

40 Inventive (Food) Principles With Examples

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This article seeks to explore the applicability of the 40 Inventive Principles of classical TRIZ across the food industry. The work comes in the wake of initial work to investigate the usefulness of TRIZ to help solve food related problems (Reference 1). The intention here has been to develop a food industry analogue to previously published articles highlighting examples of the 40 Principles in engineering (Reference 2), business (Reference 3) and architecture (Reference 4) environments.

Use this document as a reference when seeking to ‘eliminate’ food-related design contradictions using the 40 Inventive Principles. Future articles will explore the applicability of other TRIZ tools in the definition and solution of food production, processing and packaging problems.

We have colour-coded the examples such that text in green relates to ‘food processing’ concepts and ideas, and blue text relates to ‘food packaging’ solutions.

Principle 1. Segmentation

A. Divide an object into independent parts.

Separate ‘fruit’ and ‘yoghurt’ portions in a yoghurt container

TV Dinners

'Salt'n'Shake' potato chips contain separate sachet of flavouring

Ice cubes

Cheese slices

Striped (tooth)paste container

Individual cup coffee sachets

Segmented Garlic Bread/ French Baguettes

DairyLea Lunchables

B. Make an object easy to assemble or disassemble.

'Just add hot water' snack pots

Silver-foil milk bottle tops

Tear-strip/weak-point/etc openings

Microwave dinners where no removal of packaging or film piercing is needed??

C. Increase the degree of fragmentation or segmentation.

Turn two pot yoghurts into three-pot yoghurts

'One-cup' tea-bags

Multiple small doors on frozen-food cabinets

Variety-pack cereals

Crushed ice

'Sandwich pickles' - pickles chopped to sizes consistent with expected height of a sandwich

Principle 2. Taking out/Removal/Extraction

A. Separate an interfering part or property from an object, or single out the only necessary part (or property) of an object.

Non-smoking areas in restaurants

Nutrasweet - sweetness without the calories

Separate egg white from egg- for baking purposes.

Low fat products -products with low fat and all the flavour (supposedly)

Two-step sauces- vegetables have been 'taken out'.

Principle 3. Local quality

A. Change an object's structure from uniform to non-uniform

Flow spoilers inside Ribena bottle prevent drips when halting the pouring process

Sugar coating on biscuits/cakes/etc

Form a skin on top of custard

Mould (or engrave) product branding information onto product - e.g. Polo mints

Alphabet spaghetti

Engrave advertisements of other products (by the same manufacturer) onto the product.

Use non-uniformity for better transportation of fast food products (i.e. drink packaging that sticks (maybe velcro strip) to car seats????)

Date-stamping on eggs

Braille labelling

Corrugated sides on a container for hot products (e.g. disposable coffee cup) make the product cooler to hold

Provide different packaging shapes for different uses (i.e. sports, home use)

B. Change an external environment (or external influence) from uniform to non-uniform.

Grilling food provides a more directional heat source than, say, cooking in oven

Ditto shallow-frying

Fan assisted ovens.

C. Make each part of an object function in conditions most suitable for its operation.

Use temperature gradient in oven to affect the manner in which food is heated

D. Make each part of an object fulfill a different and/or complementary useful function.

Top and bottom surfaces of a baked bean tin are different in order to facilitate stacking

Principle 4. Asymmetry *A. Change the shape or properties of an object from symmetrical to asymmetrical.*

Introduce a geometric feature which prevents incorrect usage/assembly of a component (e.g. spout on a pouring container)

Spout on Ribena (or other viscous liquid pouring) bottle (yes, please!)

Change traditional products (cheese) using asymmetry (to Cheesestrings).

B. Change the shape of an object to suit external asymmetries (e.g. ergonomic features)

Take account of differences between left/right handed, male/female users

Finger and thumb grip features on containers

Develop sport packaging like bicycle grips???

Sports drinks containers worn like a walkman with pump-like delivery???

Gatorade- EDGE container.

Welch Foods PET bottle- designed to fit into car cup holders

C. If an object is asymmetrical, increase its degree of asymmetry.

Principle 5. Merging *A. Bring closer together (or merge) identical or similar objects or operations in space*

Sandwiches

Lasagne/ravioli/etc

Multi-grain bread products

Multi-vitamin tablets

Jelly-belly's

Meal Kits, Sandwich Kits (including drink and crisps).

