Kitchen chemistry

One of the world's largest food companies has reinvented its approach to R&D. Victoria Gill reports

In short

- Unilever has shaken up its R&D, opening six global centres of excellence this year
- The move is designed to maintain its innovation in an increasingly squeezed consumer market
- Unilever's major focus is on designing 'functional foods' that incorporate healthy ingedients into the food that people eat every day

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150 million times a day someone uses a product manufactured by the Anglo-Dutch consumer giant, Unilever, and one out of every two households worldwide has one of the company's products in its cupboards.

'It's exciting to work for a company that, if we get it right, has a real impact on such a huge number of people,' says Carla Hilhorst, director of Unilever's new Centre of Excellence for Structural Emulsions in Vlaardingen, near Rotterdam in the Netherlands.

The centre opened in March, and is part of a consolidation process that began in 2007 and will be complete by the end of this year. It will transform the previously fragmented 'local for local' R&D into six focused food product development centres throughout Europe (*see map*).

Hilhorst is enthusiastic about the change, which has ensured that the company stays ahead in an increasingly turbulent market, she says. 'There are new market pressures and priorities that now require this type of focused R&D approach,' she adds. 'Commodity prices are increasing and we have to respond – the price of vegetable oil has increased by three times within the past year from €500 per tonne to €1500, so we need to be even smarter with the raw materials we use.'

The healthy option

Unilever's food R&D has a health focus. It aims to reduce saturated 'bad fats' in commodity foods and to design 'functional foods', which contain additional, beneficial ingredients that its consumers worry about not getting enough of in their diet – including vitamin D and omega-3 fatty acids. The aim is to make foods that people use every day – such as margarines, dressings and cooking oils – as healthy as possible.

When announcing the company's reorganisation at the end of 2006, Patrick Cescau, Unilever's chief executive, promised a more active role for the company in promoting good nutrition. He said that the food industry must do more to rebuild public confidence, driving down the levels of sugar, salt, trans-fats and saturated fats in its products, and also play a more active role in nutrition education. (Unilever eliminated partially hydrogenated or trans-fats from its margarine and spreads in the 1990s in Europe and other regions, when research established their link to cardiovascular disease – and says it led the way for other companies to follow.)

The locations of Unilever's new centres of excellence

Carla Hilhorst, director of Unilever's Centre of Excellence for Structural Emulsions

At the structural emulsions centre, product developers are exploring healthier alternatives to the traditional fats that form the solidifying network that holds your margarine or mayonnaise together.

According to Hilhorst, such health-boosting products match consumer need and can only emerge from a commercial setting. 'Consumers' desire for healthy foods drives our marketers to make more demands of our products, and that stimulates our scientists and product developers. It's the only sustainable scenario.'

The resources that the company is pouring into R&D are evident at the new centre. The entire development process for a new product – from the study of its raw ingredients, through to piloting its manufacturing processes and designing its packaging – takes place in the centre. There are even vast kitchens where all of the food products are tried and tested by the company's chefs.

Better butter

For the Vlaardingen centre's nutritionist, Manon Zeelenberg, butter is something of a nemesis. She works for the margarine product group – monitoring public heath data released by European governments to see what Unilever could and should be including in its foods to improve people's diets.

'There is so much conflicting information about fat that people are confused,' she says. 'Lots of people go back to butter – because they return to traditional values and they see it as a natural option. But just 20g of butter contains almost 50 per cent of the maximum daily intake of saturated fatty acids, and there is a clear link between intake of these fats and cardiovascular health problems.'

Zeelenberg also scours the medical literature in order to produce material on dietary health that is supplied to healthcare professionals by Unilever.

'One key rule of thumb is that animal fats are bad, and plant fats are good,' she says. 'But it obviously goes much further than that. And we have the technology to be able to add to spreads what people are not getting enough of. For example, nutritional research has shown that people should eat fish twice a week to get fatty acids that are good for heart health. But fish is expensive – many families can't afford it so often, or perhaps they don't like eating fish. We can incorporate those fatty acids into margarines.'

According to Zeelenberg, the Netherlands has something of a margarine heritage: 'In the 1960s, when the story first emerged about saturated fatty acids and heart disease, Dutch cardiologists recommended sunflower oil to their patients because the unsaturated fats in the oil were known to be healthier,' she explains. 'But patients were struggling to incorporate this into their diet – in the Netherlands they were used to using butter on their bread, and there was no culture of using oil. So doctors asked Unilever to make a sunflower spread, and for a time it was only available on medical prescription.'

