

Brasil PackTrends 2020



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Campinas | SP
1st Edition

Cataloguing data prepared by Documentation and Information Area of Packaging Technology Center - CETEA

Brasil pack trends 2020 [electronic feature] / edited by, Claire Isabel G. L. Sarantópoulos, Raul Amaral Rego. – 1st. ed. – Campinas : ITAL, 2012.
228 p. : ll. ; 27 cm.

ISBN 978-85-7029-119-6

Online available: www.ital.sp.gov.br/brasilpacktrends

1. Packaging. 2. Packaging trends. I. Wallis, Graham. II. Weil, Daniel. III. Madi, Luis F.C. IV. Rego, Raul A. V. Sarantópoulos, Claire I.G.L. VI. Dantas, Tiago B.H. VII. Dantas, Fiorella B.H. VIII. Jaime, Sandra B.M. IX. Mourad, Anna Lúcia X. Padula, Marisa. XI. Institute of Food Technology. XII. Title.



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The State of São Paulo Government's 2012-2015 Multi-Year Plan established investments of R\$ 127 million for the Geração e Transferência de Conhecimento e Tecnologias para o Agronegócio Program (Generation and Transfer of Knowledge and Technologies for Agribusiness Program), of the Secretaria de Agricultura e Abastecimento (Secretariat of Agriculture and Food Supply). The innovation is, undoubtedly, the lever of the high value added economy and knowledge-intensive, critical ingredient for the development. With no productivity increase, the growth is limited to the quantitative evolution of the workforce. The public sector plays an essential role in the implementation of R&D and to stimulate innovation by the private sector. São Paulo concentrates an expressive park of private companies of knowledge base, which puts São Paulo in a position of leadership in the Southern Hemisphere. R&D infrastructure, with state participation, records an apparatus of technological resources that give wide sustaining to the ambitious purposes of this policy.

Initiatives such as Brazil Pack Trends 2020 have the virtue of showing, based on knowledge of the current situation and on indicators of future scenarios, what will be the trends for packages in 2020, guiding the definition of policies for the development of scientific and technological researches that support innovation and serve as a reference for strategic business decisions.

The diversity of food, beverages and other products adapted to the lifestyle and the demands of society, and their nutritional, functional and quality for consumption characteristics require inventive increments of the packages sector, which, fortunately, has been effectively and proactively to meet the demands.

The breadth of the study, which includes analysis of the market and of convenience factors, such as aesthetics, identity, safety, regulatory, sustainability, ethics, quality and new technologies, it is only possible due to the significant body of knowledge of the Instituto de Tecnologia de Alimentos (Institute of Food Technology), which is a research institution of the Secretaria de Agricultura e Abastecimento do Estado de São Paulo (Secretariat of Agriculture and Food Supply of São Paulo State), linked to the Agência Paulista de Tecnologia dos Agronegócios (São Paulo State Agency for Agribusiness Technology). Professionals are to be congratulated for their excellent work, and also ITAL, by the initiative.

Mônica Bergamaschi
SAA Secretary



In 1998, the CETEA ITAL was already considered as a center of excellence in research, development and innovation in the area of packages, providing essential services for the modernization and growth of companies in this important industrial sector. That same year, CETEA launched a pioneering project for trend analysis, which culminated in the publication of the Brazil Pack Trends 2005 document. Several researchers and experts have spared no effort to analyze market opportunities and challenges for the coming decades.

In 2008, a new analysis of package market trends was presented in the form of a chapter in the pioneer Brazil Food Trends 2020 study, conducted by the ITAL and FIESP/Deagro. Since then, a competent team CETEA, coordinated by researcher Claire Sarantopoulos, took on the challenge of dedicating specific focus to a similar survey covering the entire package sector.

For 18 months, information was collected on trends and innovations, which have been sorted and consolidated in order to provide a comprehensive view on these issues. The result, in its first edition, is the Brazil Pack Trends 2020 document, which is being launched in this month of October 2012, a new milestone for ITAL. It represents a collective work that only became viable with the valued support of the Secretaria de Agricultura e Abastecimento (Secretariat of Agriculture and Food Supply), APTA, and Plataforma de Inovação Tecnológica do ITAL(ITAL Technological Innovation Platform), with a close partnership with Projeto Embala (Packs Project) and through the support of various sponsors.

The Brasil Pack Trends 2020 is our contribution to innovation in companies of this sector and also in all industries that are users of packages. By providing this information to the Brazilian market, we aim to fulfill our primary role as a government institution, which is part of a government dedicated to innovation and development.

Luis Madi
ITAL's General Director

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Presentation

Brasil Pack Trends 2020 Team

In the next decade, the package industry will become increasingly important for the consumer goods industries. With the market changing and continuously growing, the package will stand out as an innovative component for products like food, pharmaceuticals, cosmetics, toiletries and cleaners, among others.

The packaging system will be an essential part of efficient and sustainable processes, to guarantee quality and safety for consumers. The studies for monitoring package trends will represent, increasingly, a strategic factor for business competitiveness, due to its ability to open opportunities and indicates challenges and promising alternatives of investment.

Therefore, in the fulfillment of the public service of ITAL, Brazil Pack Trends 2020 was designed to provide this type of information to the productive sector, for free, as a tool to support the process of innovation in companies.

The Brazil Pack Trends 2020 continues a series of studies of ITAL 2020, originated from the pioneering work Brazil Food Trends 2020, held in partnership with Fiesp in 2010. Brazil Pack Trends 2020 follows the same structure and methodology established previously. It is a basic document which organizes various technical and scientific papers on trends, consolidates data from expert sources, public and private, and includes previously unpublished analyzes of CETEA researchers with extensive experience in package technology.

Given the complexity of the issues covered, the study faces a limitation on the ability to see the whole range of relevant variables. However, based on the method adopted, the study offers an organized framework that allows an overview and outlook of the major areas of innovation in packaging. The study also represents a systemic framework of reference that allows continuous updates in order to keep it in line with changes in the industry.

The structure of the work covers, initially, chapters on the packaging industry in Brazil and the world, an analysis of influencing factors (drivers) of the consumer goods market and a brief description of the classification method of trends. Then, devotes specific chapters to each of the macro trends identified in Brazil Pack Trends 2020: "Convenience and Simplicity", "Aesthetics and Identity" and "Quality and New Technologies", which are more related to product innovations; and "Sustainability and Ethics" and "Safety and Regulatory Issues", which keep a closer relationship with production processes and management systems.

The Brazil Pack Trends 2020 team sees a promising future for the packaging industry in Brazil, which will, necessarily, pass by the increase of the technological innovation. In this direction, aims to, in fact, contribute to the development of our society.





Chapter 1

PACKAGING MARKET: WORLD AND BRAZIL

This chapter aims to present a panorama of packaging market in Brazil, highlighting the production and consumption indicators of different packaging materials (plastics, paper and cardboard, metals, glass and aseptic cartons) and the main end user sectors (food, beverage, healthcare, personal care and cleaning products).

1.1 WORLD PACKAGING MARKET

The growth of the global packaging market is being stimulated by a series of general trends, such as the growing urbanization, investments in construction, expansion of healthcare sector and the fast development that can be noticed in emerging markets, such as

China, India, Brazil and some countries from Eastern Europe. According to the data in Table 1.1, which shows Estimates for the packaging markets in some countries and regions, the biggest growth rates are likely to be found in emerging nations.

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WALLIS, G.; WEIL, D.; MADI, L. F. C. *Packaging Market: World and Brasil*. In: *BRASIL pack trends 2020*. Campinas: ITAL, 2012. ch. 1, p. 9-39.



Table 1.1

Packaging sales: Countries (2008, 2011 and projections for 2016)

Packaging sales by country (US\$ billion)							
Countries	2008	Share %	2011	Share %	2016	Share %	Estimated average growth 2011-2016
EUA & Canada	153	27%	168	25%	194	23%	2.9%
China	50	9%	80	12%	117	14%	7.9%
Japan	70	13%	76	11%	87	10%	2.7%
Germany	33	6%	37	5%	42	5%	3.0%
France	27	5%	30	5%	34	4%	2.1%
Brazil	22	3.7%	25	4%	34	4%	6.2%
United Kingdom	20	4%	22	3%	25	3%	2.6%
Russia	17	3%	21	3%	26	3%	4.9%
India	9	2%	17	3%	25	3%	7.7%
Other countries	148	26%	187	28%	248	29%	5.8%
TOTAL	559		675		845		

Source: DATAMARK, MARKET..., 2008

The increase in disposable personal income in emerging nations stimulates the demand for a wide range of products in their own consumer markets, resulting in the growth of industries that produce packaging for those goods. For 2016, it is estimated that Brazil's share in the world market will increase from 3.7% to 4.0%. The expectation is that China will be confirmed as the second largest market in the world, with Brazil rising from the 7th to 5th position in the ranking, in 2016 (Table 1.2).

Considering different regions, it can be demonstrated that, according to the Estimates shown in Table 1.3, the four largest regions for packaging sales are Asia, North America, Western Europe and Central and South America.

Table 1.2

The 10 largest packaging markets

Country	Sales (US\$ billion) 2011	Ranking 2011	Sales (US\$ billion) 2016*	Ranking 2016*
USA	141.1	1	163.6	1
China	79.7	2	116.6	2
Japan	76.3	3	87	3
Germany	36.5	4	42.3	4
France	27	5	30.4	7
Canada	27	6	30.8	6
Brazil	25	7	33.8	5
United Kingdom	22.3	8	25.4	9
Russia	20.5	9	26	8
India	16.9	10	24.5	10

* Estimate

Source: DATAMARK, MARKET..., 2008



Table 1.3

Packaging sales: Regions (2008, 2001 and projection for 2016)

Packaging sales by region (US\$ billion)							
Regions	2008	Share %	2011	Share %	2016*	Share %	Estimated average growth 2011-2016
Western Europe	129	23%	142	21%	178	51%	4.6%
Eastern Europe	32	6%	36	5%	51	6%	7.2%
Middle East	23	4%	34	5%	38	4%	2.4%
Africa	16	3%	27	4%	34	4%	2.4%
North America	160	29%	178	26%	206	24%	3.0%
South and Central Americas	45	8%	54	8%	68	8%	4.7%
Asia	145	26%	189	28%	250	30%	5.8%
Oceania	9	2%	16	2%	21	2%	6.2%
TOTAL	559		675		845		

*Estimate

Source: DATAMARK, MARKET..., 2008

The largest share of these regions' sales is from the Food (51%) and Beverage (18%) sectors. Pharmaceutical Products, Personal Hygiene and Cosmetics are the markets that may show the highest growth rates, between 2010 and 2016 (Table 1.4), although a lower participation on the total sales (6% and 5%, respectively).

Table 1.4

Packaging sales by end user segment: share in 2010 and projections for 2015

Share and growth by segment		
Segment	Share % 2010	Estimated annual growth 2010-2015
Food	51%	2.8%
Beverages	18%	2.7%
Pharmaceuticals & Personal hygiene	6%	4.5%
Cosmetics	5%	4.3%
Others	20%	2.6%

Source: REXAM, 2011

In relation to the packaging materials used by industries, the largest participation, in 2010, was from the Paper & board segment (31%), Plastics (21%) and Flexibles (19%). For 2015 it is estimated that the Plastics and Flexibles segments will show higher growth rates (Table 1.5).

Compared to the world market, the Paper & board segment's share in Brazil is lower (Table 1.6), having higher proportions for the Plastics (27%), Flexibles (22%) and Metals (19%) segments.

The definition of the materials showed on Tables 1.5 and 1.6 are:

- **Paper & board:** paperboard, corrugated board and liquid packaging board
- **Plastics:** rigid plastic
- **Flexibles:** Laminates, wrapping, membranes, bags, flow pack, stand up pouches, shrink film, stretch film among other films.
- **Others:** Wooden boxes, pallets and woven textile bags.



Table 1.5

Industrial segment shares: Plastics, Cellulose, Metals, Glass and Others

Global share in value by material (US\$ billion)					
Material	2010 Value	Share %	2015 Value*	Share %	CAGR
Paper & board	209	31%	254	30%	3.2%
Plastics	142	21%	203	24%	6.2%
Flexibles	128	19%	169	20%	4.7%
Metals	101	15%	118	14%	2.6%
Glass	47	7%	51	6%	1.2%
Other	41	6%	42	5%	0.7%
TOTAL	675		845		3.8%

*Estimate

CAGR: Compound Annual Growth Rate

Source: MARKET..., 2008

Table 1.6

Share of industrial segments: Brazil x World

Share - Value (US\$)		
Material	BRAZIL% 2009	GLOBAL %* 2009
Paper & board	26%	32%
Plastics	27%	23%
Flexibles	22%	20%
Metals	19%	16%
Glass	6%	8%

*Adjusted percentages

Source: DATAMARK

1.2 PACKAGING SECTOR IN BRAZIL

Industrial companies

The data available from trade associations and other recognized organizations shows 782 companies in the packaging sector working in Brazil. The sample covers, approximately, 70% of the market, includes registered companies (Table 1.7). The majority are companies in the plastics segment.

Datamark's classification for the companies shown in Table 1.7 is:

- **Rigid plastics:** converters of blown and/or injected rigid plastic packaging.
- **Flexibles:** converters of laminated and/or co-extruded packaging.
- **Plastic films:** converters of monolayer plastic films (more "commoditized" products with less differentiation)
- **Paperboard:** Includes integrated converters of cartons and other paperboard packaging and also the principal printing companies.
- **Corrugated board:** manufacturers of corrugated board packaging/sheet (includes ABPO associates and an estimate of non-associated players).

Table 1.8 shows the largest packaging companies in the world and identifies those with operations in Brazil. In the country (Table 1.9), note that seven out of ten of the largest companies are Brazilian.

Table 1.7

Number of companies and share in the total industry – Brazil

Operation	Number of companies
Rigid plastics	220
Flexibles	200
Plastic films	180
Paperboard	70
Corrugated board	60
Metal packaging	38
Caps	12
Aseptic cartons	2

Source: DATAMARK



Table 1.8
Major packaging companies: World and Brazil

Position	World ranking	Profit – Billions US\$ - 2010	Operating in Brazil
1	Koch Industries	100.0	
2	International Paper	25.2	√
3	Alcoa (includes non-packaging)	21.0	√
4	Dai Nippon Printing	19.5	
5	Toppan Printing	17.6	
6	Stora Enso	15.7	√
7	Oji Paper Co Ltd	15.4	
8	Amcor	13.1	√
9	Nippon Unipac Holdings., Ltd.	12.4	
10	Tetra Pak	12.1	√
11	Rank Group NZ (Pactiv, Graham, Silgan, SIG, CSI, Evergreen)	9.0	√
12	Smurfit Kappa	7.9	
13	Crown Holdings	7.9	√
14	Ball Corp	7.6	√
15	Toyo Seikan Kaisha	7.5	
16	Owens Illinois	7.4	√
17	Rexam	7.4	√
18	Weyerhaeuser	6.6	√
19	MWV	5.7	√
20	Rocktenn	5.4	
21	Rengo Company Limited	5.4	
22	Bemis	5.3	√
23	Berry Plastics	4.6	√
24	Sealed Air (Cryovac)	4.5	√
25	Saint Gobain	4.4	√
26	SCA (Svenska Cellulosa Aktiebolaget)	4.2	
27	Graphic Packaging Corporation (Riverwood)	4.2	√
28	Greif Bros. Corporation	4.2	√
29	Sonoco	4.1	√
30	Nine Dragons Paper Industries	3.8	
31	D S Smith Plc	3.8	
32	Cascades Incorporated	3.6	
33	M-real corporation	3.6	
34	Asia Pulp & Paper	3.5	
35	Reynolds	3.1	
36	Holmen AB	3.0	
37	Huhtamäki Oyj	2.9	√
38	Alpla Werke Lehner	2.5	√
39	Klabin S.A.	2.4	√
40	Nampak	2.3	
41	Aptar Group (Seaquist)	2.3	√
42	Mayr-Melnhof Karton AG	2.2	
43	Ardagh Glass	2.1	
44	Plastipak Packaging	1.9	√
45	Linpac	1.9	√

√: Companies established in Brazil (They do not necessarily produce packaging locally)

Source: DATAMARK



Table 1.9

Major packaging companies in Brazil by country of origin, based on estimated production capacity

Position	National ranking	Origin
1	Amcor	Australian
2	Bemis/Dixie Toga	American
3	Brasilata	Brazilian
4	Crown Cork	American
5	CSN (CBL, Prada, Metalic)	Brazilian
6	Empax	Brazilian
7	Engepack	Brazilian
8	Globapack	Brazilian
9	Iguaçu Metagráfica	Brazilian
10	Klabin	Brazilian
11	Latapack Ball	American
12	MWV	American
13	Nadir Figueiredo	Swiss
14	Nestlé	Brazilian
15	Orsa	Brazilian
16	Penha	English
17	Plastipak	American
18	Rexam	English
19	Sealed Air	American
20	SIG Combibloc	Swiss
21	Tetra Pak	Swedish
22	Trombini	Brazilian
23	Verallia	French
24	Videplast	Brazilian
25	Zaraplast	Brazilian

Source: DATAMARK

Production value and employment

The packaging market represents 2.7% of Brazilian industry by value (*Table 1.10*), and 4.1% by value of the transformation industry (*Table 1.11*). Figure 1.1 shows growth rates of packaging production, in the period 2007-2011.

Table 1.10

Total gross value and share of industrial production

Share of the market in the national industry – 2010 (US\$ Billions)	
Industrial Production	1,115
Product Sales	879
Packaging	24
Share	2.7%

Sources: DATAMARK, IBGE, 2010

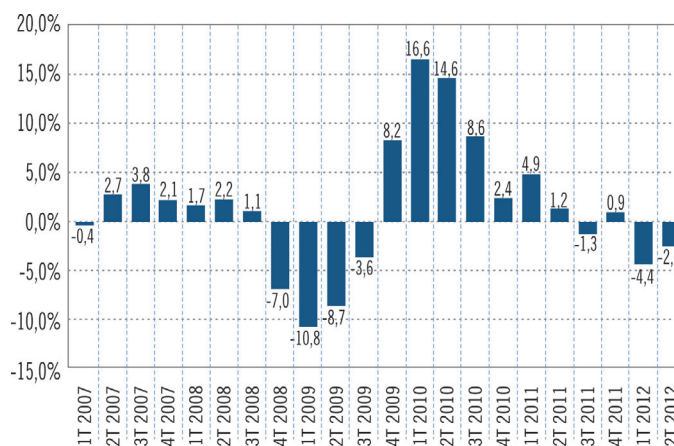
Table 1.11

Value and share of the transformation industry

Share of the packaging market in the national transformation industry – 2010 (US\$ Billion)	
Industrial Transformation Value	579
Packaging	24
Share	4.1%

Figure 1.1

Physical production of packaging: 2007-2012



Source: Tables, 2012; Ministry of Labour and Employment – MTE

The packaging sector employs more than 220 thousand people in Brazil (*Table 1.12*), the plastics and paper & board segments account for the largest share. The sector reached a record level of 226,210 registered employees, in October 2011, dropping in the two last months of the year.



Table 1.12

Employed persons and share by packaging material

Formal employment in the packaging industry by segment		
Segment	Number of registered employees	%
Plastics	117,771	52.8
Corrugated board	35,215	15.8
Paper	30,017	13.3
Metals	18,310	8.2
Wood	14,688	6.6
Glass	6,951	3.1
TOTAL	222,952	

Position in 06/31/2012

Source: TABLES, 2010; MINISTRY OF LABOUR AND EMPLOYMENT – MTE

Table 1.13

Consumption of materials by segment: Plastics, Cellulose, Metals and Glass

Material	Million tonnes			2007 – 2011 CAGR	2011-2015* CAGR
	2007	2011	2015		
Cellulose	3.7	4.3	4.9	3.8%	3.4%
Plastics	2.1	2.5	3	4.8%	4.8%
Metals	1.2	1.3	1.6	2.5%	4.4%
Glass	1	1.2	1.4	4.2%	3.4%
Total	8	9.3	10.9	3.9%	3.9%

*Estimate

CAGR: Compound Annual Growth Rate

Source: DATAMARK

Materials consumption

In 2011, the consumption of packaging was over 9 million tonnes, or US\$ 33 million. It is estimated that the materials consumption will increase to 10.9 million tonnes (3.9%/ year) for 2015 (*Tables 1.13 and 1.14*). The consumption of all materials will increase, although less for plastics and metals, in terms of volume, and for paper and metals in terms of value.

Packaging recycling in Brazil

According to data from 2010, Brazil stands out regarding recycling of aluminum packaging, with rates of over 97%, compared to Japan, USA, Europe and Argentina. With regard to PET recycling, it is just behind Japan. As for board recycling, Brazil is ahead of Europe and Argentina, but behind Japan and USA. Compared to Japan, it is possible to see that Brazil can achieve higher recycling rates for plastic packaging, tinplate and even PET and glass (*Tables 1.15 and 1.16*).

Table 1.14

Consumption of packaging materials in Brazil: Value (historical trends and projection)

Material	US\$ million			2007 – 2011 CAGR	2011-2015* CAGR
	2007	2011	2015		
Plastics	12,530	16,995	20,323	7.9%	4.6%
Cellulose	6,640	8,654	11,858	6.8%	8.2%
Metals	4,312	6,364	7,728	10.2%	5.0%
Glass	898	1,262	1,442	8.9%	3.4%
Total	24,381	33,274	41,351	8.1%	5.6%

*Estimate

CAGR: Compound Annual Growth Rate

Source: DATAMARK



Table 1.15
Packaging recycling in 2010

Packaging recycling index in 2010					
Material	Brazil	Japan	Argentina	Europe	USA
Aluminum	97.6%	92.6%	91.1%	64.3%	58.1%
Tinplate	35%	89.4%	-	71%	67%
PET	57.1%	72%	32.7%	48.3%	29%
Plastics	19.4%	77%	28%	30%	20%
Glass	46%	66.5%	-	68%	28%
Aseptic-cartons	25%	20%	-	34%	-
Corrugated board	70%	95.5%	45.5%	60%	76.6%
Paperboard	45%	-	23%	78%	35.2%

Source: DATAMARK

Table 1.16
Recycled packaging volume in 2010

Recycled packages volume in 2010 (Thousand tonnes)					
Material	Brazil	Japan	Argentina	Europe	USA
Aluminum	239	275	32	304	781
Tinplate	247	612	-	2,600	1,500
PET	282	540	70	1,450	708
Plastics	288	3,087	180	3,960	1,000
Glass	529	404	-	11,543	2,810
Aseptic cartons	77	123	-	350	-
Corrugated board	2,218	9,930	433	15,283	22,760
Paperboard	275	-	-	5,226	1,880

Source: Abal, SRI, Japan Aluminium Association, Tetra Pak, APEAL, Arpet, Abipet, CSN, Plastivida, Napcor, Petcore, PlasticsEurope, ACE, FEVE, Association of Postconsumer Plastic Recyclers, EPA, JCPRA, Rengo



1.3 PRODUCTION AND CONSUMPTION OF PACKAGING IN BRAZIL

Plastic packaging

In the period of 2007-2011, the plastic packaging market grew 7.9% a year in value (US\$) and 4.8% in volume (*Tables 1.17 and 1.18*). The following markets stand out as the most common users of packaging: biscuits, pet food, powder drinks, coffee and snacks in flexible packaging, and soft drinks, mineral water, edible oil, chemical products and fabric softeners in rigid plastic packaging (*Chart 1.1*).

For 2015, the forecast is an increase of over US\$ 3 million, in relation to 2011, corresponding to an additional volume of 500 thousand of tonnes. There has been continued growth in consumption per capita since 2007 (*Table 1.19*).

Table 1.17

Size of the plastic packaging market: Value (historical trends and projections)

Material	US\$ million			2007 – 2011 CAGR	2011-2015* CAGR
	2007	2011	2015		
Plastics	7,124	10,328	12,495	9.7%	4.9%
Flexible plastics	5,406	6,667	7,827	5.4%	4.1%
TOTAL	12,530	16,995	20,323	7.9%	4.6%

*Estimate

CAGR: Compound Annual Growth Rate

Source: DATAMARK

Table 1.18

Size of the plastic packaging market: Volume (historical trends and projections)

Material	US\$ million			2007 – 2011 CAGR	2011-2015* CAGR
	2007	2011	2015		
Plastics	1,821	2,223	2,694	5.1%	4.9%
Flexible plastics	271	301	354	2.7%	4.1%
TOTAL	2,091	2,525	3,047	4.8%	4.8%

Estimate*

CAGR: Compound Annual Growth Rate

Source: DATAMARK

**Chart 1.1**

The principal 15 plastic packaging markets in Brazil

Principal 15 markets flexible plastics	Principal 15 markets rigid plastics
Biscuits	Soft drinks
Pet food	Mineral water
Powder drinks	Edible oil
Coffee	Chemical products
Snacks	Fabric softeners
Toothpaste	Fruit & vegetables
Tomato sauce	Washing up liquid
Baking mix	Hair conditioners
Soft drinks	Bleach
Chewing gum	Flavored fruit drinks
Soap	Skin cream
Cigarettes	Agrochemicals
Washing powder	Lubricating oil
Chilled boneless beef	Yogurt
Dry pasta	Alcohol

Source: DATAMARK

Table 1.19

Plastics consumption (kg per capita)

Material	2007	2011	2015*
Plastics	9.5	11.6	14.4
Flexible plastics	1.4	1.6	1.9

*Estimate

Source: DATAMARK

With regard to plastic packaging, there was substantial growth in all segments, especially PET bottles (43% in units and 34.8% in tonnes) and plastic bottle caps (32% in units and 25.8% in tonnes) 2007-2011. This trend will continue, the estimated increase in volume is approximately 22% for PET bottles, 23% for plastic bottles, 17% for flexible packaging, 23% for plastic caps and 20% for plastic labels, from 2011 to 2015 (Tables 1.20 to 1.23).

Table 1.20

Plastic and PET bottles consumption (units volume)

type	Billion units			Thousand tonnes		
	2007	2011	2015*	2007	2011	2015*
PET bottles	12.3	17.6	21.6	501.1	675.8	824.4
Plastic bottles	8.1	10.7	13.6	273.4	324.9	401.1
Total	20.4	28.3	35.3	774.6	1,000.8	1,229.6

*Estimate

Source: DATAMARK

Table 1.21

Flexible packaging consumption (units volume)

type	Billion units			Thousand tonnes		
	2007	2011	2015*	2007	2011	2015*
Flexible Packages	126.4	139.0	156.8	230.4	259.6	303.5

*Estimate

Source: DATAMARK

Table 1.22

Plastic caps consumption (units volume)

type	Billion units			Thousand tonnes		
	2007	2011	2015*	2007	2011	2015*
Plastic caps	25.9	34.2	42.1	102.9	129.5	160.2

*Estimate

Source: DATAMARK

Table 1.23

Plastic labels consumption (units volume)

type	Billion units			Thousand tonnes		
	2007	2011	2015*	2007	2011	2015*
Plastic labels	24.6	30.5	37	33.9	34.4	41.5

*Estimate:

Source: DATAMARK



Cellulose packaging (Paper & board)

The market of cellulose packaging, excluding Liquid Packaging Board (LPB), grew 6.4% a year in value (US\$) and 3.8% in volume, from 2007 to 2011. For 2011-2015, the forecast is an increase at an annual rate of 3.2% in value (US\$) and 3.4% a year in volume (Tables 1.24 to 1.26).

The main users of this kind of package are the transport package markets for UHT milk, fruit and vegetables, and poultry, considering corrugated fiberboard material; washing powder, shoes and pharmaceuticals for paperboard; and beer, cigarettes and mineral water for paper labels (Chart 1.2).

Table 1.24

Size of the cellulose packaging market:
Value (historical trends and projections)

Material	US\$ million			2007 – 2011 CAGR	2011-2015* CAGR
	2007	2011	2015		
Cellulose	5,811	7,461	8,468	6.4%	3.2%

Estimate*

CAGR: Compound Annual Growth Rate

Source: DATAMARK

Table 1.25

Size of the cellulose packaging market:
Volume (historical trends and projections)

Material	Thousand tonnes			2007 – 2011 CAGR	2011-2015* CAGR
	2007	2011	2015		
Cellulose	3,722.2	4,315.1	4,934.5	3.8%	3.4%

Estimate*

CAGR: Compound Annual Growth Rate

Source: DATAMARK

Table 1.26

Cellulose packaging consumption
(kg/capita)

Material	kg/capita		
	2007	2011	2015
Cellulose	19.5	22.6	25.8

Estimate*

Source: DATAMARK

Chart 1.2

Principal 20 Brazilian markets for cellulose packaging

Principal 20 markets of corrugated fiberboard	Principal 20 markets of paperboard	Principal 20 markets of paper labels
UHT milk	Washing powder	Beer
Fruit & vegetables	Shoes	Cigarettes
Poultry	Pharmaceuticals	Mineral water
Chilled beef bovine meat	Toys	Milk powder
Pharmaceuticals	Toothpaste	Chocolate powder
Ceramics	Cake mixes	Shampoo
Steel	Breakfast cereals	Washing up liquid
Clothing	Hamburgers	Fabric softeners
Plastics	Panettone	Isotonic drinks
Tobacco (exports)	Snacks	Spirits
Premium biscuits	Auto-parts	Disinfectants
Dried Dry pasta	Cigarettes	Powdered cereals
Cut size paper	Electric lamps	Sterilized cream
Juices and nectars	Chocolate bonbons	Concentrate cleaning products
Washing powder	Frozen meals	Edible oil
Fabric softeners	Frozen fish	Cream cheese
Ground coffee	Powdered cereals	Mayonnaise
Washing up liquid	Soups	Pet food
Shoes	Vacuum-packed coffee	Canned fruit
Bleach	Frozen pizza	Lubricating oil

Source: DATAMARK



As to cellulose packaging the principal consumption is corrugated-board, which will reach over 3.7 million of tonnes in 2015 (*Table 1.27*). In the period of 2011-2015, an increase of about 15% is estimated for Corrugated board, 13% for paperboard cartons (*Table 1.28*) and 15% for paper labels (*Table 1.29*).

Table 1.27

Corrugated board boxes consumption
(units volume)

Material	Billion units			Thousand tonnes		
	2007	2011	2015*	2007	2011	2015*
Corrugated board	29.1	36.6	41.6	2,839.2	3,245.2	3,747.5

*Estimate:

Source: DATAMARK

Table 1.28

Paperboard packaging consumption
(units volume)

Material	Billion units			Thousand tonnes		
	2007	2011	2015*	2007	2011	2015*
Paperboard cartons	27.4	31.2	35.0	494.1	621.1	695.2

*Estimate:

Source: DATAMARK

Table 1.29

Paper labels consumption (units volume)

Material	Billion units			Thousand tonnes		
	2007	2011	2015*	2007	2011	2015*
Paper labels	26.9	29.7	24.6	27.3	28.4	32.8

*Estimate:

Source: DATAMARK

Metal packaging

The metal packaging market showed high growth in the period of 2007-2011 (*Table 1.30*), with an annual rate above 10% in value (US\$). For 2011 and 2015, the forecast is an increase in volume of about 5% for steel packaging, 25% for aluminum and 21% for tinplate (*Table 1.31*).

Table 1.30

Size of the metal packaging market:
Value (historical trends and projections)

Material	US\$ millions			2007 – 2011 CAGR	2011-2015* CAGR
	2007	2011	2015		
Steel	546.5	577.2	608.9	1.37%	1.35%
Aluminum	1,900.7	3,003.5	3,751.6	12.1%	5.7%
Tinplate/TFS	1,864.7	2,783.2	3,367.5	10.4%	1.3%
TOTAL	4,311.8	6,363.8	7,727.9	10.2%	5.0%

Estimate*

CAGR: Compound Annual Growth Rate

Source: DATAMARK

Table 1.31

Size of the metal packaging market:
Volume (historical trends and projections)

Material	Billion units			Thousand tonnes		
	2007	2011	2015*	2007	2011	2015*
Steel	0.02	0.03	0.03	278.6	282.2	297.7
Aluminum	26.9	39.0	48.6	252.4	370.9	463.3
Tinplate/TFS	28.6	29.7	35.5	681.9	685.7	829.7
TOTAL	55.5	68.7	84.2	1,212.9	1,338.8	1,590.6

*Estimate

Source: DATAMARK



Chart 1.3

The 15 biggest national markets of metallic packages consumption

Principal 15 Aluminum markets	Principal 15 tinplate markets
Beer	Canned corn
Soft drinks	Whole milk powder
Hair colouring	Condensed milk
Deodorants	Emulsion paint
Juices and nectars	Solvents
Energy drinks	Beer
Pharmaceuticals	Soft drinks
RTD tea	Chocolate powder
Aguardente premium	Corned beef
Skin cream	Tomato purée
Hair spray	Skimmed milk powder
Canned olives	Canned peas
Alcopops	Tomato sauce
Shaving foam	Aerosol insecticides
Hair straightening products	Palm hearts

Source: DATAMARK

In the period of 2007-2011 there was high growth in beverage can consumption, with an annual rate of 9.7% for aluminum packaging and 5.4% for tinplate packaging (Table 1.32). Aluminum can consumption will continue to grow, between 2011 and 2015, despite taxes being lower in the previous period. The per capita consumption of aluminum cans increased from 0.9kg, in 2007, to 1.3, in 2011, and is estimated to reach 1.6kg per capita in 2015 (Table 1.33).

Metal packaging for aerosols, despite a lower proportion consumed in metal packaging, also showed a considerable increase in the period of 2007-2011 (17.4% a year), and is estimated to grow over 5% a year, from 2011 to 2015 (Table 1.34).

Table 1.32

Consumption of cans for beverages (tonnes)

Cans for beverages	Thousand tonnes			2007 - 2011 CAGR	2011-2015* CAGR
	2007	2011	2015		
Aluminum	172.8	250.4	312.3	9.7%	5.7%
Tinplate/TFS	26.2	32.3	42.0	5.4%	6.8%
TOTAL	198.9	282.8	354.4	9.2%	5.8%

Estimate*

CAGR: Compound Annual Growth Rate

Source: DATAMARK

Table 1.33

Consumption of cans for beverages (kg/capita)

Material	kg/capita		
	2007	2011	2015
Aluminum	0.9	1.3	1.6
Tinplate/TFS	0.1	0.2	0.2
TOTAL	1.0	1.5	1.9

Estimate*

Source: DATAMARK

Table 1.34

Cans and aerosols consumption (tonnes)

Aerosols and cans (excl. beverage-cans)	Thousand tonnes			2007 - 2011 CAGR	2011-2015* CAGR
	2007	2011	2015		
Aerosols	23.1	43.8	53.5	17.4%	5.1%
Cans	564.5	545.0	658.4	-0.9%	4.8%
TOTAL	587.6	588.9	711.9	0.1%	4.9%

Estimate*

CAGR: Compound Annual Growth Rate

Source: DATAMARK

Table 1.35

Cans and aerosols consumption (kg/capita)

Material	kg/capita		
	2007	2011	2015
Aerosols	0.1	0.2	0.3
Cans	3.0	2.9	3.4
TOTAL	3.1	3.1	3.7

Estimate*

Source: DATAMARK

Table 1.36

Consumption of metal caps (units)

Crown caps	Billion units			2007 - 2011 CAGR	2011-2015* CAGR
	2007	2011	2015		
TFS	16.9	16.9	20.9	0.1%	4.6%

Estimate*

CAGR: Compound Annual Growth Rate

Source: DATAMARK



Glass packaging

The market of glass packaging grew at an annual rate of 8.9% in value (US\$), from 2007 to 2011 (*Table 1.37*). The forecast for 2015 is that the market will reach 8.6 billion units, equivalent to 1.3 million tonnes (*Table 1.38*). The consumption of one-way bottles more than doubled in volume (tonnes), in the period of 2007-2011 (*Table 1.39*).

Beverages are amongst the most common end uses of this type of packaging, as well as pharmaceutical products and food (*Chart 1.4*).

