TNO innovation for life

3D Food printing
Creating shapes and textures

March 2015

Daniel van der Linden

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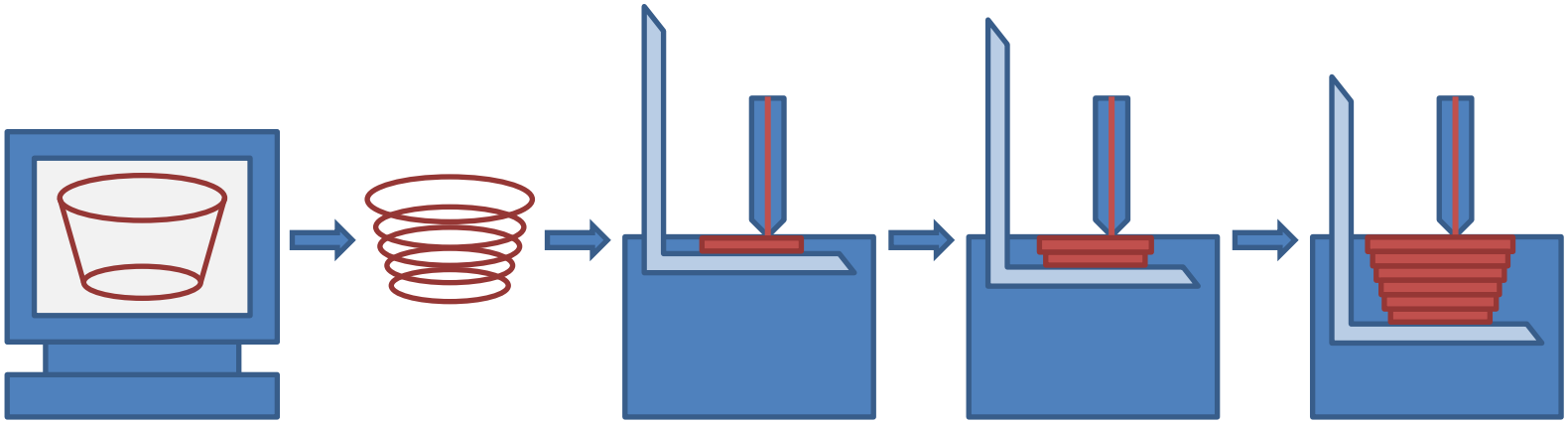
3D printing (Rapid Manufacturing)

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.



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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

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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)

?

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Food printers – on sale (soon?)

Choc Creator 2.0 - image: ChocEdge

Foodform3D- image: RIG

PancakeBot - image: PancakeBot

Foodini - image: Natural Machines

ChefJet - image: 3D Systems

Candy - image: 3DVentures

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Parties active in 3D food printing

2007 2008 2009 2010 2011 2012 2013 2014

Cornell University

FAB@HOME

PHILIPS

CandyFab Project

UNIVERSITY OF EXETER

Electrolux

Massachusetts Institute of Technology

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the sugar lab

Modern Meadow

Choc Edge creating your chocolate in style

piq chocolates

Riddel Institute Food | Innovation | Health

LONDON SOUTH BANK UNIVERSITY

3DSYSTEMS

Barilla

SMRC

NASA

HERSHEY'S

NATURAL MACHINES

Nestlé

Mondelēz International

US ARMY NATICK SOLDIER RD&E CENTER

RIG Robots in Gastronomy

3DVENTURES

FabLab Maastricht

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Technologies – FDM

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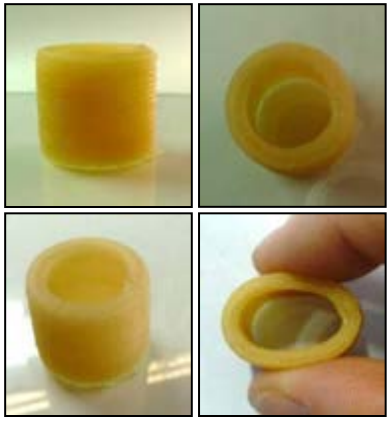
Early food products printed @ TNO



