3D Food Printing: 
*The Barilla collaboration*

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Introduction to 3D food printing – the technology
Rapid Manufacturing (3D printing)

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.
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)
Technologies – FDM
Technologies – SLS
Selective Laser Sintering of... Nesquik™
SLS of Nesquik™

- TNO logo: 40 x 40 x 4 mm
- Stirring stick: 10 cm long
- Cup: 25 x 4 mm (2 mm deep)
- Chain links: 20 x 10 x 2 mm
SLS of sugars

- Cups: 25 × 4 mm (2 mm deep)
- Stirring stick: 10 cm long
- Squares: 20 × 20 × 2 mm
- Close-up sucrose grains
FDM of chocolate

- **Freeform**: 0.5 mm diameter wire
- **Open pyramid**: base $30 \times 30$ mm
- **Grid**: $20 \times 20$ mm
- **Pyramid**: base $30 \times 30$ mm
Early food products printed @ TNO
And more fun food products printed @ TNO
And finally Michelin star chocolate dessert
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

Formulation 2

Formulation ##
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**
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.
Novel pasta types with interesting shapes

“catene (al cacao)”

“xxxx”

“scodelline”
Novel pasta types

“ricci”

“cubetti porosi”

“anelli perforati”
3D printing of pasta
Various printed pasta shapes
SPECIALITÀ
RICCI
COTTURA 5 MINUTI

LA CREATIVITÀ RENDE UNICI
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
Performance – 3D printed vegetables
3D printed personalized food

Personalization parameters
- composition & caloric content
  - added macro- (fat, protein) and micronutrients (vitamins, minerals)
- shape & size
- hardness
What would you like to print?

Let us know!

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