Table 1.37

Size of the glass packaging market:
Value (historical trends and projections)

Material	US \$ Millions			2007 - 2011 CAGR	2011-2015* CAGR
	2007	2011	2015		
Glass	898	1,262	1,433	8.9%	3.2%

*Estimate**

CAGR: Compound Annual Growth Rate

Source: DATAMARK

Table 1.38

Size of the glass packaging market:
Units (historical trends and projections)

Material	Billion units			Thousand tonnes		
	2007	2011	2015*	2007	2011	2015*
Glass	5.5	7.2	8.6	1,012	1,191	1,361

**Estimate*

Source: DATAMARK

Table 1.39

Consumption of glass packaging (tonnes, kg/capita): One-way and returnable

Material	Thousand tonnes		
	2007	2011	2015*
Returnable bottles	224.8	230.7	264.0
One-way bottles	142.2	296.4	356.5
TOTAL	367.0	527.1	620.5
	kg/capita		
	2007	2011	2015*
Returnable bottles	1.18	1.21	1.38
One-way bottles	0.74	1.55	1.87

**Estimate*

Source: DATAMARK

Chart 1.4

Principal 20 Brazilian markets for
glass packaging

Principal 20 markets for glass packaging
Beer
Cognac
Pharmaceuticals
Fragrances
Table wine
Concentrate fruit juices
Soft drinks
Coconut milk
Aguardente premium
Alcopops
Canned olives
Instant coffee
Aguardente popular
Vodka
Rum
Cider
Corn
Whisky
Quality wine

Source: DATAMARK



Aseptic carton packaging

The market for aseptic carton packaging grew at an annual rate of 8.8% in value (US\$), from 2007 to 2011 (*Table 1.40*), with a growth forecast of 5.6% a year, between 2011 and 2015. The consumption per capita will continue growing, increasing from 1.6 kg, in 2011, to 2.1 kg per capita, in 2015 (*Table 1.41*).

Table 1.40

Size of Aseptic carton packaging market:
Value (historical trends and projections)

Type	US\$ million			2007 – 2011 CAGR	2011-2015* CAGR
	2007	2011	2015		
Liquid Packaging Board (LPB)	983	1,376	1,710	8.8%	5.6%

*Estimate**

CAGR: Compound Annual Growth Rate

Source: DATAMARK

Table 1.41

Size of Aseptic carton packaging
market: Consumption
(historical trends and projections)

Material	kg/capita		
	2007	2011	2015*
Liquid Packaging Board (LPB)	1.3	1.6	2.1

**Estimate*

Source: DATAMARK

Beverages are responsible for consuming most of this type of packaging, as well as tomato products and preserved food. (*Chart 1.5*).

Chart 1.5

Principal 20 Brazilian markets for
Aseptic carton packaging

Principal 20 Brazilian markets for aseptic carton packaging	
Long life milk	
Juices and nectars	
Flavored milk	
Soy based juices	
Sterilized cream	
Dairy drink	
Coconut water	
Condensed milk	
Tomato purée	
Corn	
Mayonnaise	
Tomato sauce	
Tomato paste	
Peas	
RTD tea	
Fruit juice	
Fermented milk	
RTD fresh juice	
Ketchup	
Pasteurized cream	

1.4 MAIN PACKAGING END USER INDUSTRIES IN BRAZIL

End user industry: food

The food industry earned R\$ 316.5 billion in 2011, showing a 5.2% growth comparing to the last year (*Table 1.42*). Since 2005, the sector grew at an average of 3.7% a year with the food service channel, registering a higher growth rate than the food retail in

that period. Table 1.42 shows sales and international trade indicators of the Brazilian food sector in recent years. Table 1.43 shows the principal segments of the food industry, based on sales data for the period of 2008-2011.



Eating out, which includes restaurants, bars, snack bars and meals served inside supermarkets, has grown 15% in the last 15 years and today accounts for 30% of the country's food production. Growth prospects

are positive, since, today, the proportion of Brazilian families' budget destined for eating out is 31%, comparing to 50% in USA and EUROPE (CARNEIO, 2012).

Table 1.42
Food industry performance indicators

Performance indicators (R\$ billion)							
	2006	2007	2008	2009	2010	2011	Average growth (2005-2011)
Performance							
Net Income	263.8	269.7	279.6	286.1	300.8	316.5	3.7%
International Trade							
Exports	137.8	160.7	197.9	153	201.9	256.0	13.2%
Imports	91.4	120.6	173.2	127.6	181.6	226.2	19.9%
Trade Balance	46.5	40.0	24.7	25.3	20.3	29.8	-8.5%
Distribution Channels							
Food Retail	110.4	122.7	143.8	159.1	179.5	205.3	13.2%
Food Service	43.4	50.3	58.2	64.4	75.1	88.0	15.2%

Source: CARNEIO, 2012

Table 1.43
Food industry: principal segments by sales (2008-2011)

Principal segments by sales (R\$ billion)					
	2008	2009	2010	2011	Average growth (2008-2011)
Meat products	61	58.5	66	80.1	7.0%
Sugar	15.9	30.2	37.7	46	30.4%
Cereals	31.1	32.9	35.9	42.1	7.9%
Dairies	26.4	29	33.1	39	10.2%
Oils and fats	32	29	29.3	32	0.0%
Wheat-based products	18.7	18.9	19.9	21.9	4.0%
Several	14	15.4	17.7	20.7	10.3%
Fruits and vegetables-based products	14.8	14.9	15.6	17.7	4.6%
Chocolate, cocoa and candies	9.1	9.9	10.5	11.2	5.3%
Dehydrated and frozen meals	5.1	5.6	6.5	7.7	10.8%
Canned fish	2	2.3	2.5	2.7	7.8%

Source: CARNEIRO, 2012



One of the main factors responsible for the continuous growth of the sector, the accelerated economic development of the country in the later years has brought to the market a new emerging middle class with a higher purchasing power and a more demanding level of quality for basic food products. These changes in the purchasing behavior have intensified rivalry among the industrial food producers, which seek to attract new consumers with innovative products packed in attractive and functional packaging. In 2010, there were 105,589 launches of new food products, an increase of 4.3% comparing to 2009, however, the demand for healthy, light, fresh, natural and organic food, as well as functional and fortified options, must continue to grow in the coming years. The sales channels have suffered significant changes, with convenience stores becoming more important points of sales for consumers of all ages and origins (THE FUTURE... 2009).

Characteristics such as lightness, safety and transparency are also more highly valued by consumers. As a result, flexible packaging consumption has been stimulated by perishable and convenience foods, thanks to the growth and regularization of cheese, meat and cold cuts market. Investments in new packaging have been an efficient form for the brand owners to strengthen their brands and differentiate themselves from their competitors. In some markets, these innovations have catalyzed significant changes in the packaging mix, such as in the tomato sauces segment, which replaced tinplate cans with stand-up pouches.

The food segment will increase packaging consumption, with average rates of 4.4% a year, in value (US\$ millions), and 4.2% in volume (tonnes), between 2011 and 2015. Metal and plastic packaging should show the highest growth rates (*Tables 1.44, 1.45 and 1.46*).

Table 1.44

Historical trends and projections for packaging consumption for food: Value

Material	US\$ million 2007	US\$ million 2011	Average growth 2007-2011	US\$ million 2015*	Average growth 2011-2015
Flexibles	3,402	4,196	5.4%	4,856	3.7%
Plastics	2,422	3,235	7.3%	3,932	5.0%
Paper and Board	1,917	2,584	7.7%	3,054	4.3%
Corrugated board	1,557	1,844	4.3%	2,171	4.2%
Metals	1,212	1,613	7.4%	1,976	5.2%
Glass	174	192	2.5%	215	2.8%
TOTAL	10,705	13,665	6.3%	16,204	4.4%

*Estimate

Source: DATAMARK



Table 1.45

Historical trends and projections for food packaging consumption:
Volume (units)

Material	Billion units 2007	Billion units 2011	Average growth 2007-2011	Billion units 2015*	Average growth 2011-2015*
Corrugated board	6.2	7.0	3.4%	8.6	5.2%
Plastics	83.7	94.8	3.2%	107.3	3.1%
Metals	8.3	8.0	-0.8%	9.7	5.0%
Paper and board	14.0	16.5	4.2%	18.5	2.9%
Glass	1.2	1.1	-1.4%	1.2	3.1%
Flexibles	94.1	103.6	2.4%	115.9	2.9%
TOTAL	207.4	230.9	2.7%	261.2	3.1%

*Estimate

Source: DATAMARK

Table 1.46

Historical trends and projections for food packaging consumption:
Volume (tonnes)

Material	Billion units 2007	Billion units 2011	Average growth 2007-2011	Billions units 2015*	Average growth 2011-2015*
Corrugated board	1,229.0	1,415.2	3.6%	1,666.2	4.2%
Plastics	558.0	633.3	3.2%	769.5	5.0%
Metals	432.8	390.9	-2.5%	478.9	5.2%
Paper and board	312.0	359.8	3.6%	404.0	2.9%
Glass	189.2	170.3	-2.6%	190.1	2.8%
Flexibles	142.0	155.4	2.3%	179.8	3.7%
TOTAL	2,863.0	3,124.9	2.2%	3,688.9	4.2%

*Estimate

Source: DATAMARK

User industry: beverages

Beverage industry sales in Brazil reached R\$ 151 billion in 2011, an advance of less than 0.9% in relation to the previous year, way below the growth registered in 2010 (6.1%). The low growth was due to the poor performance of the beer segment which retracted in 2011. One of the factors was an increase in PIS/ Cofins and IPI taxes, by about 15%, over beverages, that resulted in a price increase of 1.3%. The higher

tax burden had an impact on the sector, especially on brands with lower market shares. However, some sectors maintained the good sales performance of previous years, such as tonic drinks, pulled up by energy drinks (33%) and isotonic (30%), and fruit juices (15%). Table 1.47 shows the main products in this segment, by sales, for the period of 2008-2011.



Table 1.47

Beverages industry: principal products by sales (2008-2011)

Principal products by sales (R\$ Billion)				
	2008	2009	2010	Average growth (2008-2011)
Beer	44	46	52	4.1%
Soft drinks	27	28	27	0.7%
Milk	24	27	26	1.8%
Spirits	10	10	11	2.9%
Fruit juices	10	11	12	7.6%
Coffee & Tea	10	11	11	1.4%
Other beverages*	5	6	6	6.6%
Tonic drinks**	2	3	3	14.1%
TOTAL	132.7	141.2	149.8	3.3%

*It includes mineral water and RTD tea

**It includes isotonic, fermented milk, energy drinks and nutritional supplements.

Source: DATAMARK

Higher purchasing power allows the Brazilian consumer to try new products, a trend that leads to important changes in consumer habits. The premium beer segment has, nowadays, 7% of the beer market. In the last 5 years,, that segment has grown at a 10% average rate a year, a higher rate than the 4.1% for the total beer market. The sales of Stella Artois beer, Ambev's premium brand, for example, had a 215% increase in sales in 2011 (FACCHINI, 2012).

There is a growing demand for products with a new offering in the juice market as well. Many companies, such as Juxx, Danone (with the brand Activia) and Globalbev (with the brand Amazoo), among others, have launched juices with unusual flavors, like cranberry, with functional ingredients and no preservatives.

The Federal government readjusted IPI, PIS and Cofins tax rate table in June 2012 for the cold beverage market – water, soft drinks, beer, isotonic and energy drinks, increasing the tax burden for the sector by 19% on average. However, in September the Federal Tax Authority delayed the tax increase, which should have come into force in October, through to April 2013. In exchange for the delay, the beverage producers promised to keep up investments and employment. However, the

sector will pay more taxes due to increases over the last 12 months. That is because beverages are taxed a fixed value per unit instead of a percentage of the price. That fixed value is updated every year and this year, the likely increase to the final consumer may be up to 2.15%. Thus just as in 2011, it is possible that the increase in the shelf prices might reduce consumption (FERNANDES; VERÍSSIMO, 2012).

The higher purchasing power of the emerging middle class has directly contributed for a higher demand for aluminum canned beverages, mainly beer. Between 2007 and 2011, the volume of aluminum cans used to package beer increased 56%, from 7.8 million to 12.2 million of units, increasing their share of the market from 28% to 34% in the period (DATAMARK, s.d.). The increase of the Brazilian consumer's discretionary income has enabled a change in their purchasing behavior that encouraged beer consumption at home, an occasion where aluminum cans are more appropriate compared to returnable glass bottles. Other markets that have pushed up the demand for aluminum cans are juices, energy drinks and RTD tea.

The advancement in the ecofriendly packaging accompanies the endless search for cost reduction of PET bottles by brand owners. Since they started to be used in the soft drinks market, PET packages have had cost reductions between 8% and 26%, depending on size through light-weighting both in the neck and bottle cap. Besides reduced consumption of raw material, another important trend in the PET bottle transformation process, influenced by sustainability issues, is the use of resin from renewable sources that accounts for up to 30% in bottles used in the soft drinks and mineral water markets (PACHIONE, 2010).

The huge dependency on PET bottles in the soft drinks market (approximately 60%) has forced the material converters to seek new opportunities to replicate the success of PET bottles in other promising markets. The Portuguese company Logoplaste, along with the brand Shefa, for example, seems to have started a migration from the aseptic cartons to PET bottles with light barrier in the UHT milk market. In only 6 months, Shefa has packed 30% of their production in



PET bottles, due to the excellent acceptance of the new format by the consumer, to a product that, over the last 15 years, was sold, mainly, in 1 liter aseptic cartons, mainly as a result of the better product appearance due to the packaging.

The beverage industry segment should increase packaging consumption, at average rates of 5.4% a year, in value (US\$ millions), and 4.9% in volume (tonnes), between 2011 and 2015. Metals, plastics, paper & board packaging should show the higher growth rates (*Tables 1.48, 1.49 and 1.50*) (DATAMARK, s.d.).

Table 1.48

Historical trends and projections for beverage packaging consumption: Value

Material	US\$ million 2007	US\$ million 2011	Average growth 2007-2011	US\$ million 2015*	Average growth 2011-2015*
Plastics	2,290	3,940	14.5%	4,905	5.6%
Metals	1,938	3,046	12.0%	3,795	5.7%
Flexibles	1,108	1,523	8.3%	1,861	5.1%
Paper	947	1,329	8.8%	1,654	5.6%
Corrugated board	616	834	7.9%	1,016	5.0%
Glass	562	815	9.7%	927	3.3%
TOTAL	7,462	11,486	11.4%	14,158	5.4%

*Estimate

Source: DATAMARK

Table 1.49

Historical trends and projections for beverage packaging consumption: Volume (units)

Material	Billion units 2007	Billion units 2011	Average growth 2007-2011	Billion units 2015*	Average growth 2011-2015*
Glass	2.0	2.8	8.8%	3.3	3.8%
Plastics	31.4	45.4	9.6%	57.0	5.9%
Corrugated board	0.5	0.7	7.4%	0.8	4.8%
Metals	43.9	56.1	6.3%	69.1	5.4%
Paper	12.7	15.3	4.8%	19.0	5.6%
Flexibles	34.0	43.3	6.2%	53.6	5.5%
TOTAL	124.5	163.5	7.1%	202.9	5.5%

*Estimate

Source: DATAMARK



Table 1.50

Historical trends and projections for beverage packaging consumption: Volume (tonnes)

Material	Thousand tonnes 2007	Thousand tonnes 2011	Average growth 2007-2011	Thousand tonnes 2015*	Average growth 2011-2015*
Glass	733.9	910.1	5.5%	1,035.5	3.3%
Plastics	630.3	884.9	8.9%	1,102.9	5.7%
Corrugated board	486.4	640.1	7.1%	779.5	5.0%
Metals	319.1	428.9	7.7%	531.8	5.5%
Paper	269.7	333.4	5.4%	414.1	5.6%
Flexibles	62.2	73.3	4.2%	89.6	5.1%
TOTAL	2,501.5	3,270.6	6.9%	3,953.4	4.9%

*Estimate

Source: DATAMARK

User industry: healthcare

In the last ten years, the pharmaceutical sales, including generics, OTC (over-the-counter) and other pharmaceuticals under medical prescription, have increased 43.5%, reaching 2.34 billion of unities at the end of 2011. The fast growth—of basically all types of pharmaceuticals has stimulated the major pharmaceutical companies to invest in expanding of industrial facilities, clinical studies and acquisitions. About R\$ 5 billion in investments, business and acquisitions shook the Brazilian pharmaceutical market in 2011.

Major investments are also a way for the pharmaceutical companies to prepare to face a new era without the blockbuster patented products. The expiration of a patent generates, for the manufacturers and P&D holders, a loss of US\$ 500 million in sales in Brazil, and in 2011, around 25 pharmaceuticals had their patents expire. In order to face this transformation, one of the main strategic initiatives by the sector giants is product innovation and investment in research to speed up the development of new therapeutic treatments. The considerable increase in the investments in research, caused by the patent expiration, compares with the growth of generic pharmaceuticals share in the Brazilian market, which closed 2011 with 20.5% of

pharmaceutical sector sales.

The packaging sector for pharmaceuticals, that ranges from laminated blisters and paperboard cartons to glass bottles, have gotten benefits from the soaring of the demand for generic pharmaceuticals, generating approximately R\$ 606 million in 2011, an increase of 25% versus 2010, passing the 13% growth rate of the pharmaceutical sector. Table 1.5 shows the relationship of the ten largest companies of the sector in 2010 (by sales) (PORTAL FARMACÊUTICO, 2012; FÓRUM DE LÍDERES, s.d.).

The OTC pharmaceuticals market is increasing, having been pushed mainly by the expansion of governmental healthcare programs, as well as the increase of the discretionary income of the Brazilian consumer.

The growth of the C class's purchasing power and the decrease in price of pharmaceuticals, thanks to the advent of the generics, has made pharmaceuticals more accessible to most of the Brazil's population. The average spend per capita in 2012 was R\$ 386.43, versus R\$ 337 from 2011. Classes B and C will be mainly responsible for that consumption. Together, they correspond to 80% of the total, with spending of R\$ 23 billion and R\$ 27 billion, respectively.



The decrease in the unemployment rate has also reflected on the increase of private health insurance plans, resulting, from 2003 to 2010, an increase of around 85% in the consumption of high cost pharmaceuticals. It is estimated that, from 2003 to 2010, the number of lives covered by private health insurance have jumped from 32 million to 46 million.

Table 1.51

Pharmaceutical industry:
main companies by income

Company	Control	Type	Income (US\$ MM)
Pfizer	American	Private	2,160.7
Novartis	Swiss	Private	1,949.7
Sanofi	French	Private	1,900
Roche	Swiss	Private	1,884.3
Medley	French	Private	1,607.7
AstraZeneca	Anglo-Swedish	Private	1,088.9
EMS	Brazilian	Private	903.6
Eurofarma	Brazilian	Private	839.8
Aché	Brazilian	Private	823.9
Merck	German	Private	576.9

Source: DATAMARK, PORTAL FARMACÊUTICO, 2012, FÓRUM DE LÍDERES, s.d.

The economic development has also caused changes in the most consumed generic pharmaceuticals in Brazil. Painkillers and antibiotics, even though they

are considered the main pharmaceuticals in sales volume, they begin to lose out to products aimed at treatments of more complex diseases, such as sildenafil citrate, Viagra's active principle (erectile dysfunction treatment), that in 2011, became the 4th most consumed pharmaceutical in Brazil in value. Other pharmaceuticals that treat high blood pressure, heart conditions, cholesterol and even cancer may beat the top of that ranking as pharmaceutical patents expire.

The consolidation of major pharmacies is another important trend that reflects the growth potential of the sector in Brazil. In 2011, Raia and Drogasil and Pacheco and São Paulo chains announced mergers, creating the largest groups in the sector, with sales above R\$ 4 billion. The process will continue, since many regional chains are being targeted for acquisition by the majors, mainly because the pharmaceutical market in Brazil is very fragmented. There are more than 60,000 pharmacies in the country, with the four leaders having only 25% share versus 60% share of the four biggest chains in USA. Thus, there is plenty of space to grow.

That segment should increase packaging consumption, with average rates of 5.6% a year, in value (US\$ million), and 5.6% in volume (tonnes), between 2011 and 2015. Metals, plastics, paper and paperboard packaging should show the highest growth rates (Tables 1.52, 1.53 and 1.54).

Table 1.52

Historical trends and projections for packaging consumption for healthcare: Value

Material	US\$ million 2007	US\$ million 2011	Average growth 2007-2011	US\$ million 2015*	Average growth 2011-2015*
Corrugated board	84.4	165.0	18.3%	203.4	5.4%
Paper and board	72.2	143.3	18.7%	178.0	5.6%
Glass	82.9	129.0	11.7%	160.3	5.6%
Flexibles	69.9	114.0	13.0%	141.5	5.6%
Plastics	50.2	92.1	16.4%	114.4	5.6%
Metals	5.1	16.9	34.7%	21.0	5.6%
TOTAL	125	223	15.5%	277	5.6%

*Estimate

Source: DATAMARK



Table 1.53

Historical trends and projections for packaging consumption for healthcare:
Volume (units)

Material	Billion units 2007	Billion units 2011	Average growth 2007-2011	Billion units 2015*	Average growth 2011-2015*
Corrugated board	1.3	1.8	8.1%	2.2	5.5%
Paper and board	6.6	10.1	11.5%	12.6	5.6%
Glass	1.6	2.3	9.0%	2.8	5.6%
Flexibles	2.1	3.3	11.6%	4.1	5.6%
Plastics	7.0	10.4	10.5%	12.9	5.6%
Metals	0.7	1.2	17.3%	1.5	5.6%
TOTAL	19.2	29.1	10.9%	36.1	5.6%

*Estimate

Source: DATAMARK

Table 1.54

Historical trends and projections for packaging consumption for healthcare:
Volume (tonnes)

Material	Thousand tonnes 2007	Thousand tonnes 2011	Average growth 2007-2011	Thousand tonnes 2015*	Average growth 2011-2015*
Corrugated board	46.3	63.2	8.1%	78.4	5.5%
Paper and board	34.2	52.9	11.5%	65.7	5.6%
Glass	43.6	52.4	4.7%	65.1	5.6%
Flexibles	13.0	19.7	10.8%	24.4	5.6%
Plastics	7.5	11.2	10.6%	14.0	5.6%
Metals	0.8	2.4	30.6%	3.0	5.6%
TOTAL	145.5	201.9	8.5%	250.7	5.6%

*Estimate

Source: DATAMARK

End user industry: personal care

The Brazilian personal care industry showed an average growth of 13.5% over the last ten years, increasing from a net sales of R\$ 8.3 billion (US\$ 3.5 billion) in 2001 to R\$ 29.4 billion (US\$ 17.6 billion) in 2011 (ABHIPEC, 2011b). Among the factors driving this growth, are the use of high technology by the sector, constant releases of new products, increase of life expectancy, which brings the need to maintain a youthful image, a greater consumption of products by

men, among others that are considered in chapter 2 of this publication.

According to data from the Brazilian Association of Personal Care, Perfumes and Cosmetics (ABHIPEC, 2011b), there are 1,659 companies in Brazil operating in the market for personal care products, with 20 large companies with net sales over R\$ 100 million, representing 73% of total sales. Table 1.55 shows the regional distribution of these companies.

**Table 1.55**

Personal care industry:
Number of companies by region

Companies geographic distribution	
Region	Quantity of companies
North	25
Center-West	126
Northeast	139
Southeast	1,047
South	322
Brazil	1,659

Source: ABHIPEC (2011b, 9 p.)

Analysis of the balance of trade of personal care products in the last ten years shows an accumulated growth of 293.5% in exports between 2002 and 2011, and imports increasing by 340.9% in the same period. The sector's trade deficit, which reached US\$ 163.1 million in 1997, reduced in subsequent years, dropping to US\$ 8 million in 2001 and, from 2002, became a surplus. In 2009 the surplus fell to US\$ 131 million, a decrease of 27.8% over 2008, reflecting the appreciation of the Brazilian money, which resulted in a US\$ 126 million deficit in 2011 (*Table 1.56*).

Regarding the global market for personal care, Brazil ranks third. It is first in perfumes and deodorants; second in hair care products, oral hygiene products, male, child, sunscreen; third in cosmetics; fourth in depilatories; and fifth in skin care (*Table 1.57*).

Table 1.56

Personal care industry: balance of trade (2002-2011)

BALANCE OF TRADE – PERSONAL CARE MARKET					
Year	Imports US\$ million	% Growth	Exports US\$ million	% Growth	Balance
2002	152	-23.7	203	5.9	13.2
2003	150	-1.3	244	20.3	24.9
2004	157	4.4	332	36.1	33.8
2005	212	35	408	22.8	44.9
2006	295	39.2	489	19.9	46.5
2007	373	26.8	537	10.0	40.0
2008	466	24.7	648	20.5	25.0
2009	456	-2.1	588	-9.3	25.3
2010	697	52.7	693	18.0	20.2
2011	880	26.3	754	8.7	29.8
% Average growth last ten years	16.0		14.7		

Source: ABHIPEC (2011b, 9 p.)



Table 1.57

Personal care industry: growth and country shares

Personal Care	US\$ million 2010	US\$ million 2011	Growth %	Participation %
World	387,727.1	425,866.5	9.8	
USA	60,744.0	63,086.4	3.9	14.8
Japan	43,381.7	47,267.7	9.0	11.1
Brasil	36,186.9	43,028.5	18.9	10.1
China	36,186.9	43,028.5	18.9	10.1
Germany	23,879.4	27,704.3	16.0	6.5
France	17,730.3	19,419.9	9.5	4.6
United Kingdom	16,079.1	17,019.8	7.6	4.1
Russia	12,373	14,187.0	14.7	4.0
Italy	12,158.1	12,964.7	6.6	3.3
Spain	11,007.4	11,007.4	5.1	2.6
Top 10	272,980.4	272,980.4	9.8	64.1

Source: ABHIPEC (2011b, 9 p.)

With the continued growth of the sector, there will be a continuing investment in the qualitative development of products to meet the demands of a consumer increasingly avid for quality and increasingly more complete product lines focused on the specific needs of users. The development of the category is marked by the broadening of the range of products available in the market, especially the items listed on Chart 1.6.

The sunscreen segment was the fastest growing in recent years in Brazil, thanks to better consumer understanding with regard to skin protection. This observed change in behavior of the population in recent years has brought products to the market for diversified aspects of everyday life, as lip protector, for hands, face and neck. Another segmentation that has done well is related to the skin type (e.g.: for coloured, oily skin etc.).

The growing use of sunscreen by the male segment is also significant. For men, the main attribute is achieving the basic objective. For women, besides that objective, they look for hydration, spreadability,

soft scent, non-greasy formula. Before even worrying whether the product protects against UVA and UVB, they note the texture, fragrance and packaging, the most common being PP or PET bottles with flip tops plastic tubes (with lower share) and plastic bottles with sprays.

Brazil is now the second largest market for the consumption of fragrances. However, only around 6% of sales in the Brazilian market are imported perfumes, the remainder being national brands and, among them, the major players are: Natura, Avon and O Boticário. Women have increasingly used more than just a single perfume, usually around three to four different types. However, men are more likely to remain loyal to the same perfume for longer periods.

This segment is expected to increase packaging consumption, with average rates of 5.5% per year in value (US\$ millions), and 5.7% in volume (tonnes) between 2011 and 2015. Metal and plastic packaging should show the highest growth rates (Tables 1.58, 1.59 and 1.60).



Chart 1.6

Personal care: Products in evidence in the Brazilian market

Categories	Concepts	Characteristics
Soaps	'vegetable'	Very positive and sought after by consumers, already successfully incorporated in lines of soaps
	'antibacterial'	Accounts for 12% of soap sales, due to an increased awareness of the importance of hygienic habits among consumers
Hair	"specificity"	Specific products for textures (straight or curly), dye (red, discolored, dark, blond, etc.), chemical treatment (straightening, progressive straightening), frizzy (kinky, curly etc.), aged and lifeless, brittle and fragile
	"hygiene kits"	Commercialization of hair hygiene kits (shampoo and conditioner)
	"Treatments for men"	Anti-dandruff lines, hair loss control, softness, resistance etc
	"post shampoo"	Conditioners, styling cream, treatment cream, hair end repair, hydration, volume reduction, frizz aspect improvement etc
Skin	"Beyond hydration"	The great emphasis in this category is the presence of the sunscreen in every item, when it is possible
	Product innovation	The innovation in the development of creams and lotions led to the launching of products with increasing benefits such as: perfume, tenderness, skin hydration and performance (good spreadability on the skin)
	Body creams/lotions	Category composed of items such as: body exfoliating cream, massage cream or oil, anti-cellulite, cream against stretch marks, firming lotions, creams for pregnancy, fat reducing cream
	Facial creams/lotions	Consisting of: moisturizing, anti-age, exfoliating, astringent, anti-acne, tonics, cleansing creams and lotions
	Tanning lotion and sunscreen	Includes: sunscreen, tanning lotion, facial sunscreen, labial sunscreen and self-tanner
Fragrances	Deodorants	Growth at 7.2% average in the last five years, with a marked progress of the aluminum aerosol sprays instead of bottle sprays, the principal offering in this category for many years, since it was cheaper than other packaging formats



Table 1.58

Historical trends and projections for packaging consumption for personal care: Value

Material	US\$ Million 2007	US\$ Million 2011	Average growth 2007-2011	US\$ Million 2015*	Average growth 2011-2015*
Plastics	453.1	629.4	8.6%	822.1	6.9%
Flexibles	350.5	400.9	3.4%	475.5	4.4%
Paper and board	213.8	372.7	14.9%	450.9	4.9%
Metals	93.5	236.8	26.2%	290.3	5.2%
Glass	78.3	124.7	12.4%	151.1	4.9%
Corrugated board	42.1	82.4	18.3%	101.5	5.4%
TOTAL	1,231	1,847	10.7%	2,291	5.5%

*Estimated

Source: DATAMARK

Table 1.59

Historical trends and projections for packaging consumption for personal care:
Volume (units)

Material	Billion units 2007	Billion units 2011	Average growth 2007-2011	Billion units 2015*	Average growth 2011-2015*
Plastics	11.2	13.5	4.8%	17.1	6.1%
Corrugated board	0.6	0.9	8.1%	1.1	5.5%
Glass	0.7	1.0	8.0%	1.2	5.2%
Paper and board	5.2	5.6	1.9%	6.5	3.6%
Flexibles	10.2	11.7	3.4%	14.2	5.0%
Metals	0.5	0.9	14.4%	1.2	6.9%
TOTAL	28.6	33.6	4.2%	41.4	5.3%

*Estimated

Source: DATAMARK

Table 1.59

Historical trends and projections for packaging consumption for personal care:
Volume (tonnes)

Material	Thousand tonnes 2007	Thousand tonnes 2011	Average growth 2007-2011	Thousand tonnes 2015*	Average growth 2011-2015*
Plastics	120.7	141.4	4.0%	186.1	7.1%
Corrugated board	53.5	126.7	24.0%	155.6	5.3%
Glass	44.7	57.0	6.3%	69.2	4.9%
Paper and board	41.9	46.2	2.5%	53.9	3.9%
Flexibles	21.8	23.8	2.3%	28.1	4.3%
Metals	14.2	26.3	16.6%	33.6	6.3%
TOTAL	296.8	421.4	9.2%	526.5	5.7%

*Estimated

Source: DATAMARK



End user Industry: cleaning products

The cleaning products industry closed 2011 with a turnover of R\$ 14.4 billion, an increase of 7% in relation to the R\$ 13.5 billion recorded in the previous year. The growth was driven by the class C, with an increase of 13.6% in the consumption of cleaning products. In the higher income groups there was a 2.5% drop, because, in a time of inflation, consumers from Classes A and B opt for cheaper brands, because, in general, they do not use the products, rather their servants. In contrast, the new middle class is reluctant to give up new benefits, such as convenience. Between 2008 and 2011, the products with the highest growth rates were liquid soap (35.5%), air fresheners (24.4%), cleaning liquids (6.2%) and bleach (5.6 %)

(ASSOCIAÇÃO BRASILEIRA DAS INDÚSTRIAS DE PRODUTOS DE LIMPEZA E AFINS, 2011). Table 1.61 shows the principal cleaning products in Brazil in terms of sales, for the period 2008-2011.

It is estimated that 95% of the market for cleaning products consists of micro, small and medium enterprises, and the informal market has a significant share. The battle against informality, usually products made to inferior technical standards, which encourages tax avoidance, remains one of the key issues in a sector that is looking for sustainable growth. The formal sector is viewed favorably by the packaging industry, since this trend involves increasingly the consumption of more sophisticated and better quality packaging.

Table 1.61
Cleaning products industry: major products by sales (2008-2011)

Major products by sales (R\$ billion)					
	2008	2009	2010	2011	Average growth (2008-2011)
Powder detergents	3,646	4,097	4,191	4,009	2.4%
Fabric softeners	1,637	1,828	1,919	1,800	2.4%
Air purifiers	693	883	1,472	1,661	24.4%
Scouring powder	1,409	1,331	1,333	1,196	-4.0%
Cleaning liquids	927	1,119	1,144	1,180	6.2%
Bleach	893	1,070	1,160	1,110	5.6%
Disinfectants	809	871	907	851	1.3%
Bar soap	1,122	1,235	1,029	848	-6.8%
Liquid soap	122	139	284	411	35.5%

Source: DATAMARK



Aware of the consumers concern about the environment and the influence of this has on purchasing decisions, manufacturers of cleaning products are offering their products in recyclable packaging, refills and concentrated formulations in smaller sizes. The strength of the appeal of cleaning products with lower environmental impact has led many companies to launch complete lines of environmentally friendly products, as, for example, the Bombril Ecobril line. This includes multipurpose refills, where consumers can acquire a 100 ml concentrated sachet and prepare the product at home by placing the sachet contents in the original bottle and filling with water. This trend also has repercussions in the packaging industry, which now increasingly offers smaller size packs and flexible packs not normally used in cleaning products market.

The year 2011 was marked by an increase in the competitiveness of the sector with national companies, such as Química Amparo and Flora strengthening their portfolios with brands like Assolan (R\$ 110 million) and Assim (R\$ 140 million), respectively. In addition, major international players, such as Unilever, P&G, SC Johnson

and Reckitt, amongst others, are also increasing their presence in Brazil as a way of mitigating the effects of stagnation in American and European markets.

The sector's growth has also been driven by the institutional cleaning market. Companies specialized in providing professional cleaning to individuals, corporate clients, condominiums and others are betting on the expansion of the domestic market, which has great potential. The scenario of higher labour costs indicates that demand for outsourcing will tend to increase, as this is an effective way for individuals and businesses to reduce cleaning costs.

This segment is expected to increase packaging consumption, with rates averaging 3.0% per year in value (US\$ million), and 3.1% in volume (tonnes), between 2011 and 2015. Flexible packaging should show the highest growth rates (Tables 1.62, 1.63 and 1.64).

ASSOCIAÇÃO BRASILEIRA DA INDÚSTRIA DE HIGIENE PESSOAL, PERFUMARIA E COSMÉTICOS. Caderno de tendências.

Table 1.62

Historical trends and projections for packaging consumption for cleaning products: Value

Material	US\$ Million 2007	US\$ Million 2011	Average growth 2007-2011	US\$ Million 2015*	Average growth 2011-2015*
Corrugated board	478	456	-1.2%	517	3.2%
Plastics	733	944	6.5%	1,053	2.8%
Flexibles	147	90	-11.5%	105	4.0%
Paper and board	124	179	9.7%	207	3.7%
TOTAL	1,481	1,670	3.0%	1,882	3.0%

*Estimated

Source: DATAMARK



Table 1.63

Historical trends and projections for packaging consumption for cleaning products: Volume (units)

Material	Billion units 2007	Billion units 2011	Average growth 2007-2011	Billion units 2015*	Average growth 2011-2015*
Corrugated board	0.9	0.8	-2.3%	0.9	3.6%
Plastics	15.5	17.1	2.6%	18.9	2.5%
Paper and board	8.7	8.2	-1.3%	7.9	-0.9%
Flexibles	4.2	4.6	2.3%	5.2	3.2%
TOTAL	29.2	30.7	0.3%	33.0	2.1%

*Estimated

Source: DATAMARK

Table 1.64

Historical trends and projections for packaging consumption for cleaning products: Volume (tonnes)

Material	Thousand tonnes 2007	Thousand tonnes 2011	Average growth 2007-2011	Thousand tonnes 2015*	Average growth 2011-2015*
Corrugated board	377.5	350.3	-1.9%	396.9	3.2%
Plastics	192.9	211.1	2.3%	235.8	2.8%
Paper and board	85.5	97.1	3.2%	112.2	3.7%
Flexibles	8.7	9.9	3.1%	11.5	4.0%
TOTAL	664.6	668.4	1.7%	756.4	3.1%

*Estimated

Source: DATAMARK



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Chapter 2

FACTORS THAT INFLUENCE THE CONSUMER GOODS MARKET

Consumer goods market trends are shaped by the continuing influence of demographic, economic, political and sociocultural factors, among others, that drive changes in the profile and behavior of the consumer. Thus, the study and analysis of these trends are important in order to identify opportunities for innovation in products, processes and packages.

The configuration of factors that influence the consumer market, commonly known as drivers, is quite complex because it involves a large network of interdependent variables.

This paper examines some of these factors, which are identified as its potential impact on the consumer packaged goods market (Frame 2.1).

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REGO, R. A.; MADI, L. F. C. Factors that influence the consumer goods market. In: BRASIL pack trends 2020. Campinas: ITAL, 2012. ch. 2, p. 41-65.