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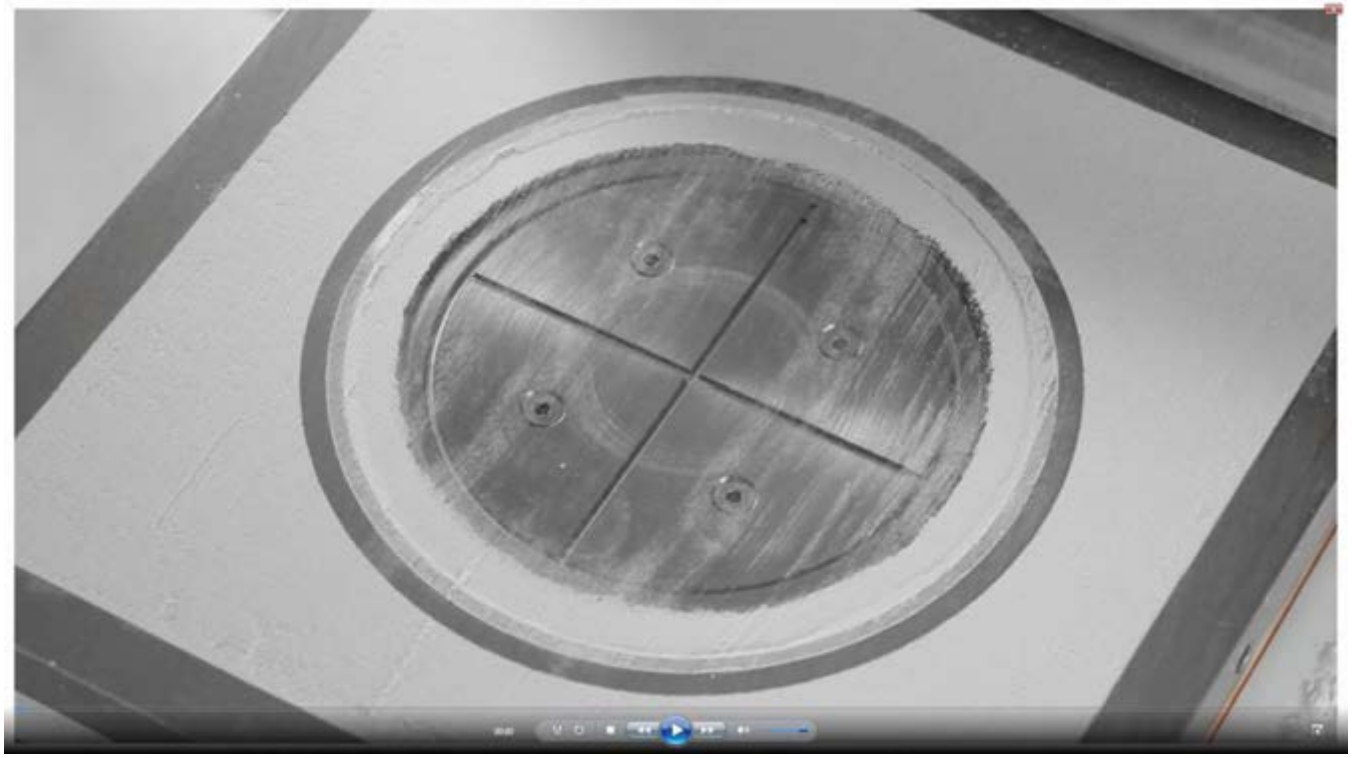
Technologies – PBP