Serve sandwiches in restaurants with choice of relishes and crisps etc.

Pizza counters in supermarkets, make your own pizza.

Multi-chocolate bars- e.g. Cadbury's Top Deck (White and Milk Chocolate).

Combine minimal processing methods- e.g. modified atmosphere and chilling, Irradiation and modified atmosphere.

Blends intoxicating Ice Cream- Merges alcohol with ice cream.

Confectionery products merged with ice cream (e.g. ice cream Mars)/
Bio/Functional Ice cream for children???

B. Make objects or operations contiguous or parallel; bring them together in time.

Ready-made meals

Cook-in sauces

Grill inside microwave oven

Micro waveable Pizza packaging that increases Pizza 'crunchiness'???

Principle 6. Universality *A. Make a part or object perform multiple functions; eliminate the need for other parts.*

Thermo-chromic spoon changes colour when temperature is too hot

Thermo-chromic beer bottle label changes colour when beer is cold enough

(Re-sealable) food container becomes a storage jar

Jelly container that doubles as a re-usable jelly mould???

Nutella spreadable chocolate- after product is consumed packaging can be used as a drinking glass.

Honey flavoured Elf Grahams packaging- can be turned into hand puppets.

B. Use standardised features.

Use of Standards in e.g. quantity measures -kg, litres, etc

Standard tin diameters to facilitate stacking

Energy Efficiency (refrigerators).

Vegetable grading of size.

Principle 7. "Nested doll"

A. Place one object inside another

Sauce sachets inside packets of pre-prepared vegetables

Introduce voids into chocolate - Aero, Wispa, etc

Pez sweet dispensers

Push pop product.

Place toy inside product (Kinder surprise).

B. Place multiple objects inside others.

Stacking containers - reduce manufacture and disposal volume

Shopping centres

'Gob-stoppers' made up of different coloured layers so that it changes colour as it gets consumed

Ice-lollies - layer of nuts on top of chocolate coating on top of ice-cream layer on top of chocolate core

C. Make one part pass (dynamically) through a cavity in the other.

Bottles with drinking straws inside

IncrEdibles pasta or egg based products- after heating a stick is used to push product up and through packaging.

Principle 8. Anti-weight *A. To compensate for the weight of an object, merge it with other objects that provide lift.*

Mix air into souffle to achieve rising effect

Size constituent parts within muesli so that each portion contains the appropriate quantity of each (e.g. small, dense things tend to migrate to the bottom of the packet)

Knead bread.

B. To compensate for the weight of an object, make it interact with the environment (e.g. use aerodynamic, hydrodynamic, buoyancy and other forces).

'Float' toppings on top of quiche, etc prior to cooking (make use of surface tension effects)

Principle 9. Preliminary anti-action

A. If it will be necessary to perform an action with both harmful and useful effects, this action should be replaced with anti-actions to control harmful effects.

Irradiated food

Genetically modified food benefits some properties (at the potential risk of making the world resistant to anti-biotics)

B. Create beforehand actions in an object that will oppose known undesirable working stresses later on.

'China blackbird' inserted in deep-fill pie improves temperature circulation within pie-filling during cooking

'Widget' in Guinness to combat poor head formation.

Principle 10. Preliminary action *A. Perform, before it is needed, the required change of an object (either fully or partially).*

Pre-cooked meat/salad/etc products

Part-cooked bread

Pre-grated cheese/carrot

Marinading

De-seeded fruit

Instant mashed potato

Pre-formed pastry products- i.e. croissants in tins, vol-au-vonts.

Stir-Fry vegetable mixes.

Vegetable preparation before delivery to food manufacturer (i.e. sliced, diced etc.)

Hatfield Simply Tender Fresh Pork- injected with a solution to increase tenderness.

B. Pre-arrange objects such that they can come into action from the most convenient place and without losing time for their delivery.

Cook using a recipe detailing sequence of events required

Principle 11. Beforehand cushioning

A. Prepare emergency means beforehand to compensate for the relatively low reliability of an object ('belt and braces')

Keep the phone number of the delivery pizza shop handy when Darrell is cooking

Cup and saucer

Wrap napkin around neck of a wine bottle prior to pouring

Tamper proof packaging - clip-tops, tear-tabs, etc

Boned fish

'Spill proof' drinks containers.