Frame 2.1

Influence factors analyzed on the consumer packaged goods market

Areas	Influence factors	Examples of impacts in the consumer goods sector
POPULATION	Growth rates Changes in the age structure Demographic bonus Changes in the structure Familiar Urbanization	Changes in the consumption profile of the population Growth of the Silver ¹ segment Infant population decrease Purchasing products in portions and minor amounts Growing demand for convenience
ECONOMY AND POLITICS	Brazilian economy growth Economic development policies Social inclusion policies	Increased demand for consumer goods Pressures on natural resources Pressures for sustainable production and consumption
INCOME AND CONSUMPTION	Growth of the luxury market Social advancement and consolidation of the new middle class Segment BOP potential ²	Growth in demand for higher aggregate value products Changes in the composition of the consumption basket Demand for products with value offers
EDUCATION AND CULTURE	Educational level LOHAS ³ consumer growth E-consumers growth Changes in behavior of new generations	Increase in the level of consumer exigency Valorization of health and well-being Valorization of practicality and simplicity Changes in the supply chain Growth of e-commerce Valorization of social responsibility Valorization of ethics Valorization of interactivity
ENVIRONMENT ⁴	Guidelines and international agreements Climate changes Legislation about solid waste	Inclusion of environmental policies Searching for more efficient production processes Assignment of responsibilities to the various “actors”

¹ Name of senior consumer segment, composed of people over 60 years.

² Name of the consumer segment at the base of the socioeconomic pyramid (Bottom of the Pyramid).

³ Abbreviation for Lifestyles of Health and Sustainability.

⁴ The influencing factors related to the environment are analyzed in Chapter 7.



2.1 POPULATION

The evolution of demographic variables indicates that the next decades will be marked by a developing market, with many changes in consumption habits derived from the aging of the Brazilian population, the occurrence of a demographic bonus, changes in family structure and population concentration in large urban centers.

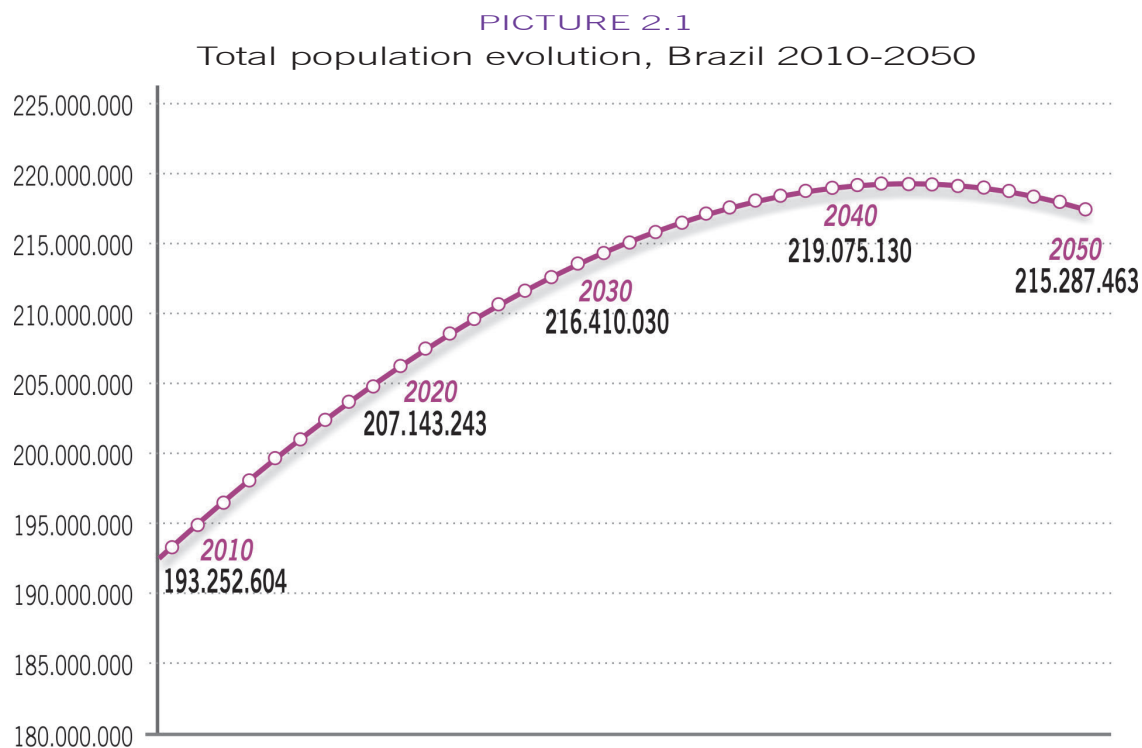
Rate of population growth

According to data of the Projeção da população do Brasil por sexo e idade (Projection of Brazil's population by age and sex) document, 1980-2050 (IBGE, 2008), the Brazilian population should show growth until 2039 and, from 2040, it will begin a downward trend (Picture 2.1). Additional 13,890,639 people is estimated between 2010 and 2020, 9,266,787 between 2020 and 2030, 2,665,100 between 2030 and 2040, and a reduction of 3,787,667 people between 2040 and 2050.

Changes in the age structure

Designed from the trends in birth and mortality rates, population growth (IBGE, 2008) will lead to changes in the age structure (Table 2.1) which should influence the profile of the consumer goods market in the next decades.

In relation to the children and youth population, from 0 to 14 years, we expect a decrease of 15.9% from 2010 to 2020, and this trend should accentuate even more until 2050. The markets of certain products designed for children, such as pharmaceuticals and food, will have to adjust to this movement. The same tends to happen with young people aged 15 to 24 years, but only after 2030.



Source: IBGE, 2008



Table 2.1
Projections of Brazilian population growth

Population	2010	2020	2030	2040
Total	193.252.604	207.143.243	216.410.030	215.287.463
Growth rate		7,2%	12,0%	11,4%
0 to 14 years old	49.439.452	41.571.334	36.761.006	28.306.952
Growth rate		-15,9%	-25,6%	-42,7%
15 to 24 years old	33.644.014	33.856.048	28.713.078	22.507.190
Growth rate		0,6%	-14,7%	-33,1%
15 to 64 years old	130.619.449	146.447.173	150.795.092	138.081.864
Growth rate		12,1%	15,4%	5,7%
65 years old or above	13.193.703	19.124.736	28.853.932	48.898.647
Growth rate		45,0%	118,7%	270,6%
70 years old or above	8.612.707	12.220.408	18.679.185	34.328.890
Growth rate		41,9%	116,9%	298,6%
75 years old or above	5.026.875	7.309.457	11.064.331	22.659.940
Growth rate		45,4%	120,1%	350,8%
80 years old or above	2.653.060	4.005.531	5.912.229	13.748.708
Growth rate		51,0%	122,8%	418,2%

Source: IBGE, 2008)

On the other hand, the Brazilian economy will suffer a strong influence of the growth of the population aged over 55 years, and especially with the increase in the number of elderly people in long term. For example, the population over 75 years, which is expected to grow 45.4% between 2010 and 2020, will increase more than four times by 2050.

The aging factor has been the subject of several studies, because it is manifested in several countries. The aging factor brings challenges in the areas of public health and social security, among others. On the other hand, it has created opportunities for, once the productive sector is emerging as a market for seniors with higher purchasing power, with very particular preferences. For example, a Canadian study (OLIVEIRA, 2003) identified needs to suit food products in front of an aging population: smaller portions, reducing the weight of packages, packages easy to open and manipulate, with labels showing clear indications on ingredients and consumption restrictions for this age group.

Demographic bonus

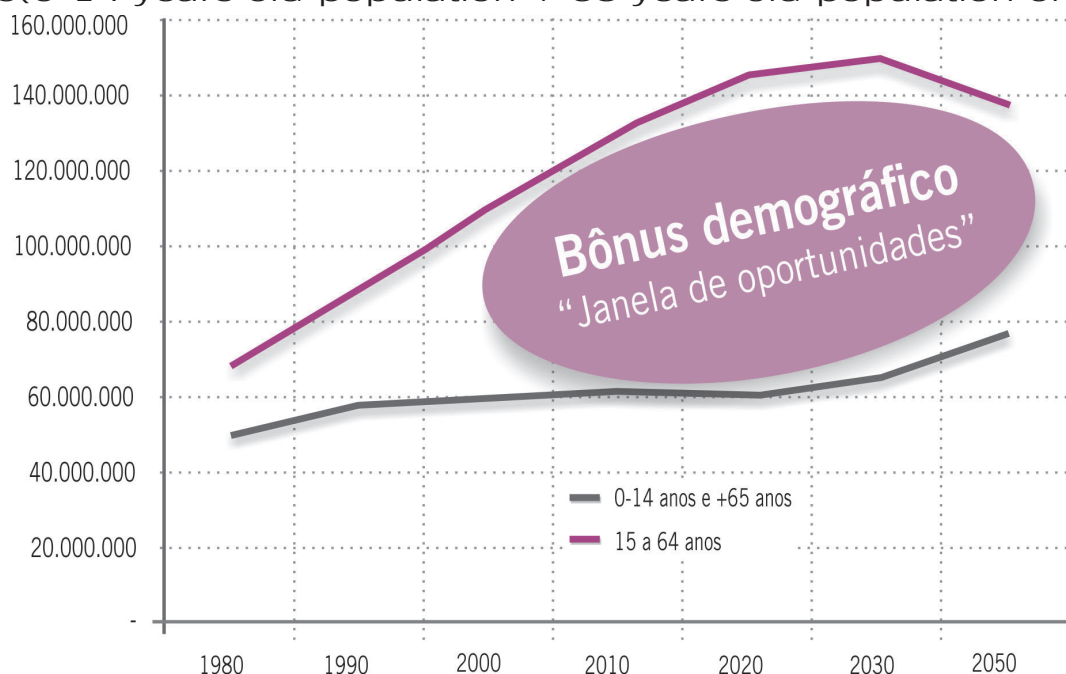
It is estimated that there will be a very favorable situation for the country, due to the growth of the track in which the economically active population is, which is expected to remain superior than the economically dependent group until 2025 (Picture 2.2). This condition, characterized as demographic bonus, is considered a window of opportunities for socioeconomical development. So, in the next two decades there will be a very favorable condition to increase the Brazilian families' consumption.

At the same time, the aging of the population will be a progressive increase in the dependency relationship between the elderly and the economically active population (Table 2.2), ranging from 10.10% (2010) to 35.41% in 2050 (IBGE, 2008).



PICTURE 2.2

Identification of demographic bonus: 15-64 years old population versus (0-14 years old population + 65 years old population or above)



Source: IBGE, 2008

TABLE 2.2

Evolution of dependency relationships of children and elderly of the economically active population: 1980-2050

	(A) 0 to 14 anos	(B) 15 to 64 anos	65 years old or above	Relation (A)/(B)	Relação (C)/(B)
1980	45.339.850	68.464.223	(A)/(B)	Relation	6,95%
1990	51.789.936	88.410.746	(C)/(D)	58,58%	7,23%
2000	51.002.937	110.951.338	9.325.607	45,97%	8,41%
2010	49.439.452	130.619.449	13.193.703	37,85%	10,10%
2020	41.571.334	146.447.173	19.124.736	28,39%	13,06%
2030	36.761.006	150.795.092	28.853.932	24,38%	19,13%
2050	28.306.952	138.081.864	48.898.647	20,50%	35,41%

Source: IBGE, 2008.



Changes in family structure

In Brazil (IBGE, s.d.), there is a trend of gradual change in the structure of families in a slightly more pronounced manner in the number of couples with children. In 17 years, the relative participation of this couples declined from 59.35% to 47.30%, approximately (Picture 2.3). Conversely, there was an increase in the number of couples without children (from 12.88% to 17.40%), of single person households (7.26% to 11.50%) and of women with no spouse and children (15.06% to 17.40%).

These changes in the profile of the Brazilian family affect the market for consumer goods, with the increase in the relative participation of non-traditional family structures. For example, the familiar category DINK (Dual Income No Kids), which could represent nearly 20% of households by 2020, usually is characterized by a strong propensity to seek satisfaction through the purchase of consumer goods. The growth of single person households tends to increase the demand for smaller portions and packaging of food and beverages, cleaning and hygiene products and cosmetics, among others.

Urbanization

Since 1980, Brazil has a predominantly urban population and there is a progressive increase decade after decade. In 2010, over 160 million people now live in cities, above 84% of the total population (POPULAÇÃO., 2012). This population is accustomed to the peculiar consumer goods market of the cities, characterized by the need for greater convenience. Still, some aspects deserve mention, such as regional differences, the distribution of people by municipality and the formation of metropolitan areas and megacities.

Regionally, the data from the last demographic census (IBGE, 2010) indicate that the South (84.93%) and Midwest (88.82%) are positioned close to the national average. However, there is a higher concentration in the Southeast Region (92.92%) and relatively smaller urban populations in the North (73.51%) and Northeast (73.13%).

Regarding the distribution of the population it is found that 45.19% of the cities have less than 10,000 inhabitants, comprising only 4.73% of the total urban population (7.6 million inhabitants). In these municipalities, over 40% of people live in rural areas. Moreover, half of the urban population (51.45%, 82.7 million) are concentrated in just 2.39% of the cities that have more than 100 thousand inhabitants, of which over 90% live in urban areas (IBGE, 2010).

Another aspect concerns to the large urban agglomerations. According to the CENSO (IBGE, 2010), Brazil has 36 metropolitan regions and 3 development integrated regions (Table 2.3). The Southeast concentrates almost half of the urban population in these regions, including the three most populous cities in Brazil: São Paulo, Rio de Janeiro and Belo Horizonte. It can be observed that there are differences between the various regions, considering the percentage of people living in urban areas, ranging from 53.17% to 99.37%. Therefore, the less saturated regions still have the capacity to absorb residents from rural areas, or new consumers who tend to incorporate the consumption habits of urban life.

Such differences suggest that the evolution of consumer habits in the next decades will occur with different dynamics depending on the region, something that should be considered in the analysis of the trends identified on this study.



TABLE 2.3

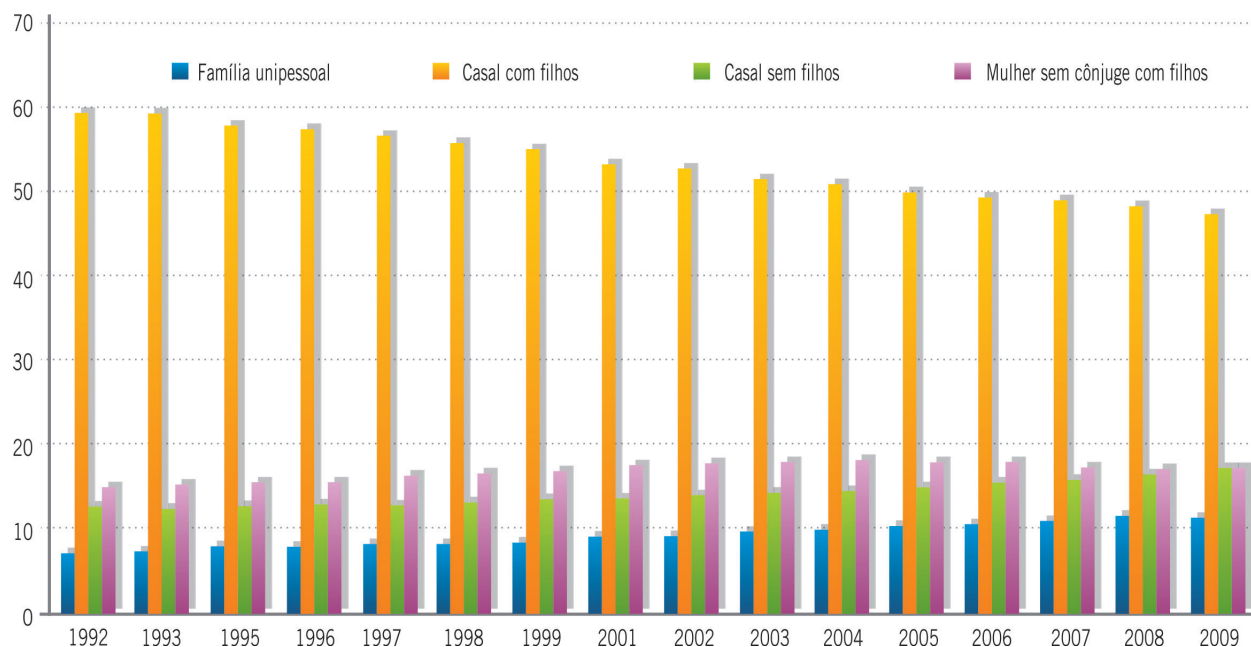
Resident population in metropolitan regions and development integrated regions in urbanized areas

Regions	Population		
	Total	Urbanized areas	% of urban population
TOTAL	89.420.179	83.580.248	93,47%
SOUTHEAST	43.698.658	42.445.109	97,13%
São Paulo - SP	19.683.975	19.091.568	96,99%
Rio de Janeiro - RJ	11.835.708	11.752.169	99,29%
Belo Horizonte - MG	5.414.701	5.115.006	94,47%
Campinas - SP	2.797.137	2.656.549	94,97%
Grande Vitória - ES	1.687.704	1.636.326	96,96%
Baixada Santista - SP	1.664.136	1.653.640	99,37%
Vale do Aço - MG	615.297	539.851	87,74%
SOUTH	13.500.179	11.853.617	87,80%
Porto Alegre - RS	3.958.985	3.740.684	94,49%
Curitiba - PR	3.174.201	2.794.629	88,04%
Norte/Nordeste Catarinense - SC	1.094.412	784.817	71,71%
Florianópolis - SC	1.012.233	912.173	90,11%
Londrina - PR	764.348	721.246	94,36%
Vale do Itajaí - SC	689.731	589.056	85,40%
Maringá - PR	612.545	585.229	95,54%
Carbonífera - SC	550.206	391.984	71,24%
Foz do Rio Itajaí - SC	532.771	471.054	88,42%
Chapecó - SC	403.494	304.000	75,34%
Tubarão - SC	356.721	267.904	75,10%
Lages - SC	350.532	290.841	82,97%
MIDWEST	6.724.635	6.362.340	94,61%
RIDE Distrito Federal e Entorno	3.717.728	3.454.711	92,93%
Goiânia - GO	2.173.141	2.115.090	97,33%
Vale do Rio Cuiabá - MT	833.766	792.539	95,06%
NORTHEAST	20.789.036	18.452.218	88,76%
Recife - PE	3.690.547	3.559.616	96,45%
Fortaleza - CE	3.615.767	3.383.886	93,59%
Salvador - BA	3.573.973	3.436.366	96,15%
Natal - RN	1.351.004	1.192.202	88,25%
Grande São Luís - MA	1.331.181	995.563	74,79%
João Pessoa - PB	1.198.576	1.112.653	92,83%
Maceió - AL	1.156.364	1.117.978	96,68%
RIDE Grande Teresina	1.150.959	1.001.275	86,99%
Aracaju - SE	835.816	615.918	73,69%
Campina Grande - PB	687.039	513.539	74,75%
RIDE Petrolina/Juazeiro	686.410	478.315	69,68%
Agreste - AL	601.049	319.566	53,17%
Cariri - CE	564.478	436.326	77,30%
Sudoeste Maranhense - MA	345.873	289.015	83,56%
NORTH	4.707.671	4.466.964	94,89%
Manaus - AM	2.106.322	1.972.885	93,66%
Belém - PA	2.101.883	2.018.429	96,03%
Macapá - AP	499.466	475.650	95,23%

Source: IBGE, 2010



PICTURE 2.3
Family structure in Brazil



Source: IBGE, s.d.

2.2 ECONOMY AND POLITICS

Brazilian economy growth

On the global crisis scenario that began in 2008, the projected economic indicators require frequent revisions. Even so, some studies in this direction indicate situations reasonably favorable to the Brazilian economy growth. For example, the OECD Economic Outlook study (2012) estimates growth rates for GDP for the periods 2012-2017, 2018-2030 and 2031-2050, shown in Table 2.4. It is expected that Brazil reach a growth rate above all developed countries that comprise the G7, slightly above to the world average, but lower than other emerging countries, such as China, India, Indonesia, and also Turkey (in the first two considered periods).

According to the survey conducted by PriceWaterhouseCoopers (HAWKSWORTH, 2006), Brazil will take a prominent position in the world economy in 2050. This study indicates Brazil positioned between the four largest economies, surpassing Germany and Japan, considering estimates for GDP growth in terms of purchasing power parity. It should be noted that in absolute terms, each of the top three must have a size of four (U.S. and India) to almost five (China) times that of the Brazilian economy. In terms of GDP per capita designed to Brazil in 2050, despite representing an increase of US\$ 8,311 in 2005 to US \$ 34,448 in 2050, it will remain below the G7 countries and also in relation to several emerging countries, like China Russia, Mexico and Turkey.



TABLE 2.4
Potential GDP growth

Countries	GDP growth rate (%)		
	2012-2017	2018-2030	2031-2050
World	3,4	3,3	2,4
China	8,9	5,5	2,8
Índia	7,2	6,5	4,5
Rússia	3,6	2,7	0,9
Indonésia	5,9	5,1	3,7
México	3,2	3,5	3,0
Turquia	5,2	4,1	2,3
Brasil	4,4	3,9	2,5
Estados Unidos	2,1	2,4	2,1
Japão	0,9	1,3	1,3
Alemanha	1,6	1,1	1,0
Reino Unido	1,5	2,1	2,2
França	1,8	2,1	1,4
Itália	0,6	1,6	1,6
Canadá	2,1	2,1	2,3

Source: OECD Economic Outlook, 2012

Although the rhythm of growth of the Brazilian economy depends on overcoming factors, such as inflationary pressures and infrastructure deficiencies, the expectations are optimistic for the next decade. According to a study from McKinsey & Company (HIROSE et al., 2012), the development will promote

a strong expansion of the consumer goods market (Frame 2.2) in the 2010-2020 period, according to the projected growth in sales of various products categories (HIROSE et al. 2012). This growth should be higher in the North and Northeast, in the inner cities and in the cities located in the metropolitan areas.

Frame 2.2
Projected growth for consumer goods

Approximated projected growth (2010-2020)	Exemplos de produtos
Between 2,5 and 3 times	Juices, air fresheners, alcoholic beverages, sunscreens, products for pets (Pet), skin products, beers etc.
Between 2 and 2,5 times	Ready meals, bottled water, fragrances, frozen and refrigerated foods, bath products, carbonated beverages, baby food, coffee, pasta products, sweets and confectionery, cleaning products etc.
Between 1,5 and 2 times	Canned foods, snacks, wine, dehydrated foods, milk, ice cream, teas, cosmetics, oils and fats, deodorant, condiments and sauces, bakery products and confectionery etc.

Fonte: McKinsey & Company (HIROSE et al., 2012)



Economic development policies

According to the Ministry of Planning (federal government), Brazil adopts a “model of economic and social development that combines economic growth with income distribution and provides poverty alleviation and the inclusion of millions of Brazilians in the formal work” (MINISTÉRIO DO PLANEJAMENTO, 2012).

The More Brazil Plan (PPA, 2012) is a multiannual policy for the 2012-2015 period and sets the vision for the future construction of a country with a sustainable development model, based on the pursuit of “social equality with quality education, knowledge production, technological innovation and environmental sustainability”. Among the values to be respected, this plan highlights Social Justice, Sustainability, Cultural Diversity and National Identity.

Aiming to accelerate the pace of economic development and increase competitiveness of the productive sectors, we highlight here the Growth Acceleration Program (PAC2) and Greater Brazil Plan.

The PAC2 is based on an ambitious set of measures to encourage investment, including “Encouraging Credit and Financing, Improvement of Investment Environment, Discharge and Tax Administration, Long-Term Fiscal Measures and Fiscal Consistency” (MINISTÉRIO DO PLANEJAMENTO, 2012).

Another program, the Greater Brazil Plan, is the current industrial policy that aims at the sustainable development and the competitiveness increase in various sectors, including agribusiness, personal hygiene, perfumery and cosmetics, chemical industry and health complex. This Plan defines as priorities the creation and strengthening of “critical skills of the national economy”, the “productive and technological densification of value chains” increase, the expansion of “domestic and foreign markets of Brazilian companies”, and the guarantee of a “socially inclusive growth and environmentally sustainable “(PLANO..., 2012, p. 38). Table 2.5 presents the strategic objectives of the Greater Brazil Plan.

Social inclusion policies

Besides the economic development plans, specific plans for the social inclusion of vulnerable populations have been implemented, which are highlighted here the Brazil without Misery and the Live without Limit.

The Brazil without Misery plan seeks to ensure favorable conditions for the social inclusion of poor people in the country, with impact programs such as Bolsa Família, which promotes the transfer of income (Income Guarantee) for more than 13 million households. Another program aims to include poor people in the productive sector, through actions of professional qualification, solidarity economy and entrepreneurship, among others. Table 2.6 presents data on the number of people served (until 06/29/2012) in some of these actions.

The National Plan for Disabled People’s Rights (Live without Limit) comprises 15 ministries programs, with a budget of more than R\$ 7 million. The goal is the “equalization of opportunities so the disability will not be used as a source of impediment to the realization of dreams, desires, projects, valuing and encouraging the leadership and choices of Brazilians with and without impairments”.

Considering the social dimension of sustainability, inclusion of people with special needs is an issue that should be gaining more space in Brazilian society. More than a change of values, the existing huge amount of disabled people should exercise strong pressure for environments and products more inclusive.

To illustrate the scale of the problem, according to the 2010I BGE Census, the population with visual impairments is over 35 million people, while the motor deficiency is seen in more than 13 million Brazilians (Table 2.7). These are data that demonstrate the need for solutions to enable the reading of information on labeling, transport, handling and disposal of packaging, in short, to make them more inclusive.

Progressively, the convergence of development policies and social inclusion will strengthen the purchasing power and improve the quality of life of Brazilian families in the next decades, sustaining a favorable scenario for the consumer goods market.



TABLE 2.5
Greater Brazil Plan - Priorities, Objectives and Targets (2011-2014)

Strategic Objectives	Base-Position (2010)	Targets
To increase fixed investment in % of GDP	18,4%	22,4%
To increase corporate spending on R&D in% of GDP	0,59%	0,90%
To increase HR qualification: % of industry workers with at least high school	53,7%	65%
To increase national value-added: increase Industrial Transformation Value/GrossValue of Production (ITV/GVP)	44,3%	45,3%
To increase % of knowledge intensive industry: industry ITV of high and medium-high technology/total ITV of innovative industry	30,1%	31,5%
Strengthen MSMEs: increase in 50% the number of innovative MSMEs	37,1 mil	58,0 mil
To produce in a cleaner way: reducing energy consumption per unit of industrial GDP (energy consumption in tonne of oil equivalent - toe per unit of industrial GDP)	150,7 toe/ R\$ million	137,0 toe/ R\$ million*
To diversify Brazilian exports, widening the country's participation in international trade	1,36%	1,6%
To increase national participation in technology markets, goods and services for energy: increase Industrial Transformation Value/Gross Production Value (ITV / GPV) sectors linked to energy	64,0%	66,0%
To increase access to goods and services for quality of life: increase the number of urban households with access to broadband (PNBL)	13,8 million	40 millions of households **

* Estimate at 2010 prices

**PNBL target

Source: Plano Brasil Maior (Greater Brazil Plan), 2012



TABLE 2.6
Brazil without Misery Plan – People assisted

Actions	People assisted until 06/29/2012
Bolsa Família Program - PBF – families assisted	13.462.659
Bolsa Família Program - PBF – Families expansion	463.099
Bolsa Família Program - PBF – Pregnant Variable Benefit - BVG	141.405
Bolsa Família Program - PBF – Nursing Mother Variable Benefit - BVN	147.854
Bolsa Família Program - PBF – Benefit to Overcome Extreme Poverty in Early Childhood - BSP	1.975.011
Professional qualification – Pronatec – Jobs offered	256.069
Professional qualification – Pronatec – Total subscriptions	123.060
Bolsa Verde – families assisted	20.920
ATER e Sementes – families assisted	128.920
Fomento – families assisted	7.483
Schools Majority Bolsa Família in Mais Educação Program	17.572
Unidades Básicas de Saúde (Basic Health Units) - UBS	2.077

Source: Plano Brasil sem Miséria (Brazil without Misery Plan), 2012

TABLE 2.7
Brazilian people with visual and motor impairments

Age range	Visual impairment			
	Is unable in any way	Great difficulty	Some difficulty	Total People
Total	506.377	6.056.533	29.211.482	35.774.392
0 to 14 years old	66.400	297.603	2.080.352	2.444.355
15 to 64 years old	301.961	3.976.160	22.037.125	26.315.246
65 years old or above	138.016	1.782.770	5.094.005	7.014.791
Age range	Motor impairment			
	Is unable in any way	Great difficulty	Some difficulty	Total People
Total	734.421	3.698.929	8.832.249	13.265.599
0 to 14 years old	117.935	85.091	250.387	453.413
15 to 64 years old	298.765	1.851.569	5.266.174	7.416.508
65 years old or above	317.720	1.762.269	3.315.688	5.395.677

Source: IBGE, Demographic Census 2010



2.3 INCOME AND CONSUMPTION

A study of the Social Studies Center at FGV (NERI, 2012) highlights the increase trend of the relative participation of Class C (Brazil Criteria) in Brazilian society, from 37.6% in 2003 to a projected 60.2% in 2014, the increase trend of classes A and B participation, although at a slower rhythm, and a great reduction trend in the participation of classes D and E, from 54.8% in 2003 to a projected 25.0% in 2014 (Picture 2.4).

The Brazilian consumer goods market should suffer continuing influence of changes in the relative participation of A, B, C, D and E social classes. These changes have given more evidence to three distinct segments, composed of people from the upper stratum of class A with a very high purchasing power (AAA

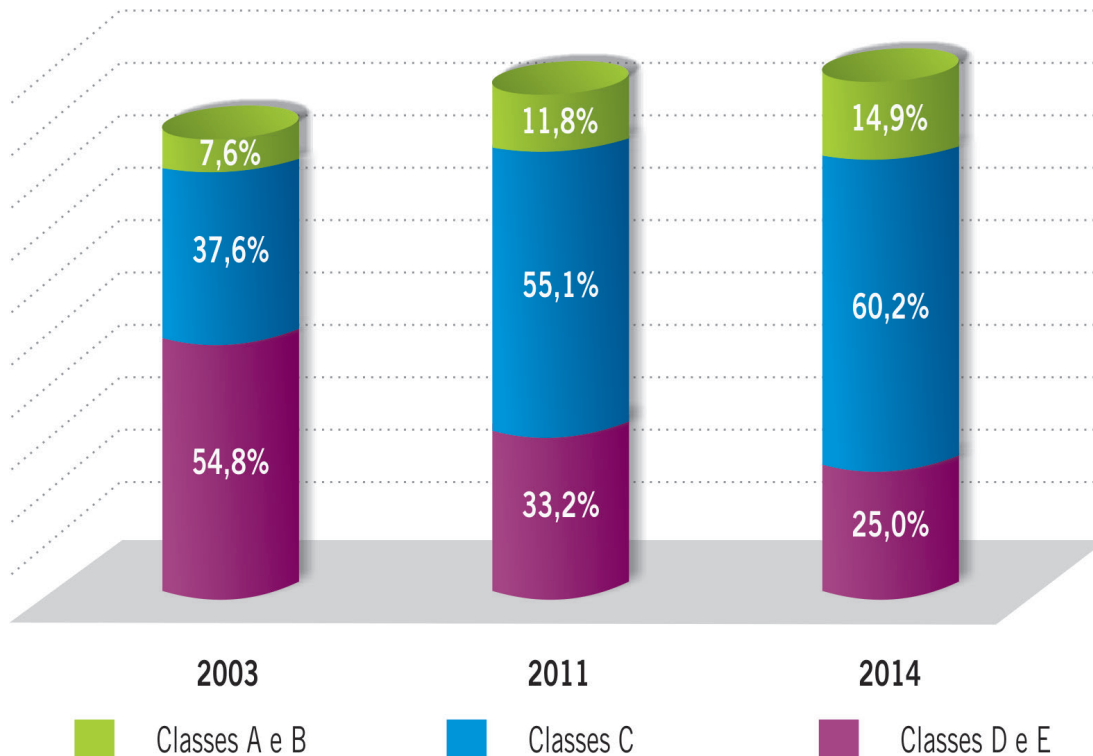
segment), of the new middle class expanded and with a transformed profile due to the incorporation of emerging consumers from classes D and E, and of the lower income strata of the population who are still wholly or partly outside of the consumer market.

Luxury Market Growth: Triple A segment

Researchers from IBRE/FGV (CONSIDERA; PESSOA, 2012), while acknowledging the advances in the distribution of wages, partly due to the improvement in the education level and the real increase in the minimum wage, consider that, “keeping in mind that the functional distribution of income is essential to personal income distribution, it can be said that Brazil will

PICTURE 2.4

Brazil, Social Classes Distribution, 2003, 2011 and 2014 (projection)



Source: Social Policies Center, CPS, FGV (NERI, 2012)



continue, for many years, showing high rates of personal income concentration, although decreasing”. Therefore, the Triple A segment should keep the more sophisticated consumer goods market warm, in which the aesthetics and design of packages perform strategic functions for adding value to prestige products.

A study of Bain & Company (D'ARPIZIO, 2011) estimated that the luxury market growth in Brazil was around 20% between 2009 and 2011. According to KPMG (RESURGENCE..., 2011), the Brazilian luxury market grew 22% in 2010, amounting to US\$ 7.6 billion. KPMG has estimated a growth of 15.2% per year between 2010 and 2025, reaching a value of US\$ 63.5 billion, which would represent 6% of the global luxury goods market. However, it should be noted that, in emerging markets like Brazil, luxury goods have distinct characteristics from those known in developed countries. For example, emerging consumers tend to seek social recognition and status symbols, characterized by values such as excess, extravagance and ostentation (D'ARPIZIO, 2011).

However, the major driver of growth in the industrial sector should come from two segments that maintain close ties: a New Middle Class and the people at the base of the Brazilian socioeconomic pyramid.

Social ascension and consolidation of the New Middle Class (Class C)

The Brazil Food Trends 2020 study (BRASIL..., 2010) showed that the participation of groups of individuals of the lower income, in the total income of the country, increased by 52.4% from 1996 to 2008, while the higher income stratum had reduced its relative participation from 47.5% to 43.2% during the same period. This small movement toward a more equitable society regarding income distribution gave a strong positive impact on the Brazilian economy. According to the Fecomercio-SP (2012, p. 6) study, “more than 12 million of families (nearly 40 million of people) climbed to income classes B and C between 2003 and 2009.”

According to a study of the Strategic Affairs Department, the federal government (BARROS;

DIECKMANN; MENDONÇA et al., 2011), the high income growth of the poorest population promoted a “reduction of inequality and a widening of the Brazilian middle class without precedent in history. “For the authors, the determinants of this movement were the social protection system, the more inclusive model of economic growth, the expansion of the access to credit, the actual increase in the minimum wage, the increase of productivity and the education level of the workforce, among other factors.

The New Middle Class has driven the consumer goods demand in Brazil and caused structural changes in the market, since these customers require products that meet their desire for greater sophistication of purchase, for an affordable price, according to their purchasing power, that, even having been enlarged, is still very low. This condition brings challenges for the consumer goods industries. For example, a work of PROFUTURO (WRIGHT; SILVA; SPERS, 2009) indicates some characteristics to be observed to attend this popular products market: affordability, simplicity, adequacy of benefits to popular profile, selective use of technology and suitability for sale in small retail stores, among others.

A research of Ipsos company (PESQUISA..., 2008) revealed the heterogeneity of the low-income consumers, classified into five groups, according to their affinity of consumption habits and motivations for buying: Spenders (15% of consumers), Cautious (44%), Indebted (8%), Austere (14%) and Les Miserables (19%). It was observed that three groups (Cautious, Austere and Les Miserables), which represent the vast majority (77%) of low-income consumers, do not value or attach little value to the status provided by the purchase of goods and services of prestigious brands, or do not have sufficient resources to allow that the pursuit of status serves as a major factor of motivation for the purchase. On the other hand, only 15% of these consumers (the group of Spenders) exhibit a behavior similar to consumers in classes A and B, by having higher income compared to the others. The Indebted group also demonstrates some propensity to consume goods and services of prestigious brands, but their debts inhibit their desire for consumption.



The Ipsos research shows that a very low percentage of the low-income consumers that has a microwave, with an average of 13% and maximum of 23% (group of Spenders), and also that less than half (42%) usually consume frozen food. Those are relevant data to the food packages segment. Another research of Boston Consulting Group (BARRETO; BOCHI; ABRAMOVICS, 2002) identified the products of the class C shopping list, subdividing them into “Essential Items”, “Abandoned if \$ is Short” and “Desirable Superfluous”. As an example, Frame 2.3 presents some of the items considered in the research.