Fat fortunes

The centre's developers are obsessed by fats – one rather slender technologist went so far as to describe himself and his team as 'fat nerds'.

The unique structuring properties of fats have enabled this entire field of product development. Traditionally, structured emulsions, such as margarines, were made stable using saturated triacylglycerols (TAGs). These are present in fats and form a network of crystals across the liquid oil when cooled. This provides a perfect scaffold to hold the product together that is also thermoreversible, so these mixtures of fats and oils are also useful in cooking.

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Is this the world's fattest sculpture?

But even small amounts of saturated TAGs contain a large amount of saturated fatty acids, so Unilever and other food companies have searched for ways to replace them. This can in principle be done with other lipids or lipid-like molecules, including waxes, that contain long saturated fatty acids chains and form a similar crystal network. But there are other molecules that also reversibly self-assemble into scaffolds, including certain plant sterols that form a supporting network of fibrils. However, product applications of these alternatives remain a challenge.

'With margarine, it used to be that the more water and less fat in the product, the less firm it was,' says Arjen Bot, group leader in emulsion technology. 'But with gelling agents – such as gelatine – we can compensate for the fat we take out.

'We've also found new approaches that don't require these gelling agents. We can make almost entirely fat-free spreads using two ingredients in the water phase that don't mix – a polysaccharide and a protein. Alternatively, we can cross-link the protein-covered oil droplets to make an oil-in-water emulsion with similar properties to a fat-continuous spread [water droplets in a oil-based system],' says Bot.

Bot's team is now applying a technique using supercritical carbon dioxide to build an emulsion with the minimum amount of fat crystals – dissolving the fat in supercritical CO_2, and expanding it through a nozzle.

'The expanding gas blasts apart the fat crystals into much smaller particles, giving them much greater surface area. If you increase the surface area, there are more connections to stabilise the emulsion,' says Bot.

Unilever developers also assess the thermodynamic properties of each of the structural ingredients, and of the oils used to make certain products – because each ingredient mix or emulsion has a different function. Spread for your toast should be spreadable when you take it out of the fridge, and cooking margarines need to give structure to your pastry.

'The melting point of an ingredient is crucial,' says Eckhard Flöter, group leader in fat technology. 'If you want your finished product to melt in the mouth, it must melt very rapidly at that temperature, otherwise it will feel waxy and unpleasant. In the chocolate industry this relates to avoiding chocolate bloom, the white stuff you find on old chocolate.'

And designing foods to incorporate additional, beneficial ingredients complicates this further. 'Omega 3 fatty acids, for example, are prone to oxidation, which makes the food smell and taste of fish, so we have to find suitable design processes and ingredients, such as chelators and antioxidants, that will protect these oils from oxidation.'

Something in the air

The walls of the Vlaardingen centre feature murals and photographs of the company's product developers and its products. In the canteen (where of course there is no butter to be found) communications manager Jonna Wiersma tells me

Unilever's famous dessert could have been an award-winner

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that the centre has been designed, right down to the décor, to stimulate innovation, and that Unilever is always looking for novel ways to encourage breakthroughs. 'Each year we have a patent competition, and our scientists and technologists submit their best patent applications,' she says. Sadly, the competition was not up and running when the ubiquitous Vienetta dessert was invented. 'But it would have won today though,' Wiersma assures me.

'And for the opening ceremony of this centre, we commissioned a sculpture made from 10 tonnes of emulsifier [monoglyceride],' she adds. 'It was officially credited as the world's tallest emulsifier sculpture.' The sculpture remained in the entrance hall for several weeks (although the heat had caused one of the characters in the moulded scene to lose an arm).

A grand scale

Unilever produces tens of millions of tubs of margarine per year, and to translate its nutritional research into products on the supermarket shelf the company has to establish reliable sources of raw materials, and produce, package and transport quantities on a vast scale.

In the pilot plant, where production processes are tested and tweaked, oils are neutralised, bleached and deodorised before they go into production. 'It's all because of oxidation,' explains Sjef Dickhoff, manager of the pilot plant. 'When the oil gets here it often has a really bad smell. Oxidised coconut oil, for example, smells soapy. And crude palm oil smells really bad.'

The pilot plant is a minimised version of the manufacturing that is carried out in huge Unilever plants throughout the world, and every aspect of the process can be changed and fine-tuned. 'Here we're dealing with batches of 50–200kg, but by the time the process gets into the factory, we're dealing with six tonnes per hour, so we need to get it right,' he says. 'We have a group of expert tasters to test the finished product before it goes into production.'

