Packaging Innovation

Packaging and dispensing systems for ‘intelligent’ delivery
A world leader in technology and product innovation

- Over 400 engineers, designers, scientists, and consultants
- The majority of our business is fee-for-service product development
- 70% of our work is repeat business – our team members become trusted partners for our clients
WHAT WE DELIVER FOR OUR CLIENTS
WHO WE WORK FOR

We have worked with many clients in diverse, high volume markets including consumer goods, consumer electronics, diagnostics and drug delivery
We work across a range of industries and so have both market specific knowledge and technical depth, backed by robust processes and systems.
We have assigned over 3000 patents to our clients
Trends in Personal Care Products

- Multi-functionality
  - E.g. BB, CC creams

- Personalisation
  - E.g. Skin hydration, diagnostics, connected devices

- Home-Use Devices
  - E.g. Hair removal, anti-ageing, connected devices, regulated products

- Packaging and dispensing
  - E.g. Airless packaging, foaming technology, late point differentiation

- Ageing ‘well’ rather than ‘anti-ageing’
- Sustainability
- Multi-sensorial
- Natural / organic ingredients
Consumable delivery capability

- Extensive experience of consumables, packaging, appliance and consumable/durable development
  - Liquids, slurries, aerosols, foams, powders, sprays…

- We have worked across numerous markets and products:
  - Novel soft drinks and alcoholic dispensing systems
  - Novel brewing systems for tea and coffee
  - Cosmetic and personal care devices
  - Drug delivery devices (e.g. inhalers, transdermal)
  - Sprays and aerosol products

- We use a tried and tested approach of combining analytical methods, pragmatic test work and innovative design to produce step change technologies and products for our clients
Formulation & physical chemistry

- Dispensing systems are exactly that... a **system**
- Whether we’re developing an inhaler or a beverage dispense system, it is very important to understand how the product / formulation interacts with the dispensing mechanism(s)
- Our understanding of...
  - Rheology of flow
  - Hydration & wetting characteristics
  - Materials properties
  - Physical chemistry & reactions
  
  ....enables us to work seamlessly with your formulation team, and to ensure this understanding is embedded in our engineering designs
Dispense

- Relevant skills inc:
  - Thermodynamics
  - Liquid and soft solids pumping
  - 2 phase flow
  - Mixing, emulsification and dissolution
  - Solvent extraction
  - Heating and cooling
  - Modelling, e.g. computational fluid dynamics
  - Control systems

- Supported by excellent general mechanical and electrical engineering & system design skills
Capillary Flow in a Diagnostics Instrument - Video

Contours of Volume fraction (phase-2-blood)  (Time=2.5155e-01)  Dec 16, 2011
ANSYS FLUENT 13.0 (3d, dp, pbns, vof, lam, transient)
Inspiration from the MEDICAL industry
From medical-to-skincare …. a natural evolution …. 

- A package’s delivery system always matters, and this is even more apparent in the skincare category. Brands have been working with suppliers to develop skincare packages that will give consumers the most effective, enjoyable and convenient experience when using a product. “Consumer concern with skin, always high, has now been boosted immeasurably by product innovation.” This includes the increase in “medicalized” skincare products, as well as high-tech devices.

*(Diagonal Reports, Global Skincare: Consumer Behavior/Regimes and Market Report 2015)*
Our Packaging Capabilities

Medicinal products / medical device packaging design including:

- Structural packaging design
- Package labelling
- Packaging graphics
- Trademark logo design
- Tamper proofing *card cartons*
- Blister pack design *including child proofing*
- Package leaflet design
  - *Patient information leaflet (PIL)*
  - *Instructions for Use (IFU)*
- User testing and Validation studies *with users*
Packaging and system design for TOBI podhaler®

- Inhalation therapy kit for **Cystic Fibrosis (CF)**
- Designed to **simplify** the treatment regime and create a **positive user experience**
Packaging and system design for TOBI® podhaler®

- Structural and graphical packaging design including:
  - Blister pack design
    - Design of child resistant opening method
    - Graphics to aid novel opening method
  - Package leaflet design including PIL and IFU
    - for multiple languages
- Updated brand and created trademark logos
- User focussed design
  - User testing and Validation study
    - with child and adult CF patients
    - Connections with UK CF hospitals
Key design features
Mixing in a wet-dry blister

- Cold form dimples in lower foil layer
- Deposit dry reagents
- Lay top foil
- Form permanent heat seal
- Form two frangible seals
- Fill wet reagents
- Seal wet reagents with permanent seal
- Punch alignment holes, trim
- Finish
Our Drug Delivery expertise includes a range of mechanical and powered products for injection, infusion, inhalation, and transdermal delivery.