As noted by the researchers, food products represent items that consumers try to preserve more. Among the factors influencing food purchases, the research highlights the price/sale (38%), the expiry date of the products (22%), flavor and aroma (13%) and brand recognition (13%). The toiletries form a group quite sensitive to the decrease in disposable income, and may

be greatly reduced on the shopping list. For this category the key influencers are price/sale (31%), smell (22%) and brand recognition (22%). Cleaning products for the home are the ones that provide personal satisfaction to the housewives of the class C. In this category, consumers are more influenced by price/sale (31%), smell (20%), brand recognition (16%) and yield (14%).

BOP segment potential

However, even with the rise of the low-income social strata, observed in recent years, Brazil still retains a large portion of the population out of the consumer market, while setting a strong social inequality and a huge potential for future growth. This contingent of the population is often identified as the segment BOP - Bottom of the Pyramid.

FRAME 2.3
Boston Consulting Group Research - Class C Shopping List

Categories	Essential Items	Abandoned if \$ is Short	Desirable Superfluous
Food	Rice, beans, pasta, meat, chicken, vegetables, coffee, milk carton, margarine, soybean oil, tomato paste, powdered drinks	Mineral water, beer, biscuit/cookie, milk cream, condensed milk, cold cuts, yogurt, mayonnaise	Beer, wine, sweets, desserts, cold cuts, packaged snacks, frozen, prepackaged, cake mix, fruit juice
Toiletries	Bleach, detergent, steel wool, toilet paper, washing powder and washing bar	Fabric softener, paper napkin, insecticide, glass cleaner, furniture polish	Grease for shoes, broom/squeegee
Home cleaning	Sanitary napkin, razor, toothpaste, deodorant, soap and shampoo	Conditioner, moisturizer, shaving cream, thin soap, dental floss	Toothbrush, dental floss

Fonte: Barreto; Bochi; Abramovics et al., 2002



According to the Boston Consulting Group study (AGUIAR; CUNHA; PIKMAN, 2008), two-thirds of Brazilian families are on the threshold of economic viability, eager to be part of the consumer society. This repressed demand exists also in other regions, such as Africa, China, India and Eastern Europe, representing a huge potential market, named “next billion” by the authors of the study. In recent years, this potential has become reality in Brazil, largely due to economic growth and policies of income distribution.

According to researchers at the Boston Consulting Group, the exploration of the consumption potential of people at the base of the socioeconomic pyramid may require a business model with specific characteristics regarding product design, distribution systems, communication programs, organizational structure and strategic alliances. For example, they cite the creation of smaller and less expensive packages as one of the best ways to make products more accessible to this segment of consumers (AGUIAR; CUNHA; PIKMAN, 2008).

The movement of large corporations towards the base of the pyramid markets can cause significant changes in the consumer goods sector and, consequently, in the packages sector. For example, Tetra Pak, aiming to explore the market potential at the base of the pyramid, established as a major challenge to provide “properly packaged products that they need, increasingly, at an affordable price”. In the words of Dennis Jönsson, president and CEO of the Tetra Pak Group:

“Our industry had traditionally been developing products from bottom to top, adding value along the way. We must now do the opposite to realize the potential of this market. Maybe we need to rely on a different approach in relation to the risk, to the investment and to the organization in different markets to meet the challenges of distribution and point of sale. We are convinced that innovation, partnership and commitment are the key to success in this market. We develop and sell products differently to increase the availability of good nutrition in developing countries. This is an opportunity that our industry cannot afford to lose. It is an opportunity to transform lives by making safe and healthy food available to a new generation of emerging consumers.”

In the next decades, the influence of the BOP segment may be very large, an optimistic scenario marked by the economic growth sustentation, continuity of income distribution policies and progressive increase in investment in education. These and other factors will determine the greater or lesser rise from the base of the Brazilian socioeconomic pyramid to the consumer goods market. Millions of new consumers will be incorporated into this market, expanding the New Middle Class, further leveraging the demand and changing the configuration of this market.



2.4 EDUCATION AND CULTURE

Educational Level

Data of Séries Estatísticas & Séries Históricas (Statistics Series & Historical Series) (IBGE, s.d.) indicate that the educational level of the population has shown improvements in recent years, with a growth of population with 11 or more years of study, as well as significant reduction in the percentage of uneducated people and people with less than 1 year of study (Picture 2.5).

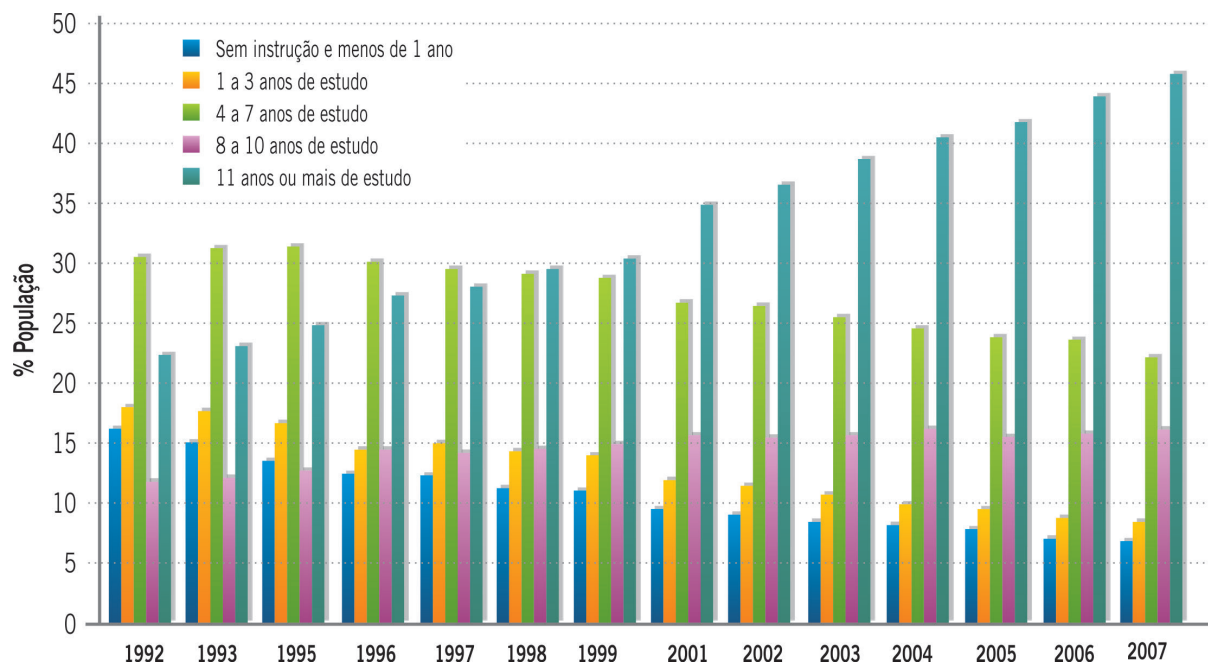
Since higher levels of education are associated to higher levels of family income, also tends to increase the ability of consumers to opt for greater variety of items within each category of consumer goods. Another effect that tends to occur is the increase on the level of demand on the quality standard of the products, derived from the increased availability of information and improvement of cultural level of consumers.

According to IBGE, the impact of higher education on family income may be proved by comparing the average monthly expenses according to different levels of education (years of schooling) and also based on differences in household expenses outlined in the indicator “existence or no existence of a person with complete or incomplete higher education in the family composition”.

Picture 2.6 shows that the average monthly expense of households with 11 or more years of study more than tripled compared to those with less than one year of study. Moreover, data from POF 2008/2009 indicate that “families who had no person with complete or incomplete higher education in its composition had a total average monthly income of R\$ 1,659.99; those with at least one person with complete or incomplete higher education R\$ 4,296.05, and families with more than one person, R\$ 8,117.27” (IBGE, 2010).

PICTURE 2.5

Population distribution by education level: 1992-2007

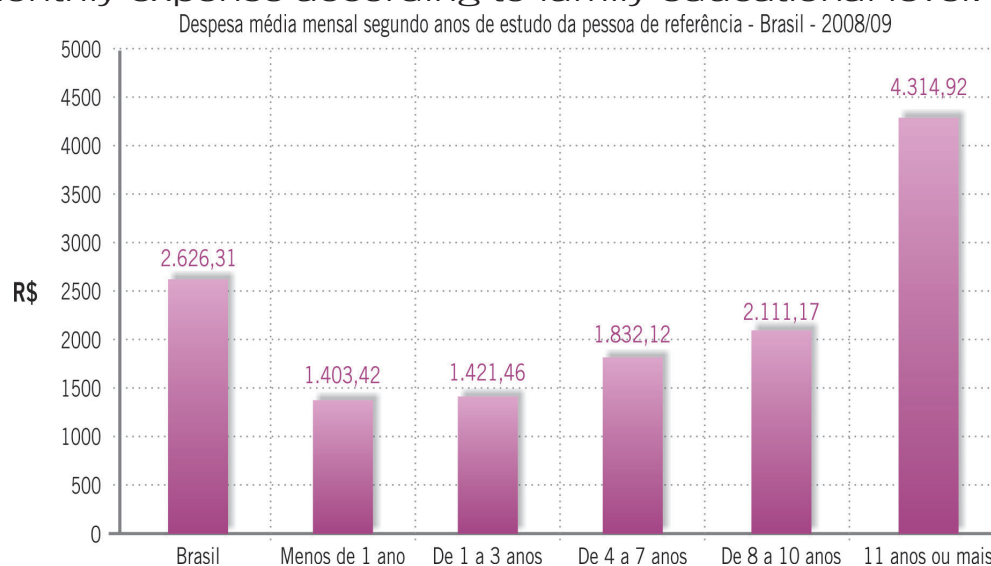


Source: IBGE, s.d.



PICTURE 2.6

Average monthly expense according to family educational level: 2008/2009



Source: IBGE, 2010

LOHAS consumers growth

The greater interest in health and well-being has led the growth of a specific segment of consumers, labeled as LOHAS (Lifestyles of Health & Sustainability), whose lifestyle requires products and services aligned with their values and worldview, configured from a greater access to education and information (GLOBAL..., 2008). The purchasing decisions of these people are strongly influenced by healthiness and sustainability criteria. These people seek a balance between a healthy lifestyle and responsible about the impact of individual consumption on the environment and community.

The LOHAS should not be confused with “green” consumers, which in general are more radical in relation to the effect of consumption on the environment. LOHAS profile includes features such as: modern, adept to new technologies, which requires transparency of companies and authenticity of their brands, they are skeptical in relation to propaganda, they exchange information with each other about consumer habits, they seek for solutions that offer high quality product with intrinsic other more

subjective attributes, such as social responsibility of the manufacturer (GLOBAL..., 2008).

Despite being found in developed countries like USA, France, Germany, UK, Australia and Japan, there is evidence, although not scientifically proven, that it is a worldwide phenomenon manifested also in China, India and Brazil. The value of this market in the U.S. was estimated at US\$ 209 billion in 2007, with the prospect of great growth in the future due to its high growth rate (GLOBAL..., 2008).

A study conducted by researchers from various areas outlined different scenarios for European society, considering awareness about the importance of healthy lifestyle. It is interesting to reflect about the possible impact of these scenarios on consumption, characterized by society intolerance to unhealthy products and habits, strong presence of government in promoting this lifestyle, including offering tax incentives (NUTRITION..., 2004). In the configuration of this scenario, in addition to influencer, this factor would become coercive force of food consumption habits and other products and services.



E-consumers growth

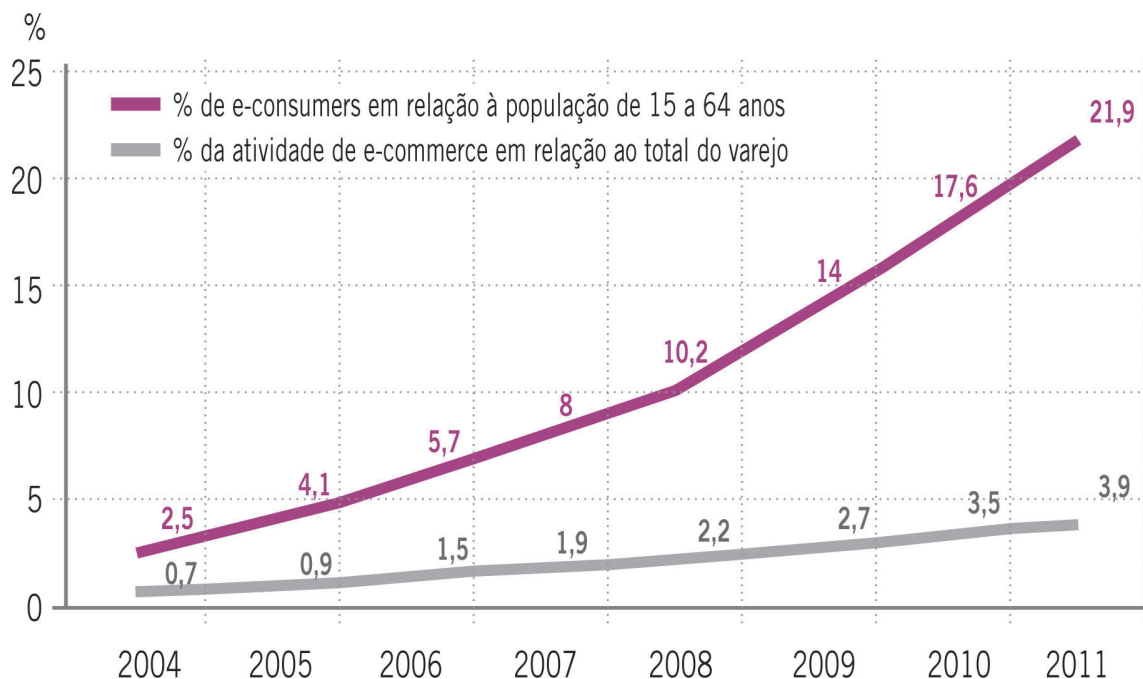
The ingress of the internet and social media in Brazil has occurred widely and rapidly in society, with impacts on the buying habits of the population. A research conducted by Capgemini company (DIGITAL... , 2012) shows that more than two thirds of consumers in developing markets, including Brazil, declare interest in seeking information about new products on social media and blogs. According to a study by McKinsey & Company, the Brazilian e-consumers have represented a growing part of the population from 15 to 64 years, growing from 2.5% in 2004 to 21.9% in 2011 (Picture 2.7).

The use of the internet for buying consumer goods affects the logistics system in the industry. Products that were transported by consumers come to

depend on a packaging system in transport vehicles for delivery, and may require new packing characteristics. The use of the internet and social networks to obtain information about products changes the traditional way of identification of goods, that used to be exclusively by the information contained in its labeling. A PWC study (CUSTOMERS..., 2011) considers that, in 2020, the global retail will provide a personalized service to consumers, with integration of interactive communication channels. It is estimated that retailers adopt more sophisticated communication tools and should adapt to changes that will occur in the supply chain. The growth of service delivery and the great diversity of items sold, among other things, will require from retailers a greater efficiency to offer greater convenience and variety for consumers.

PICTURE 2.7

Growth of e-commerce activity and of the number of e-consumers in Brazil



Source: Chanes; Hoefel; Martins, 2012



Changes in new generations' behavior

According to a study performed by the Grail Research company (CONSUMERS..., 2011), “each generation is characterized by different experiences that shape their perspectives and behavior”. From this premise, the behavior of different generations has been studied in relation to the impacts on the consumer market, commonly by classifying these generations into categories, such as “Boomers,” Generations X, Y, Z, Alpha etc. This approach indicates characteristics that may lose or gain importance in the population consumption profile over time and, for this reason, a brief reflection on their potential influences on the Brazilian consumer market is held. However, it is important to note some of the limitations of this type of analysis.

Firstly, there is the problem of generalization of categories between countries, since the relevant historical facts to force any change in consumption behavior of a generation relative to each other differ from country to country. The ratings assigned to successive generations of consumers have emerged from researches in countries such as the United States, with demographic profiles and specific market structures, in other words, with a complex set of variables able to shape certain purchase and consumption profiles. Thus, it is necessary to be careful on the use of labels X, Y or Z to analyze Brazilian generations.

A second aspect concerns the variation of the classification criteria adopted to define those categories among different researchers. For example, some authors consider the Generation Y and the “Millennials” as being the same, on the other hand, others consider them as distinct segments. The adopted nomenclature varies often, as well as the tracks considered for the years of birth of each generation (Frame 2.4).

FRAME 2.4

Generations of consumers categories

Categories	Birth year
“Silent Gen”	1924-1945(a) 1929-1945(d) 1930-1945(e)
“Baby Boomers”	1940-1960(a) 1945-1965(b) 1946-1964(d) 1946-1964(e)
Generation X	1963-1978(a) 1960-1980(b) 1965-1977(d) 1965-1976(e)
Generation Y	1980-1999(a) 1980-2000(b) 1978-1994(d) 1977-1994(e)
“Millenials”	2000-2007(a)
Generation Z	1995-2010(b) 1995-2005(d) 1995 em diante
Generation Alpha	2010-2025(b)

Source: (a) Eating..., 2007; (b) Consumers...,



according to different classifications

Characteristics

Austerity, against waste, supporters of mass marketing, value well-known brands, easy to read labels, light packages etc. (c).
Traditionalists, strong loyalty, experience-driven decisions, disciplined, modest (d).
Value the reason, the morality and the ethics; conservatives, enjoy consistency (e).

Prosperity and increasing propensity to consume (b).
Idealists and competitive (b).
Optimism, women in the labor market, higher disposable income, greater health concern, valorization of information about products, looking for variety, appreciation of the brand status, etc. (c).
Ambitious, driven by status (d).
Individualism, materialism, excessive predilection; appreciate health, well-being and energy; value the feeling of being young, skeptical, distrustful of authorities (e).

Individualistic and skeptical about the authority (b).
Valuation of professional training, valorization of status, valorization of retail experience, early access to different media and use of personal computers, new family structures, increased use of credit for acquisitions, high propensity to consume etc. (c).
Independent, flexibility to change, comfortable with diversity, immediatists (d).
Accustomed to changes, value family, information and technology; has diversity and global thinking as core values (e).

Optimism, brand loyalty, mastery of digital technologies (b).
Created with extra care and guidance of parents, tolerant to different cultures and lifestyles, seeking immediate gratification, supporters of personalized online marketing, awareness of social and environmental problems, attraction for fashion products, differentiated, ethical, global, competitive prices, interactivity, supporters of social networks etc. (c).
Desire for freedom, comfortable with change and diversity, value social responsibility, supporters of new media and technologies (d).
The choice of products depends on the acceptance of their peers, multitasking, technology enthusiasts, innovators, curious, value what is real and true; susceptibility to break rules; idealistic and oriented to social causes, believe they can build a better future (e).

Optimism, brand loyalty, mastery of digital technologies (b).

Greater living with uncertainty, globally connected, flexible and tolerant to different cultures (b).
Socially responsible and supporters of "green" products, multifunctional, simple and with interactive designs (b).
Biggest concern with environmental issues and public health, cultural diversity, domain and dependence of digital technologies, familiarity with new technologies etc. (c).
New conservative; value respect, truth; planners, with a propensity for savings account; more resigned and responsible; accept limitations; independent thinkers; obtain necessary information through the internet; civic sense, globalized; value safety (e).

Accustomed to technologies and innovations; appreciate the convenience in attributes, form of distribution, messages and products experience; more pragmatic; seeking security, accustomed to scarcity; more inclined to escapism through entertainment, social networking, radical sports, eating out of the home etc. (f).

2011; (c) Canadian..., 2005; (d) The generational..., 2005; (e) Williams; Page; Petrosky; Hernandez, 2011; (f) Wood, 2011



Finally, inside a generation it is possible to find different consumer segments, which further complicates the use of this approach to explain the buying behavior and consumption. This can be verified in the study of Boston Consulting Group (BARTON; FROMM; EGAN, 2012), which highlights six different groups of consumers: Hip-ennial, Millennial Mom, Gadget Guru, Clean and Green Millennial, Old-School Millennial e Anti-Millennial.

Therefore, care should be taken to stereotypes that lead to misinterpretations about the segmentation of the consumer market will not be created. Still, the analysis of different generations of consumers is considered useful to reflect on the factors that may influence the packages sector in the future. Therefore, there is a brief reflection on the potential impacts arising from changes in the relative amount of the Brazilian

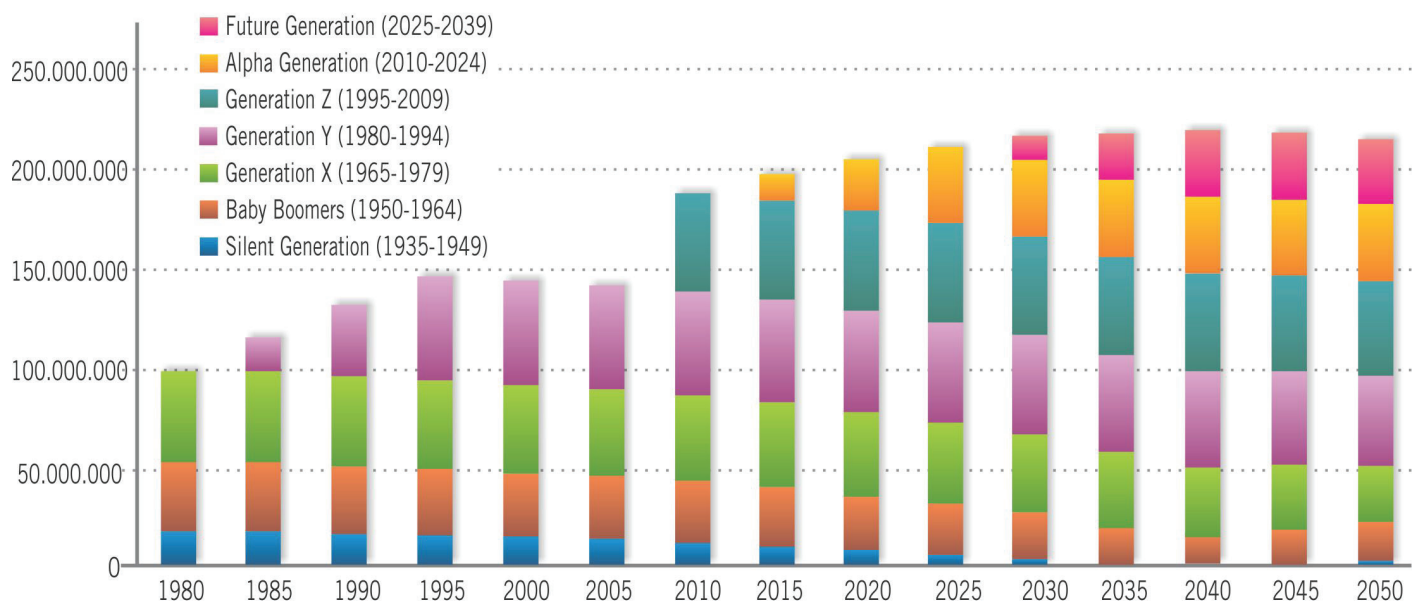
generations of consumers, over time, and the emergence of new lifestyles and consumption habits.

To assess the evolution of generations in the next decades, the tabulation of data from the IBGE (2008) was made and an own criterion for population segmentation according to the generations (Picture 2.8) was adopted. To facilitate the analysis, it was adopted as the standard the time interval used in existing classifications of generations Z (1995-2010) and Alpha (2010-2025), just avoiding the overlapping of dates to avoid double counting occurs. Thus, it has been agreed to classify the Brazilian population in the following “generations”: Silent Generation (1935-1949), Baby Boomers (1950-1964), Generation X (1965-1979), Generation Y (1980-1994), Generation Z (1995-2009), Generation Alpha (2010-2024) and Future Generation (2025-2039).

PICTURE 2.8

Variation of the relative amount of population (x1000 inhabitants) from different generations, 1980-2050

Variation of the relative amount of population (x1000 inhabitants) from different generations, 1980-2050



Source: IBGE data, 2008 – own elaboration



Despite the limitations of this study, it is possible see that, in the next decades, the consumer market in Brazil is expected to progressively renew itself, both on the demand side as in the offer. From 2025, Brazil should have a mature Generation Y, between 30 and 45 years, a Generation Z between 15 and 30 years and a Future Generation entering adolescence.

From 2025 until 2050, increasingly, new generations will dictate the rules of the market, a scenario of much uncertainty, since there is no way to predict the behavior of the current generation Alpha in adulthood and, much less, imagine how they will be the consumers of a generation yet to be born, the Future Generation,

which will consist, in 2050, of people between 10 and 25 years. However, based on data from the studies listed in table 2.10, the new generations can exert strong influence on the consumer goods market, since their purchase behavior and consumption will be shaped by the intense use of digital technology by connecting to social networks, pragmatic and multicultural profile, awareness of social and environmental problems, enhancement of social responsibility, appreciation of ethics, of the real and of the true, pursuit for simplicity and convenience, valorization of shopping experience and greater inclination to escapism, among other things..

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Chapter 3

PACKAGING TRENDS

The drivers that influence the package market cause changes in consumption behavior, which acquire a new profile. These changes bring challenges and opportunities for companies across the entire supply chain, since they propitiate the launch of new solutions to meet the new demand and may even lead to the replacement of products categories.

In the current scenario, where such transformations are intensely manifested, innovation becomes an essential competitive strategy for growth and for the long-term survival. Thus, the analysis of trends is highlighted as a fundamental step in the innovation

process, because it offers investment alternatives, in accordance with the prospects of attractiveness, viability, risk and return.

The Brasil Pack Trends 2020 project aims to be a facilitator in the evaluation phase of innovation process

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SARANTÓPOULOS, C. I. G. L. et al. As tendências de embalagem. In: BRASIL pack trends 2020. Campinas: ITAL, 2012. cap. 3, p. 67-83.

trends. At the same time, establishes a link between the potential development of new packages and technological solutions available for its completion. To accomplish this goal, this document presents the overall scenario of trends that manifest in the packages sector, built from the information collected from specialized

sources, which are analyzed and systematized by a team of experienced market professionals and researchers from the *Centro de Tecnologia de Embalagem* (Center Packaging Technology) (CETEA) and from the *Instituto de Tecnologia de Alimentos* (Institute of Food Technology) (ITAL).

3.1 The bases for the definition of package macro trends

The purpose of this document is not to predict the future, but to inform the reader about certain news and future possibilities, to stimulate ideas and support competitive strategies for development and use of packages. Bring up existing knowledge and structure it to help to think about the future. The long-term thinking ensures proactive policies and helps shape the future in the direction that we wish to see it established.

In implementing the Brasil Pack Trends 2020 project, various reports on trends were studied, with different approaches and purposes. The selection of these studies had as main criterion the reputation and credibility of the enterprise that accomplished the work. Considering several studies that deal with trends at a global level, the team of authors noted that those, in their opinion, will probably have greater representation in the Brazilian market. Therefore, the results presented do not have conclusive character, but aim to enrich the own analysis of enterprises on the technologies issues that may be strategic in the future.

In summary, we present some selected documents from the most recent studies conducted in greater depth on the topics covered in Brazil Pack Trends 2020:

- **Brasil Food Trends 2020 (BRASIL..., 2010):** Brasil Food Trends 2020 represents a result of this work done by ITAL, in partnership with the Federation of Industries of the State of São Paulo (FIESP), regarding the packages for food and beverage areas. It contains a specific chapter on the impact of trends on food package sector, which is based on the five macro trends set for the consumption of food and drink:

Sensoriality and Pleasure, Healthiness and Wellness, Convenience and Practicality, Reliability and Quality, Sustainability and Ethics.

- **The Fast Moving Consumer Goods Packaging Market 2012-2022 (THE FAST..., 2010):** elaborated by the Visiongain enterprise, specialized in market research, presents statistics and projections for the packaging market for different countries, including Brazil, covering the Food, Beverage, Health Care and Personal Care segments.
- **The Future of Packaging – Long-Term Scenarios to 2020 (THE FUTURE..., 2009):** published by the renowned Smithers Pira, identifies trends and drivers for the packaging market. It considers different segments in the analysis: Food and Drink, Cosmetics and Healthcare, Industrial and Transport, and Other Consumer Packages. Includes analysis of specific trends for the different packages materials: paper and paperboard, flexible plastic, rigid plastic, metal and glass.
- **Packaging Solutions Throughout The Supply Chain - Technology, Trends and Future Outlook (BARNETT, 2012):** is a study of Business Insights enterprise that highlights the challenges of packaging supply chain for increase innovation and productivity and reduce costs. It analyzes the impact of sustainability policies and new technologies on the packaging industry. It presents several case studies of companies with applications of nano technologies, RFID, waste reduction, etc.
- **Consumer Packaging Report 2011/12 (REXAM..., 2011):** study performed by Rexam presents an overview of the packaging industry, with analysis by regions

(Europe, Asia, Oceania, Africa & ME, North America, South & Central America), by material types (Paper & Board, Rigid plastic, Glass, Flexible plastic, Beverage cans, Other metal, Other) and by sectors (Beverages, Healthcare, Personal care, Household care, Ambient food). Highlights as megatrends for the packaging industry: Demographic trends/ ageing society, Sustainability/ethical consumerism, Health and wellbeing/health conscious, Value/ hi lo consumerism/ premiumization, Convenience/on the go lifestyles, Concerns about product safety and security, Growing ethnic diversity /rapid urbanization.

- **Market Statistics and Future Trends in Global Packaging (MARKET..., 2008):** study performed by the World Packaging Organization with the Smithers Pira, which presents statistics and projections of the packaging market by regions (Oceania, Asia, South & Central America, North America, Africa, Middle East, Eastern Europe), by users sectors (Food, Beverage, Healthcare, Cosmetics, Other consumer, Industrial/bulk packaging) and by materials (Paper and board, Plastic packaging, Metal, Glass, Others). It analyzes drivers and packaging market trends.
- **InnovationParc Packaging 2011 – Quality of Life (INTERPACK, 2011):** material collected on the booths and at conferences presented in the InnovationParc sector of Interpack Trade Fair 2011, which discusses the package innovations according to solutions classified into categories: Simplicity (Reduction, Convenience), Identity (Belonging), Health (Wellness), Meaning (Sustainability), Aesthetics (Design).
- **Innovation in Food and Drinks Packaging – Opportunities in Added Value and Emerging Technologies (RAITHATHA, 2009):** market study performed by Business Insights, about drivers, trends and innovations in the food and beverage sector. It classifies the trends into three categories: Convenience, Ethical and green, and Health. It analyzes trends by type and specific packaging materials and by region: Asia Pacific, Europe, Latin America, Middle East & Africa, and North America.
- **Future Food and Drinks Packaging – Emerging Ethical, Food Safe and Convenient Formats (ANNETTE, 2008):** study

performed by Business Insights that highlights trends in categories: Green Packaging, Supply chain efficiency, Food safety packaging, Convenience and New materials. It analyzes the packaging market evolution, specifically for plastic, metal, glass, paper and cardboard materials.

- **Packaging Trends in Food and Beverages (PACKAGING..., 2009):** performed by Mintel, an enterprise specialized in market research, it details drivers, trends and innovations in packaging for the food and beverage sector, based on three trends categories: Sustainability, Health and Wellness, and Convenience and Functionality.
- **The Plastic Packaging Market Outlook in Food and Drinks: Market Forecasts to 2014, Key Players and Innovation (THE PLASTIC..., 2011):** performed by Business Insights , provides data on the plastic packaging market for the food and beverage industry, highlighting drivers, trends and innovations.
- **Innovations in Glass Packaging for Food and Drinks - Premium and Sustainable Applications and The Impact of Emerging Markets (INNOVATIONS..., 2010):** performed by Business Insights, it presents drivers, trends and innovations on the glass containers market for the food and beverage industry.
- **II Caderno de Tendências, Higiene Pessoal, Perfumaria e Cosméticos (ASSOCIAÇÃO..., 2010):** project developed in partnership with the Brazilian Association of Toiletries, Perfumes and Cosmetics (ABIHPEC), Brazilian Agency for Industrial Development (ABDI) and the Brazilian Service of Support for Micro and Small Enterprises (SEBRAE), it analyzes global patterns of consumption and highlights general and sectorial trends.
- **Beverage Packaging: Brazil (BEVERAGE..., 2008):** study performed by Euromonitor that highlights drivers and trends of the packaging sector for different categories of processed foods (dairy products, sauces, dressings and condiments, canned/preserved food, chilled and frozen foods, impulse foods, dried processed food), materials and package types (Metal, Rigid Plastic, Glass, Liquid Cartons, Paper-based containers, Flexible packaging, Closures).

- **Food Packaging: Brazil (FOOD..., 2008):** study performed by Euromonitor that highlights influence factors and trends of the packaging sector for different categories of beverages (Soft drinks, Alcoholic drinks, Hot drinks), materials and package types (Metal, Rigid Plastic, Glass, Liquid Cartons, Paper-based containers, Flexible packaging, Closures, Multipacks, Returnables).
- **2020 Future Value Chain: Building Strategies for the New Decade (2020 FUTURE..., 2011):** document elaborated by

The Consumer Goods Forum and Capgemini, HP and Microsoft. It presents a vision about the future of the consumer goods market.

These documents were selected in order to obtain a comprehensive view of consumer goods market trends and also of trends related to packaging supply chain, since the package is an input of the main industries analyzed in the study, namely: food, beverages, personal care and health care.

3.2 THE PACKAGE TRENDS MAPPING

Through comparative analysis, we identified common trends highlighted in many documents analyzed, which were classified into five major groups called package megatrends (Chart 3.1). The creation of

these five megatrends aims to provide a framework for the analysis of trends and innovations in the sector, in a more organized and systematic way.

3.3 CONVENIENCE AND SIMPLICITY

The modern consumer values products that make daily life easier and that allow time saving. Translating it into the development of packages, this desire means: ease of opening, possibility of resealing, ease and simplicity of preparation, use of product and disposal of the package, portability for consumption on-the-go, at any place at any time. The package should play this role for everyone, not just the elderly and children. The package should reduce waste, minimize risks.

The consumer interacts with the package in many ways, from the choice at the time of purchase, during the product consumption, until the time of disposal. The package development must consider these aspects in order to facilitate such interaction. Thus, the package must be functional and uncomplicated. Universal design principles should be applied to the package: convenient use, intuitive and simple; discernible information, graphic and structural design; equitable utilization, in other words, the package should be used by people with different abilities.

The package must also meet the market segmentation. The increased number of households with only one person and the increasingly troubled urban life have created a demand for products in individual portions, especially in the case of foods and beverages. Beyond that, there is also the economic issue, because this type of packages allows smaller outlay and different consumer options in the case of households with more than one person, in other words, each individual of the residence can choose what they want to consume.

The consumer has experienced rapid social and behavioral changes, and is aware, has greater exigency level and constantly seeks objective information to aid in purchase decisions. This information comes directly from the package or from the interaction that it favors through interactivity tools, because the consumer has easy access to the internet through smart phones since the moment of purchase.

Manufacturers and users of packages should be aware of these trends, so their packages will be able to meet these new consumers, with their lifestyle.

FIGURE 3.1
Ease of opening and resealing

Although present in most products, easy of opening and resealing are still trends in the packages sector.



Photo: reproduction

FIGURE 3.2
Ease of use and preparation in microwave

Consumers are looking for products that can aggregate convenience with focus at the time of consumption, ease of preparation and that minimize the use of glass, cutlery and other utensils.



