Packaging that Makes Food Products Sell
Innovations in Packaging Materials

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Why do we need food packaging?

Wrap Rage

A survey in Yours (magazine for over 50s):
  97% said "too much excess packaging"
  71% said they had been injured trying to open food packaging
Why do we need food packaging?

Purposes of Food Packaging
Food Packaging Systems
Purposes of Food Packaging

What one word do you think of when you think of packaging?
Purposes of Food Packaging

What one word do you think of when you think of packaging?

i. Containment
ii. Protection
iii. Convenience
iv. Communication
Containment

Food that is produced must be transported and distributed to the urban population.

Food must be CONTAINED in some way:

- different for different commodities
- different for the same commodity at different stages of processing
Protection

To distribute the food from production to urban consumer takes time

During that time food can spoil
  bacterial and mould proliferation
  eaten by insects or other pests
environmental factors
    high humidity
    light exposure

Food is moved numerous times
Each movement exposes food to stresses which can cause deterioration in quality
  e.g., bruises in apples
Packaging system should absorb energy associated with stresses
  ➤ protect the commodity from stress
Protection
Convenience

Probably always been an element of convenience associated with packaging. But now, acceleration in engineering packages to offer specific attributes of convenience to consumers.

Package that is able to be microwaved is added convenience by reducing the time of meal preparation.
Convenience
Convenience
Communication

For food scientists, containment, protection or convenience of packaging most important

For food company communication most important
Communication
Communication
Purposes of Food Packaging

Food Packaging Systems
Food Packaging Systems

Not good business sense for food company to
design a food product in product development laboratory
just choose the cheapest packaging material available
put the product into cheap package

Need to design food packaging system (package material = one component)
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Need to design food packaging system (package material = one component)

Four elements must be integrated into planning of food packaging system
  i. Ingredient Food Technology
  ii. Processing Requirements
  iii. Packaging Materials
  iv. Consumer/Market/Corporate/Societal Demands

All four elements needed if new product is to have higher chance of successful product launch
Food Packaging Systems

What are the Constraints on the System?

i  Budget
ii  Safety
iii  Quality
iv  Brand Image
Budget

Ideally any manufacturer wishes to keep costs to a minimum.

But, in purchasing packaging materials and equipment, compromise of increased costs associated with other 3 concerns.

Value for money more important than costs alone.
Will cheapest packaging material cause production line problems?
Are packaging materials with a higher cost required because market research has shown that for your product an attractive design and appearance increase sales?
Safety

Safety is an ever increasingly important issue to the food industry

Essentially a zero-tolerance policy employed for safety of food packaging

Package must prevent or slow the rate of microorganism entry into the package for as long as the shelf-life of food

Must be minimal interaction between the components within the packaging material and the food itself during this time

An extra issue is food safety = tamper proof or tamper evident packages
Quality

This concern encompasses a number of factors:
how long do specific quality attributes have to be maintained?
e.g., what molecules must be prevented from entering/leaving?
what degree of convenience does your package impart to your customer?
e.g., microwavable popcorn, whipped cream in a can
Consumers make a purchasing decision about competing products in less than 4 seconds.

Package and product must demonstrate visibility and appeal.
  Design associated with the package
    Shape
    Printed design
  Package allows the product to be prominently displayed

Constraints on the System
Constraints on the System

Brand Image
Food Packaging Systems

Four elements of food packaging system

i. Ingredient Food Technology
ii. Processing Requirements
iii. Consumer/Market/Corporate/Societal Demands
iv. Packaging Materials
1. Ingredient Food Technology

Some questions about ingredients
- What are physical and chemical properties of food ingredients?
- How reactive are ingredients at given time-temperature processing treatments?
- Are any ingredients likely to react with certain packaging materials?
- What performance enhancing effects will specific ingredients have on your choice of packaging?
Ingredient Food Technology

[Image of a container of Pace Chunky Salsa]

- **Brand:** Pace
- **Type:** Chunky Salsa
- **Variation:** Medium
- **Ingredients:** Not visible in the image
- **Serving Suggestions:** Not visible in the image
2. Processing Requirements

For solid and liquid foods the traditional means of food preservation are:
- Heat at various time – temperature combinations
- Chilling
- Freezing
- (Dehydration)
- (Irradiation and Chilling)

In many of these traditional processes, packaging materials must withstand the same processing conditions as the food.