**Injection & Infusion**
- PFS, Autoinjectors, Reconstitution, Needle Free, Infusion Pumps, Connected Devices

**Inhalation**
- DPI, MDI, Nasal, Nebulizers, Active Devices, Connected Devices

**Transdermal**
- Active transdermal
Experience across different technology and energy modalities

We have decades of experience in the following areas:

1. Therapeutic and diagnostic devices
2. Wearable technology
3. Optics
4. Ultrasound
5. Radio frequency
6. Flexible and ultra-thin electronics
7. Dispensing
8. How energy modalities can have synergistic effects with formulations
### Different energy modalities for skincare ‘delivery’ applications

<table>
<thead>
<tr>
<th>Energy Modality</th>
<th>Therapeutic Benefit</th>
<th>Sensorial</th>
<th>Transdermal Delivery</th>
<th>Activation/Release</th>
<th>Dispensing/Dispersal</th>
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ID Examples

Flow - home health hub
Glucometer
The Nexthaler was fully developed at Cambridge Consultants. It was the first “open, inhale, shut” inhaler to be developed.

“Cambridge Consultants represented a ‘one-stop shop’ for all our requirements,” Paolo Chiesi, vice-president and R&D director.
High volume OTC diagnostic devices

We designed 2 similar products to meet different market requirements in EU and US

The Persona™ was taken from lab chemistry to launch, achieving radical cost reduction due to understanding of fundamentals delivering laboratory level performance in a handheld device

Smart engineering included low cost optical array, electronics and sensor ASIC design

ClearBlue™ was the world’s first digital pregnancy test and both products are still sold worldwide
We cover the skills required to develop multidisciplinary devices

- Optics
- Packaging
- Design for Manufacture
- Fluidics
- Immunochemistry
- Electronics and Software
- Human Factors
Moulded Optics

- Moulded optics advantages:
  - High volume production
  - Low cost
  - Reproducibility

- Design experience:
  - Lenses
  - Light guides
  - Passive illumination

- Process optimisation:
  - Analytical tolerance modelling
  - Image processing to measure shrinkage
  - Laser studies of surface and material quality
Fluid Dispensing Systems
Innovative Packaging
Technology driven innovation

- Identified potential for using electrostatic technology as a makeup applicator
- We developed the core technology for the product implementation and delivered a proof of concept demonstrator
- The resulting product generated $10 million sales in the first month and helped create a $400 million business

“The Air Touch product was a critical initiative in this business whose objective is to meet the needs of the highly discerning consumer.”

Rowena Pullan, Director – Research & Development, Proctor & Gamble
Key features

- Small motor delivers crème to tip for launch
- Transformer takes 3V lithium battery up to 15,000V
- Conductor transfers charge directly into crème
- Conducting button completes circuit
PHILIPS

Inventing the consumable-durable

- We ran a Structured Idea Management process for Philips to identify a new product concept
- The lead idea was a consumable-durable product combination
- This was driven by a combination of technical talent and stakeholder insight
- We designed the interface to protect it from competition
- Enabled client to achieve $55M in sales during first year of launch

“For some tough jobs, if we went anywhere else, it would take longer and the results would be lower quality”

Charles Cook, Philips Consumer Lifestyle.
The CC foamer technology

Cambridge Consultants have developed a novel mechanism for generating micro-foams without requiring liquefied propellants (VOCs) or dissolved gases.

- The technology we have developed:
  - Creates high quality foam
  - Produces foam with up to 95% gas phase volume, <50 micron bubbles, and a uniform size distribution
  - Does not require VOCs, flammable propellants or dissolved gases
  - Can use nitrogen or compressed air as the propellant
  - Can use PET bottles as the container, allowing a wider range of bottle shapes
  - Is low cost and suitable for mass manufacture
  - Can be filled on standard aerosol lines

Potential applications: soap based cleansers, shower foams, hair mousses
Patents are pending on several embodiments of this technology
A variation of CC’s foamer technology can be used to create foamed emulsions

Foamed emulsions can have richer creamier textures than surfactant emulsions

This property may enable this technology to be used in the development of skin moisturisers, dermatological products or shaving foam products where a lubricating effect is required

Foamed emulsions may be used as a vehicle for the topical delivery of non-polar actives which can be dissolved in the oil phase. Foams do not run when dispensed onto the skin and enable very uniform distribution of the actives over a large surface. In some cases the oil droplets are sub-micron and may be used to deliver actives through the epidermis and into the dermal layer of the skin.