Photo: reproduction

CHART 3.1
Package Trends



Package Contributions

- Ease to handling
- Ease to consumption with no need of accessories
- Functionality to people with motor impairments
- Progressive consumption
- Waste reduction
- Ease to consumption and removing the product
- Individual portions
- Preservation of active principles and functional properties
- Compression for disposal
- Minimization of the waste volume
- Product appeal
- Brand on evidence
- Convenient preparation
- Time saving

- Preparation and consumption straight from the package
- On-the-go consumption
- Progressive consumption
- Meals fragmentation and organization
- Portability
- Customer engagement and loyalty
- Consumption personalization
- Reducing in material consumption
- Ease to brand recognizing
- Simple packages
- Adequacy to social changes and lifestyles
- Less outlay
- Waste reduction
- Ease to prepare

- Sophisticated and luxurious packages
- Premium quality
- Prestige for the masses: "masstige"
- Multisensory packaging design
- Differentiation
- Aesthetics effects
- Materials and colors extravagance
- High quality printing
- Invitation to indulgence, guiltless pleasure
- Packages that stimulate new sensations and emotions

- Escape of everyday life
- Packages associated to healthy lifestyle and wellness
- Packages that transmit reliability and safety
- Apparent naturalness
- Retro image
- Idols consumption
- Be our guest
- Limited edition packages

- Oxygen, CO₂ and ethylene absorbers
- Humidity absorbers/controllers
- Antimicrobial packages
- Aroma emitters
- Time-temperature indicators
- Antitheft systems
- Oxygen indicators
- Biosensors

- Improvement of the barrier properties
- Improvement of mechanical properties (plastics and cellulosic)
- Increase of thermal stability of thermoplastic polymers
- Incorporation of active compounds
- Traceability and security systems
- Biomaterials of plant and microbial
- Natural or chemically synthesized biopolymers from renewable source
- Biopolymers from agricultural waste and from food, beverage and timber industry waste
- Biodegradable/Compostable
- Recyclable

- Natural sources consumption reduction (Resource efficiency)
- Weight reduction (Lightweighting)
- Volume reduction
- Energy reduction (Energy saving)
- Emitters like GEE* reduction (Carbonfootprint)
- Materials from renewable resources
- Waste reduction
- Dose/consumption adequacy
- Shelf life extension

- Ecodesign
- Recycling
- Development of recycling technologies
- Waste disposal
- Reverse logistics
- Extended responsibility
- Accreditation and Validation
- No to Greenwashing

- Food protection and preservation
- Control of chemical contamination
- Food contact legislation
- Compliance of positive lists
- Compliance of migration limits to food and/or food simulants/ mathematical modeling
- Control of consumer exposure to contaminants
- Evidence of safety of new technologies and new materials
- Harmonization of the legislation - international trade / globalized market (EU, US/Canada, Mercosur, Southeast Asia, China, Japan)

- Declaration of Compliance and Traceability
- Control of physical and microbiological contaminations
- Good Manufacturing Practices (GMP)/ Hazard Analysis and Critical Control Points (HACCP)
- Certifications
- Harmonization of process safety management systems – globalized market
- Traceability and identification of origin

FIGURE 3.3

Active principles preservation

Products with nutritional and nutraceutical properties, containing vitamins and other excessively unstable compounds, lose their functionality when mixed with liquid or in contact with oxygen. Thus, the packages will increasingly act in preserving such components, from the moment of filling to consumption.



Photo: reproduction

FIGURE 3.4

Simplicity and ease of information

Limited to the necessary, these are characteristics that are increasingly attracting consumers.



Photo: reproduction

FIGURE 3.5

On-the-go consumption and portioning

Packages that allow the gradually and on-the-go consumption, in individual portions, attending to nutritional issues or minimizing costs and waste.



Photo: reproduction

3.4 AESTHETICS AND IDENTITIV

The consumer has needs, feelings and desires which he expects to meet with the products he choose, buy and consume. He seeks an objective and subjective satisfaction that results in feelings of pleasure and accomplishment, new emotions, and escape from of everyday life routine. The package should encourage the consumer's personal identification with the product or the brand.

Consumers have a sophisticated lifestyle and demand products with high added value, such as a status symbol. This is the phenomenon of products "premiumization" and, consequently, the sophistication of packages that reflects the demand for products with top quality, Premium, associated with luxury and indulgence.

Another Brazilian consumers' lifestyle of marketing importance to the packaging sector is the valorization of life quality and wellness, resulting in the demand for products that can bring some health benefits, which display information about its origin, aspects of quality, and safety.

The memory of the past, of the "good times" in retro packages, even in limited editions, pleases the consumer. Packages that transform products into gifts, collectibles, children's entertainment, and interactivity tool for the young will succeed.

The package reinforces the consumer's perception, provides differentiation and appeal to the product through the aesthetics of colors, shapes, images, graphics, even exaggerated and extravagant, generating large sensory and emotional stimulation.



Life-Style Packaging - Natural, safe and handmade

Creative packages that inform about the quality care of ingredients, production, and enhance the natural origin of the product.



"Premiumization" - luxury, indulgence and hedonistic consumption

Provide new sensations and the pursuit of guiltless pleasure, linking sensory experience with consumer expectations and emotions.

Personal Identification - Limited Editions and products endorsed by celebrities

Releases on specific occasions and products associated to celebrities attract consumers who seek something different.



Pleasure Experience - Stimulus to sensoriality

Packages provide interactivity with the consumer, involving several senses in appreciation of a product.



Packaging Renovation - Use of symbols, colors and special shapes

Identification and recognition of the brand by the package, to differentiate and express product quality, authenticity and personality.



3.5 QUALITY AND NEW TECHNOLOGIES

Smart packages: active and intelligent packages

The active packages act on the product or the package headspace to extend shelf life and the microbiological safety of foods and beverages. The active ingredient may be associated to the intrinsic characteristics of the polymers of what it is made or from additives incorporated into plastics, paper, metal or combinations of these materials.

These are examples of active packages: oxygen, CO₂ and ethylene absorbers; humidity absorbers/controllers; odor absorbers; cholesterol removers; ethanol, CO₂, SO₂, and scents emitters; antimicrobials, antioxidants packages, self-heating and self-cooling packages.

FIGURE 3.6
Active packages examples



Oxygen absorbers



Liquid absorbers, with possibility of antitheft system aggregation



Ethylene absorbers



Antimicrobial package: SO₂ emitter



Self-heating package

Photo: reproduction

Smart packages monitor and give an indication of freshness and quality of food, as well as information that enable traceability and safety. This process includes detecting and reporting indicators, sensors and transmitters.

These are examples of smart packages: time-temperature indicators; ripening and freshness indicators; oxygen, ethylene, and CO₂ indicators; pathogenic microorganisms and toxins indicators;

optimum temperature for consumption indicators; biosensors and nanosensors.

The future of active and intelligent packages should be linked to developments to encourage interactivity, fun/entertainment and personalization of products. The package will empower the consumer to modify or optimize products, as well as to decide issues related to quality and freshness. Smaller and cheaper electronic components will favor the innovations.

FIGURE 3.7
Active packages examples



Time-temperature indicator

Ripening indicator

Residual oxygen indicator

Photo: reproduction

Nanotechnology

The term refers to the technology used in product development at the nanometer scale (10⁻⁹ m), which have distinct properties from those of similar products on the macro scale. These are highlights for the package area: nanocomposites (nanoclays and resins), carbon nanoparticles/nanotubes, oxides and metal at the nanoscale commercialized by manufacturers of resins and additives for packages.

Nanotechnology applied to cellulosic and plastic packages can help to overcome their limitations, resulting in:

- **Improvement of properties:** gas barrier, humidity barrier, UV radiation barrier, stiffness flexibility, heat resistance.
- **New features:** antimicrobial package, oxygen absorbers, humidity absorbers, smart packages: sensors and indicators, self-cleaning surfaces, permanent antistatic surfaces.

- **Sustainability:** weight reduction - lightweighting - by improvement of the properties and improve of the biopolymers limiting properties.

The challenges related to nanotechnology associated with package are: lack of environmental and regulatory aspects of food safety that approach this

technology under development; concern of consumers subjected to campaigns of environmental groups; high development and production costs; and longer time between research and commercialization.

FIGURE 3.8
Examples of nanotechnology applications in package



PLASMAX technology
SiO_x inner coating



Violation indicator

Photo: reproduction

Biopolymers

One of the most significant trends in the package area is sustainability, which caused great impact on the development of materials from renewable sources.

Biopolymers, defined by the Brazilian Association of Technical Standards as polymers or copolymers from renewable sources (ABNT NBR 15448-1, 2008) can be from natural origin, or synthesized from raw materials from renewable sources, or produced by microorganisms. Given the lack of infrastructure in industrial composting plants, the tendency is to grow the recyclable biopolymers market, such as the “Green” polyethylene from Braskem and Plant-Bottle from Coca-cola, with advantages such as conservation of energy and raw materials and saving natural resources.

The challenges of new materials are: overcoming the limitations in the properties, especially for use in food packages; increase availability; improve competitiveness with polymers from lower cost fossil source; and solve environmental issues, such as the negative impact on the recycling chain of other materials and the emission of greenhouse gases, in the case of biodegradable material that is not designed for industrial composting plants.

The future is in the manufacture of package materials from waste/byproducts from industries of food chain, from the timber industry and from biofuels production.

FIGURE 3.9

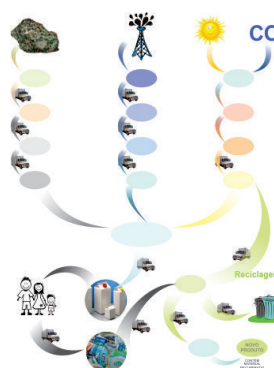
Examples of biopolymers in package



Photo: reproduction

3.6 SUSTAINABILITY AND ETHICS

The negative changes that the planet is suffering, understood as consequences of actions of mankind on nature, gave rise to a new global consciousness and environmental efforts to reduce the emission of greenhouse gases by all productive sectors. Studies of Life Cycle Assessment have been considered one of the best instruments for quantifying the environmental cost of products and services. This technique, in its simplest form, the Life Cycle Thinking, becomes a powerful tool to be applied to continuous improvement of existing processes and to guide further development of products and processes to become more sustainable. Applying this concept to the packages unfolds into four trends to be pursued in the next decade: Optimization of the product/package system, Reuse & Recycling, Waste Management & Reverse Logistics and Credibility and Ethics.



Life Cycle Thinking & Supply Chain, or "Think about Life Cycle" throughout the production chain have proven to be an effective tool in implementing initiatives that reduce the environmental impact of products and processes.

Optimization of Package System: rethink the packaging challenging their limits of weight, shape, materials and accessories without compromising the integrity of the product. Maximize the mass ratio between content and packaging, concentrate products, reduce sizes, distribute more units per volume transported.





Reuse & Recycling: encouraging the use of recycled materials reduces the consumption of natural resources and is generally associated with lower energy consumption and emissions. The reuse of packages increases its durability and also amortizes its environmental cost.



Credibility & Ethics: environmental marketing supported by internationally proven metrics is a powerful tool for consumer information. Credibility has been attested by the use of standardized environmental labels and declarations and also by certifications avoiding the Greenwashing.

Waste Management & Reverse Logistics: the National Policy of Solid Waste (NPSW) establishes a shared responsibility between manufacturers, importers, consumers and public authorities in the proper disposal of waste generated. The waste generated must have chains of destination and/or reusing established and economically viable.



3.7 SAFETY AND REGULATORY ISSUES

Food safety is a topic that is of interest on all consumers, regardless of purchasing power. In a globalized world, where communication and media are privileged and information flows at great speed, the dissemination of news and information about food safety, whether correct or not, affects millions of consumers, making them more attentive, demanding and informed.

The current consumers want to rely on a certain brand and product and want to be sure and confident that they are getting a quality product and that the consumption of this product will not cause any health problems in the short or long term.

The package is crucial to ensure the safety, quality and reliability of food products, while maintaining the desired shelf life, the correct transportation and sales, informing consumers about the safety and nutritional value of the product, the date of manufacture or expiration date, the location of the food manufacturer

and instructing on how to prepare the food.

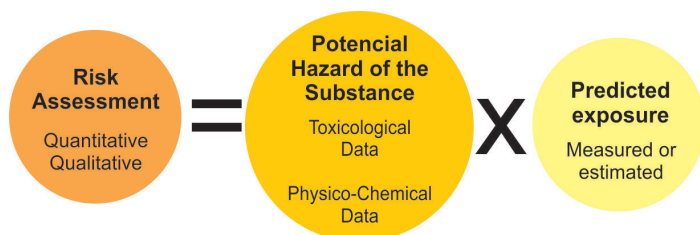
In this context, the package cannot be a source of chemical, physical or microbiological contamination of the food.

The chemical composition of the package is critical to consumers' safety. The substances which are part of the package composition must have the toxicity and potential , risk of migration into foods studied, so that the consumers' exposure to such substances can be evaluated and their risk known and controlled. Laws based on risk and consumer exposure to these substances were and are designed to control chemical and toxicological contamination of packages and protect the health of consumers.

The physical and microbiological contamination is mainly related to processing, handling and storage, and must be controlled by process safety management systems and quality certifications.

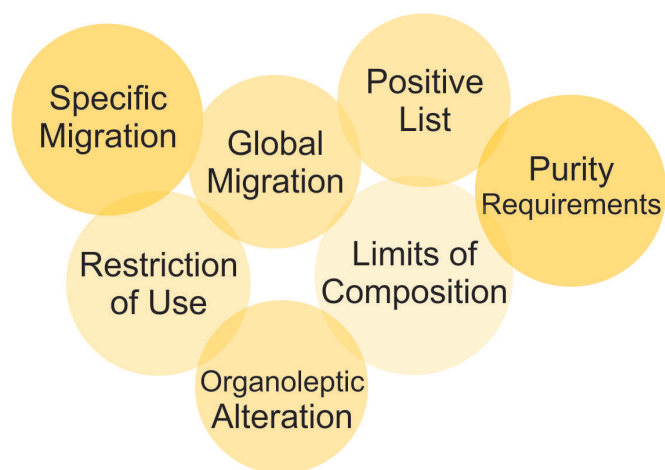
Sophisticated analytical techniques and

mathematical modeling with parameters closest to real situations are applied to estimate the migration of package components to food. Moreover, studies are conducted to assess consumer exposure to these migrants to address the lack of more realistic data (OLDRING, 2010).



The laws for package materials for food contact are designed to ensure consumer safety through control of chemical contamination due to the migration of package components to the product.

They are constantly evolving to incorporate new substances and new technologies such as active packaging, post-consumer recycled materials and nanomaterials, and are revised to incorporate new interpretations based on scientific and technological knowledge. All materials in direct contact with food must demonstrate compliance with the requirements of the laws.



Declarations of Compliance are required in order to transfer information and to formalize the responsibility of the package material manufacturer and ensure correct use in the conditions set out.



The laws vary among countries and efforts for harmonization, implementation and mutual recognition are expected by importers and exporters of food and food packaging in world trade.



Process Safety Management Systems are efficient mechanisms to bring about transparency and continuous improvement of package manufacturing processes and include:

- GMP - Good Manufacturing Practice and application and validation of HACCP - Hazard Analysis and Critical Control Points.
- **Certification** of quality systems based on international standards BRC-IoP, FSSC 22000 (ISO 22000 and PAS 223); ISO 22000, IFS PACSecure, among other standards and systems.

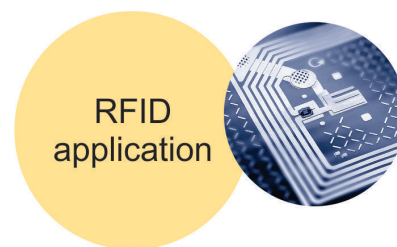


Organizations and associations work for the harmonization of standards and regulations related to food safety, benefiting international trade and food quality (MERMELSTEIN, 2012).

The traceability of package materials, whether automated or not, is a requirement of some laws and

it is becoming increasingly necessary for safety and identification of the origin of packaged products.

RFID will offer significant opportunities for manufacturers, retailers and consumers.



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Chapter 4

CONVENIENCE AND SIMPLICITY

These days, packages are more and more versatile and functional for users and consumers. Packages can play a part in the promotion of the brand, sometimes becoming the brand itself, and can enter into the purchase decision process of consumers. In this way, convenience and simplicity of a package along with information it contains can be decisive in the choice of a product at the point of sale.

Traditionally, the development of packages had the primary functions of contention, protection and storage as its focus. This has resulted in products packaged with less than desired convenience and usefulness. It is only with the most recent developments that we see more attention being paid to these functions, now that producers and users are more aware of what consumers expect (DUIZER et al., 2009).

The modern consumer looks for time-saving, tends to be more aware of features which bring

practicality to their life, considering the most basic aspects such as ease of opening, the possibility to reseal and instructions on how to prepare or use the product. They are even aware of the more sophisticated features such as on-the-go consumption, indicators of freshness and interactive devices. Convenience is not just an indulgence, but provides waste reduction and, amongst other things, improves the lives of the elderly. The importance of convenience is indisputable and the challenge is to serve convenience while offering

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DANTAS, T. B. H.; DANTAS, F. B. H. Conveniência e simplicidade. In: BRASIL pack trends 2020. Campinas: ITAL, 2012. cap. 4, p. 85-105.



consumers a believable way to make conscientious choices (CULLEN; STEMBRIDGE, 2011). For this reason, producers and users must be aware of these trends, in order that their packages are adequate for this new consumer, which is in a state of constant change and evolution.

The question of convenience applied to the consumer is considered in an important concept, the Universal Design. This concept is extensively applied to design products, making them easier to use for all age users and different levels of ability. Another design concept, User-Centered Design, evaluates consumer needs and the aesthetics of the products (YIANGKAMOLSING et al., 2010).

The principles which rule the universal design concept were established in 1997 by the Center for Universal Design, at the North Carolina State University, and are presented as follows: equitable use, namely, the design may be used for people of diverse abilities; flexible use; simple and intuitive use; perceptible information; tolerance for error, i.e., the design minimizes hazards and the adverse consequences of unintended or accidental actions; low physical effort; appropriate dimensions.

Based on these principles of universal design,

used in the identification of needs directed at flexible packages, researchers Yiangkamolsing et al. (2010) identified five principles relevant to universal design applied to packages:

1. Simple, intuitive and convenient use
2. Perceptible information
3. Structure and graphic design
4. Easy opening
5. Equitable use

Logically, these are some of the aspects to be observed in the development of innovations in packages, mainly when the constant social and behavioral changes of the modern consumer are considered. Thus, in this chapter, we will present the main trends focused on convenience and simplicity, based on information obtained from many sources, such as market reports, scientific papers, electronic newsletters about innovation and contests in the packaging sector. Table 4.1 shows the unfolding of macro tendencies described in this chapter as well as packages contributions related to such macro trends.

4.1 FUNCTIONALITY ON FOCUS

The large number of products introduced on the market and the changes in life-style demand projects for differentiated packages. Such variation can present better results if focused on the functionality of the

package, principally referring to the ease of opening, holding, carrying and discarding, the possibility to reseal, the simplicity of use, prepare and consume, among other factors.

Ease of opening

This functionality is already present in practically all categories of products. One of the main factors in the demand for this is the aging population, but developments in this area can go beyond this (ANNETTE, 2008). For example, we can quote the Zork easy open closure. This was originally developed for bottles of wine with the appearance of a screw cap, but with the

“pop” property of a cork. The system consists of three parts: an external part that allows easy viewing in case of violation; a metal foil that provides an internal oxygen barrier; and an internal part that provides the “burst” at the moment of opening and can be resealed after consumption (Figure 4.1).



TABLE 4.1

Convenience and simplicity – Developments and Contributions to Packages

Unfolding of the macro trends	Package contributions
Functionality on focus	
Ease of opening	Ease of handling, eliminates the use of accessories, functional for people with physical disabilities
Resealing	Progressive consumption, waste reduction
Simple to use	Ease of consumption and removal of the product, single portions
Preservation of components and active ingredients	Maintenance of active ingredients, nutritional and functional properties of the product
Ease of disposal	Crushing for disposal, minimization of waste volume
Visibility	Product appeal, highlighted brand
The package and the market segmentation	
Microwave preparation	Convenient preparation, time saving, preparation and consumption from the package, preservation of product's sensorial characteristics
On-the-go consumption and portability	Consumption on-the-go, mealtime fragmentation, time saving, ease of transportation, meal organization
Interaction	Involvement and customer's brand loyalty, access to product information, personalization
Simplicity and ease of information	Reduction of material consumption, brand and product ease of identification, free of complications and exaggerations
Portions	Adaptation to changes on social, life-style and nutritional needs, association with lower cost, waste reduction, ease of meal preparation



PICTURE 4.1
Easy-open cap



Source: Press Release

Metallic packages and cartons are already well-established examples to this trend, but there are still more innovations, like, for example, the tuna tin from the American company Bumble Bee (Picture 4.2), in which the traditional lid was replaced by aluminum seals, minimizing the opening force compared to conventional ring-pull lids; a welcomed change for the elderly and people with motor difficulties (ANNETTE, 2008). Other examples like this are the easy-open lids for plastic trays (Picture 4.2) and easy-open bags (Picture 4.3), which allow the opening of the package without accessories such as scissors or knives; and even lids for glass pots, also with a focus on the market for elderly and consumers with diminished dexterity.

PICTURE 4.2.
Easy-open packages



Source: Press Release

Cryovac's *Grip & Tear* system (Picture 4.4) allows the easy opening of vacuum shrink bags by simply pulling on a tab. This not only facilitates the opening, but maintains better hygienic conditions in the handling of the product, minimizing contact with the hands and the surface used for cutting. The pulling of each tab exposes only one part of the product, keeping the rest protected from manual contact.

PICTURE 4.3
Easy-open vacuum packages



Source: Press Release

PICTURE 4.4
Cryovac's easy-open *Grip & Tear* System



Source: Press Release



Resealing

As well as ease of opening, many consumers still desire being able to reseal the package. This is an important aspect in package development, as it can reduce loss of product and increase the usage time of the package material during the progressive consumption (BARNETT, 2010). There are presently several examples of packages with this characteristic, mainly those destined for drinks, like water and isotonic drinks. This characteristic is present in packages for foods, such as cans and pouches with zipper. There are even more examples in which this function can be implemented, like the Clear Lam Packaging thermoformed tray, with an opening and closing system which allows partial consumption of the product (Picture 4.5).

Another example is the Amcor ReClose package, for meat and dairy products. Besides the resealing convenience, it has a higher resistance to wear and tear, and assists in maintaining the freshness of the product, minimizing its contact with the environment (Picture 4.6).

Resealing systems can be found even in packages where the consumer would never have thought, like the battery blister used by Contour (Picture 4.7). Another example of resealing linked to the convenience of the product use is Wetbone's package of water for dogs; this package is a pouch with a larger upper area where the animal can consume the product (Picture 4.8).

PICTURE 4.5

Resealable plastic tray



Source: Press Release

PICTURE 4.6

Resealable flexible packages



Source: Press Release

PICTURE 4.7

Resealable systems in blisters



Source: Press Release

PICTURE 4.8

Resealable pouches



Source: Press Release



Simplicity of Use

Taking into consideration the rhythm of consumer's lives, many food and drink companies are searching to add practical benefits to packages focusing on the moment of consumption, minimizing the use of cups, cutlery and other utensils. Recently, Orville Redenbacher's, a ConAgra Foods brand, released a microwave popcorn package, with no need of traditional bowls, as the package takes this very format at the end of preparation (Picture 4.9). Besides, the package allows you to see the corn popping and has a wide opening to share the product with many people.

PICTURE 4.9

Package for product preparation and consumption



Source: Press Release

Attending to the modern consumer demands, which needs convenient products and packages, quickly made, but without giving up of consuming fresh and tasty products, Kraft Foods launched the Fresh Take line. Fresh Take consists of a ready-made mix of cheese and breadcrumbs, to be used to enhance chicken, meat or fish dishes. Besides its attractive appearance, the package is a pouch, in which the ingredients are kept separated in two compartments by a seal; the pouch itself contains instructions on how to use and can be used to mix

these ingredients by simply tearing the central seal (Picture 4.10).

The Swedish company OneCafe offers a fresh filter coffee, with superior quality, brought from Uganda, in a sachet package that is individual and easy to open and discard. The package can be fixed to the side of the cup where the coffee will be consumed, allowing the sachet to later be placed back inside of it, avoiding spillage (Picture 4.11). Another example is the Tstix package, for soluble drinks such as teas and coffees. It is made in the form of a stick, with perforations allowing the flowing of hot water and the dilution of the product, still serving for the homogenization, substituting the spoon (Picture 4.11).

PICTURE 4.10

Package with multiple ingredients



Source: Press Release

For those who think about the glass packaging industry as something stationary, with no room for innovation, Owens-Illinois, in conjunction with a local retail network in the United States, developed the



Versaflow system. This system consists of a glass pot for tomato sauce with a different shaped neck which allows the use of the product without losing or having remnants of sauce in the closing area (Picture 4.12).

PICTURE 4.11

Personalized consumption in a functional package

Source: Press Release



PICTURE 4.12

Ease of product removal from package



Source: Press Release

With a differentiated vision, Guactruck, a small company in the Philippines, serving fast-food in a stylish food truck, decided to innovate the presentation of its products. The meals are served in an exclusive pack (Picture 4.13) with many appeals: besides the visual, the main focus is the question of sustainability, using a mono-material package, in the shape of a flower that opens; there is no glue or plastic, which favours recycling. Assuming the responsibility for everything that comes out of its restaurant, the company came up with an incentive system for the package to be returned for recycling. The customers are offered one free meal for every ten returned packages.

Regarding packages for paints, two minor modifications, which make a huge difference in terms



of convenience, are highlighted here. One of these is the can from German company, Huber; a can in the traditional shape but with an internal accessory for the removal of excessive paint on the brush, what is generally made at the edge of the can (Picture 4.14). Another interesting development is that of Sherwin-Williams; with a plastic *twist & pour* package, the highlights are the twistable lid, which eases opening, in comparison

with traditional sealing, and the internal device, which allows the removal of paint inside the package, avoiding a mess from drips (Picture 4.14).

Even more practical, from Sherwin-Williams, is the plastic *ready to roll* package which comes with a tray to take away the excess paint on rollers, making it unnecessary to remove paint from inside the package (Picture 4.14).

PICTURE 4.13

Personalized consumption with sustainability appeal



Source: Press Release

PICTURE 4.14

Practical use of the product and without waste



Source: Press Release



Preservation of components and active principles

Currently, there are various products in the market with nutritional and nutraceutical properties, containing vitamins, energetic substances etc. However, it is known that many of these substances, mainly vitamins, are highly unstable. They lose their function when mixed with liquids or when in contact with oxygen. In other words, such substances start to degrade as soon as they are on the production line. The same happens to some ingredients, such as aromas, which degrade after prolonged contact with water (STEEMAN, 2012).

To avoid the loss of such compounds, there are a number of caps in development and others already on the market for this use. Two of these, from Tap-The-Cap (Picture 4.15) and Viz Cap (Picture 4.16) companies, keep the compound protected within a special compartment; upon putting pressure on the spout, the compartment opens, making the compound and the liquid to be mixed. In another development, from Teamplast, the cap frees a portion of vitamin powder to be mixed, allowing the instant preparation of the drink, which wins in freshness and healthiness (Picture 4.17).

PICTURE 4.15

Caps to conserve compounds and active principles



Source: Press Release

PICTURE 4.16

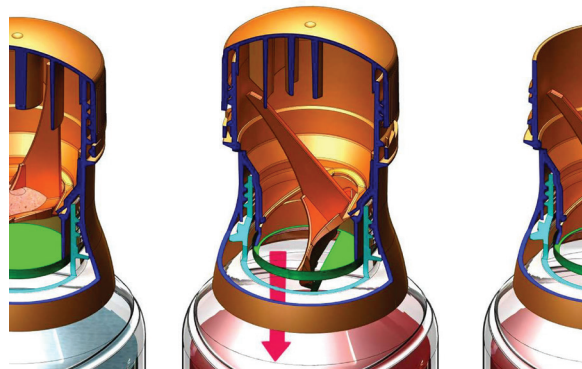
Caps to conserve compounds and active principles



Source: Press Release

PICTURE 4.17

Caps to conserve compounds and active principles



Source: Press Release



Ease of disposal and recycling

At the final step of its lifecycle, packages must be easy to dispose and, moreover, in a way that is best for the environment. This characteristic can influence the consumer in the purchase decision, given the increase in recycling and the need to reduce household waste volumes (HILL, 2010). Many current consumers are aware of how likely packages are to be recycled, showing a pattern in the consumer's point of view (DODDS, 2008).

Already on the market, an example that focuses on disposal and recycling is Crystal mineral water, from Coca-Cola. It comes in an Eco bottle (Picture 4.18), that, besides its material reduction appeal (20% less PET than previous bottles) and using PlantBottle technology (with up to 30% of the main materials from sugar cane), it boasts a 37% reduction of its initial volume after its twisting.

PICTURE 4.18

Packages with a reduced discard volume



Source: Press Release

“See it to believe it”

One of the many ways of functional design is the package that allows visualization of the product. An example of this, in the English market, was the use of clear plastic packages for ready-made soups. Traditionally, ready-made soups were dry and sold in sachets or cans, with the advantage of a long shelf life. More recently, clear plastic packages (Picture 4.19) have taken the lead, allowing the consumer a clear view of what he will eat, making appearance an important factor in choosing a brand and a product (HILL 2010).

This function can also be observed in Cryovac's Mirabella fresh meat packages (Picture 4.20). The system is made of two films: one used for tray sealing, with anti-fogging and high oxygen barrier properties; and another internal film, that besides avoiding the meat contacting the seal, has a high permeability to oxygen, avoiding the darkening of the meat, as it keeps a high concentration of oxygen in the modified atmosphere inside of the package.

PICTURE 4.19

Ease of product visualization



Source: Press Release

PICTURE 4.20

Anti-fog package



Source: Press Release



4.2 THE PACKAGE AND THE MARKET SEGMENTATION

Microwaves and time-saving

In the eventful life of the modern consumer, considering the workday, the traffic, and a family in which both heads of the family work, the microwave has become a huge ally in the preparation of quick meals. As such, packages must reach the requirements of such technologies in order to reduce the need of manual work by the consumer, allowing direct use in the microwaves, not just for heating but also for its consumption. Microwaves have become more and more used in the daily lives of consumers. This process is completely different from any other cooking process. Absorption of energy from the microwave field results in an internal heat generation within the product. However, some products are affected negatively by this process, mainly those of crusty nature, which lose this characteristic with the absorption of water vapor during the heating (ALBERT; SALVADOR; FISZMAN, 2012).

Relatively new microwave-friendly packaging technology do not just allows quick preparation but offers healthier steam prepared meals and products can be crisped or browned using microwave (HILL, 2010).

Examples of packages for preparation or heating in microwaves include Dream Steam (Picture 4.21) and Estersteam (Picture 4.22). Both possess a valve which allows internal pressure control, produced by the vaporization of the water present in the food. Along with the traditional internal cooking by microwaves, there is also external cooking using vapor. After cooking, the vapor created is released by a valve system, while still within the microwave, providing safety for the consumer by avoiding burns upon opening the package. In some cases, it's still possible to use a modified atmosphere in order to extend the product's shelf life.

PICTURE 4.21

Dream Steam package for microwaves



Source: SealPac International

PICTURE 4.22

Estersteam package for microwaves



Source: MHA Marketing Communications

Cryovac holds the *Simple Steps* technology (Picture 4.23), which associates a *skin packaging* with a vapor pressure relief system aimed at practicality and safety in heating food in microwaves. The food is heated in its own package; its sides don't heat up, allowing you to pull the tray from within the microwave. The easy-open seal is only taken off after heating. The permeability of the vacuum package is adjusted to the



product, i.e., high oxygen barriers for pastry and meat products and films with permeability to gases for fresh seasoned vegetables to be vapor cooked.

PICTURE 4.23

Examples and instructions of the *Simple Steps* package



Source: Press Release

Another example is the Campbell's soup package (Picture 4.24), joining the ease to heat the product in the microwave with the practicality of consuming directly from the package; it is made of a multilayer plastic pot with a high oxygen barrier, closed with an easy open seal and plastic cap. The seal is removed and the plastic cap is placed on the package for the heating and consumption of the product.

We can still find other products, whose preparation in microwaves causes doubts for its consumers. However, with advances in package technology, it's possible to find foods like spring rolls, French fries, pizzas and Mexican tortillas (Picture 4.25) all to be prepared in a microwave and without losing their crunch. This is done by using packages with known accessories such as heat susceptors, based on metalized films or special coatings. The heat susceptors absorb microwave energy and heat up to high temperatures, transferring heat to the product in contact and around it. (ZUCKERMAN; MILTZ, 1996).

PICTURE 4.24

Package for heating and direct consumption



Source: Press Release

PICTURE 4.25

Packages with heat susceptors for microwave heating



Source: Press Release



On-the-go consumption

Among the many factors that drive trends, a diminishing in family size and a change in lifestyle has been observed. People are more and more looking for quick meals, compensating for this in a way by spreading meals throughout the day. Despite from some cultural variation, generally consumers are tending to commute longer distances and to fill their free time with more and different kinds of leisure activities (BLAKE, 2006). To keep up with this demand, on-the-go packages came about. Such packages need to be compact, easy to open, and in some cases be able to be reclosed, so that the entire product doesn't have to be consumed at once.

The drinks industry must also be prepared for on-the-go consumption. Although packages for this product are inherently transportable, there are options

which allow better convenience, offering packages less likely to break and easy to consume (ANNETTE, 2008).

An example of this is Hardy's Shuttles wine package (Picture 4.26), containing a single portion for consumption, 187 ml, in a glass bottle closed by an acrylic cup. Twisting the top, the bottle is opened and the cup is freed for consumption. Other examples, as an alternative for glass, are the bottling of alcoholic drinks in composite (Picture 4.26) and metallic packages.

On-the-go consumption paired with the possibility of split consumption can be seen in Frappuccino glass bottles (Picture 4.27) from Starbucks Coffee. This bottle also has the sustainability appeal, as the consumer reuses the package, and the association of glass with products of higher quality.

PICTURE 4.26

Sophisticated drinks for on-the-go consumption



Source: Press Release

PICTURE 4.27

Packages for on-the-go consumption with sustainable appeal on reuse



Source: Press Release



Icons of packaging items easily associated with on-the-go consumption are caps used in sports drinks. There are already many products on the market but it is possible to find some innovations, like the Powerade silicon valve cap, from Coca-Cola (Picture 4.28). Besides showing a form which allows usage during sports practice and a label which allows you to see how much is left, the cap shows other qualities making it stand out from the crowd: flip-top opening with more than 180 degrees, flux valve, double tamper-proof system and a sealing system which eliminates the aluminum seal for hot filling systems. The cap can be opened and closed with only one hand.

PICTURE 4.28

Packages for on-the-go consumption



Source: Press Release

Still regarding the on-the-go consumption, there are collapsible packages, not only after consumption, with the appeal of sustainability by discard volumes reduction and also having the product transported in its most compact form possible. As an example, we have the Accordion Package project of a foldable package (YANKO DESIGN, 2012). Made for dry products, like soups, the collapsible package containing the product can be extended to the addition of water and the consumption of the product directly from the package (Picture 4.29). Another interesting project is Coffree, a sachet which transforms itself into a cup, by simply adding hot water; the tab containing the instructions works as a handle (Picture 4.29).

PICTURE 4.29

Portable packages



Source: Press Release

In Brazil, there are already many items for on-the-go consumption, like the Pocket Polenguinho cheese, in an easy-open pack containing two pieces of the product. Also, there is the Fast line from Nestlé, for dairy drinks, with a strong appeal to on-the-go consumption, “any time, any place”. They also had an excellent development in interaction with the consumer through their website, with music and games, as well as mobile apps with information about their products.



PICTURE 4.30

Brazilian packages with on-the-go appeal



Source: Press Release

PICTURE 4.31

Healthy on-the-go foods – Drink'n'Crunch and Cereal on-the-go



Source: Press Release

Another important factor influencing on such consumption is meal substitution. The market for cereal bars is one of the main beneficiaries in this respect, leading to the development of new products and consequently creating packages that attend to its consumers. The Kellogg's company offers cereal in individual portions, ready for direct consumption from the cup, the Drink'n'Crunch (Picture 4.31), needing only the addition of milk. Another example is from Cool Gear International; the package contains a foldable spoon and it is divided in two parts. The upper part contains the cereal and the lower part contains milk, keeping it cool with a gel present in the lower chamber (Picture 4.31).

On-the-go consumption does not just involve the food and drink market. Personal hygiene, cosmetic and pharmaceutical sectors must also be in tune with this trend. The package can be used as an important tool to differentiate from other products. For example, the company Jordan with a portable oral hygiene kit contains a foldable brush and a tooth paste (Picture 4.32). Another example is the sale of sunscreen in pouches with cap, offering more convenience when carrying in bags, purses etc., and allowing them to be reclosed.

PICTURE 4.32

Portable oral hygiene



Source: Press Release



Bringing the restaurant to home

Nowadays, the consumer has a large number of options to have meals without leaving the house. There are many reasons for this attitude, like easiness and safety, mainly in large urban areas. Besides delivery systems implemented by restaurants, there are specialized websites which concentrate access to different establishments, allowing the client to choose the meal. Furthermore, many restaurants have invested in the presentation of their take-out products, as much

the visual factor as the ease of consumption. An example of this is the Danish restaurant's Sticks'n'Sushi (Picture 4.33). It provides an excellent visual along with the practicality of a system of mini trays, keeping the dishes organized and separated from each other.

In the same way, Sta-Pack, from BMJ in Indonesia, offers separated compartments for its dishes without compromising the ease of transportation (Picture 4.34).