Enclose eggs in plastic bubble packaging??.

Include 'fold-out' receptor with filled salad rolls (very messy product)??

Include napkin with a hole in the middle when serving ice-cream cones- place cone through the hole in napkin- prevention of ice-cream spillage onto hands??.

Principle 12. Equi-potentiality

A. In a potential field, limit position changes

Principle 13. 'The other way round'

A. Invert the action(s) used to solve the problem (e.g. instead of cooling an object, heat it).

Gaspacco

Iced tea/coffee

Arctic roll/Baked Alaska

Sushi (in the west we used to perceive fish as only a cooked product).

B. Make movable parts (or the external environment) fixed, and fixed parts movable.

Drive through restaurant/'Meals-on-wheels'

Home-delivery shopping

Synergy of the above: Same company delivery of meals + video + wine.

C. Turn the object (or process) 'upside down'.

Store bean/etc tins upside down in order to ease removal of contents upon opening (or else open from the bottom if the tin is not of the stacking variety)

Principle 14. Spheroidality - Curvature

A. Instead of using rectilinear parts, surfaces, or forms, use curvilinear ones; move from flat surfaces to spherical ones; from parts shaped as a cube (parallelepiped) to ball-shaped structures.

Introduce fillet radii between surfaces at different angles (e.g. yoghurt container) in order to ease removal of product

Pringles - aesthetically pleasing potato chips

B. Use rollers, balls, spirals, domes.

Insert ball into canned cream to improve mixing when shaking

Licorice spirals - compacts a long length of licorice into a small package

Pasta spirals - increase surface area and therefore sauce retaining area/ Use spiralled bread sticks- better retention of dip.

Rolling pin

Kitchen roll/foil/film/etc

Use 'roller ball' pen concepts in Sherbert/ powdered confection dispersion and as a means of intricate cake icing.

Use spiralled ice-cream cones to decrease ice-cream spillage onto the consumers hand??.

C. Go from linear to rotary motion (or vice versa)

Eat spaghetti by wrapping it around a fork

Rotating ice-cream cone holder (US patent!)

'Stirred not shaken'

Cook using spit- i.e. kebabs.

D. Use centrifugal forces.

Lettuce spinner - uses centrifugal forces to dry leaves after washing

Candy floss.

Principle 15. Dynamics

A. Allow (or design) the characteristics of an object, external environment, or process to change to be optimal or to find an optimal operating condition.

Flexible drinking straws

Packaging that moulds into your hand shape???

B. Divide an object into parts capable of movement relative to each other.

Pepper/coffee/etc grinder

Fold-out product labelling allows supply of more product information

C. If an object (or process) is rigid or inflexible, make it movable or adaptive.

Articulated spoon - folds up to allow more compact packaging

Increase the flexibility of sauces, meals etc.

Customisable sauces- basic tomato sauce, with two choices of mix within the same packet to suit different same household tastes??.

Packaging that, once used, is easily folded up for easy storage and recycling.

D. Increase the degree of free motion

Stir contents of a pan to prevent sticking

Principle 16. Partial or excessive actions

A. If 100 percent of an object is hard to achieve using a given solution method then, by using 'slightly less' or 'slightly more' of the same method, the problem may be considerably easier to solve.

Over-size bottles and other containers to ease delivery of correct quantity of product when filling

Over-fill containers then scrape out excess to speed packaging process

Principle 17. Another dimension

A. If an object contains or moves in a straight line, consider use of dimensions or movement outside the line.

Articulated drinking straw

Spaghetti twists

A straw that can be used by one or two people???

B. If an object contains or moves in a plane, consider use of dimensions or movement outside the current plane.

Corrugated-bottom pizza box improves heat retention capabilities

Profiled bottom microwave container (e.g. shallower in the middle) improves ability to heat product evenly

Corrugated lasagne sheets

Crinkle-cut potato chips

Manipulation of air-flows to improve cooking yields.