Other materials (ZnO, talc, TiO2) locate themselves at oil/water interfaces. Due to the large surface area of the oil droplets, our foamed emulsions may be used to deliver high loadings or uniform coatings of these materials and thus may form the basis of foamed sunscreen, foundation products or certain dermatological products

Patents are pending on several embodiments of this technology
Potential formats

CC emulsification technology module as part of the durable or consumable element within...

- Pre-pressurised aerosol can
- Powered device
- Hand-actuated mechanisms
- Many others....

**Appliances**

**Hand operated devices**
Innovative Packaging & Dispensing

Eco-friendly foam

Creamier textures and more stable foams are created

Low-cost attractively shaped plastic packaging can be used instead of aluminium cans as there are no flammable propellants

Compressed gas propellant (eg nitrogen or air) does away with potentially harmful emissions

Foaming mechanism combines gas and formulation to create a smoother texture

Formulation to be foamed (eg make-up or shaving cream)

Compressed gas drives the liquid up the dip tube and into the foaming mechanism
Concept Generation

- Foamer + ‘Clarisonic’ style combination
Characterisation of Sprays, Droplets & Liquids

Droplet Size Characterisation

High-Speed Imaging

![Diagram showing droplet size distribution and high-speed imaging results.](image_description)
Examples of nebulising systems

- Hydrodynamic sprayers
- Ink-jet printing systems
- Ultrasonic atomisers
- Piezo-electric nebulisers
- Electrostatic sprayers

![Diagram showing different types of nebulising systems and their characteristics.](image)
Case Study: Investigation of methods for transport of fine persistent mist

- Small droplets settle slower than large droplets (Stokes’ law). A settling speed <1 cm/s requires droplets ~10-20 μm.

- Small droplets like mist or fog will suspend for many seconds, so can be convected.

- However, small droplets evaporate more readily, and hence travel a shorter distance.

- Evaporation is dependent on the relative humidity (%RH), e.g., an air volume of 0.15 m³ requires ~1.3ml of water to raise its relative humidity from 50% to 100% at 20°C.
Introducing Vortik
VORTIK RE-WRITES THE RULES OF SPRAYING
WHAT ISSUES DO YOU ENCOUNTER WITH SPRAYS?
Conventional sprays...

A conventional nozzle generates spray directly at the nozzle.

This results in a fixed interaction between the flow rate, particle size and can pressure.
……..but with Vortik

- Cyclone diameter and absolute pressure controls flow rate
  - These can be independently controlled
- Pressure ratios determine particle size distribution
- Larger feed channels allow thicker liquids to be sprayed
- Vortik can shift the particle size distribution both larger and smaller than conventional sprays
Multiple inlets allow for mixing of different liquids at point of spray
.....and it is a scalable technology

A 3mm cyclone typically delivers 0.1cc / second

A 20mm cyclone typically delivers 1 litre / minute
FROM DISPENSING CREAM....
...TO SPRAYING PAINT
There are applications for Vortik
COULD VORTIK WORK FOR YOU?
The Future ....
Intelligent packaging?
Our expertise spans the entire wireless spectrum

- **ID**
  - Applying Bluetooth Smart for consumer, medical and industrial applications

- **Access**
  - Co-created Ember Corp., one of ZigBee market leaders

- **Sensor**
  - Created CSR plc, market leader in Bluetooth technology

- **Voice / Audio**
  - Developed the Air Traffic Radio that manages all of US airspace

- **Data**
  - Development partner for Iridium Satellite for all ground based terminal technology

- **Video**
ID Examples

![Image of a smartphone with a heart rate and temperature app]  
![Image of a woman holding a device labeled "idration fluid management system"]
Solitair is a demonstration of how worn technology, communication design and application design can be combined

Allowing active management of UV exposure, this demonstration was part of a family, showing how connectivity can enhance wellness
DropTag® Platform
PROJECT EXAMPLE

Using low cost, smart connected device for condition monitoring

- We have developed a technology platform called DropTag
- This is a low cost device that can monitor many attributes and report those conditions to any Bluetooth enabled device
  - Temperature
  - Vibration
  - Humidity
  - Pressure
- This enables real time logging, automated alerts and the ability for everyone in the supply chain to understand the condition of their goods.