PICTURE 4.33

Package for transporting ready meals



Source: Press Release

PICTURE 4.34

Stackable packages for ready meals transportation



Source: Press Release

Interactivity

The concept of interactive packages is related to the fulfillment of multiple functions and requires or invites consumer involvement. Besides the protection and exposition of the product's brand, the interactive package adds value. The interactive role that package plays relates to providing information about the contents or engaging consumers through creativity and fun (RAITHATHA, 2009).

Regarding information, we find interactive packages ranging from simple to technological. Examples of the simple packages can be found easily at sale points, like packages with information in Braille.

They can be found on the most diverse products and available in many materials from cardboard, used, for example, in frozen meals and cereals, to metallic and glass packages like in chocolates and jellies (Picture 4.35). There are also information systems through two-dimensional codes, like QR codes and Matrix Data (Picture 4.36), described in the Quality and New Technologies chapter. Such codes allow the consumer to access many product information, like origin, nutritional value etc.

Another example is Nestlé's KitKat, for mailing (Picture 4.37), which comes designed as a postcard



that the consumer fills out with a message and other information and sends as a present.

And for kids, the WarHeads Double Drops bubble package (Figure 4.38), which comes in two flavors, the product may be consumed separately or mixed.

On the subject of entertainment, the package can be used as a tool of many possibilities. It's nothing new as it's been a good while that this concept is used, like in cereal and jelly packages, and was aimed at the kids market. However, new technologies, including internet, cell phones, tablets and other devices, allow a higher level of interaction. It's possible to create personalized labels on websites, like with Pringle's chips or Jones Soda (Picture 4.39).

PICTURE 4.35

Information in Braille



Source: Press Release

PICTURE 4.36

Examples of two-dimensional codes



Source: Press Release

PICTURE 4.37

Package to be mailed



Source: Press Release

PICTURE 4.38

Interactive package aimed at kids



Source: Press Release

PICTURE 4.39

Label personalized with the cover of this document



Source: Press Release



Another example of consumer interaction is the use of electronic print technology. Together, Innovia Films and PragmatIC Printing companies developed a biaxially oriented polypropylene label (BOPP) with printed logic circuits. Amongst the infinite possibilities of use of this technology, the initial prototype consists of a label which activate a sequence of lights that flash when in contact with the consumer (Picture 4.40)

PICTURE 4.40
Printed electronics



Source: Press Release

Simplicity and ease of information

The new consumer has their convictions and arguments, since he wants to and can control his own life. He no longer believes in a simple declaration; he rejects marketing arguments that are misleading or questionable. He wants transparent, simple and intelligible information. He also rejects quite complex information and values producers who give comprehensible and honest information about their products. Thus, the consumer looks around more and looks for symbols on the package which help in choosing a product.

One way of promoting simplicity and to make the purchase process easier for the consumer is to develop a package easy to understand and identify (HORTON, 2008). Package users search new types and designs that offer simplicity, cost and material reduction, without losing the benefits of convenience and sustainability. Besides this, consumers usually get confused when bombarded with an unending list of characteristics and

benefits that each product has (PIRA INTERNATIONAL, 2009). In this way, simplicity is a trend in the package area, but with a focus on the item and not the brand, attempting to attract the consumer by the intelligent use of photography, prints, transmitting the benefits of the product in a subtle way. Brands from some of the big supermarket chains are good examples of this (Picture 4.41). They offer quality items, usually made by companies of high repute, but focusing on the product, showing cost benefits from the economy of its own packages, marketing and other factors.

Another example of simplicity is from the English company Yorkshire Provender Soups (Picture 4.42). The original package displayed a “from farm” positioning to the consumer, with some visibility of the product on the lower part of the label, which covered the package. The newly developed package brought a significant visibility of the products and increased the brand’s recognition (HILL, 2010).



PICTURE 4.41

Private brands – simplicity of information



Source: Press Release

PICTURE 4.42

Simplicity of information – original package (above) and new package (below)



Source: Press Release

Individual portions

The increase in the number of single person households and a more complex urban life has created a demand for products in individual portions (RAITHAHTA, 2009), especially with food. Besides the association with the minor expenditure at the purchase, this type of package allows for varied choice in houses where there is more than one person, i.e., each individual, or each consumer in the residence, can choose their own meal (RAITHATHA, 2009).

Uncle Ben's developed a meal kit (Picture 4.43), released on the German market, which includes rice and sauce in different parts of the package, which simply needs to be heated in the microwave before consumption.

Yutaka's Sushi Kit is another example of a single portion meal (Picture 4.44). The kit has all the ingredients needed to make sushi, in individual packages: miso sauce, ginger, soy sauce, horseradish, nori, rice and sesame. Moreover, it contains utensils for consumption.

PICTURE 4.43
Individual meal



Source: Press Release



PICTURE 4.44

Sushi kit



Source: Press Release

Individual portions can also be used as a convenient way to benefit the consumer's health (BLAKE, 2006) and the package can be a tool for this. The company Protica, specialized in nutraceutic research and innovation, offers many products in individual portions, like high absorption proteins in the form of drinks and jellies (Picture 4.45). The portioning can also be carried out in terms of calories, like, for example, the "100 calories" line from Mabel (Picture 4.46).

Another area where individual portions are relevant is the third age consumers' market. Japanese company QP Corp developed individual portion products keeping this group in mind: soft foods, easy to chew and swallow, nutritionally adequate, with easy to read information and, in terms of convenience, apart from portioning, are foods ready for consumption after simply heating (ANNETTE, 2008).

In the kids' market, packages are attractive, fun and, in general, have a health appeal like, for example, Foodles from Crunch Pak in partnership with Disney. This product comes in an individual portion, with many compartments, mixing products such as fruits, vegetables, cheeses, yoghurts and cereals (Picture 4.47). There are also innovations in baby food. Plum Organics, apart from innovation in individual portions packaged in pouches, developed a system for direct consumption from the package, simply needing to directly attach a small spoon at the opening of the pouch (Picture 4.48).

PICTURE 4.45

Nutraceutics in individual portions



Source: Press Release

PICTURE 4.46

Calories portioning



Source: Press Release

PICTURE 4.47

Individual portion with a healthy appeal



Source: Press Release



PICTURE 4.48

Individual portion with ease of consumption



Source: Press Release

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Chapter 5

AESTHETICS AND IDENTITY

We are facing a new challenge. Consumption will be influenced by many factors over the coming years, all having the “modern consumer”, with his wider conscience, demand levels and constant search for information that will help the purchase decision, as the focus. This is why it is necessary to see the consumer as a complete human being, with needs, desires and feelings, in search of an objective gratification which positively meets his demands and also subject to emotional development.

In recent years, consumption in Brazil has changed. We still face disparities in income concentration, but, on the other hand, we have a growth in the number of people in the A and C classes, with more expression in class C which is moving the consumption. Besides this, we can mention other factors that will influence consumption in the next years, such as more young childless couples, people

living alone, third age consumers, the advancement of women in the technology and work market, or social networks. Today, we live in what could be called the “second screen phenomenon”, defined by the habit of watching TV and surfing the internet simultaneously, in other words, consuming TV socially and sharing with an audience on social networks.

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DANTAS, F. B. H.; JAIME, S. B. M. *Estética e identidade*. In: BRASIL pack trends 2020. Campinas: ITAL, 2012. cap. 5, p. 107-137.



The new consumer has a bigger conscience, bigger needs and always looks for information that helps in purchase decisions (UNIVERSITY OF SÃO PAULO, 2011). A deeper analysis which turns into an essential tool for innovation in companies is to see the consumer as a complete human being, with needs, feelings and desires who expects to be satisfied with the products chosen at the moment of purchase. He searches an objective gratification, which positively responds to his needs, and also subjective gratification, which promotes feelings of realization, closeness and emotional involvement (MESTRINER, 2012).

Some of these consumers demand products with a higher aggregate value, with status symbols, which show a sophisticated lifestyle. The *premiumization* of products and, consequently, of the package reflects this consumer demand for products of a higher quality, associated with luxury, indulgence and hedonist consumption. In the globalized world, the consumer wants to be included, to feel part of the group, and adopt a certain lifestyle. Personal identification with the product or with the celebrity promoting it can create this feeling of “being part of a group”.

Another lifestyle which deserves to be highlighted and which moves the product and package market is that which values quality of life and well-being, resulting in the search of products which can bring some health benefits, that show information on origin, which show the quality aspects, with healthy and natural ingredients.

Styles which can be considered disconnected, but which have the same effect – consumption, can find that packages contribute significantly, transmitting, communicating and connecting the product or the brand to the consumer.

The package reflects the brand positioning in the market, reinforces the consumer’s perception, transmits security, stands out and appeals to the consumer by means of aesthetic renovation of colors, shapes, images, graphic designs etc., in an unequivocal sensational stimulus. Aesthetic or aesthetically different packages significantly increase the consumer’s reaction time and awaken the immediate desire, independent of the price (REIMANN; ZAICHKOWSKY; NEUHAUS et al., 2010).

Table 5.1 shows the featured trends, such as the unfolding of the Aesthetics and Identity megatrend and the possible contributions to packages.

5.1 PREMIUMIZATION Luxury, Indulgence and Hedonistic Consumption

Luxury Packaging

The increase in middle class purchasing ability in emerging markets and the valuing of consumption for products with a better aggregate value allows for the acquisition of new types of foods being packaged; before they were seen as being very expensive and even as an unnecessary luxury (SARANTÓPOULOS et al., 2010). With consumer income being more available, there has been a strong demand for premium products, which reflects social position but at the same time offer indulgence and satisfaction. A luxury product or service gives distinction to who uses it, which in turn

gives pleasure, exclusivity, elegance, desire, rarity, excellence, prestige and even need.

The Brazilian luxury market’s taxes have increased from 20 – 25% in recent years due to a series of factors such as the 2008 recession, the current situation in the EuroZone and the enlarging of the Brazilian middle class. Notwithstanding, Brazil still has a large resistance to luxury products made outside its borders, impeding an even larger growth in this sector (CESA, 2012).

Consumer demand for higher added value goods reflects also on higher quality products with and indulgent

character. These demands or factors of influence on the market have created the term *premiumization*, which relates to the new consumer needs – “Accessible luxury”. The premium product will differ the consumer from his peers, the reason why it is so attractive (HILL, 2010).

Premiumization is not only focused on luxury brand categories, but also on lower priced products. This has been named “accessible premium”, satisfying consumer demand for a quality and innovative product, without needing to spend a fortune.

To transmit a sensation of purity, the transparency of the glass package is often combined with attractive and exotic and, in some cases, luxury shapes to maximize the premium quality and sophistication of certain products, exploiting the prestige and authenticity of the brand.

Products sold in glass containers with a trend of offering luxury and sophistication are often from the alcoholic beverages section. Some vodka packages

illustrate this sophistication perfectly. In 2011, the company Indústrias Reunidas de Bebidas Tatuzinho, owner of the Velho Barreiro brand, bet on this trend and developed the bottle for its product Diamond, coated in a woven mesh of silver and gold studded with 211 gems and a 0,7 carat diamond encrusted in the centre. These are limited edition packages – only 60 units, and reinforce the product’s identity. The luxury version of this product costs R\$ 212 thousand (approx. US\$100 thousand) and even before release, two units were already reserved for Brazilian businessmen. With the launch, the company was hoping to call attention to Brazilian cachaça and value the product as a premium drink, able to compete with best distilled drinks of the world, increase export value and enter the Velho Barreiro brand in the history of Cachaça (ROSA, 2012) (Figure 5.1).

Table 5.1
Aesthetics and Identity – unfoldings and contributions of the package

Featured trends	Package Contributions
Premiumization	packages that transmit sophistication, luxury, premium quality, prestiges for the masses: masstige.
Packaging renovation	multisensory packaging design; differentiation, aesthetic effects, color and material extravagance, high quality printing.
Pleasure experience	invite to indulgence, to guiltless pleasures; packages that promote new sensations and emotions, escape the norm.
Life-style packaging	packages that can be associated with a healthy lifestyle and well-being; which evoke trust and security; apparent naturalness, retro image.
Personal identification	idols consumption; be our guest; limited edition packages.



FIGURE 5.1

Premium packages - drinks



Source: Press Release

Another product showing this premium tendency came from *Bling Drinks* H2O, which developed a glass package for water, decorated with Swarovski crystals (Figure 5.2). The glass package, besides transmitting sophistication and luxury, drove characteristics of authenticity and prestige for the brand.

FIGURE 5.2

Premium packages - drinks



Source: Press Release

Beauty is one of the areas which is growing the most in the Brazilian luxury market, especially the fragrance and cosmetic sectors. The package for *Gold Rush* enamel from Models Own, coated in gold and incrustated with 1,118 diamonds, is sold in Jewellers (Figure 5.3). In this same line, DKNY created a perfume vial for US\$1 million, sculpted in 14 carat gold, with more than 2,900 precious stones forming the New York skyline (O VALOR..., 2011) (Figure 5.3).

FIGURE 5.3

Premium packages - cosmetics



Source: Press Release

Shiseido, the largest cosmetics company in Japan, celebrated 30 years in the line of *Cle de Peau Beauté* products last august, by putting three 50g pots of *La Crème* on sale, for a measly 1,050,000.00 Yen each, that's more than US\$ 13 thousand (Figure 5.4).

In Brazil, the line Make B. from O Boticário, presents products with an exquisite design and practical solutions. The highlight is the *Swarovski* crystal put in each package, associated with the contrast between the black color and the holographic effects (Figure 5.4).

FIGURE 5.4

Premium packages - cosmetics



Source: Press Release



Hedonist consumption: Packages as a source of happiness

Hedonist consumption is defined by the principle of satisfaction and the use of products and services that bring intrinsic pleasure. Consumption no longer being a way of resolving a need, but for the wish of happiness, even if momentary (RIEPING, 2012).

The main characteristic of hedonist consumption is the search for immediate pleasure, satisfying one's feelings, stimulating all emotional aspects. An extremely clear example of hedonist consumption is: after a work shift, a consumer goes to the mall to browse. Generally this browse costs her one product which she acquires while passing the window displays. She passes in front of a sweet shop and thinks "I'll buy a box of chocolates because I deserve it." This is a clear statement that this consumer was looking for a product to bring her pleasure. In this light, the design of the product must, besides functionality, incorporate a sensational experience into the product.

Innovations in shape and size, together with technical advancements in printing, will highlight products against the competition, revitalizing the brand, will increase the appetite appeal and attract the consumer. With this, the item will have a premium product position in the market and will have a bigger differentiation when compared with other products.

An example of products with an extreme indulgence in the packages is Gü's desserts (Figure 5.5). The image printed on the dark and matte cardboard packaging, along with the print quality, conveys the excellence of the ingredients used and creates a look and attractive feel in the eyes of the consumer, highlighting the unique and refined taste of their desserts.

Taste for refined products, pleasure and satisfaction are the hallmarks that define the trend for search for "indulgence without guilt" products (adding new attributes to lower rejection of items which are high in calories, fat etc., or reducing portion or package size), products with different flavors and textures (gourmet products), interactive products and exotic products that

enable new sensory impulse and escape the everyday (HILL, 2010; REGO, 2010).

Chocolates cause these feelings, especially when associated with superfruits like pomegranate, acai and raspberry, highly valued for their antioxidant properties. The company Brookside combines dark chocolate with these three fruits and utilizes a flexible package that can be self-sustaining (stand up pouch) or not, with a very attractive photo (Figure 5.5).

FIGURE 5.5
Packages for indulgent products



Source: Press Release

Another good example of an "indulgence without guilt" product which used packaging resources to attract consumers is the *Five* line of ice cream from Häagen-Dazs, which, as its name implies, is made with only five ingredients: milk, heavy cream, sugar, egg yolks and ingredients that give it flavor (mint, vanilla, caramel etc.). Furthermore, the clean and refined layout of the package reflects the brand's architecture and translates the concept of the new product (Figure 5.6).



FIGURE 5.6

Packages for “indulgence without guilt” products



Source: Press Release

The consumer can also quench the mental and emotional pleasure and even provide new experiences. There are products that promise to remove the consumer from routine, relax the mind and seduce the senses, such as Lull, a blend of botanical extracts and fruit juices with antioxidant power that promises to relax the mind similar to a day at the spa. For Lull, the package used is an aluminum bottle with easy-open metal lid, which facilitates on the go consumption (Figure 5.7).

Another example of a product that can lead the consumer to new experiences is a drink based on ancient wisdom, Jianchi, from Coca-Cola, available in three flavors for each expectation: serenity - intense relaxation and to help find serenity when the days get complicated; transparency – to purify and help gain balance and positivity in all circumstances, and force – to illuminate and recover from daily stress. The packaging consists of a PET bottle with a screw cap and sleeve label with vibrant colors, aseptically filled (Figure 5.7).

The drink *Slow Cow*TM has a relaxation objective that helps in improving memory, concentration and learning capacity without causing sleepiness. The drink contains no calories, has no caffeine, no sugar and no preservatives. It contains L-Theanine, an amino acid and glutamic acid compound, which induces relaxation without drowsiness. It also contains linden and hops, which help reduce nervousness. The product is packed

in 250 ml two-piece cans, of slim format, with a clean visual and a metallic finish (Figure 5.7). In October 2011, the company unveiled the new package and the addition of the NPN sign (Natural Product Number) on the label, a license granted by Canada to certify product safety, effectiveness and quality under conditions of recommended use.

FIGURE 5.7

Products for relaxation of the mind in new sensations



Source: Press Release

New sensations may also be offered by retailers through interactive machines that provide product samples and are able to create more relevant and entertaining experiences at the point of sale. The goal is to promote visually stunning experiences that engage shoppers. Kraft Foods and Intel developed the DIJI-TASTE Sampling Experience, a cube-shaped kiosk that distributes product samples based on audience data (Figure 5.8). The interactive kiosk detects the user's age and offers a dessert sample. It allows up to four users to access the system simultaneously (Figure 5.8). Macy's store, which sells cosmetics and perfumery, is testing stations called Beauty Spot that assist consumers to evaluate cosmetics and fragrances. The use of visual elements is an important tool for providing recognition and brand identification as it was discovered that some women prefer to explore beauty products on their own, however, this is not always possible



when products are placed out of reach or are behind the counter (Figure 5.8).

Other aspects of hedonistic consumption are related to health and well-being diets, with improved physical appearance and beauty. In such cases, the packaging must be clear enough to convey to the purchaser and future consumers the purchase benefits. The ViaVienté, 5Alive and Beauty Candy products are examples of where you can observe how packages can attract the consumer's attention (Figure 5.9). Beauty'in

is the brand of “cosmefoods” (foods with cosmetic properties) created in 2010 and Beauty Candy is a collagen-based bullet that had their packages of 150 grams exchanged because the old stand up pouches confused consumers. According to the brand owner, consumers mistook the bullets in the old packaging with cosmetics refills. The new package is a cartridge (more like food packages) and the window facilitates product identification by the consumer (MAIS..., 2012).

FIGURE 5.8
Interactive Machines



Source: Press Release

FIGURE 5.9
Packages for well-being products



Source: Press Release

5.2 PACKAGING RENOVATION

Use of symbols, colors and special shapes

The use of visual elements is an important tool for providing recognition and brand identification. Packaging is one of the most important intermediaries between the consumer and the brand, is their first contact with the product. Thus, the companies should seek to differentiate with innovative and high impact designs in order to highlight their products among the options available in retail outlets.

To build a brand identity efforts should be directed towards the creation of a symbol or logo combined with

expressions that define its essence, personality, style and competitive positioning. The brand identity can be constructed through names, letters, emblems, pictures or symbols able to differentiate it from other brands and provide its rapid recognition, as in the examples shown below (Figure 5.10). A brand should always be linked to the image of the company and represent the consumer expectations through cognitive resources (HILL, 2010; SERAGINI, 2010; BRANDT, 2010).



FIGURE 5.10

Identities of consolidated brands



Source: Press Release

FIGURE 5.11

Examples of package shapes that have become market icons



Source: Press Release

The choice of packaging material, for example a plastic, metal, glass container etc., is usually done according to the product characteristics and protection requirements. However, a wide variety of formats can be found within the same category.

In each category there is the option for choosing a standard or unique format shape, because in this case, there is still the possibility of product differentiation through the use of special labels, seals and closures. In many cases, a simple and functional packaging format offers a projection mark and can ensure consumer loyalty.

However, the preparation of a different structure or format can enhance brand value in a unique way and impact the brand perception and recognition.

As examples, we present the unique shape of the Yakult packaging, Toblerone chocolate and Absolut vodka, without forgetting the traditional Contour format of the Coca-Cola bottle, among others (Figure 5.11). These are examples of packaging formats which

have become icons and which have led to the quick identification of the mark by the consumer.

Therefore, the macro tendency related to the use of symbols and special shapes looks for brand identification and recognition by means of the package, in order to differentiate and express the product's quality, authenticity and personality.

In many cases, especially in the categories of products, innovation in the structure or shape is used to challenge the limits of package design (HILL, 2010).

This trend is quite strong in the cosmetic category that utilize packages with unique and exclusive formats to create a clear differentiation of their products from other brands within the same category. As an example we present the Nina Ricci perfume designer labels, with lavish packages that represent the urban woman in vibrant color, Jean Paul Gaultier, which explores the elegance of feminine curves in the shaped bottle, and Vivienne Westwood, with a unique gold crown or scepter style lid (Figure 5.12).



FIGURE 5.12

Packages for perfumes for unique and exclusive shapes



Source: Press Release

As with the cosmetic market, the search for unique and differentiated shapes is a strong trend in other package category to ensure the recovery of the product, attract consumer attention at point of sale and the brand successful. Although the food and beverage market avoids heavy investments in new package developments, due to lower profit margin and higher turnover of product, betting that direction ends up being a resource against a backdrop of reduced funding for advertising (FORÇA visível., 2011).

Premiumization stimulates the development of new and attractive packaging for food and beverages. The packaging innovation, in turn, plays a fundamental role in influencing the purchase decision. To meet a specific market demand, the shape of the package can be developed with the objective to explore the sophistication and luxury of some product categories. Attractive and modern options, differentiated by the shape and aesthetically pleasing also have been the target of many developments in various segments of packaging in the world market (INNOVATIONS., 2010).

Premium fruit juice category is also betting on different ways to increase brand recognition. Examples include packages from French company Père Juice that mimic the shape of a pear to emphasize that the product is 100% natural; from Gloji, an energy drink based on Goji Berry, an exotic fruit from China, which at

first seems like a perfume, and which bet on a different shape to reflect the natural quality, the absence of artificial additives and the product energetic properties; and the example of POM Wonderful 100% natural pomegranate with its unique format, which refers to pomegranate and demonstrates the brand's personality for not being a usual product (GLOJI, 2012; ROLL GLOBAL, 2012; SUNRISE PACKAGING, 2012) (Figure 5.13).

Differentiation can also be used in the fresh products line. American company Live Gourmet, with its package in the shape of a square and a circle) in addition to achieving greater visual prominence to its products, made gains in space optimization, improvements in its automatic packaging system and even provided easy handling and closing to the consumer (Figure 5.13).

FIGURE 5.13

Packages with distinct shapes to represent premium and natural



Source: Press Release



Alcoholic drinks is another category seen constantly innovating in modern and aesthetically pleasing shapes, like packages for Rosé and Verde wines from the Lagosta brand, re-created with the objective of modernization and targeted to a more refined audience; another example: Ultra Premium Vodka, from Roberto Cavalli, a sophisticated Italian product and marketed in glass packaging with a snake coiled around it; Samurai vodka, presented in glass packaging that appears to have been cut in half by a sword, and the package for the liquors brand, SX Latin liquors, which explores in its curvaceous shape feminine sensuality during dancing (BUSINESS INSIGHTS, 2010; BAILADO Sensual..., 2011) (Figure 5.14).

FIGURE 5.14

Packages that show modern, pleasing and sensual shapes



Source: Press Release

Another trend associated with shape is to explore the functional aspect of the package, such as ease portability, handling and optimizing the feel in the hand, for better premium positioning of the brand and differentiating itself in retail outlets. The ergonomic shape is especially important for packages for sporting and on-the-go consumption (Figure 5.15). Other examples are glass containers for olive oil Dama Hojiblanca by Sandeleh Food, an ergonomically shaped handle which facilitates its use, the packages for Mojito cocktails in a different shape, and packaging for cappuccino Três Corações brand in a non-cylindrical shape,

ergonomic and compact (BUSINESS INSIGHTS, 2010; BUSINESS INSIGHTS, 2011; CAPPUCINO ..., 2011) (Picture 5.15)..

FIGURE 5.15

Packages with functional and ergonomic shapes



Source: Press Release

Packaging designs with unusual shapes and differentiated have become a very useful tool to ensure the visual appeal for products geared especially for children (BUSINESS INSIGHTS, 2011). In the quest for differentiation, the format of the package can also be directed to the playful and entertainment aspect, such as those for personal care using characters from movies or television to attract public attention from children and captivate adults for its quality and visual appeal (Figure 5.16).

In the Brazilian market, the search for identity and brand recognition has been constantly explored in the packaging of various products with special shapes and made from different materials, thus ensuring its innovative character, visual appeal and differentiation from the other products in the same category (Figure 5.17).



FIGURE 5.16

Examples of packages which explore a playful and entertainment shapes



Source: Press Release

FIGURE 5.17

Other examples of packages that search differentiation by means of shape



Source: Press Release

Colors and Images

Inside the aesthetics and identity macro tendency, the use of colors and images is an important tool for building brand identity and ensuring consumer loyalty and positioning through a unique appearance.

Colors and images are used to obtain a unique and exclusive graphic design, with power to express the value and brand personality, as well as provide information

about the product features. Among the options, is the use of different colors and illustrations (on the package or by using labels / printing techniques) and still underexplored resources in Brazil, corresponding to the use of photography and typography (HILL, 2010).

Color is one of the most important tools for the development of the design concept of a package, usually



employed to stimulate the association of the brand to the product (natural or environmental appeal), awakening feelings and expressing its personality, captivating and influencing the consumer in the purchase decision.

Two major trends are seen in the use of colors and images in graphic design packaging. One is the unlimited use of strong and striking patterns, to attract consumer attention and / or forward the premium appeal of a given product category. Another trend is the use of a limited number of colors for the product category associated with the aspect of healthiness or with sustainability appeal.

The use of striking colors, carefully selected to create distinct brand identity, was completed on premium product packages from the Archer Farms portfolios in the United States, which also made use of the option to keep a die-cut window to reveal the product (HILL, 2010) (Figure 5.18). In Brazil, the Pullman brand introduced a new package for its product, Bisnaguito, who gained a vibrant color and was highlighted as the brand's mascot, seeking a closer relationship with the consumer, combining modernity with tradition and offering more visibility in retail outlets (Figure 5.18). The packaging portfolios for sweated condensed milk and cream, Parmalat brand, has also been revamped with new colors and a design to highlight the products in retail outlets and attract the attention of consumers (EXAME.Com, 2012) (Figure 5.18).

The trend of limited colors was used on packages of English snacks brand Bear to convey an aspect of being 100% natural, free from added sugar, preservatives or additives in products. With matte finish and limited colors to indicate the simple and natural aspect of the product, the packaging reflects the brand's personality (HILL, 2010) (Figure 5.19). Moreover, the use of limited colors is a feature favorable to products with a sustainable appeal, as the reduction or absence of pigments in packaging facilitates the material separation and recycling process. It was demonstrated by the beer brand Itaipava with the AMA Project logo design (Environment Mobilization Area Project), which aims to preserve the environment (EXAME.Com, 2012) (Figure 5.19).

FIGURE 5.18

Packages with striking colors to create distinct brand identity



Source: Press Release

FIGURE 5.19

Limited colors to represent the healthiness or environmental appeal of the product



Source: Press Release

Marketing techniques indicate color separation into three groups: warm (red, orange and yellow), cool (green, blue and purple) and neutral (monochromatic colors like black, gray and brown) which are usually associated certain values and feelings to attract consumer attention. The green color, for example, has a strong bond with the balance and nature and, therefore, is commonly used in products that are natural, healthy or with some ecological appeal. The natural brown paper or paperboard is also used in some cases for



that purpose. The blue color arouses feelings of loyalty, trust and friendship, and red represents dynamism, is stimulating, passionate and exciting and can be used to highlight specific points to attract attention (MARCONDES, 2011; HILL, 2010).

The color can even be given through the addition of pigments to the packaging material itself. This technique is constantly observed in the market of glass containers, with the development of special colors, either to confer light protection to sensitive product, to promote the image or highlight the key attributes of the product. As an example, the blue color of the glass bottle for water from Elisabethen Quelle, in Germany, was used mainly to highlight their purity and freshness attributes (Figure 5.20). In order to strengthen output growth in the Brazilian market, the extra virgen olive oil, Gallo brand, has invested in a darker glass bottle to better preserve its quality against direct exposure to light (Figure 5.20).

FIGURE 5.20

The use of color in glass to highlight the *premium* quality of the product



Source: Press Release

In the Brazilian market, an example of this trend for plastic packages is that of PET bottles for water, Ouro Fino brand, who bet “on being different” and broke sharply from standard colors usually used in

packages for mineral water (clear, blue or light green) to highlight and open new markets (MARCONDES, 2011). In this case, the company also bet on the differential by the shape of the package. Another example is the black PET bottles for energy drinks (Figure 5.21).

FIGURE 5.21

Colored PET packaging for drinks



Source: Press Release

Illustration is another option used to indicate the nature and quality of a product. With more sophisticated illustrative shapes the personality of the brand can be conveyed, highlighting itself at the points of sale and increase the product appeal. Below are some products that have adopted a strong illustrative style, with the aim of demonstrating the brand identity. An example is the brand of handmade cookies, Two by Two in the UK, which aimed at increasing public interest from children, using illustrations of animals from traditional tales and fables, and each picture of the animal represents the shape of animal cracker sold (Figure 5.22). What On Earth is another UK brand that introduced a simple and beautiful concept package for organic food. The package was produced in gray tones on a plain background to represent the organic nature of the food; the package also has a label colored to indicate different types of products (Figure 5.22).



The illustration in the package can be employed as paper labels or shrink sleeves or no-label-look type (which does not appear to be a label). The shrink film remains an excellent choice due to its high quality graphics, scratch resistance and can be used to decorate unusual shaped containers in a way that is not possible with conventional labeling techniques. An example of an unusual shaped bottle and shrink film is presented by the products of flavored water brand SoBe Lifewater, from Pepsico, obtaining a perfect alignment of the body and tail of gecko (trademark of product) along the spiral indentation that runs along the body of the bottle (THE PLASTIC ..., 2011) (Figure 5.23). The use of the shrink sleeves involving the whole package (sleeve) with vibrant, cheerful colors, and high print

quality can be seen in the example of the Zipp Vitalize portfolio, whose graphic design exploited the image of a zipper to reveal the product flavor (HILL, 2010) (Figure 5.23). In Brazil, this trend is explored a lot in plastic bottles for yogurt and milk drinks. It is possible to use shrink sleeves as a tamper evidence feature, surrounding the container's body and closure system, for quality assurance and product safety. As an example of no-label-look, the beverages brand 51 Ice Balada had a label on its bottle developed in BOPP and printed with special ink and high quality. The company Campari also started producing Infusion vodka in Brazil in glass bottles with self-adhesive no-label-look labels, with the addition of a cobalt blue color in the glass (EXAME. Com, 2012; CAMPARI..., 2012) (Figure 5.24).

FIGURE 5.22

Products that use differentiated illustrations to promote the nature and identity of the brand



Source: Press Release

FIGURE 5.23

Products that use illustrations in shrink films labels



Source: Press Release

FIGURE 5.24

Products that use no-label-look labels



Source: Press Release



In some cases, changes that would modify the texture and surface finish of various packaging materials to improve the perceived quality of the product are necessary. Among the options trends focused on the use of metallized material, combinations of matte and glossy effects in the same package or the use of textures that can be associated with nature or the tradition of the packaged product can all be highlighted.

For other purposes the matte finish can differentiate the packaging aspect from other products in the same category, taking it to a premium positioning. Examples include the glass containers for water brand Q Tonic and Cold Spring, with the latter having the matte effect applied on the ceramic label (ACL - Applied Ceramic Label) while keeping the “window” effect (transparency) near the label (INNOVATIONS. ..., 2010; HILL, 2010) (Figure 5.25). This technique is susceptible to be used, but this feature is still little explored in Brazil. The Sensations crisps portfolio from Elma Chips, in Brazil, knew to explore the matte effect on their packages, differentiating it from other products in the same category (Figure 5.25).

FIGURE 5.25

Packages with a superficial matte finish



Source: Press Release

The use of thermochromic inks and labels to indicate the recommended drink temperature for consumption is ideal to create a special effect or simply glow in the dark, is the option that has been constantly

used in the beer market, especially in limited or commemorative editions. An example is the beer can from Nova Schin, which was produced with a special paint technology similar to that used in fluorescent switches, which absorb light they are exposed in order to glow in the dark or under black light after (Figure 5.26). Another example is the label for glass bottles for beer brand Coors Beer and Coors Light produced with thermochromic paint to indicate the ideal temperature for consumption of the product, so that the white coloring of the mountain turns blue when reaching a temperature equal to or below 6 °C (Figure 5.26). Dutch beer brand Heineken has also launched an aluminum bottle called Star Bottle that glows under black light. The special ink applied to the packaging appears on the surface of the cylinder drawings showing shooting stars (Figure 5.26). The aim is to strengthen the brand concept for those who seek quality, taste, innovation, and especially style. The idea was to show their concern for creating the best experience when drinking a premium beer (INNOVATIONS., 2010; ... HEINEKEN, 2012; ... LATA 2012; EXAME.COM, 2012)

FIGURE 5.26

Packages that use thermochromic inks



Source: Press Release

Another graphic design option is the use of photographs, whose focus is to show, in a sumptuous manner, the product quality to stimulate consumer desire. Other approaches may be directed to indicate the authenticity and origin of the product and still present ways to direct them to a specific people group (HILL, 2010). This concept is still not widely used in Brazil, but one of the examples presented are the packages for the energy drink Firefly manufactured in England which, instead of showing the product flavor on the label by fruits (strawberry, orange etc.), it displays photographs of observations about the state of mind of those seeking for this beverage (Figure 5.27).

Another example is the food brand Via Roma, which made Tuscany and its inhabitants the focus of their packages, marking the Italian origin and authenticity of its products (Figure 5.27). The various photographs used create an authentic Italian image, with strong personality and expression of emotion to ensure the highlight at point of sale and consumer loyalty (HILL, 2010; EXAME.COM, 2012).

FIGURE 5.27
Products that use photographs in graphic design



Source: Press Release

Typography is another feature of graphic design used to create a distinctive image on the packaging, via a text graphically treated, and thus highlight the brand identity. The decision on using typographic features is directed to the desired form of communication, ie, it should represent the values of the brand so that it is perceived by consumers with readability and be distinguished on the shelves. One example presented is the packaging for juice brand Cawston Vale, from the UK, which relaunched its product portfolio with a new name, Cawston Press, with a new brand identity, aiming to draw attention to the premium quality of its products and to revitalize the sector (Figure 5.28). Sivaris is another product category, a rice produced in Spain, who revitalized and created a new visual identity by the typography and color in packaging tubes and seals common to the market (HILL, 2010) (Figure 5.28).

Therefore, the brand identity can be created through a variety of graphic design techniques and thus ensure the positioning of the product by means of a unique appearance.

FIGURE 5.28
Packages that renew their identity with the use of typography



Source: Press Release



5.3 PLEASURE EXPERIENCE – Sensory Stimulation

From a physiological standpoint, the multi-sensory is directly related to the five senses that translate the world to our mind, namely, vision, hearing, touch, taste and smell, and to enable any one of them or some of them at the same time there is the need for a stimulus. In a way, the packaging may be responsible for sharpening the sense of sight and touch, and depending on the situation, can also stimulate smell and hearing, leaving out only the palate, which is directly related to the product.

The introduction of relief in packaging materials has the primary function of highlighting the trade mark or the print product and also producing the same identification by touch, promoting their differentiation (USO DE ..., 2000). This process is known as embossing / debossing and is widely used in the beverage segment, especially in cans.

In 2011, the brewery Heineken launched an aluminum can for a beer called Touch, whose walls are finished in high relief, providing a sense of texture when handled by the consumer (Figure 5.29). The finished texture is the result of the application of a varnish and a special ink on the package. According to the manufacturer, a chemical reaction makes the varnish repel the ink, forming bubbles that create the embossed on the outer surface of the can. Besides the tactile aspect, texture also gives greater grip, especially desirable when the can is wet (MARCANTE..., 2011).