C. Use a multi-storey arrangement of objects instead of a single-storey arrangement.

Stacking tins

Biscuit packaging

Double/triple layer sandwiches

Layered salads- gives the consumer the mix or keep separate.

D. Tilt or re-orient the object, lay it on its side.

Stack products horizontally to prevent damage - e.g. After Eight mints

E. Use 'another side' of a given area.

Product labelling on both sides of paper - e.g. 'lucky draw' chocolate bar promotions in which the 'winner' is printed inside the packaging

Principle 18. Mechanical vibration

A. Cause an object to oscillate or vibrate.

'Shake before opening'

Use shaking motion as a means of heating product????

Shake product to increase consistency in line with customer preference???

B. Increase its frequency (even up to the ultrasonic).

Ultra-sonic cleaning of recycled containers

Use ultra-violet light for baby food packaging sterilisation.

C. Use an object's resonant frequency.

Microwave cookery essentially uses resonant frequency of water molecules

D. Use piezoelectric vibrators instead of mechanical ones.

Piezoelectric vibrators improve fluid atomisation from a spray nozzle (no food applications currently known)

E. Use combined ultrasonic and electromagnetic field oscillations.

Geo-physics techniques to aid identification of sub-soil structures

Principle 19. Periodic action *A. Instead of continuous action, use periodic or pulsating actions.*

Facilitate removal of sauce from bottle by shaking

Take account of seasonal effects - Easter eggs, Christmas cake, etc

B. If an action is already periodic, change the periodic magnitude or frequency.

Multi-speed blenders

Multi-blade knives have different size flutes for cutting different texture products

C. Use pauses between actions to perform a different action.

Simmer

Add-in herbs and spices during dwell between microwave heating times (i.e. heat/stand-or-stir/heat)

Principle 20. Continuity of useful action

A. Carry on work continuously; make all parts of an object work at full load or optimum efficiency, all the time.

Re-brand seasonal product types in order to facilitate through year production - e.g. filled easter eggs become filled hearts become filled Halloween products become.... Etc

Cooking with an Aga or Rayburn oven

B. Eliminate all idle or intermittent actions or work.

Make heating/cooking times for desserts consistent with eating/digesting times for main course

Principle 21. Hurrying

A. Conduct a process, or certain stages (e.g. destructible, harmful or hazardous operations) at high speed.

Break toffee with a hammer

'Flash-fry' meat products or onions in order to help retain flavour.

Freeze drying to retain freshness.

Principle 22. "Blessing in disguise" or "Turn Lemons into Lemonade"

A. Use harmful factors (particularly, harmful effects of the environment or surroundings) to achieve a positive effect.

Most E numbers

Strichnine in gin

Use of bacterial cultures that are beneficial to the human body (e.g. Bio-yoghurts).

B. Eliminate the primary harmful action by adding it to another harmful action to resolve the problem.

pH balanced foods

C. Amplify a harmful factor to such a degree that it is no longer harmful.

Tenderising of meats.

Principle 23. Feedback

A. Introduce feedback (referring back, cross-checking) to improve a process or action.

Thermo-chromic product labelling informs user when temperature is correct

Thermo-chromic containers inform the user when the product has been properly heated through

Thermochromic paint on egg informs user when the egg has soft, medium or hard- boiled (I think we should patent this one!)

Lids of pre-cooked foods detach when product is heated through (this also helps to control the browning process and eliminate the tendency to burn the topping)

Use odour to inform user when food is cooked

Kettle whistles when water is boiling

Thermo-chromic advertising (i.e. when temp drops to a certain level- "it's cold why not pop into starbucks and buy a hot coffee, when the temp increases to a certain level- "it's hot, why not pop into starbucks and by a nice iced tea)????

B. If feedback is already used, change its magnitude or influence in accordance with operating conditions.

Introduce increasingly sensitive sensors in order to better understand a food process.

Introduce intelligent sensors and control methods. Sensors and controls that monitor production hall temps and change operating temps accordingly.

Principle 24. 'Intermediary'

A. Use an intermediary carrier article or intermediary process.

Bread-crumbs coatings on fish/meat slices etc (to disguise what's underneath usually)

B. Merge one object temporarily with another (which can be easily removed).

Place cakes and similar large, fragile items on a cardboard base to prevent damage when serving

Herb garni for flavouring.