Technologies – SLS

SPICE BYTES

Curry Cube, Paprika Pyramid, Cinnamon Cylinder , Pepernoot Pentagon

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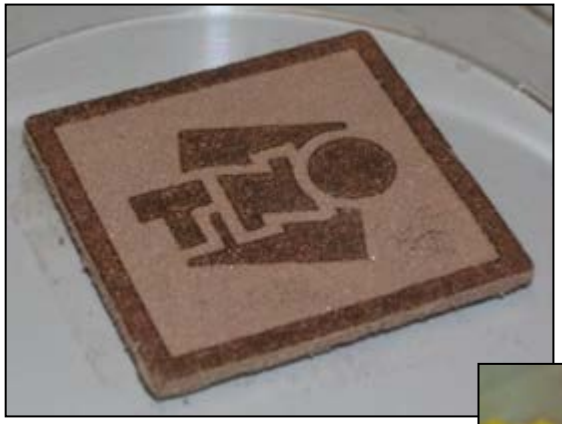
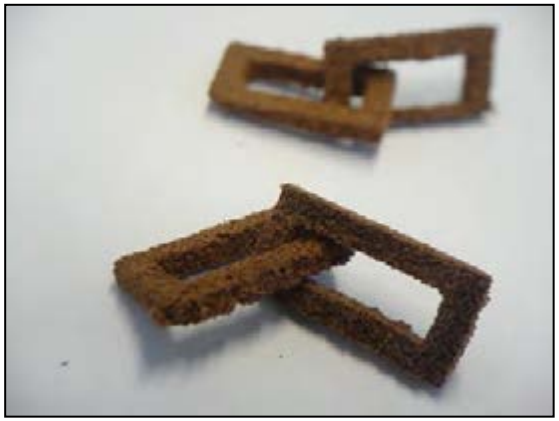
Early food products printed @ TNO





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**

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How to 3D print food

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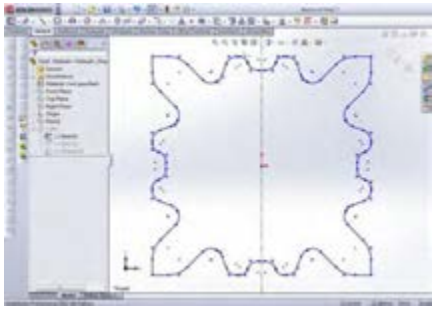
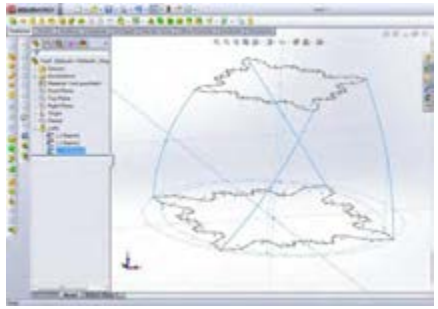
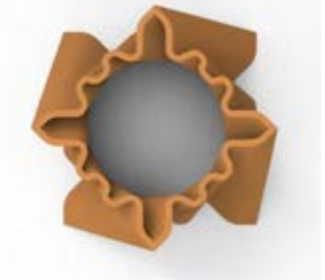
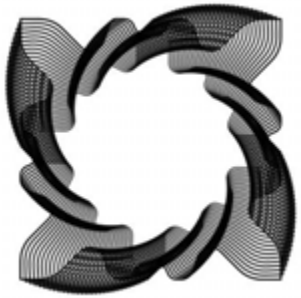
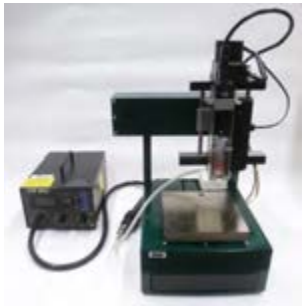
From idea to 3D printed shap

material and
process parameters

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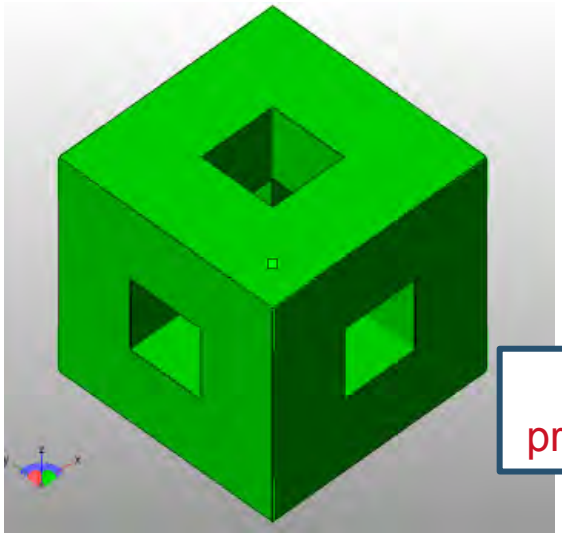
New food products: not straightforward