The same company also launched the K2 bottle, exclusive to the brand, replacing the long neck used in Brazil and the short neck used in other countries. The new package will be available in both standard and raised, but for the Brazilian market only the embossed bottle was adopted with a curved shoulder and back logotype (SENSIBILIDADE..., 2011) (Figure 5.29). Also in the beverage segment, but in a different context of multi-sensory, the American company Miller Lite introduced in 2010, the Vortex bottle, designed with special grooves inside the neck, creating a whirlpool when poured (Figure 5.30).

FIGURE 5.29

Packages with embossed labels



Source: Press Release

FIGURE 5.30

Bottle with grooves on the inside of the neck



Source: Press Release

Smell is another sense that can stimulate through the packages. According to the publication Business Insights (2010), the *i-wine* product, presented in the United Kingdom in 2008, proposes a guessing game by presenting labels with an odor that provide the necessary clues of the wine's grape variety. For this, consumers must scrape the label and smell the aroma of grapes (Figure 5.31).

FIGURE 5.31

Bottles whose labels give off an odor



Source: Press Release



5.4 LIFE-STYLE PACKAGING – Natural, Safe and Handmade

There is no doubt about the importance of the development of productive and industrialization procedures in the evolutionary process of humanity. Products are more readily available to people with more affordable costs due to large-scale production, with established quality standards. However, one can see that many current consumers search for a return to traditions: the memory of Grandma's recipes, the good times, the handmade, the natural, the simple, the return to traditional techniques of production, small scale manufacturing. In this sense, the industry must be aware of opportunities in each sector, whether it is from food and beverages, or other products.

Factors such as aging, scientific discoveries which link certain diets to disease, as well as income and life in big cities are influencing the pursuit of a healthier life-style, not only for the purpose of weight loss, but also spiritual, mental and emotional health through nutrition. In addition to eating, the quest for well-being is also a life-style. According to Lynn Dornblaser, Mintel (2012), 63% of American consumers were concerned about what they buy and 46% would like to find more recipes presented on packages. Brazilians also were concerned about what they consume in the survey by Fiesp / Ibope in 2010 (O PERFIL..., 2010), when 45% of respondents who were overweight said they were seeking a healthier diet. Women older than 45 years showed great concern for the health, being able to motivate deeper dietary changes.

For consumers, natural products are synonymous with what does not cause harm. In other words, something that is natural is considered healthier. Even though this is not always true, what consumers believe is important for the food industry. Therefore, everything that relates to natural is noteworthy and of use. Consumers also value the natural preparation and preservation processes that protect ingredients and their nutritional qualities.

There is still no legislation defining or regulating the products marketed as natural, but this is an inevitable process for national and international

organizations, so that the appeal of these products is 100% reliable. The natural denomination represents products without preservatives, colorings, sweeteners or artificial flavorings, without chemical additives and without hydrogenated fats, minimally processed and not irradiated (REGO, 2010). However, in Brazil, the use of expressions such as "natural product" is not permitted by the *Brazilian Sanitary Surveillance Agency* (ANVISA) as they are not already accounted for in existing legislation and may lead consumers to mistake the true nature of the product. According to the institution, the Brazilian legislation in the food sector is good, so what is not in it, is not allowed to be used in food (ANVISA, 2012).

In other countries, the focus of the information contained in the package is the inherent quality of the product, and the appeals more clearly describe specific attributes, for example, contains no additives, vitamin fortified, information around the word natural (all natural or 100% natural). Another approach used abroad is to explain what the product contains what the ingredients are and where they came from; for example, if it contains biodegradable surfactants derived from coconut or lecithin emulsifier derived from soy (DORNBLASER, 2012).

Generally, the word natural can mean many things, but the most important is that the information contained in it must be clear, consistent and transparent (Figure 5.32).

The company Belvoir Fruit Farms has a line of 100% natural beverages with the following appeal: "We press real fruits and cook ginger and lemongrass here on the farm, to ensure that our drinks have a real taste as if they were homemade". (HILL, 2010). Thus, the package must convey this message to the consumer. To do this, an exclusive glass bottle was developed, with relief details, a paper tamper evident seal on the lid and a hand drawn typography in order to create a highly distinctive "homemade" look and feel (Figure 5.33).



FIGURE 5.32

Products that bring natural expression to the package



Source: Press Release

FIGURE 5.33

A package which gives the homemade feeling



Source: Press Release

Another example in this line is the Donnyboy Fresh Food Company, also with fruit juices, the *Preshafruit*, whose differential is the process of obtaining the juice through the High Pressure Processing (HPP), keeping the characteristic flavor of the fruit with full retention of vitamins and a longer shelf life. Thus, the packaging, with high transparency, conveys a refreshing feeling; through its futuristic shape tries to pass to consumers the innovative process used in its manufacture (Figure 5.34).

FIGURE 5.34

Packages which show naturalness and innovation



Source: Press Release

The natural appeal can also be seen in the increased availability of fresh fruits and vegetables for consumption, which, coupled with the convenience of the consumer on the go (or *ready to eat fresh and healthy snacks*), provide growth of this segment.

The packages of these products are, for the most part, rigid and transparent plastic, and when the feature of modified atmosphere is used, the specification must consider parameters such as the size of the package in relation to the weight, the volume of head space in the package and its characteristics of permeability to gases and water vapor (SARANTOPOULOS; ANTONIO, 2006). We can also find products in flexible packages such as sliced apples and carrots, and products in stand up pouches, for example, the already peeled pineapple (Figure 5.35). The package from Robbie Flexibles demonstrates laser micro perforations that control the rates of permeability to oxygen and carbon dioxide, delaying senescence of the product and increasing its shelf life (FRUTAS..., 2011). Besides the modified atmosphere, depending on the product, it is necessary to use ascorbic acid or calcium ascorbate (calcium associated with vitamin C), for color and texture maintenance.

Also in the segment of fruits and vegetables ready to eat, products such as Dipperz stand out and are much appreciated by Americans. The packaging, thermoformed trays, has compartments for sweet and savory sauces to be consumed along with the fruit. The tray can also have tabs that contain granola, yogurt and other fruits with a shelf life of 21 days (Figure 5.36).



FIGURE 5.35

Fresh products ready to consumption



FIGURE 5.36

Products with sauce and cereals



Despite the wide availability of fruits and vegetables in Brazil, these ready for consumption products are still in short supply, but the change in life-style of the population and lack of time for food preparation is guiding us in that direction. In 2010, the company Fugini launched the Fruta Pronta product line, consisting of pieces of fruit in syrup packed in sterilized plastic pots. Each package contains a single serving of 113 grams sold in two portions (FRUTAS., 2010). The Hawaiian Dole Food Company for years has in its portfolio canned natural fruit juice, also using sterilized plastic packages, but the brand emphasizes that the product is “all natural” and without artificial sweeteners (Figure 5.37).

FIGURE 5.37

Fruits in syrup for quick consumption



Still in the natural aspect can observe an overlap of concepts among consumers regarding the products “organic” and “natural”. According to Decree No. 6323 of 27 December 2007, the organic agricultural production is one in which they adopt specific techniques by optimizing the use of natural and socioeconomic resources available and respect for cultural integrity of rural communities, aiming at economic and ecological sustainability, maximizing social benefits, minimizing dependence on non-renewable energy, using, where possible, cultural, biological and mechanical methods (BRASIL, 2007). Thus, it is possible to say that the concept of organic food is quite broad and its principles are related to health issues, environmental and social.

In the market for organic products, innovative packages don't prevail and few products have different or unique packages, an aspect that could be better explored by segment. Among these products we can mention the mascara Organic Wear by Physicians Formula displaying the colors and format that refer to the environment. The color of the tube resembles recycled papers and the cover is shaped like leaves. Another example is a Spanish balsamic vinegar, LA Organics, marketed in glass packages produced on a small scale and therefore costly (EMBALAGENS.... 2012) (Figure 5.38).



FIGURE 5.38
Organic Products



Source: Press Release

Consumers are more concerned about the health and seek to improve their diet, either by experiencing a disease in the family, or in their own life to realize the need for change. Nowadays, for example, drinks are not only bottled water and cans of soda, the development of drinks with added vitamins and other nutrients is an important area within that industry (VISIOGAIN, 2012). Thus, the benefits related to the trend of health and wellness in life also move the consumer industry. In this context, the company TheWell @ GSW, which works with market research in the area of health and wellness, brought the concept of the health heroes, trying to associate the image of the heroes we know with how companies direct their marketing. The goal is to solve the dilemmas of welfare for consumers, connecting them with brands with healthy intentions, gaining their loyalty and affection.

Five figures or profiles were elected to illustrate how brands and their products can be classified according to their attitude toward the consumer, namely, discoverer (The Pathfinder), Inspector (The Mystery Solver), immediate (A Hero in the moment), employee (Action Hero) and help (The Helper Hero). Each company has the profile of a hero to define the sales strategy (Goffe, 2012). A selling strategy does not always depend on the package, as is the case with the brands or products in the inspector profile, which use other tools such as research sites, to attract the consumer, and with employee profiles, seeking

partnerships to supply their products to schools, for example. Another example is the brand or product with the immediate profile, which centralizes its stake in consumption on the go by investing in products for vending machine.

The ready meals from London based company, Scratch Meals, can be considered examples of products with the pathfinder profiles, i.e. one who has the courage to explore a new market. The product came in 2010, first in free markets and trade in natural products, and proposes food consumption which is 100% natural, has no additives or preservatives and is balanced, locally sourced and prepared by hand. The consumer prepares his own food following the recipe that comes on the back of the pack as a draft handwritten (scratch) and packages are recycled PET, allowing you to view all the ingredients, so that the card surrounding the tray relates to a purchase performed in fairs, markets or warehouses and grocery stores (Figure 5.39).

FIGURE 5.39
Product with the pathfinder profile



Source: Press Release

The product with the helper hero profile enables a new combination, a new option as one product combined with another to do well. An example of a product with helper hero profile is the flavoring for water from Kraft Foods, called Crystal Light, which contains



electrolytes for hydration during and after exercise, no artificial sweeteners, no preservatives, and with 75% fewer calories when compared to other beverages. The product is sold in individual portions, sachets, and each box contains six units (Figure 5.40).

FIGURE 5.40
Product with the helper
hero profile



Source: Press Release

Also in the context of health, we can find many packaging products with the words “no preservatives”, “no sugar added”, “no dairy”, “not genetically modified” etc. In this case, the consumer feels more attracted to the “no” and the “less” (better for you), and the positive aspects of the product are highlighted by the packaging which exercises power over the consumer’s purchase decision (Figure 5.41). According to ANVISA, this claim is also not permitted in Brazil, since the expressions are not found in current legislation (ANVISA 2012).

An example of a domestic product oriented toward health is the functional beverage *Body Light*, from an industry in Santa Catarina, Max Wilhelm. The package is attractive and follows the needs and expectations of this alternative audience who cares about quality of life (Figure 5.42). The heat shrinkable label conveys the feeling of smoothness, the design communicates confidence and wellness and the colors identify the flavors, contributing to the distinction at the point of sale (SENSAÇÃO..., 2012).

FIGURE 5.41
“Less” products (*better for you*)



Source: Press Release

FIGURE 5.42
Drinks with Fiber



Source: Press Release

Another way to explore packaging for healthy food and beverages is to draw or design one which resembles pharmaceuticals. This feature is named as a trend for products with active and functional ingredients (RAITHATHA, 2009). As an example we can mention the drink *Protica Profect*, sold in plastic bottles in the form of a pharmaceutical product containing 80 mL (Figure 5.43). Each vial provides a dose of 25 grams of hypoallergenic protein ready to drink, and in this case the package plays an important role in communicating the potential of the product. Raithatha (2009) states that this new approach can significantly increase the cost of the product and to meet the expectations of the consumer, apart from the convincing pack, the product must actually meet what was described on the label.



FIGURE 5.43

Functional drinks packages resembling pharmaceuticals



Source: Press Release

Retro or “vintage” packages

The retro or vintage packages are gaining strength in all segments and allow a psychological return to a past of less pressure, less rigor and more permissive consumption. The retro style allows successful redemptions products and brands, providing feelings of discovery or rediscovery of different generations. For cosmetics, retro products and packages refer to the times of Grandma and, in general, emphasize values such as authenticity, simplicity, identity, association, independence and fun (MARCONDES, 2011).

Companies like Coca-Cola, Nestlé and Schincariol have realized that retro aesthetics is a great strategy to stir the emotion of consumers. Who want to confirm this now is Heinz, who is relaunching its ketchup in an old package (Figure 5.44).

First marketed in 1876, Heinz's flagship sales kept the iconic long-necked bottles and metal lid until 1990, when replaced by plastic squeezable package. The idea came from the observation that many consumers still associate the brand with a glass bottle and even question where the “antique” version is sold. The limited edition also has an original illustration on the label, to celebrate 135 years of the brand. The “vintage” version was sold until August, just in the United States. Nescau Cans, in retro version, capture the most remarkable graphics in the history of the product since its launch in 1932, in four packs from

FIGURE 5.44

Retro Packages



Source: Press Release



different times: 1932, 1960, 1986 and 1998 (Figure 5.44). The 1932 can, for example, shows the origin of the chocolate name, the joining of Nestlé with cocoa. At the time, the product received the spelling “Nescáo.” The name that still holds today, Nescau, only emerged in the cans since 1960. In 1986, the package added the popular slogan “Energy that gives taste”, and the

collection ends with the package from 1998 (EXAME, 2011).

The four cans arrive with the same formula of Nescau 2.0, 400 grams. The collection can be purchased in retail outlets throughout the country and is part of Nestlé’s actions to commemorate the 90th anniversary of the company in Brazil.

Local Products (Localvore) and with origin guaranteed

Today we are facing a radical change in consumer behavior, wanting to know the food they purchase. This trend is observed since the beginning of the decade and can deeply alter the supply of new products.

The package plays a fundamental role in communication with the consumer and can be used as a tool to connect and inform the consumer of the product origin. Examples may be seen also in Brazil, such as traced milk from Aurora, whose program was named Produto Aurora Rastreado (Aurora Traced Product) (PAR) (Figure 5.45). The P.A.R. is a system of traceability and automated quality control. By purchasing P.A.R. Aurora milk the consumer has access to a code (ten digits) printed on top of the container through which they can consult some relevant data regarding production on the company website, such as the date of production, the production unit, the production line and the milk producer, shown on “Google Maps”. The system was developed by Tetra Pak and is called Active Traceability.

The QR Code is also a resource that can be used to track the product and will be discussed in Chapter 6 of this publication. An example of this shift in consumer behavior is the movement of consumption of local produce, which is gaining momentum in developed countries and goes beyond regional appreciation, of pride from acquiring a food grown on local land (Figure 5.46). Of course, this detail is considered in the purchase decision, but other aspects such as quality and freshness, and sustainability, are also part of the motivation for this new consumer. The environmental impact of food production depends on the way it is

grown. Knowing that the food being consumed has not traveled thousands of miles by ship, train, truck or plane, and thus does not contribute to the emission of carbon dioxide and other greenhouse gases, makes it a good option for consumption (FAIRCHILD, s.d; DEWEERDT, 2012). A local product is usually defined as one generated within a radius of 100 miles (approximately 160 kilometers) - “Food Miles” - and its concept can be used not only by the final consumer, but also for businesses, restaurants and hotels that have a social responsibility (DEWEERDT, 2012).

FIGURE 5.45
Traceability system to show product origin

Consulte o seu código:

Para consultar, digite no campo abaixo o código encontrado no topo da caixinha de leite Longa Vida Aurora.

Digite o código P.A.R.



Source: Press Release



FIGURE 5.46

Products of local origin



Source: Press Release

In Brazil, the certification of origin is conducted by the National Institute of Industrial Property (INPI) and, according to INPI, over the years, some cities or regions gain fame because of their products or services (INSTITUTO NACIONAL DE PROPRIEDADE INDUSTRIAL, 2012). When quality and tradition meet in physical space, the Geographical Indication (GI) emerges as a decisive factor to ensure product distinction, delimiting the area of production, restricting its use to farmers in the region (usually an association), preventing others from using the name of the region with low quality products, in other words, a record of that product that protects any falsification in its composition and guarantees its origin, in addition to increasing their competitiveness in relation to other producers.

The certification also features two other modes, the Indication of Origin (IP), which is required to present evidence to prove that they have the known geographical name such as a center of extraction, production or manufacture of the item or service delivery; and the

Designation of Origin (DO), for which it is necessary to describe the qualities and characteristics of the product or service which stand out solely or mainly because of the geographical environment or the natural and human factors (Inst. Nacional de Prop. Ind., 2012). The domestic products with the most Designation of Origin belong to Valley region of vineyards, including: Almaúnica, Casa Valduga, Dom Candido, Miolo etc.. Another domestic product which received Geographical Indication (GI) was the Minas Artisanal Cheese produced in the region of Serro. In such cases where certification is provided to the product, the package should highlight its superior quality distinguishing it from the others (Figure 5.47).

FIGURE 5.47

Products with Geographical Indication of proof of origin



Source: Press Release

5.5 PERSONAL IDENTIFICATION

Limited Editions and Products endorsed by celebrities

Limited Editions are products that are launched for a certain period or where the sale only found in certain places and can be linked to specific events. They may be intended to attract a different consumer, to create or maintain a brand and also to create seasonal product variants (HILL, 2010).

According to Hill (2010), Marmite is a British

company that produces yeast spread to be consumed as snacks, for which there is no middle ground, consumers either love or hate it.

The company's website even takes two paths: the consumer chooses I'm a lover or I'm a hater. Marmite produces many limited editions, like Guinness Marmite for St Patrick's Day in 2008, Lovers Marmite



for Valentine's Day in 2009, Marmite Extra Old XO in 2010 and recently a Marmite to celebrate the jubilee of Queen (Figure 5.48).

Many Brazilian companies have realized the power of limited edition packages and now use this feature to attract more consumers. In Brazil, we had interesting and successful examples, as the package family of Leite Ninho from Nestlé, which reproduce the format of traditional dairy products with various prints, in limited edition for collectors (Figure 5.49). The Green-and-Yellow rooters design of the 2010 World Cup in South Africa was also used in conventional metal can in a limited edition (Figure 5.49). We also had in 2009 a special edition of Diamante Negro Chocolate, from Kraft Foods, now Mondelez International. The packaging had a seal / lid for easy opening laminated with metalized PET with coextruded polyethylene, rotogravure printing with a matte finish. Moreover, it had a hermetic seal with calculated barrier properties for preserving the crispness and freshness of the product. The easy-open technology allowed the consumer the convenience of partial opening, protecting the product not yet consumed for longer. The new technology has waived the individual packaging of chocolate (Figure 5.49).

FIGURE 5.48

Limited editions of Marmite packages



Source: Press Release

Commemorative dates, such as birthdays, Easter, Christmas, Mother's Day and Valentine's Day, are an invitation to limited editions releases of innovative package formats (Sarantopoulos et al., 2010). In late 2011, the company Mars launched M & M's in a package shaped like a Christmas tree in the Brazilian market. The material used was a paper cartridge card with 100 grams of chocolate confectionery in green and

red. Catupiry also released metal packages with motifs to celebrate Christmas after 100 years of business with commemorative packaging. Kero Coco also celebrated 15 years in 2010 with images of Brazilian, Romero Britto (Figure 5.50).

FIGURE 5.49

Limited edition packages in Brazil



Source: Press Release

FIGURE 5.50

Other Brazilian limited edition packages



Source: Press Release

In 2013, Café Palheta, from the brand Sara Lee, one of the most traditional of the Rio de Janeiro state, will commemorate 70 years of existence. To initiate the actions of celebration date, the company put a limited



edition package illustrating its line of roast and ground coffees on the shelves of all the outlets of the state. The new packages have graphics which show the habits and characteristics of the people of Rio. The commemorative series features three different versions that make up the “Portraits of Rio” collection. In each version of package, one of the characteristics of the people from Rio will be promoted: a warrior, an artist and honest. The special packages from Café Palheta are illustrated with images of the Marquês de Sapucaí, of Maracanã, of Christ the Redeemer and of the Lapa arches (Figure 5.51).

Sporting events are also an inspiration for the

brands, for example, the 2012 Olympics games. Coca-Cola Brazil launched a series of commemorative packages for the games made in aluminum (Figure 5.52). Packages for personal care lines by Procter & Gamble also added a new design and official logo of the games. The strategy is part of the company sponsoring the event.

Other examples of commemorative packages include Budweiser in China, to celebrate the Year of the Dragon, Diet Coke to celebrate autumn in the United States and Nestlé in 2010, to commemorate the 120 years of the Leite Moça in Brazil (Figure 5.53). In the case of Nestlé, the promotional campaign lasted a year.

FIGURE 5.51

Commemorative packages
for coffee



Source: Press Release

FIGURE 5.52

Commemorative packages
for the Olympics



Source: Press Release

FIGURE 5.53

Examples of commemorative packages



Source: Press Release



Celebrity Endorsement

The obsession with celebrities is typical of the fashion and media world, but has become an effective tool in the advertising of foods, beverages and cosmetics. Examples like that of British chef Jamie Oliver, who, after his successful television show has his own line of products, and of so many others like Ferran Adrià, Nigella and even those who are successful in Brazil, like Olivier Anquier and Claude Troisgros, showing the influence of a celebrity in sales of products (Figure 5.54).

FIGURE 5.54

Products endorsed by famous chefs



Source: Press Release

Products endorsed by celebrities provide instant credibility and branding, but there must be harmony between the famous person chosen and the target audience and the product or brand. Some aspects that guide this compatibility are: the celebrity's values, costs involved in the use of image acquisition, correspondence between the celebrity and the product, popularity, availability, reliability, if the celebrity is a consumer brand, profession etc. Celebrities are certainly a good way to generate positive attention in relation to advertising and often compensate for a lack of innovative ideas (KATYAL, 2012).

A company that consistently associates the product to the image of a celebrity is Pepsi, which

has had representatives like the NBA star (American basketball) Shaquille O'Neal and singers Beyoncé, Britney Spears and Mariah Carey. Other examples are sports brands Nike and Reebok, which had Tiger Woods and Venus Williams as representatives, respectively. The cosmetics segment has used much of this resource to attract the attention of consumers. This is the case for the famous MAC Cosmetics, a makeup manufacturer highly regarded in the fashion world and showbiz stars showing the Viva Glam line, associated with the image of some iconic celebrities like Lady Gaga and recently Nicki Minaj. In the Viva Glam line, the colors are unique and the package contains celebrity autographs (Figure 5.55).

In Brazil, top model Gisele Bündchen launched the cosmetics brand Sejaa appealing to the use of natural ingredients, calming fragrances and packages made from recycled paper (Figure 5.55).

FIGURE 5.55

Packages of products endorsed by celebrities



Source: Press Release



Perfumes are also good examples of association with established results and packages with a great visual appeal on glass (Figure 5.55). In the food products sector, we can see, even in Brazil, a large association of drinks companies with celebrities. Coca-Cola is a good example of this type of marketing, with its stylized bottles by famous designers like Franco Moschino in 2009, Donatella Versace in 2010, and Karl Lagerfeld in 2011 (Figure 5.56). On the proposal of the bottles Moschino, Donatella Versace and Alberta Ferretti among others, the goal was to “wear” the same with colors, prints and everything that could remind you of joy and wellness. The aluminum bottles, with their fashionable “dresses” were auctioned at the Tribute to Fashion show, during the fashion week in Milan. Profits were allocated to programs to help victims of the earthquake in Abruzzo. More recently, Jean Paul Gaultier paid homage to Madonna in the Night & Day kit. The package that symbolizes the day brings its traditional pattern of stripes and the package of the night reproduces Madonna’s corset in the 90s (JEAN. ..., 2012).

Another example of products in Brazil associated with the image of a celebrity were glass cups by Danúbio (Figure 5.57), one of the ten largest dairy companies in the world, who had a partnership with Brazilian designer Alexandre Herchcovitch in the Fashion for Food project, which joined the style of the fashion world with healthy food and a quality of life.

FIGURE 5.56

Packages of products endorsed by celebrities



Source: Press Release

PICTURE 5.57

Glass cups signed by Alexandre Herchcovitch



Source: Press Release

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Chapter 6

QUALITY AND NEW TECHNOLOGIES

Recent and important innovations will be associated to active and intelligent packages – usually denominated smart packages – to new materials with less environmental impact and to the revolutionary nanoscience and nanotechnology.

In order to satisfy the consumer expectations, who seeks for safety, quality, convenience and well-being, years of financial investments and efforts of technologists and scientists were needed to the development of packages which consumer uses on a daily basis, such as aseptic plastic and carton packages, retortable pouches and plastic packages, resealing and easy-to-open systems, microwavable packages, high

barrier plastic packages, modified atmosphere packages and many more. The success of those innovations was due to integrated development of product/process/packaging/equipment/packaging material/distribution system.

Concerning the future, multiple technological advances will be necessary to bring solutions to the package sector, what has become an important tool to the producer for obtaining competitive advantage

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SARANTÓPOULOS, C. I. G. L.; DANTAS, T. B. H. *Quality and new technologies*. In: *BRASIL pack trends 2020*. Campinas: ITAL, 2012. ch. 6, p. 139-169.



in terms of functionality, product shelf life, brand image, safety, environmental benefits and price. Recent and important innovations in the sector will be associated to active and intelligent packages – usually denominated smart packages, which aim the preservation and the safety, especially of foods, beverages and pharmaceuticals; new materials with

less environmental impact, such as biopolymers; and to the revolutionary nanoscience and nanotechnology, which improve the material properties and give new functionalities to the packages.

Regarding the Quality and New Technologies macro trend, highlighting trends and contributions of the package are presented in Chart 6.1.

Chart 6.1
Quality and New Technologies trend unfoldments

Highlighting trends	Packages Contributions
Active packages	Oxygen absorbers, CO ₂ absorbers, ethylene absorbers, moisture absorbers/controllers, antimicrobial packages, scent emitters
Smart packages	Time-temperature indicators, freshness indicators, ripeness indicator, oxygen indicators and sensors Anti-counterfeiting/anti-theft systems, self-heating and self-cooling packages Traceability, identification and interactivity
Nanotechnology	Improvement of the barrier properties (gas, aroma, water vapour and light) of cellulosic and plastic packages Improvement of mechanical (plastics and cellulose) and thermal properties (thermoplastic polymers) Incorporation of active compounds, especially antimicrobials and oxygen absorbers, in plastic and cellulosic packages Production of nanosensors and nanoindicators of relevant information (smart packages and printed electronics) Increase of biodegradability and recyclability
Biopolymers	Biomaterials from vegetal source and microbial source Biopolymers chemically synthesized from renewable source Biodegradable/compostable Recyclable biopolymer Biopolymers from supply chain wastes of food industry, wood industry and biofuel production.

6.1 ACTIVE PACKAGES

Active packages and intelligent packages are associated, hence they are called smart packages, though they are conceptually different. The term “active packages” refers to a series of technologies in which the package interacts directly with the product or through the package headspace, in order to assure the quality and safety or to increase the shelf life of foods and pharmaceuticals. They are basically divided in two groups: those ones that absorb harmful compounds to the packed product and those ones that emit compounds that improve the properties and/or increase the shelf life of the product.

The active packages include oxygen absorbers which aim to protect the product against oxidative degradation reaction, that causes the loss of sensorial properties (such as flavor, color and odor), and against the loss of active principles in cosmetics and pharmaceuticals; CO₂ absorbers for roasted and ground coffee, minimizing the package blowing; ethylene absorbers for fresh fruits, slowing down the ripening; moisture absorbers/controllers to protect products against humidification; off odor absorbers; cholesterol absorbers etc.. Among the active packages, the highest application volumes are in moisture and oxygen absorbers.

The inverse function of emitters also increases the stability and assures the quality of many products. Examples of this category of active package are antioxidant compounds emitters, ethanol emitters with anti-mold properties, CO₂ emitters with antimicrobial action (fungistatic and bacteriostatic) and SO₂ emitters acting on certain fungi. Related to those antimicrobial packages there are also films with ionic silver incorporation.

The ultimate emitter-active packages are also known as Controlled Release Packaging – CRP, which means that they release, in a controlled manner, during storage, active compounds such as antimicrobial agents, antioxidants, flavor enhancers, enzymes, nutraceuticals compounds and others.

The incorporation of metals (zinc and magnesium) to preserve color, of enzymes blockers, antiadherente packages, and many other functionalities can also be classified as active packages, lots of them produced based in nanotechnologies. The modified atmosphere packages are traditionally considered as active packages.

The early active packages were focused on incorporating the active agent in sachets. Nowadays, the focus have been either on the incorporation or the immobilization of the active agent in the package material itself (mono or multilayer), in caps, corks, liners and labels. This is a way to maximize the active package efficiency and minimize problems related to the inclusion of a foreign item inside the package, which may lead the customer to a misinterpretation and may prejudice the production line.

The technological advancements in active packages are limited by legal barriers concerning the food safety. Active compounds need to be registered on positive lists and the total and specific migration limits must be respected. Though, as the legal requirements are being fulfilled, the companies are beginning to quantify the economic advantages of the active technology usage, and the consumers realized the quality and/or safety improvement, it is very likely that the active packages will become an important technology for food and beverage preservation.

Oxygen Absorbers

The residual oxygen inside the package is chemical and biological-active for the degradation of foods, beverages, pharmaceuticals, cosmetics, agrochemicals etc. Therefore the conventional use of passive barrier

package associated to the nitrogen gas flushing, vacuum or modified atmosphere was complemented by the active package with oxygen absorbers.

The oxygen absorbers are able to reduce the



oxygen concentration to very low levels (0,01%) and keep it during storage. They effectively prevent oxidation damages and microbiological deterioration in many products. In oils, fats and fatty products, oxygen absorbers prevent the rancidity; in processed meat, fruit and vegetable they prevent discoloration; in food rich in aroma, like juices, they reduce the loss of typical flavor; in bakery products and cheeses, they control the microbial deterioration; and in food rich in vitamins, they prevent the loss of its nutritional value. Oxygen absorbers allow the reduction or even the elimination of preservatives like antioxidants and antimicrobials agents. They can also be used for controlling of the deterioration caused by insects, which grow in nuts, grains and dried foods; they act as well as over grown insects and their eggs.

The technologies associated to the oxygen absorbers use one or more of the following concepts: iron based compounds (iron oxide, iron carbonate, iron sulphate, iron sulphite-sulphate); organic substances with low molecular weight (ascorbic acid, sodium ascorbate, catechol); enzymatic systems (glucose oxidase, alcohol oxidase); photo-reducer components; oxidable polymers; unsaturated fatty acid (for instance, oleic, linoleic and linolenic acids); microorganisms immobilized in solid substrate, which means, biological oxygen absorbers; sulphite and its analogous (bisulphite, metabisulphite and hydrosulphite).

The incorporation of active compounds in polymers demands a very fast absorption kinetic. The polymer permeability, in which the active is incorporated, might be a restriction to the reaction rate, comparing to the one obtained with iron powder spread in appropriate vehicles in the sachets, what provides a large superficial area for reaction. As an alternative to the addition of metallic compounds to the plastics, various compounds with low molar weight are suggested for oxygen absorbers, but most of them face regulatory barriers. The most promising alternative seems to be the oxidation of the polymer itself to absorb oxygen. The control of oxidation byproducts, especially of possible toxic migrants, is one of the most important challenges. Another important parameter, the control

of the absorber reactivity through an “activation” step, such as the use of radiation, seems to be a good solution to the activity loss of the incorporated absorbers before package use.

The oxygen absorption technologies should not start the reactions before the package to be in contact with the product. That is because the absorbers action has a finite characteristic. Hence, the trend is towards the development of mechanisms that start the absorption on demand, allowing the package storage or handling avoiding the absorption capacity “waste” before the contact with the product. Therefore, the absorbers will start acting at the desired moment, which means, when the package is sealed.

Cryovac, a division of Sealed Air Corporation, sells the family of active packages called Freshness Plus, which technology aims to maximize the freshness, aroma and appearance, minimizing the microbiological deterioration and oxidation reactions of pigments, aromas and nutrients. The family of films includes off odor absorbers – *Odor Scavenging* and oxygen absorbers – OS films – *Oxygen Scavenging* (Figure 6.1). The active component is an oxidable terpolymer, activated on demand by ultraviolet light on the processing line. Because it is not iron-based, it does not bring any problem to the lines with metal detectors, does not alter the coloration and transparency of the package and does not depend on the product humidity to act as an absorber as for iron based absorbers.

An important driving force for the development of oxygen absorbers active packages is the need for keeping the current quality level (or even improve it) when the package material is changed, especially when a new material is introduced to a food or beverage category. That was observed when the PET bottle was introduced as a package alternative to the metallic or glass bottle for beverages that, for presenting a lower barrier to the oxygen, needs to be improved. Another driving force for it is the reduction of the complexity of multilayer plastic structures, though keeping the product protection, what brings environmental benefits as it does not put the possibility of mechanical post-consumer recycling at risk.

FIGURE 6.1

Hormel's PartyTray: sliced processed meat packed in Cryovac active film, Freshness Plus, sorted with other products in a rigid plastic tray



Source: Press Release

The company Honeywell sells the Aegis OXCE polyamide, an oxygen absorber resin formulated to ensure high barrier to PET bottles. From 5 to 7% are added to the PET, keeping the PET transparency and recyclability. The company Invista also holds the active barrier technology, the OxyClear resin, which contains high transparency oxidable polyester and allows injection and blow molding and recycling of PET bottles. ColorMatrix presents the Amosorb oxygen absorber technology applied to mono and multilayers bottles (Figure 6.2). Constar sells the Oxbar technology, an oxygen absorber for multilayer PET bottles and MonOxbar and Diamond Clear (high transparency) for recyclable monolayer PET bottle. Valsper sells the

active barrier resin ValOR™ compatible with PET, long term Activ 100 series and fast action Activ 300, for mono and multilayer packages, to the food, beverage and medical-pharmaceutical industry, which absorbing function is activated by the moist of the product at the package filling. Graham Packaging holds the Monosorb oxygen absorber technology for monolayer PET bottle. In the field of bottle caps, Grace Darex Packaging Technologies has an oxygen absorber technology called Celox.

FIGURE 6.2

Oxygen absorber technologies: Amosorb SolO₂, Oxbar, MonOxbar, DiamondClear



Source: Press Release

Packages with antioxidants

The package with the incorporation of antioxidants is another type of active package that can be used for the control of lipid oxidation. It acts mainly by the mechanism of radicals scavenging, avoiding the propagation of the oxidation reactions. Synthetic antioxidants approved for food contact are options as antioxidants agents, as well as antioxidants

natural extracts, which have been the target of recent studies. One of the suggestions is the association of this technology with the moisture and/or oxygen absorbers, increasing the food protection potential.

The direct addition of antioxidants in food and beverages is very common, since they are approved for use as food additive. However, in fresh food and in many



products used as raw materials, the use of food additives is not allowed. In those cases, the incorporation of antioxidants into the packaging material would be a way to protect the food, with controlled release of that active compound, which would work in the headspace and/or over the product surface in an active package system.

Various formulations of antioxidants for incorporation into plastic packages have been studied, such as synthetic antioxidants as BHT (3.5-Di-tert-butyl-4-hydroxytoluene), BHA (2-tert-butyl-4-hydroxyanisole), TBHQ (tertiary butylhydroquinone) and propyl gallate. Immobilized enzymes in plastic packages can also actively work as antioxidants. Although, in

the manufacturing of plastic packages, one part of the antioxidant loses its scavenging functionality and another part may be lost to the environment during the thermal process due to its high volatility. The antioxidant concentration in polymeric films also decreases, even before the packaging use, during storage, due to its oxidation and by diffusion of the compound to the film surface, followed by evaporation. Therefore, the emitter packages have to be normally formulated with a higher than usual concentration to preserve the product. On the other hand, the addition of high quantities of additive in the polymer may alter the optical and mechanical properties of the packaging.

Moisture absorbers and controllers

Related to the humidity control, the active packages segment shows two distinct lines: one of them seeks to reduce the relative humidity to the maximum around dry products (food or pharmaceuticals) and electronics components, which is obtained by the use of moisture absorbers (desiccant). The other line aims to control the relative humidity level around fruits, vegetables and fresh meat, generally above 75%, using the moisture regulators or liquid absorbers.

The most common desiccants can be divided into the following categories: physical (silica gel – SiO_2 , clay, molecular sieve); hydrated salts; hygroscopic salts; superabsorbents polymers (polyacrylate sodium, carboxymethyl cellulose (CMC) and copolymer amide); and chemically active desiccants – CaO .

The use of moisture absorbing sachets is a widely used and established technology in the pharmaceutical market. However, the use of desiccants incorporated into the package may grow with the development of new technologies. As an example, the company Amcor developed a desiccant incorporated into a laminated film to be used in packages for pharmaceuticals that are moisture sensitive, extending the product shelf life and increasing its stability. The desiccant is incorporated

into the sealing layer of the blister, eliminating the need of an extra accessory or material (Figure 6.3).