'We have an annual patent competition to encourage new ideas'

The final challenge is to package a product attractively, while making sure it is protected. It's part of Frédéric Dreux's job as packaging materials technology manager, to find out, together with the developers, what each food product is sensitive to and how to prevent degradation.

The packaging team he is part of then designs the packaging that will protect it and tempt shoppers to pick it off the supermarket shelf.

'It's often an advantage to be able to see the product through transparent packaging, so we can test which wavelengths of light it is sensitive to, and use coloured materials to filter those out,' Dreux says.

Probiotic drinks are a particular challenge, he adds, as they are so sensitive to light. 'There's a layer of black in the middle of probiotic drink bottles to make sure that no light at all can get in.'

But the biggest priority is to ensure that products aren't contaminated – microbes would multiply very quickly in water-based food products, such as yoghurts or ketchup, so once bottles are filled, caps need to be completely secure.

'We can't just wrap lots of tape around seals to keep them sterile, they would be a nightmare to open,' says Dreux. 'So we have to test our caps under worst case scenarios – storing a bottle upside down for long periods, and checking that it is protected from microbes.'

It's a tough time for the food industry. Unilever has not only had to face rapidly increasing raw materials prices, but some heavy criticism from environmentalists for its use of palm oil. The good news for the firm is that, if anything, the current economic climate is making consumers even more health conscious.

By reinventing its R&D approach, Unilever hopes to come up with some new ideas that will satisfy demand from busy but health-conscious consumers.

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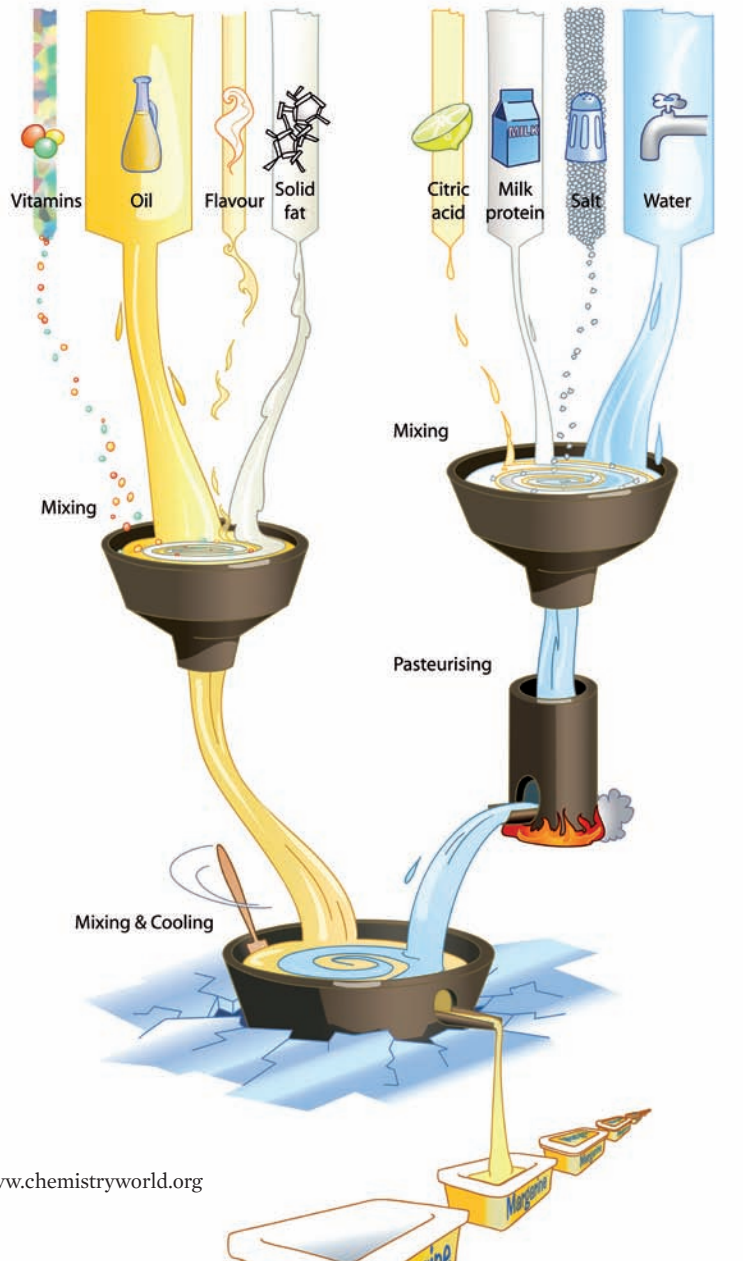

The making of margarine: the new centres take a product from development right through to packaging