material and
process parameters

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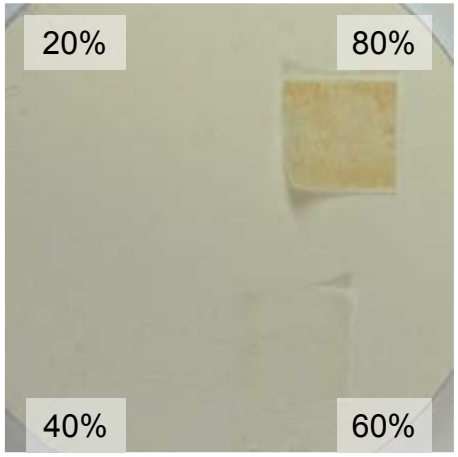
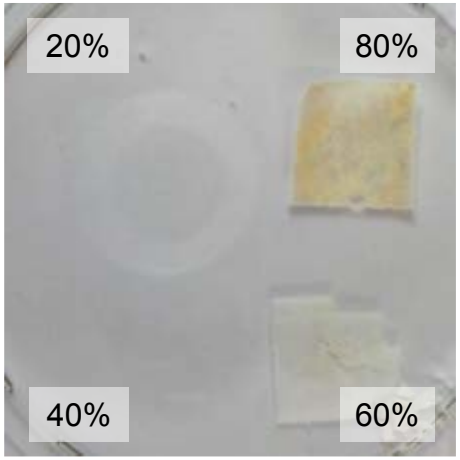
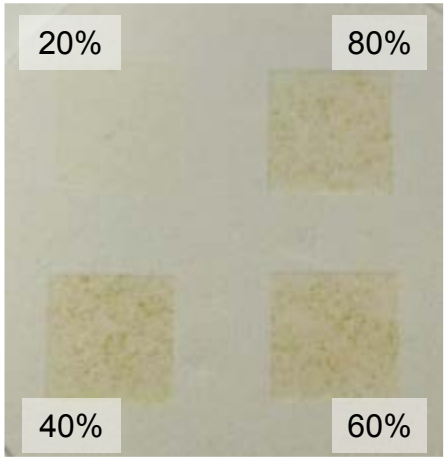
Formulation + process optimization