New concept product offering to various sectors

DropTag – a simple-to-use low-cost condition-monitoring system, comprising smart sensor pucks, an app and a secure server.

DropTag® LOGGER has two handling sensors:
- 12G accelerometer for vibrational analysis and journey characterisation
- 100G accelerometer for accurate impact detection

Aperture houses temperature and humidity environmental sensors

DropTag® LOGGER continuously monitors and logs environmental conditions and records critical events
Sample rate of data collection can be varied up to 1kHz

Micro SD card logs all event history
- 8GB capacity - sufficient for 7 x 24hrs of continuous logging of all channels
- SD card can be accessed via a removable side panel

Connection from external 3xAA battery pack
(DropTag® LOGGER only)

The DropTag® platform is a family of Bluetooth Smart devices incorporating Bluetooth Low Energy technology

For the purposes of the trial the DropTag® LOGGER will have all communications inhibited

Flat back face with self-adhesive backing
Backplate and access panels are secured by screws
DropTag® LOGGER measures 64 x 64mm

DropTag® LOGGER can be solely powered by an integrated coin-cell for Bluetooth Smart communications only (with SD card data logging disabled)

Human readable identification code

QR code for fast identification via smart device
DropTag® system

- **Internet**
  - CENTRAL SERVER
    - Analysis
    - Data
    - Reporting
    - Key management
    - Many results

- **SMARTPHONE**
  - Local results

- **GATEWAY**

- **PUCK**
  - Humidity
  - Accelerometer
  - Temperature
  - Bluetooth Smart

- **TABLET**

- **DASHBOARD**
Many market application areas

- **Telematics**
  - Car insurance through driver profiling and accident detection
- **Logistics**
  - Integrity of parcels during distribution
- **Pharma**
  - Integrity of drugs during transportation (exposure to heat and/or humidity)
- **Condition Monitoring**
  - Looking for abnormal conditions or events that inform intelligent maintenance schedules
Vibrational Analysis

- We can detect many subtle vibrations due to the low-weight, low-inertia DropTag sensor puck.
- In this (vehicle) example we’re able to detect:
  - Engine RPM
  - Gear change RPM
  - Gear selected
  - Wheelspeed RPM
  - Driver X, Y, or Z (via their driver signature)
To conclude … What does the market want and what do we do?

- provide multi-sensory innovative consumer experiences
- create dispensing consumable/durable solutions that meet commercial requirements
- improve the consumer experience at home as well as out-of-home
- increase production efficiency through improving delivery in the manufacturing environment
- can heat, cool and mix, and dispense sprays, foams and powders to create novel new products
- technology generated can also be applied in many embodiments, from a single-use product to a consumable domestic appliance, through to commercial vending machines in out-of-home settings.
Introducing....

CX

Consumer Xperience
A CONCEPT BECOMES A PRODUCT THAT WILL SELL WHEN GENUINE CONSUMER NEEDS ARE MET WITH LEADING EDGE TECHNOLOGY
A concept is nothing if it doesn’t work
A concept is nothing if it can’t be made
Facilities

In-house mechanical prototyping and fabrication facilities
In-house surface-mount PCB assembly, secondary assembly and re-work stations
A concept is nothing if no-one wants it
CX is our way of bringing your consumer into the concept creation process....
CX follows your Consumer Journey from first encounter to final use

**THE CONSUMER JOURNEY**

- **Desire for a Product**
- **Attraction to Specific Product**
- **Evidence of Function**
- **Purchase**
- **Open**
- **Use**
- **Disposal**
During that journey your consumer will not only encounter DESIRE
But face FRICION
We consider where Desire and Friction occurs on your consumer's journey.