For aseptic processing packaging, food could be sterilized by one means, packaging could be sterilized by another

newer processing options for sterilizing packaging

Some examples are:
- electromagnetic energy, high energy visible light, ultraviolet light
- ultra-high pressures, pulsed electric fields, sonification
Tetra Pak Aseptic Processes

The packaging material is formed into a tube

The tube is filled with the product

The tube is shaped and cut into individual packages

Reel of packaging material

The packaging material is sterilized
3. Consumer/Market/Corporate/Societal Demands

Time spent by people preparing meals has declined rapidly.

Consumer delegated to food industry the task of meal preparation. Packaging permits consumer to purchase pre-prepared food that is nutritious, safe and appetizing. Portion control, re-sealing.

Planning the packaging system must take account of trends in consumption and lifestyle by consumers. Food that is being marketed will meet one or more consumer needs.

What effort is your packaging making to preserve the planet’s resources?
Consumer/Market/Corporate/Societal Demands

PET bottles

Plant Bottle initiative spearheaded by Coca-Cola

Up to 30% of base polymer made from sugar cane
4. Packaging Materials

Materials science continues to provide the food industry with wider options for packaging materials.

Better packaging functionality

Physical properties of packaging materials permitting or limiting properties of a given packaging system

Innovative structures

Better communication

www.tradeindia.com
4. Packaging Materials

Metals
Plastics and Composites
Glasses/Ceramics
Paper and Wood Derivatives
Metals

Main metals used = steel, aluminum and tin (first two structurally, Sn for coating)
Physical Properties

Advantages
Impermeability (tight knit atomic structure)
Strength (yield strength of high strength aluminum alloy and mild steel ~250 MNm$^{-2}$)
Conduct heat well (good during thermal processing)
Recyclable (good for corporate image)
Opacity (prevents light-promoted chemical reactions in food)
Rigidity (although steel [200 GNm$^{-2}$] better than aluminum alloy [70 GNm$^{-2}$])
  → ability to withstand vacuum or pressure

Disadvantages
Dense – therefore heavy (Al [2700 kgm$^{-3}$] less dense than steel [7700 kgm$^{-3}$])
Properties not easily modified for tailoring package physical properties to meet specific package system requirements
  → only option is varying thickness
Not that easy to work with during package manufacture
  → requires more expensive equipment
Reactive
  → so protective coatings necessary
Metals
Metals
Metals
Metals

Two-Piece Cans

Advantages
No side seam, and only one double seam (easily formed because no side seam)
35% savings in metal compared to 3-piece can
Better appearance of printed surface because no side seam

Example: Korea – Non-carbonated beverages have been converting from 3-piece steel cans to 2-piece aluminum can.

http://www.pacificcan.com/en/3pc_can_replacement.html
Metals

Pressurized Cans
**Metals**

**Pressurized Cans**

**Advantages**

43% reduction in metal content
“freshness” sensation upon can opening
Metals

Old is New

114 year old brand image
Plastics and Composites
Composites grouped with plastics because:
composites almost always have plastic
(in addition to paper and metal in some)
methods of fabrication are similar to manufacture of multi-layer plastics
Physical Properties

Advantages
Properties variable and manipulable
Lightweight (for thermoplastics used in food industry, densities range from 900-1400 kgm$^{-3}$)
Ability to mould to specific sizes and shapes
Corrosion resistant
Tough (i.e., will not fracture when banged or dropped)
Microwavable
Transparent (generally)