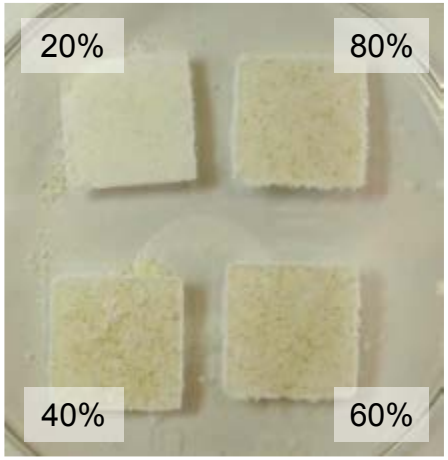
Formulation 1



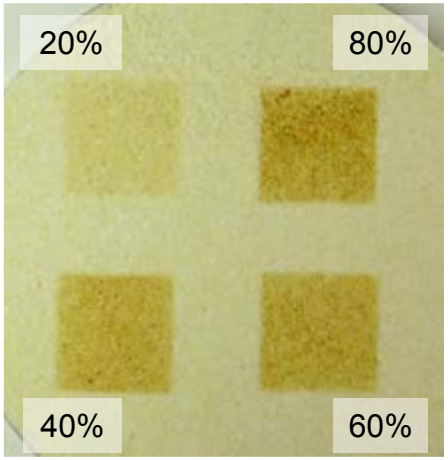


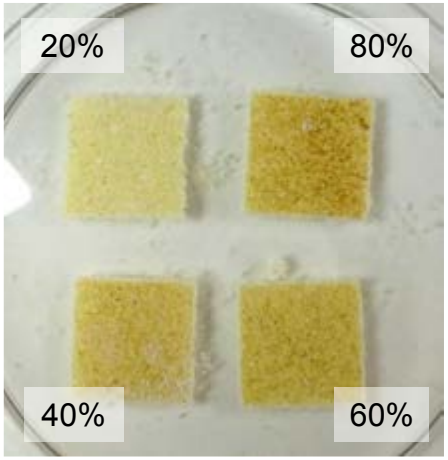
Formulation 2





Formulation ##

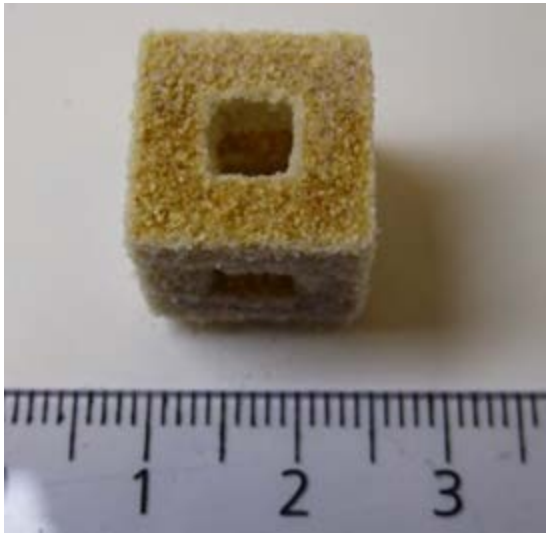




Optimized formulation

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



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Food printing at TNO

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Pasta printing project

Barilla *pasta printer*

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.

Barilla

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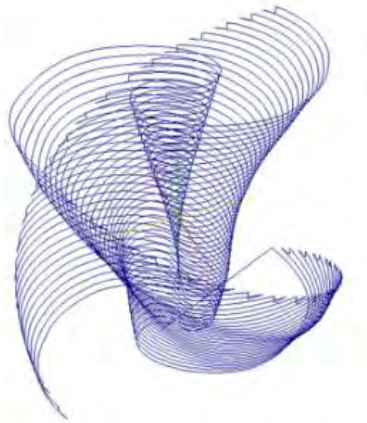
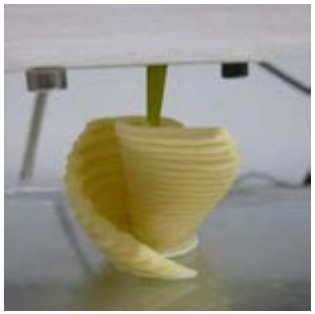
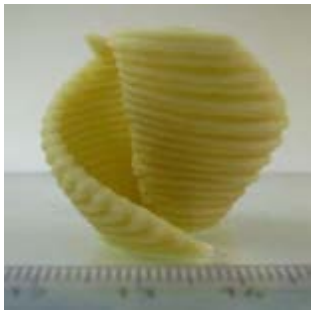
3D printing of pasta







Barilla

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Various printed pasta shapes

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Michelin star chocolate dessert

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“Fabergé egg”

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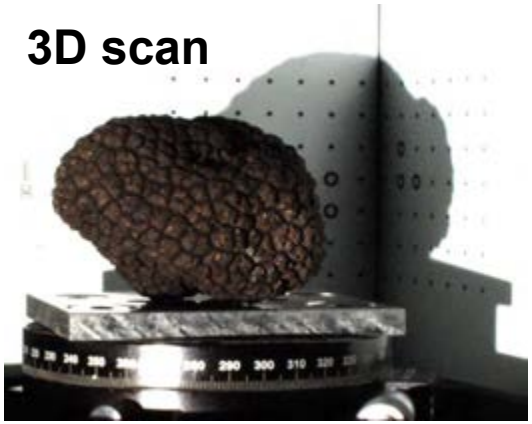
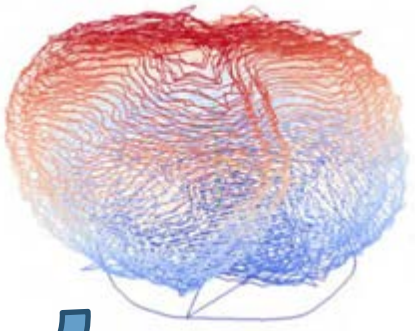
truffle