THE CONSUMER JOURNEY

Attraction to Specific Product

Positive Brand

Evidence of Function

Good advertising

Purchase

Open

Use

Good Results

Uncomfortable

Disposal

Life too short

Desire for a Product

8 April 2015

Commercially Confidential

86
An innovative **auto injector** for delivering progesterone in oil

An **internally funded** project to showcase our capabilities
Background

- **Progesterone** is a hormone vital to sustaining pregnancy
- Most women undergoing **fertility treatment** require regular doses of progesterone
  - Drugs used in IVF treatment can lower a woman’s progesterone levels

- Administered through **injections**
The issues

- Progesterone injections have many **usability issues**
  - Intramuscular injections
  - Viscous drug
  - Manual **self-injections** into upper buttock area
  - Inconvenient preparation of drug
  - Regular injections
Our goal

- The essence of the project was to **solve the usability issues** associated with injecting progesterone
  - **Reduce stress** and anxiety
  - **Improve comfort**
  - **Reduce fear** (pain perception)
  - Enable patients to **self-inject** – gain control
  - **Simplify** injection process

**Improve overall user experience**
piOna

- piOna eases the pain of this unpleasant process with several innovative features
piOna

- **Warming technology** ensures the progesterone is at body temperature, and reduces injection duration
piOna

- **Simple and intuitive** to load and prime with a standard needle and syringe
PiOna

- Ergonomically designed to improve the user experience and comfort
piOna

- A **soft touch**, retractable needle shield hides and needle to reduce anxiety
piOna

- **Reassurance** through visual, audible and tactile feedback
The styling

- To challenge the aesthetics of medical products
- To be non-threatening and desirable yet still inspire trust
- To be approachable and intuitive to use
- To create a positive bond with the user
Inspiration from the FOOD Industry
Mr D Ennis required an innovative product to launch Ennis Foods Ltd and asked Cambridge Consultants for help – over 10 million units were sold in the first year

- Mr Ennis had identified a major market for pre-packed breakfast cereal pack for home or on-the-move
- We assisted by:
  - brainstorming solutions
  - developing detailed pack design
  - planning filling & sleeving systems
  - supporting Mr Ennis’s submission for investment capital
- Mr Ennis raised £6M in Venture Capital to equip a factory in Ireland and for the launch
- Products were test launched in Jan 98 and were soon stocked in 2,000 outlets. Today the product is:
  - listed at Boots, Sainsbury’s and Morrisons
  - available at British Rail, airlines, Shell
“No need to fridge-it widget”

- Bass were losing supermarket shelf space as none of their beers had a widget
- Competitors had heavily patented the space
- We developed a solution that performed well, was low cost, and created its own IP
- With its introduction Bass’s market share grew from 5% to 25%
- The production line and widget design is still in use today, some 15 years on

*We need the lowest cost, highest performing widget on the market that doesn’t infringe anybody else’s IP...in just over a year*

- Bass
PHILIPS

Barista quality coffee in the home

- We have worked with Philips on appliances for over 15 years
- Work has included:
  - Concept generation
  - Design implementation
  - Fluidic analysis (CFD)
  - Transfer to manufacture
  - Optimum flavour extraction ~20%

“For some tough jobs, if we went anywhere else, it would take longer and the results would be lower quality”
Charles Cook - Philips Consumer Lifestyle
A new concept in coffee systems

- DE Master Blenders 1753 wanted to develop a new coffee system – a bean to cup machine with bean canisters.
- The proprietary bean canisters allow bean varieties to be changed every drink, and keep the beans sealed when not in use.
- The interface between the canisters and the machines is protected.
- The canister includes an anti-refill system to maintain the commercial feasibility of the system.
DIAGEO

Frozen drinks on tap

- Invented technology to continuously deliver frozen cocktails in a cost effective way
- Combined analytical techniques and our innovation processes to quickly come to an optimised solution
- Integrated that technology with standard chiller units and produced first batch for consumer trials
- With the design transferred to manufacturing partner, the machines are being rolled out across Europe

“If we don’t have the capability, we know there’s a man who can, and here he is – Cambridge Consultants”

Mark Harrison - Packaging and Dispense Innovations Director – Diageo
Hoppier – personalisation on tap

- Speciality or craft beers are seeing significant growth in popularity
- We took a Science Led Innovation approach to understand how we could build on the traditional “dry hopping” process in a more convenient and engaging way to existing systems like the Hop Rocket and Randall
- The system we have created uses pressure to extract aroma and flavour from real hops to add to the base beer
- Consumer are able to select which hop type and the level to which they are added
- This is built on espresso technology

For more information see http://www.cambridgeconsultants.com/media/press-releases/beer-gets-barista-touch-2