Introduction of a gauged spice dispenser that allows you a customisable level of 'spiceyness' - medium, hot, very hot??

Principle 25. Self-service

A. Make an object serve or organise itself by performing auxiliary helpful functions

Large Yorkshire puddings act as the food container as well as being edible

Ditto taco-shells, pitta-bread, Cornish pastie, etc

Self-heating tinned food/drinks

Self-cooling soda tins

Self-regulating temperature coffee cups - keep the contents warmer for longer

B. Use waste resources, energy, or substances.

Sausage skins

Principle 26. Copying

A. Instead of an unavailable, expensive, fragile object, use simpler and inexpensive copies.

Own-brand products (although they're usually the same thing in sheep's clothing)

Fish-cakes replace most of the (expensive) fish with potato

Re-constituted chicken for chicken burgers.

Saffron is expensive, use a 'copy' to mimic the colour.

Use biotechnology in the synthesis of food additives.

B. Replace an object, or process with optical copies.

C. If visible optical copies are already used, move to infrared or ultraviolet copies.

Use sensors for quality rather than visual inspection.

Principle 27. Cheap short-living objects

A. Replace an expensive object with a multiple of inexpensive objects, compromising certain qualities (such as service life, for instance).

Disposable pepper-grinders attached to container

Instead of extremely robust packaging to increase shelf-life, use MAP packaging.

Include disposable, fold out plates with certain food products (such as ready made salads etc.???)

Inclusion of disposable plastic blade connected to packaging- could be used as a means of customisable levels of fragmentation and segmentation (e.g. mixed salads, consumer can chop it up to his/her own preference???)

Principle 28 Mechanics substitution

A. Replace a mechanical means with a sensory (optical, acoustic, taste or smell) means.

Pump odour of freshly baked bread around a supermarket

B. Use electric, magnetic and electromagnetic fields to interact with the object.

Irradiation

Ohmic heating

C. Change from static to movable fields, from unstructured fields to those having structure.

Intelligent microwaves

D. Use fields in conjunction with field-activated (e.g. ferromagnetic) particles.

Heat a substance containing ferromagnetic material by using varying magnetic field. When the temperature exceeds the Curie point, the material becomes paramagnetic, and no longer absorbs heat (not sure if this has any food application - yet)

Principle 29. Pneumatics and hydraulics

A. Use gas and liquid parts of an object instead of solid parts (e.g. inflatable, filled with liquids, air cushion, hydrostatic, hydro-reactive).

Spreadable cheese (e.g. in a dispensing tube)

Coffee concentrate (instead of instant powder) - probably better for tea!

'Fresh-baked biscuit' scent spray

Sauce concentrates that change flavour depending on what is added e.g. Unox Townsend and Eine Sauce- with incorporates a concentrated sauce paste (parameter changes) to make one litre of brown, white or tomato sauce (increase dynamism).

Crystal farms 'Cheese in an aerosol'.

Principle 30. Flexible shells and thin films

A. Use flexible shells and thin films instead of three-dimensional structures

Honeycomb

Easter-eggs

Waterproof cardboard milk/soup/yoghurt cartons

Tube dispensers - e.g. spread cheese, pate, icing, etc

'Chocolate coated'/iced products

B. Isolate the object from the external environment using flexible shells and thin films.

Egg-box

Principle 31. Porous materials

A. Make an object porous or add porous elements (inserts, coatings, etc.).

Whipped cream

Souffle/mousse/etc

Hollow Easter-egg

B. If an object is already porous, use the pores to introduce a useful substance or function.

Filled chocolate - liqueurs, toffee-fillings, etc

Principle 32. Colour changes

A. Change the colour of an object or its external environment.

Thermo-chromic product labelling - informs user when correct serving temperature has been attained

Packaging that changes colour when the products shelf-life has expired??

B. Change the transparency of an object or its external environment.

Clear packaging enables user to see contents

In order to improve observability of things that are difficult to see, use coloured additives or luminescent elements

Fluorescent safety markings help guide people out of a building after power failure

Use opposing colours to increase visibility - e.g. butchers use green decoration to make the red in meat look redder.

Selective colouring system??? E.g. only colours rat faeces or other foreign bodies???