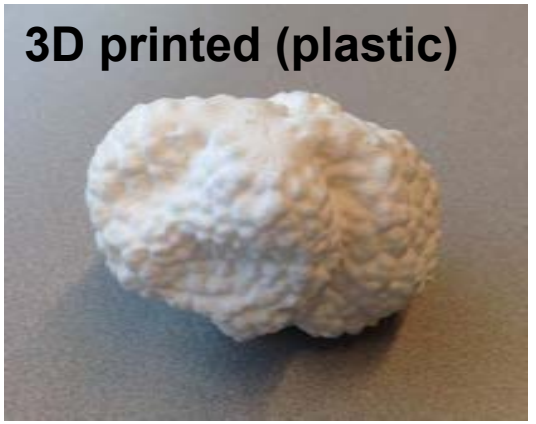
3D scan



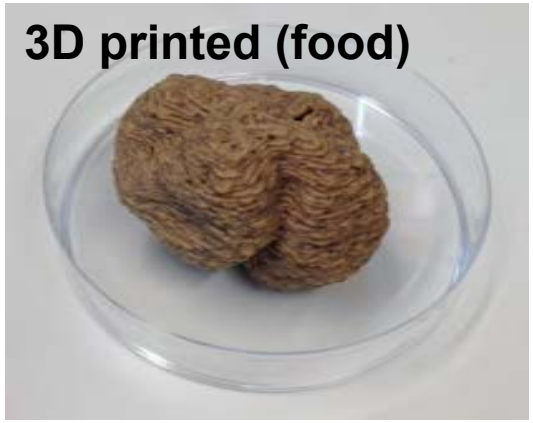
printer file



3D printed (plastic)



3D printed (food)



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“Autumn”

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“Masterpiece”

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Beyond shape...

Food printing of textures

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Personalized food printing

PERFORMANCE
Personalised Food for the Nutrition of Elderly Consumers

“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

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3D printed personalized food