Disadvantages
Very few can be heat processed
Tend to attract dust in low humidity retail environments (due to static electricity)
Concern with possibility of plasticizer migration
  food safety concern
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Gas Permeability

cc = cubic centimetres of gas
sq. m = square metre of package area
Not stated: per atm of oxygen pressure
Gas Permeability

Permeability to moisture vapor

This is frequently expressed as moisture vapor transmission rate (MVPR)
  Defined at a specific temperature
  Defined at a specific relative humidity (90 or 70%)

SI units for permeance
  (transmission rate) are:
  \( \text{kg.m}^{-2}.\text{s}^{-1}.\text{Pa}^{-1} \)

Partial vapor pressure of water molecules
  defined by temperature and relative humidity
Plastics and Composites

TetraPak

Classic example of a multilayer package
Probably the most familiar laminate

Package has low oxygen and moisture vapor transmission rates, excludes light and has good printing capabilities
Plastics and Composites

Retortable Plastics
Plastics and Composites

Retortable Plastics
Plastics and Composites

Innovative Structures
Plastics and Composites

Innovative Structures
Plastics and Composites

Enhanced Gas Removal
Plastics and Composites

Enhanced Gas Removal
Plastics and Composites

Enhanced Gas Removal
Glass/Ceramics
Physical Properties

90% of glass production is used for foods and beverages with the split 1:2

Advantages
Impermeability (tight network of covalent bonds)
Clarity – product visibility due to completely amorphous structure
Extremely inert- therefore no need for lacquers or other internal coatings
Easily recyclable – new glass formed from 15%-30% of old glass (for energy saving)
Rigidity ( [70 GNm^{-2}] \rightarrow ability to withstand vacuum or pressure

Disadvantages
Dense – therefore heavy [2500 kgm^{-3}]
Impossible to modify properties for tailoring package physical properties to meet specific package system requirements
Extremely brittle – but can be lessened by a surface treatment during manufacture also, structural design so that expected impact points have more glass
Poor thermal conductivity \rightarrow longer processing times
Poor thermal shock resistance – due to relatively high thermal expansivity but poor thermal conductivity coupled with low crack resistance
Glass/Ceramics
Enhanced Barrier Properties

PET bottles plasma-coated with very thin glass layer
30 fold better carbon dioxide retention
5 fold better oxygen exclusion
Paper and Wood Derivatives
Physical Properties

Advantages
Superior printability characteristics – good high quality graphics allow communication
Wide range of paper types – select papers or boards with specific food compatibility characteristics
Light – depending on type, densities range from 200 to 1400 kgm⁻³
Rigid – paperboards protect their contents from damage
Opacity – very good at cutting out light which can damage some products
Very recyclable for simpler types

Disadvantages
Susceptible to water and food ingredient migration poor containment performance
Terrible moisture and vapour barrier properties (but within laminates it is OK)
Opacity – does not allow consumer to see product
Frequently used for shipping of bulk food materials but do see examples at supermarket for direct sale to consumers.

Different structures (height and number of flutes) can be used to make up the fibreboard, and they can be double and triple stacked.
Paper and Wood Derivatives

Multiple Structures

http://beachpackagingdesign.com
http://bestinpackaging.com/2014
Paper and Wood Derivatives

Microwave Susceptors

Allow crisping in microwave oven controllable temperatures tailored to desired product quality

http://www.sirane.com/
Paper and Wood Derivatives

Printable Communication Devices

Communicate to consumer phone
quality information
safety information
special offers
Smart Sensors

Sensor sensitive to low (1.5 ppm) levels of ammonia off-odour in fish identified communicated to retailer.
Conclusions

• Packaging innovations help sell food products
• Innovations arise with all four types of packaging materials
• Composites and polymers likely to drive future packaging innovations
• Small RFID and smart sensors within food packaging likely to be integrated in food product communication strategies