  60%
Optimized formulation

**Settings**

- Line distance = 0.1 mm
- Writing speed = 1250 mm/sec
- Laser power = 50 %
- Layers = 50
- Shape = Hollow cube 15x15x15 mm
- Layer thickness = 0.3 mm
Food printing at TNO
Pasta printing project

Founded in 1877, Barilla is now the world's leading pasta maker. Barilla produces pasta in over 120 shapes and sizes. Barilla products are sold in over 100 countries worldwide.
3D printing of pasta
Various printed pasta shapes
Michelin star chocolate dessert
“Fabergé egg”
truffle

3D scan

printer file

3D printed (food)

3D printed (plastic)
“Autumn”
“Masterpiece”
Beyond shape...
Food printing of textures
Personalized food printing

“Yesterday”
leg of chicken mash

“Today”
hand-made, shaped
leg of chicken
(non-personalized)

“Tomorrow”
PERFORMANCE meals
personalised & shaped meals,
industrially manufactured
Personalized food parameters

For any given food item (e.g. a piece of broccoli) the following parameters can be personalized:

**Composition**
- total # calories
- added macronutrients: protein, fat
- added micronutrients: minerals, vitamins, PUFAs

**Other**
- size
- hardness
3D printed personalized food
3D printed personalized food

Personalization parameters

- composition & caloric content
  added macro- (fat, protein) and micronutrients (vitamins, minerals)
- shape & size
- hardness
Multi-texture 3D cake-type product

shape after baking
The big issues

**Fully personalized food**
How to develop printers that can produce fully personalized food products ("Star Trek Food Replicator")

**Print faster & high res**
How to fundamentally print faster and in higher resolution with various technology-food ingredient combinations

**Create food textures**
Go beyond the printing of shapes to the printing of food textures – both existing and new, designed textures

**New value chains**
Define the altered or new food value chains, products and services that will emerge
Food printing development

timeline

shaping

2014

personalized recipes

creating textures

full personalization
The future tastes good
What would you like to print?

Let us know!

Daniel van der Linden
TNO – Healthy Living

Daniel.vanderlinden@tno.nl
office +31 888 665 404
mobile +31 6 302 301 47

TNO.NL/3DFOOD