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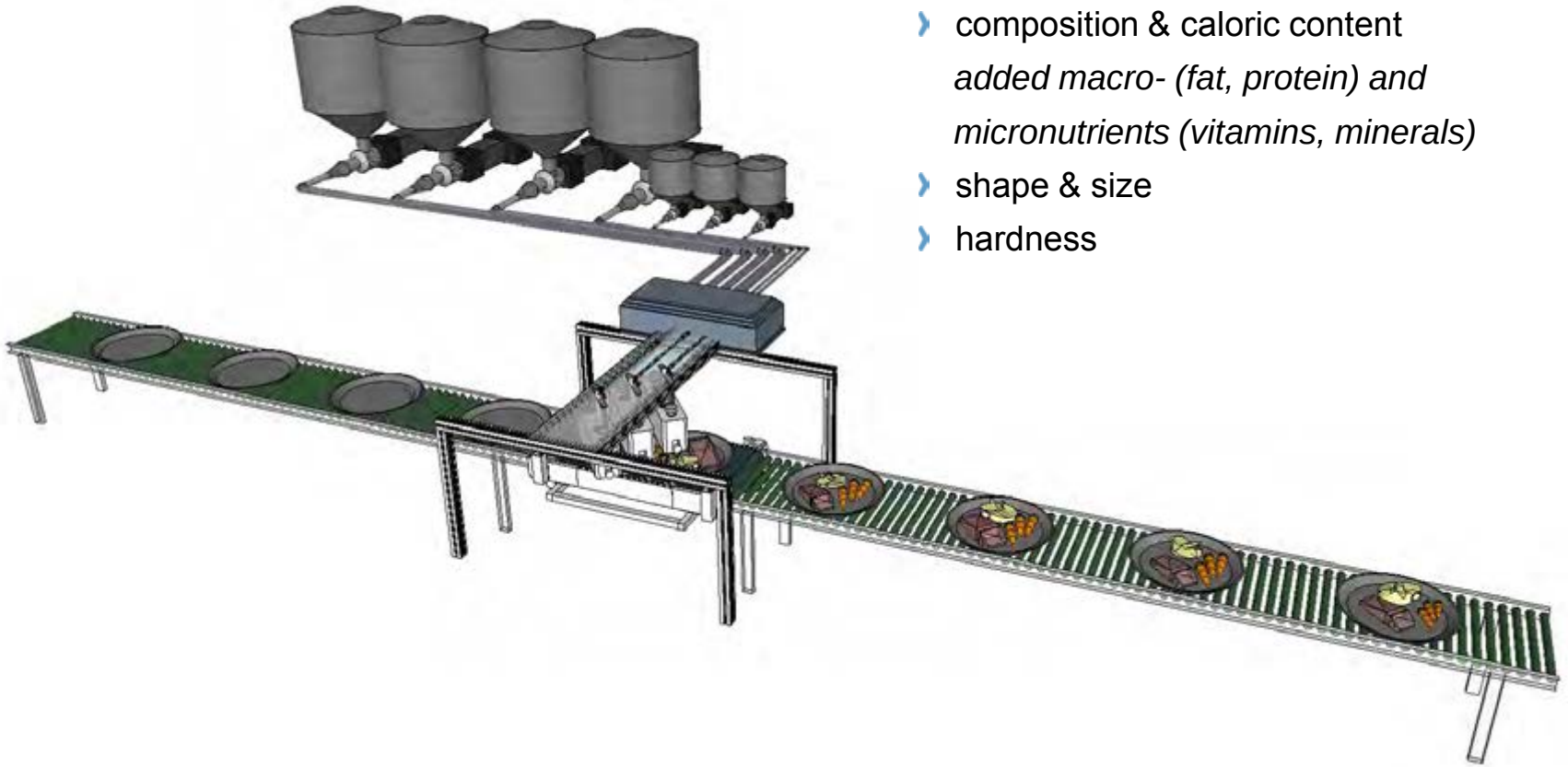
3D printed personalized food



Personalization parameters

- composition & caloric content
  added macro- (fat, protein) and micronutrients (vitamins, minerals)
- shape & size
- hardness

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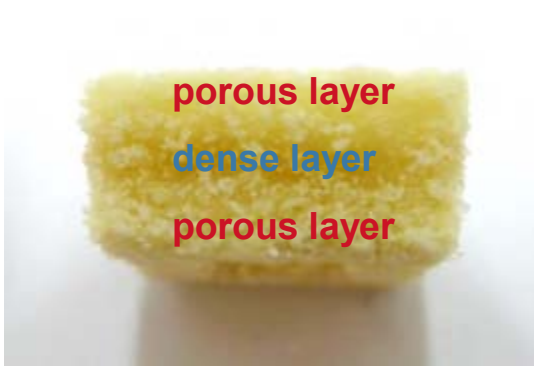
Multi-texture 3D cake-type product



shape after baking

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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

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Food printing development

timeline

2014

shaping

personalized recipes

creating textures

full personalization

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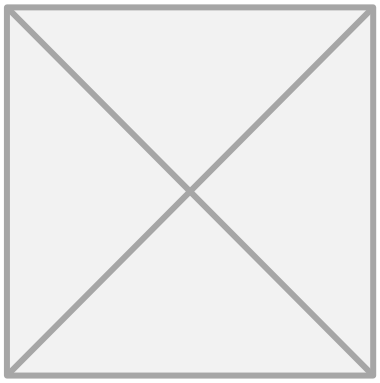
The future tastes good



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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