Understanding Manufacturing Processes in Prepared Foods

Prepared Consumer Foods Innovation Gateways, 3rd June 2015
Professor TJ Foster,
University of Nottingham, Division of Food Sciences
• Raw material modification for functionality that matter to the consumer: nutrition, flavour, structure, colour.

• Value addition moved the industry from MAKE-SERVICE-CARE, with focus on LEAN-AGILE-VIRTUAL manufacturing

• **E-commerce**, satisfying consumer needs moving the industry more to SERVICE and CARE.

• Unit operations ‘building block’ approach miss opportunities for process innovation.

• Process Synthesis: Understanding data relating to raw materials and process to produce desired products at minimum cost
* development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

**Figure 1.** Evolution of the food industry in terms of value added to products and shift in emphasis from process engineering to product engineering. This transition has implied a change in concepts and techniques that support each approach.
Food Quality & Manufacturing

preferences, acceptance and needs (PAN)

- tailored packaging
- sensory perception
- tailored food products
- structure / formulation
- translational process design

Choice for processing:
- integrative process design
- miniaturised / distributed

Raw materials from:
- bioprocessing
  - separation of metabolites

Quality sensing; feedback / feed forward control

Consumer level
Product level
Process level
Ingredient level

European Technology Platform on Food for Life
Strategic Research Agenda 2007-2020
Trends & Drivers:

- Increasing cost and scarcity driving importance of **security of supply**, use of fewer materials and less energy including water for all outputs as well as more reliance on **renewable resources**.
- The rise of the **digital economy** and an associated increase in **customised products** will have an impact on traditional products. Integration is expected to have more of an influence on innovation than will new R&D.

National Competencies (2025)

- **Understanding designing and manufacturing formulated products**
- ‘Plug and play’ manufacturing
- Design & manufacture for small-scale & miniaturisation
- **Systems modelling & integrated design/simulation**
- Flexible and adaptive manufacturing
- Combining product development steps in parallel / concurrent engineering
“Manufacturing in 2050 will look very different from today, and will be virtually unrecognisable from that of 30 years ago….as manufacturing becomes faster, more responsive to changing global markets and closer to customers...exposed to new market opportunities and more sustainable”

• **Mass personalisation of low-cost products, on demand**
  – “Direct customer input to design will increasingly enable companies to produce customised products”

• **Distributed production**
  – The production landscape will include capital intensive super factories producing complex products; reconfigurable units integrated with the fluid requirements of their supply chain partners; and local, mobile and domestic production sites for some products.
  – The factory of the future may be at the bedside, in the home, in the field, in the office and on the battlefield.

• **Digitised manufacturing value chains**
  – they will create new ways to bring customers into design and suppliers into complex production processes.
Food Microstructure Design

**CONSTRUCTION**
- Process
- Ingredient

**DECONSTRUCTION**
- Process (mouth/gut)
- Ingredient (enzymes)

**Reconstruction**
- Interaction with body mucins (associative and new phase separation)
- Microstructure changes as a function of enzyme action
- Impact on / of starting materials / structures

Controlled oral response (taste, flavour, texture)
In body functionality
A Pre-Competitive vision for the Food Industry

A safe, secure food manufacturing supply chain

A resource efficient food manufacturing supply chain

An innovative, resilient food supply chain for the 21st century populations
EPSRC Centre for Innovative Manufacturing in Food

£5.6m to be spent on Research
Started 1st December 2013
www.manufacturingfoodfutures.com

Prof Tim Foster, Prof Shahin Rahimifard and Prof Ian Norton

Biomaterials Group
Centre for Sustainable Manufacturing and Recycling / Reuse Technologies: SMART

Centre for Formulation Engineering
Our Focus

Sustainable Food
Supply and Manufacture

Sustainable Food Supply Chain
Eco-Food manufacturing
New flexible manufacturing processes
New processing technologies
Food manufacturing for healthy diets and lifestyles
Upgrading of ingredients

Innovative Materials,
Products and Processes

The two Centre Grand Challenges and their six Research Themes

Co-creating products of the future –
With ingredient and process developments
Our Focus

A resource efficient food manufacturing supply chain

Sustainable Food Supply Chain

Eco-Food Manufacturing

New processing technologies

Food manufacturing for healthy diets and lifestyles

Upgrading of ingredients

An innovative, resilient food supply chain for the 21st century populations

New flexible manufacturing processes

Upgrading of ingredients

Food safety

Energy and water

Waste minimisation

Authenticity and traceability

Understanding and changing behaviours/drivers

Next generation (integrative research)

Health and wellbeing of the future

Smarter packaging

New and smarter ingredients

Priority Areas for research to maintain and enhance the UK’s competitive position in global food manufacture
Microstructure & Processing

Black: LBG / water phase
Orange: milk protein phase
Green: fat phase

- Premix
- HT1
- Homo.1
- Acidification Flavoursing
- HT2
- Homo.2
- Filling
New Textures

LBG

BMP + Fat

Heat

Acidify

Homogenise 200 Bar

Salt

Fill

Hardness 80

LBG

BMP + Fat

Heat

Homogenise 200 Bar

Acidify

Salt

Fill

‘Stretchy’ 25
New Textures
### Ingredient Interchangeability: Proteins

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Interchangeability</th>
</tr>
</thead>
<tbody>
<tr>
<td>x% LBG</td>
<td></td>
</tr>
<tr>
<td>x% Gelatin</td>
<td></td>
</tr>
<tr>
<td>x% Milk Protein</td>
<td></td>
</tr>
<tr>
<td>22% Fat</td>
<td></td>
</tr>
</tbody>
</table>

x% LBG
x% Gelatin
x% Milk Protein
22% Fat

x% LBG
x% Gelatin
y% Soy Protein
22% Fat
Fat Reduction

Philadelphia

Full Fat  Low Fat  Zero Fat
New Structures from Cellulose

Starch-like processing histories

Fibrillation in high shear for new rheologies

Encapsulation and functionalisation

Controlled de-crystallisation and re-crystallisation
Filler Phase Interchangeability

25µm

50 µm
• Additive manufacture

[Images of manufacturing processes]

• HIP / Additive layer manufacturing & flash sintering

[Images of manufactured items]

www.epma.com

Melt extruded cellulose
Instant Emulsions

Concentrate mix by hand

Product

Cold Water

Oil / fat

Emulsifier

Dairy protein

Starch

+ salt / flavour / preservative / colour

OR

Cold Water / own oil

mix by hand

Unilever Patent Protected
Instant Emulsion Process

- pH 7.0
- pH 8.5
- pH 5.0
- lecithin
- Protein
- Water
- Final Starch swelling
- Product

Emulsification

Structure
Industry Report

Disposable Technologies and Single Use Systems for Biomanufacturing

2014

www.disposablebiomanufacturing.com
Thank you for your attention.