Change the emissivity properties of an object subject to radiant heating

Use emissivity of container to better control heating profile/rate

Principle 33. Homogeneity

A. Make objects interacting with a given object of the same material (or material with identical properties).

Make the container out of the same material as the contents, to reduce chemical reactions.

Principle 34. Discarding and recovering

A. Make portions of an object that have fulfilled their functions go away (discard by dissolving, evaporating, etc.) or modify these directly during operation.

Ice structures: use water ice or carbon dioxide (dry ice) to make a template for a rammed earth structure, such as a temporary dam. Fill with earth, then, let the ice melt or sublime to leave the final structure.

Dry pasta +sauce products utilise this principle- some water is absorbed (to cook the pasta) the rest evaporates.

Use ice as a means of separating products instead of more packaging in the same container (would work excellently in frozen products)???

B. Conversely, restore consumable parts of an object directly in operation.

Grey-water recycling systems

Principle 35. Parameter changes

A. Change an object's physical state (e.g. to a gas, liquid, or solid).

Frozen foods - easy to transport/store

'Yoghurt on a stick' - frozen snack food/ Frozen yoghurt- healthy alternative to ice cream.

Jello/ Jello containing alcohol.

Double cream/whipping cream

Dehydration to inhibit microbial growth.

Kellog's Cereal and Milk bars- utilise dried milk.

Ice filtering in brewing-e.g. bud ice, fosters ice.

B. Change the concentration or consistency.

Concentrated or de-hydrated orange juice makes transportation easier.

Dried/desiccated fruit

Increase consistency of sauces to improve holding (i.e. to pasta).

C. Change the degree of flexibility.

Switch from glass to flexible plastic packaging for sauces, etc, where a squeezing action will help to get the product out of the container

Change the temperature.

Raise the temperature of fluids to reduce viscosity in order to ease flow during production - e.g. filling molasses tins

Use temperature gradients present in ovens and refrigerators

Change the pressure.

Vacuum packing of perishable goods.

Reduction of pectinesterase activity by High Pressure Treatment.

Change other parameters

Irradiation of fresh products increases life

Micro-waveable containers

Principle 36. Phase transitions

A. Use phenomena occurring during phase transitions (e.g. volume changes, loss or absorption of heat, etc.).

Heat pipes

Use a phase change to store energy - e.g. store energy as ice, or, where heating is the issue use sodium acetate to store heat energy

Principle 37. Thermal expansion

A. Use thermal expansion (or contraction) of materials.

Fit a tight joint together by cooling the inner part to contract, heating the outer part to expand, putting the joint together, and returning to equilibrium.

Through-bars help straighten buckling walls in old buildings

Bread making utilises expansion of dough.

B. If thermal expansion is being used, use multiple materials with different coefficients of thermal expansion.

Bi-metallic strips used for thermostats, etc

Principle 38. Enriched Atmosphere

A. Replace common air with oxygen-enriched air.

Scuba

CAP and MAP packaging.

B. Replace enriched air with pure oxygen.

Cut at a higher temperature using an oxy-acetylene torch.

C. Expose air or oxygen to ionizing radiation.

D. Use ionized oxygen.

E. Replace ozonized (or ionized) oxygen with ozone.

(No known examples)

F. Insert an active ingredient

Carbonated drinks

'Exploding' chocolate bars

Functional foods, where one ingredient performs a specific function.

Morita Silk Water product- low calorie beverage with silk powder- promotes collagen regeneration for 'beautiful' skin.

Principle 39. Inert atmosphere

A. Replace a normal environment with an inert one.

Freezing food extends its life

B. Add neutral parts, or inert additives to an object.

Most preservatives

Nitrogen top-off in bottled products

Principle 40. Composite materials

A. Change from uniform to composite (multiple) materials where each material is tuned to a particular functional requirement.

Concrete aggregate.

Rebar re-enforced concrete

Glass-re-enforced plastic

Fibre re-enforced spray/paint-on roofing treatments

Fire-glass

Hard/soft/hard multi-layer coatings to improve erosion, etc properties

Straw and pressed earth building materials.

Use of composite plastics and packaging to increase shelf life, ease of use and avoid unwanted interactions between packaging and foodstuff.

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