FIGURE 6.3
Desiccant incorporated into
the Amcor package material



Source: Press Release

The CSP Technologies holds a technology to the incorporation of active materials into polymers, resulting in the family ACTIV-POLYMER. A desiccant material (molecular sieve or silica gel) is incorporated into the polymer, associated with an agent that promotes microscopic channels inside the polymer structure which favor the diffusion of substances such as water through the polymer. This family of products, commercially called ACTIVE-PAK, has three components: a polymer (hydrophobic): PP or PE; a channel former agent

(hydrophilic): polyglycol, ethylene/propylene glycol; and an active desiccant component: molecular sieve, silica gel or combined desiccants. The CSP's desiccant polymer can be used as an internal layer of tubes, cap liner, seals and internal layer of a laminated structure with aluminum for blister. Concerning the liquid absorbers, there are many products in the market, such as ThermoMarite® or Peaksorb® (Peakfresh Products, Australia), Toppan™ (ToppanPrintingCo., Japan) and Dri-Loc (Cryovac Sealed Air, EUA), used for meat, fish, chicken and fresh products in general. Basically, the system consists in a superabsorbent polymer located between two plastic films or non-woven with micro perforation. The most used absorbent polymers are the polyacrylate sodium, carboxymethyl cellulose fiber and amide copolymers.

FIGURE 6.4

Liquid absorber incorporated into the film for minimally processed fruits: “Fruit Pop” Pouches (Maxwell Chase Technologies)



Source: Press Release

Cryovac associated an anti-theft system to the liquid absorber in the Dri-Loc® Theft-Sensor Pad product, which contains a label called Sensormatic Ultra-Max® label, to be used with the EAS system – Ultra-Max® Electronic Article Surveillance (Figure 6.5).

An example of innovation in this field was given by the German company Sealpac, which developed a thermoformed packaging system, for vacuum packing, with double compartment; the first packs the product and the second collects and holds the liquid exuded from the meat, increasing the product shelf life, allowing the package to be displayed straighten up or hanging on hooks in the expositors (Figure 6.6).

FIGURE 6.5

Liquid absorbers with anti-theft system



Source: Press Release

FIGURE 6.6

Liquid absorber in thermoformed package



Source: Press Release

An observed trend is the association of moisture/ liquid absorbers with other active package technologies, such as oxygen and aroma absorbers, antimicrobials and pH controllers, multiplying the benefits of the active package. The concept is to provide the synergism reached by the relative humidity control, and microbiological growth in fresh products, resulting in combined effects of hurdle technologies.



Ethylene absorbers

The ethylene is a plant growth hormone which has a prejudicial impact, even in low concentrations, over the quality and the shelf life of many fruits and vegetables during storage and distribution. The ethylene induces the ripening, accelerates the respiration rate, and, consequentially, the senescence. The use of packages with ethylene absorbers increases the shelf life of fruits and vegetables, which decreases the loss due deterioration, makes the out of season commercialization possible, expands the markets and may reduce the transportation costs when it allows the ocean freight, instead of the air freight, in exportations.

Examples of active ethylene adsorbers compounds are: activated vegetable charcoal, aluminosilicate (zeolites), activated clay, silica gel, bentonite, vermiculite, Fuller's earth, silicon dioxide dust, Oystone dust, metallic oxides (i.e. aluminum oxide) and many other minerals. Some adsorbers have been combined with catalyzer agents or oxidants chemical compounds which modify or destroy the ethylene after the adsorption. Examples of combined substances are the activated vegetable charcoal impregnated with metallic catalyzer (bromine or palladium) and alumina, silica gel or zeolites impregnated with potassium permanganate (KMnO_4).

The ethylene absorbers can be presented in sachets and pads/blankets introduced in the packaging lines, or can be incorporated into thermoplastic polymers or cellulosic materials. In order to conduct the action of the absorber, it is possible to spread it in a multilayer material, leaving permeable layer in contact with the food.

An example of ethylene absorber in the form of an accessory for the package is the product called It'sFresh! e+ Ethylene Remover, commercialized by Food Freshness Technology, which has been used in supermarkets in England for fruits sales. It is actually a label, fitted to be in contact with the fruits, containing a mixture of clay and other minerals that remove the endogenous ethylene to low physiological activity, reducing the damage to the products. The accessory is

placed at the bottom of the packages (Figure 6.7).

An example of incorporation of ethylene absorber in corrugated cardboard is the box Fruit Fresh, developed by SCA Packaging together with the Fraunhofer Institute in Germany. The active material is incorporated in the glue that sticks the waves to the external boards, during the production of the corrugated fiberboard, which is followed by the normal manufacture process (Figure 6.7).

PICTURE 6.7

Ethylene absorbers in the form of label, sachet and incorporated into the cellulosic package material.



Source: Press Release

The incorporation of finely spread minerals in polymers is generally done in low density polyethylene, but it is also observed in the market the incorporation in polyamide and polyethylene blends. The mineral is encapsulated in particles by the polymer, forming a maze among the polymeric chains, which can adsorb gases like ethylene. Most of those films are opaque and have limited absorption capacity for that gas. The choice of the polymeric substrate must always consider the permeability to the vegetable respiration gases for which it is designated or use a perforated film, to avoid anaerobic conditions, which accelerate the deterioration of fruits and vegetables and can even bring risks of pathogenicity. Companies such as PEAKFresh, Bio-Fresh, Evert-Fresh, Amcor and many others sell active films for application in home packages, in bulk packages and for pallets covering.

Besides promoting the ethylene absorption, the incorporation of certain minerals in polymers may also increase the films permeability, in a way that the ethylene and the CO₂ leave the package faster and the oxygen gets in faster as well, affecting a little of the vegetable physiology, due to a small change of the atmosphere inside the package, in relation to the

air. Those changes in the permeability may reduce the concentration of ethylene inside the package headspace and, consequentially, increase the shelf life, independently of any ethylene absorption.

FIGURE 6.8
Ethylene absorbers incorporated into plastic films



Source: Press Release

Antimicrobial packages

The function of the antimicrobial package is to power up the same functions as the conventional packages, which means, assure the safety, keep the quality and extend the product shelf life. Besides, it can reduce the potential of recontamination of processed food and beverages, simplifying treatments that aim to eliminate the contamination of package materials and promote the auto sterilization, at least in theory, of some products, like acid beverages such as fruit juices. They can be sorted in two types: the ones in which the active agent migrates to the surface of the food and the ones in which it is effective without the need of migration.

Modified atmosphere packages with carbon dioxide, which has fungistatic and bacteriostatic

activity, are examples of active antimicrobial packages. Ethanol and CO₂ emitters in the form of sachets control the growth of fungi on food and the contamination in the packages. SO₂ emitters are used in the form of sachets/pads or incorporated films to control the development of fungi (*Botrytis Cinerea*) on grapes (Figure 6.9).

Antimicrobial active compounds can also be incorporated in the package material. While incorporated in plastic packages, they generate the bioactive polymers. Various synthetic compounds (also called chemicals), natural compounds and probiotics have had their antimicrobial potential analyzed, such as the metallic ions, natural extracts, organic acids and their salts, bacteriocins, fungicides, enzymes,



alcohols, gases (chlorine dioxide, *triclosan*) and natural extracts. Cinnamon, clove, garlic, oregano, rosemary and grapefruit seed extracts, when incorporated into package systems, have been effective against the microbiology deterioration. Traditional fungicides used in agriculture such as benomyl ($C_{14}H_8N_4O_3$) and imazalil ($C_{14}H_{14}Cl_2N_2O$) have been incorporated in plastic films showing antifungal activities.

Since the most of antimicrobial agents have different action mechanisms, the mixture of active compounds can increase the shelf life through a mechanism of synergy.

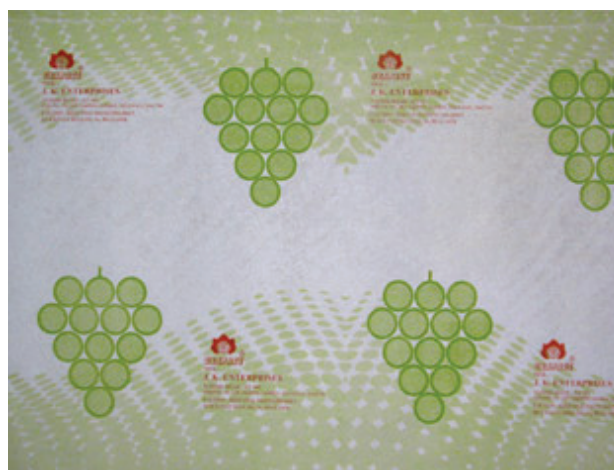
The antimicrobial agents can be directly incorporated into the package material, in the form of a mechanical mixture at the polymer processing or chemically immobilized and applied as a coating. In the chemical immobilization, covalent bonds immobilize the antimicrobial agent in the polymeric structure and an intense contact between the package and the product is necessary, such as what happen with vacuum-packed products and low viscosity liquids.

The main focus on the development will probably be the mechanisms of manipulation of the antimicrobial agents, their liberation kinetics and the natural antimicrobials, incorporated in synthetic polymers or in biopolymers. The preference for the natural antimicrobials is due to the possibility of ease getting a legal approval and attending the requirements of the consumer who seeks healthier food and natural products.

The main challenges can be summarized in: meeting the legal requirements related to the approval for food contact; tradeoffs related to adverse effects over the product, the consumer health and/or the environment; lack of efficacy evidences; need of direct contact with the active agent and high costs.

FIGURE 6.9

Sulfur dioxide quick release emitter – Grape Guard. Sodium metabisulfite is the active compound applied in laminated films for grape preservation



Source: Press Release

Hygenization

Although this is not a commercial reality, the Fruitwash Label might be a trend related to labeling. The current labels, besides being hard to remove, are most used only for producer identification and, in a few cases, they are used as a source of information about the fruit origin and allow the inclusion of a barcode. The Fruitwash Label (Figure 6.10) turns itself into soap as the fruit is washed, helping to remove the dirt and other residues that might be on the product surface.

FIGURE 6.10

Label that turns into soap at the fruit washing



Source: Press Release

Special films for meats

One of the most commercialized products in Brazil is fresh meat. The vacuum packages used for fresh beef gives a long shelf life to the product, from 2 to 4 months, but they affect the product appearance, giving a purple color to the meat caused by the lack of oxygen, reducing the appeal for selling at retail. Aiming to sort it out, the company Curwood developed the technology FreshCase, which involves the use of sodium nitrite on the film layer in contact with the meat (Figure 6.11). The nitrite, in contact with the meat, turns into nitrous oxide, a gas which reacts with the meat pigment, the myoglobin, making it with the reddish coloration wished by the consumer (REYNOLDS, 2012).

Another example of special film is used on the freezing system developed by the Japanese company Mustumi, which uses electric current for fast freezing of the product, minimizing the oxidation and reducing the size of the ice crystals that are formed on the food cells. The film used as the package is electroconductive, enabling the freezing process that preserves flavor and texture of the food and increases the shelf life (Figure 6.12).

FIGURE 6.11

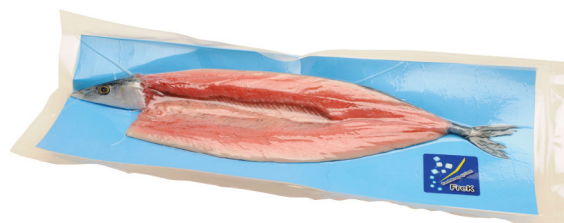
Active package for keeping the reddish coloration on the fresh meat



Source: Press Release

FIGURE 6.12

Electroconductive film



Source: Press Release

Aroma and flavor emitters

This new area of development brings high interest to the concepts of the correlation of brand to the multisensoriality and to the growing acceptance of the importance of aspects such as emotions and memories at the shopping decision (RAITHATHA, 2009).

One of the main companies in this sector, the Scent-Sational Technologies, holds the patent of the encapsulated aroma release technology, approved for contact with food, beverages, personal hygiene products and pharmaceuticals. The microencapsulated scent can be applied as a coating onto the package (film, bottle, cap, board, pot, glasses, etc.) at production line (Figure 6.13). While handling, the microcapsules of aroma are ruptured and the scent is released. The release activation can also be done by heating, for example, in the microwave

FIGURE 6.13

Scent release inside or outside the package



Source: Press Release



or by humidity. That encapsulated aroma release technology can be applied to various manufacturing processes of plastic packages: blow moulding, injection, thermoforming, extrusion and in liners and gaskets. It can also be applied in inks and coatings. The coating can be done on plastic packages and on cardboard.

Self-heating and self-cooling packages

Package systems that heat up or cool down the products attract consumers due to the great appeal of convenience. Exothermic reactions are used for self-heating, such as water and calcium oxide – CaO. For self-cooling, an endothermic chemical reaction that steals heat from the environment can be used, or the heat pump, that uses steam or another compound, such as CO₂, as cooling fluid for heat transfer. Those technologies are normally associated to devices attached to the packages.

There have been some packages that are self-heating, which were initially developed for coffee beverages and now also hit the market of ready to eat soups. There are only a few examples of packages that are self-cooling, aiming at the beverages market, though that topic has been researched for more than one decade.

The Hot-Can self-heating technology (Figure 6.14) consists in an aluminum can with double chamber, which contains the product in the external chamber and water with calcium oxide, separated by a membrane in the internal chamber. When a button on the base of the can is pressed, those compounds get mixed and generate an exothermic reaction that heats up the product in the external chamber (Figure 6.14). HeatGenie is another example of self-heating package based on solid fuel, which will generate energy converted into heat in a controlled manner. The fuel stays held in a compact module attached to the base of the package (Figure 6.14).

In Italy, one company sells coffee beverages in packages that use the endothermic reaction technology between thiosulfate pentahydrate and water for cooled beverages. Another example is from Joseph Company from California, the can called ChillCan (Figure 6.15), that generates a fast expansion of the pressurized CO₂ that evaporates and cool down the beverage in minutes.

The appeal of the technology involves consumer satisfaction and even satiety. The aroma can be released inside or outside the package. The emitters can be used as a complement to food aromas or replacing the food compounds that might be harmful to health.

FIGURE 6.14
Self-heating packages



Source: Press Release

FIGURE 6.15
Self-cooling packages with



Source: Press Release

It is expected that the nanotechnology shall bring innovations, especially in the sector of package self-cooling for beverages and that other technological platforms such as the combination of thermoelectrical and photovoltaic systems will be able to be used. Issues of sustainability associated to the recycling of the packages and use of non-aggressive to the environment cooling liquids, will be very important matters at the developments.

6.2 SMART PACKAGES

Smart packages communicate and monitor information about the content and the environment of a product to the consumer, retailer and producer. Usually they are devices incorporated in the package, applied on it as a label and even fixed on the product.

We can fit in that category: time-temperature indicators, ripening and freshness indicators, oxygen indicators, ethylene indicators, pathogenic microorganisms and toxins indicators, carbon dioxide indicators, counterfeiting indicators, biosensors (pathogens detection) and devices with many other functionalities.

The indicators work in a passive way, sourcing

information about the freshness, microbiological safety and quality of the products.

Innovations in the sensors technologies, such as nanosensors and biosensors, are increasing the application possibilities of smart packages. The search for safety and traceability has moved developments on. The trend for cost and size reduction of electronics components also helps the sector. The possibility of embed those sensors in traceability and monitoring systems will allow that many links of the supply chain have access to the collected information. The compatibilization and incorporation of those sensors in package materials should be evolving.

Time-temperature indicators

The time and temperature indicators – TTI show the thermal history of the product and whether exposed to extreme conditions during the distribution chain. That allows any action to be done by the distribution chain and also alerts the consumer to the product safety. The evolution of this technology can lead us to the replacement of the expire date by a more precise indication of quality given by the indicator.

They are devices that can be generally used in the retail package or in the industrial packages of ingredients and raw material. Many indicators do not measure the quality of the product directly; therefore they need to be tailor-made to the kinetic of deterioration/alteration of the product in which it is going to be used. The time-temperature indicators can also be used as a microbiological quality indicator, once they are tailored to the microbiological deterioration process of the product.

The technologies associated to time-temperature indicators are linked to: the migration of a ink/dye through a porous material, which depends on the temperature and time; the chemical, enzymatic or polymerization reaction, which rate depends on temperature; temperature sensitive inks and pigments; and pH indicators. Most of the indicators work based

in the color change. A potential field for development is the association of those time-temperature indicators with control and traceability technologies.

The temperature monitoring technologies have become more effective, easy to use and on an affordable price. PakSense has developed a programmable monitoring label, with LED indicators that show any temperature fluctuation out of the specified range, allowing a fast identification of packing problems in the transportation and distribution of the product (Figure 6.16). The register initialization is pretty simple, requiring only folding one of the label edges to activate. It is still possible to collect the registered data using a proprietary reading device, plotting graphs and reports that allow the user to completely visualize the occurrences over time.

The company FreshPoint offers various solutions of time-temperature indicators, commercially named OnVu Logistic (Figure 6.17), co-developed with Ciba Specialty Chemicals, now part of BASF group. The system is based on an “intelligent” ink that changes its color at a rate determined by the actual temperature that the product was exposed to. It can be applied on the conventional label or on the package. The indicator is activated by a UV radiation source at the packaging

line and initiates the freshness indication and the end of shelf life. It can be calibrated to match different deterioration mechanisms and product shelf life in function of the temperature.

FIGURE 6.16
PakSense's time-temperature indicator



Source: Press Release

FIGURE 6.17
Active ink-based time-temperature indicator



Source: Press Release

Quality, freshness and ripening indicators

Quality, freshness and ripening indicators have similar functionalities to the temperature indicators; however, they measure the compounds directly related to the product quality, resulting from microbial growth or chemical or biochemical reactions. There are still some challenges concerning the ease of application and costs, being also under the legislation for food contact material (RAITHATHA, 2009).

A freshness indicator example has been developed by To-Genkyo. The indicator consists in a label which has its color changed when reacting with the ammonia produced by the microbiological degradation of meat products. At the color changing, the barcode becomes illegible to the scanning system, making the sale no longer possible. The label has the shape of an hourglass and the consumer is taken to recognize its function intuitively (Figure 6.18).

The Jenkins Group, in New Zealand, in partnership with HortResearch, has developed a ripening sensor, the RipSense, which reacts with the aroma released by the

fruit during the ripening, changing color and allowing the consumer to choose the ripening level of the fruit according to its preferences. The sensor is initially red, gradually turns into orange and finally gets yellow (Figure 6.19).

FIGURE 6.18
Freshness indicator



Source: Press Release

Electronic smart packaging

One of the most intriguing technological races involving public and private R&D companies is the search for making the printed electronics available in high volumes and commercially viable (IAPRI, 2012). The application of nanotechnology in the electronics industry has allowed the creation of such small electronics circuits capable of being printed on thin and flexible surfaces. It is the born of the *e-packaging*, which involves the printing of conductive circuits directly on the package material. *E-packaging* goes beyond the radiofrequency identification – RFID and the monitoring/surveillance via EAS labels – Electronic Article Surveillance. It does not aim to replace the current technologies, but aggregate more functionality, intelligence and interactivity to the current concept of package, something that the silicon chips do not allow.

In the package sector, the printed electronics can be used for complex function for many purposes, from safety systems, temperature registers that tailor expire date to devices of audiovisual interaction with the consumer, displaying images, emitting sounds or even vibrating (powder products dosing). In the field of pharmaceuticals it can instruct the patient over voice commands, reminding him of the medication, inform whether the pharmaceutical has been consumed. In

consumer goods packages, it can work as an anti-theft and anti-violation system.

An example of anti-theft/anti-violation system is sold by MeadWestvaco, called Natralock, which the main appeal is the safety, made with a blister, a tear-resistant card and a siren system, that sounds like on the currently used anti-theft systems, but it is also activated if the package is twisted or broken, by the rupture of the ink filaments (Figure 6.20). MWV uses a printed integrated circuit printed by flexography with conductive ink, “electronic ink”, graphene-based (nanomaterial), produced by Vor-ink, which has an excellent conductivity, competitive cost and flexibility, that allows the material to be bended without damaging the electronic circuit. Retailers embed a reusable electronic module of sound alarm to the circuit, which sounds if it is removed from the package or if the circuit is broken.

FIGURE 6.20
Conductive paint-based



anti-theft device

Source: Press Release

FIGURE 6.19

RipSense ripening indicator



Source: Press Release



Another example of printed electronics is the technology named eCoupled intelligent wireless power, by Fulton Innovation, which allows the heating of the package without the use of an external heat source and neither is a self-heating package. The printed electronics on the package makes it to be heated by a wireless power charger that allows the consumer to select one of three temperature levels for consuming (Figure 6.21).

Innovia Films, manufacturer of special films, and the company PragmatIC Printing, pioneer in printed logic circuits, have integrated the functionality of the printed electronics on BOPP labels. It is actually a prototype of an interactive label for active packages that activates a light flash sequence when the consumer holds the bottle (Figure 6.22). This is only one of the possibilities of the technology that can be used to interact, attract and inform the consumer through lights and sounds. For instance, it can be applied for changing the price of a product when it is close to the expire date.

Bemis Company and Thin Film Electronics ASA announced an agreement to develop a platform of smart and flexible sensors, specifically for the package, in order to develop a new package category that collects and transmits data on a wireless system for the food and healthcare markets.

The printed electronics is also one of the most promising technologies in the field of traceability, as discussed in the next item.

FIGURE 6.21
Printed electronics and wireless power-based heating device



Source: Press Release

FIGURE 6.22
Label that flashes lights



Source: Press Release

Traceability, communication and interactivity

Many technologies, currently used or in development, are focused on product identification and traceability, specially required by producers, retailers and consumers. Such technologies aim at data codification in order to incorporate in the packages the expected information.

Besides, the package can promote the interactivity or invite the consumer to be involved, through the

information and entertainment. That interactive package functionality can be possible through innovative systems attached to the package (RAITHATHA, 2009).

The barcodes and lot numbers are currently the most common way of tracing the product life cycle, being applied on the primary or secondary package. They allow the suppliers and retailers to trace the distribution of a product until its reach the consumer.

Just like the time-temperature indicators, that tracks distribution environment of a product, the development of radiofrequency identification – RFID labeling can monitor each stage of the distribution chain. Because the label do not need a straight visual verification, various products can be identified at once, making the distribution faster and efficient (BARNETT, 2011a).

An RFID label is essentially a tracking system or a smart label that can track each item connecting it to an information system on a network. It can be read individually or in group or even at a distance. Information can be added by the players of the supply chain, during the distribution. They consist in two modules, one for processing and data storage and another for transmitting and receiving data from the network. A separate device, the reader, is used to obtain information from the tag. The RFID tags allow multiple items to be monitored throughout the supply chain, without the need for visual checking, which increases the speed and efficiency of distribution. Eventually, it is hoped that the tags will replace the barcodes (BARNETT, 2011a).

In the future it is expected that the RFID labels will be multifunctionals, aggregating sensors for monitoring, communication and settings. For instance, gathering time-temperature sensors connected to a database, to inform retailers about the remaining shelf life of perishable goods and stock control.

Nowadays, most of the RFID labels use silicon-based semiconductors. However, there are some technologies in development based on printed electronics using conductive polymers (pentacenes, oligothiophenes) and metallic inks (copper nanoparticles, silver and gold). Another research field involves the use of carbon nanotubes as the antenna on the RFID label, to transmit and receive data, although that has not been as developed as the metallic nanoparticles-based conductive inks (BARNETT, 2011a). Hence, it is expected that the nanotechnology may bring many innovations in this field.

Many systems have been developed, including nanoscale barcodes, quantum dots and magnetic particles, however, the probability that such technologies will be widely used in food packages it is not clear yet and it will depend on the unitary cost and the ease of

use. It is more likely that the RFID labels will have a double purpose of tracking and authenticating items (ROBINSON; MORRISON, 2010).

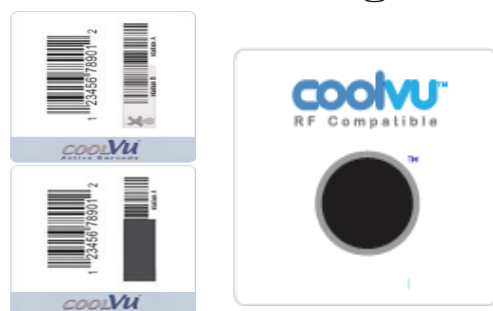
Concerning the printed electronics and RFID labels, there are many companies developing and selling those technologies. Companies such as CimaNanoTech and Novacentrix manufacture nanoparticles-based copper and silver inks. These can be formulated in organic or aqueous suspension and printed on various substrates. Other active players include DuPont, HP, Samsung and Hitachi (ROBINSON; MORRISON, 2010).

Other examples of technologies designed for traceability are the ones by the company FreshPoint, named CoolVu. One of them, CoolVu Active Barcode (Figure 6.23), consists in an active barcode, transforming traditional barcodes into smart tools for traceability, in which a time and temperature-dependent reaction alters the optical properties of the barcode, resulting in a situation in which part of the additional code becomes readable after a pre-defined temperature variation. The quick and exact read of the barcode at any point of the distribution chain ease the decision making by the user based on the temperature variation history. The other, called CoolVu RF (Figure 6.23), it is an addition to the existing RFID systems, allowing the electronic monitoring and the transmission of the product temperature history. The working principle of that system is based on the electronic characteristics (capacitance and resistance) of the metallic layer within the indicator, which are affected by the time-temperature variations. Therefore, as the RFID chip is attached, a reader can collect the data from the label which includes the product temperature history and remaining shelf life. By that, it is possible to have an intelligent inventory management, creating an opportunity for loss reduction of perishable goods controlling the output of goods for sale.

Concerning the traceability, there are some non-technical issues to be considered. These include regulatory and safety topics for materials used in contact with food and ethical issues that arise from the use of RFID labels to track products that may allow the tracking or data storage about the consumers (ROBINSON; MORRISON, 2010).



FIGURE 6.23
CoolVu Active Barcode and
CoolVu RF technologies



Source: Press Release

In the field of traceability, communication and interactivity, although the printed electronics is more promising, there are other simpler options, such as the bidimensional codes, for example the Quick Response Code – QR Code and the Data Matrix, capable of containing much more data than the unidimensional codes. They are called mobile codes (Picture 6.24). They can carry various information interesting to retailers and consumers, being able to be updated even after production without messing up the printing on the package. It has been revealed as a tool to aggregate new experiences to the product consumption and brings consumer and manufacturer closer to each other.

The QR Code allows interconnecting real world objects with information and services available on internet. That bidimensional code can be read by most of the smartphones equipped with a camera, since they have a software for QR Codes reading. The app allows the user to take a picture of the QR Code printed on the package, or even point the camera at it and get the URL to access the information and services indexed by the code.

The Campo Largo winery, in Brazil, uses the QR Code to interact with the consumer (Figure 6.24), allowing the visualization of further information, in digital format, at the supermarket shelf, about the company, the products line, beverage harmonization recipes and videos about the wine production.

The American company Great Day Farms uses the QR Code on their eggs packages (Figure 6.25). The

code allows basic information about the product, such as origin, name and location of the package plant, date and time of the eggs collection and even further data such as general information about eggs, safety tips and the company quality standards.

FIGURE 6.24
Bidimensional codification
technologies: DataMatrix
and QR Code



Source: Press Release

FIGURE 6.25
QR Code for interactivity
with the consumer



Source: Press Release

Another example of interactive package is the CEREpak, by MeadWestvaco (Figure 6.26). It is not only a package, but a data capture device; it registers day and time of the removal of every capsule or pill. Those information are transferred to a computer, through a special reader, and can be transmitted to the responsible doctor. The technology includes a microprocessor hidden in the blister and conductive paints that indicates the break of each small pill chamber. System technologies to remind the patient of the medication times can even be included in the packaging by using light, sound or vibration.

FIGURE 6.26
Indicator of day and time of pharmaceutical consume, interaction device with the patient



Source: Press Release

The future of active and smart packages

The target of active and smart packages has been enlarged to many products categories. Retailers will have interest in those technologies for increasing efficiency, reduce losses and keep the quality in the whole distribution and commercialization chain. The focus on new development has also changed from

benefits for the producers and retailers, such as shelf life increase, to customer satisfaction with freshness, quality and information benefits. It will be a challenge to the producers to aggregate value to their products associated with the increase of the deriving cost for the use of those technologies.

6.3 NANOSCIENCE AND NANOTECHNOLOGY

Nanoscience and nanotechnology are applied in the development of products at manometric scale (10^{-9} m), which has different properties from those at macro scale. They promise new solutions for the challenges of the package sector, especially plastic and cellulosic, which have limitations in their properties. They have a huge potential for improving the materials properties and performance, as well as increase the package functionalities, in new applications of active packages (absorbers and emitters), smart packages with nanosensors (pathogens, gases, abuses, contaminants, and theft), indicators (freshness, abuses, quality) and on systems for identification, authenticity and traceability.

An impact of at least US\$ 3 trillion by the nanotechnology is projected in the global economy in 2020 and also the involvement of 6 millions of workers until the

end of the decade (ROCO; MIRKIN; HERSAM, 2012).

There are various types of materials involved in nanotechnology: nanoclays, carbon nanoparticles/nanotubes, metals and oxides in manometric scale, silicate nanoplatelets, nanocomposites (mixture of nanomaterials and petroleum or renewable sources polymers), nanocatalysts and, recently, nanocellulose, amide nanocrystals, chitin, chitosan and other inorganic materials.

Due to its high aspect ratio (ratio between length and width), low nanomaterials concentrations are enough to improve certain properties of polymers without significantly altering its density, transparency and, especially, the processing characteristics. The opportunities for development in this field are great, but they still require a lot of research and investment.



Nanotechnology applications in packages and distribution

In the package sector, some applications and functionalities of the nanotechnology have been developed, such as:

- Improvement of the barrier properties (gas, aroma, water vapor and light) of plastic and cellulosic packages (through coating).
- Improvement of mechanical properties (plastic and cellulosic materials).
- Increase of thermal stability of thermoplastic polymers.
- Improvement of adhesion and surface modification.
- Incorporation of active compounds, especially antimicrobial and oxygen absorbers.
- Production of nanosensors (of microorganisms and chemical contaminants) and relevant information indicators (smart packages).
- Increase of biodegradability and compostability.
- Increase of recyclability (additive to minimize the yellowing of recycled PET bottle by ColorMatrix – Joule RHB – Figure 6.27).
- Production of packages with antistatic, antiadherent and autocleaning surfaces (repel humidity and dust and allow an easier removal of the packed product).
- Traceability systems (time-temperature indicators – TTI and RFID tags based on printed electronics, instead of silicon semiconductors, which allow the product to be monitored and tracked) and safety systems (safety paints, nanoscaled barcode: nanobarcodes).

Hence, the nanoscience and nanotechnology allow the development of processes and products that meet the requirements of the packaging sector in terms of energy and material reduction, more safety, quality and freshness of the products, more packages recyclability, reduction of solid waste, safety at the production and distribution, product identification and stock control.

The development of nanosensors and nanoindicators is promising. It is in this field that most of the academic researches and investments of funding agencies are focused on. It is a sophisticated and technologically advanced field, including commercial application of smart paints, printed electronics and electronic tongue.

FIGURE 6.27

Additive in nanometric scale improves the optical properties of recycled PET bottle



Source: Press Release

Lightweighting, downgauging

Besides increased mechanical resistance and barrier properties, the incorporation of nanomaterials in polymers and cellulosic materials rises the opportunity for package material reduction (downgauging or lightweighting) and price reduction, which ease the

pressure caused by the issues as sustainability and cost. When the package physical and barrier properties can be kept with less material, there is energy reduction, non-renewable source material reduction and reduction of the packages carbon footprint.

Barrier materials

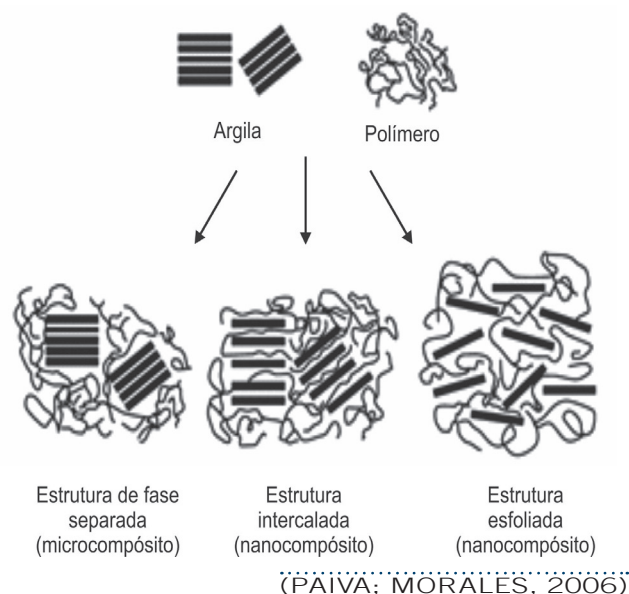
The polymeric materials are permeable to gas and water vapor, differently from metallic and glass packages, and that limit the application for various products categories. However, the barrier properties can be improved by using nanocomposites and oxide coatings.

Nanomaterials (clays, nanofibers, nanoparticles, etc.) work as small physical barriers to the permeation of gases and vapor through the polymers, making a tortuous path of the permeant through the polymer, slowing down its permeation. When they are present in a sufficient number, they slow down the mass transfer. The effective increase of the package barrier depends on the nanoparticles dispersion on the polymeric matrix. That dispersion is associated with the polymer, nanomaterial and compatibility agents, used to disperse the nanomaterial on the polymer (ROBINSON; MORRISON, 2010). It also depends on the concentration of the nanomaterial and the degree of exfoliation. If there is no layers separation (exfoliation and intercalation), which means that the polymer chain does not penetrate the nanomaterial layers, a conventional composite is obtained, with separate phases, immiscibles, in which the improvement of the mechanical properties can be verified, but not the increase of gas and water vapor barriers, just like the nanocomposites (Picture 6.28). The greater the degree of exfoliation, the bigger the gas and water vapor barrier.

Although the incorporation of nanomaterials, especially clays, can be done in various polymers, the polyamide-based nanocomposites are the most commercial successful in barrier resins for packaging (examples: Imperm® by Nanocor® Inc MXD6 polyamide-based and HFX by Honeywell).

The company InMat sells nanocomposite water base barrier coating - Nanolook, for films. The material combines polymer with nanoclay dispersed in water. The coating does not interfere in the biopolymers recyclability and compostability. It aims at the dry and oxygen sensitive food markets, such as coffee, nuts and snacks.

FIGURE 6.28
Structure of nanocomposites



The coating of films with silicon oxide SiO_x through a physical vapor deposition process with a good uniformity and adherence provides high humidity and gas barrier, keeping the package transparency. It is actually a polymer coating with nanometric particles, usually applied in PET film, or bio-oriented polyamide. An example of that technology is the film family called Ceramis, by Amcor. In the field of PET bottles, Toyo Seikan Kaisha sells the SiBARD technology, which is a double internal package coating. Initially an organic silicone film is formed and it provides flexibility and adhesivity to other internal coating of the silicon oxide, with good gas barrier properties. The coating is very thin, does not compromise the recyclability and has high transparency. Mitsubishi Shoji Plastics uses the coating technology called Plasma Nano Shield (plasma enhanced chemical vapor deposition) of amorphous carbon for high barrier PET bottles.

To increase the light barrier of polymeric packages, zinc nano-oxide and titanium nanodioxide are incorporated in polymers as anti-UV agents. DuPont is selling a titanium dioxide nanoparticle (Light Stabilizer 210) as a barrier to the UV light.

Active packages: oxygen absorbers and antimicrobials

Applications of nanomaterials in oxygen absorbers are commercially done by: NanoBioMatter, ColorMatrix, Honeywell, Mitsubishi Gas Chemical, Toyo Seikan (SIRIUS oxygen-scavenger technology), Multisorb Technologies Inc., among other companies.

The O2Block by NanoBioMatters is an oxygen absorber additive which physicochemical treatment allows it to be dispersed directly on various polymeric systems (Figure 6.29). The technology is based on the surface modification of a clay which becomes functional with active iron to work as an oxygen absorber. Nanoclay is used as the carrier of the active iron, which provides synergy to the oxygen absorber system.

The company Honeywell sells a family of nylon-based barrier resins, called Aegis, based on nanotechnology, with two oxygen absorbers grades: Aegis® OXCE for PET bottle for beer and scented alcoholic beverages and Aegis® HFX for PET bottles for hot filling, used for juices, teas and condiments, like ketchup.

The incorporation of nanoparticles such as zinc oxide and ionic silver in nanocomposites for packages and coatings has antimicrobial action. The nanomaterials have been the target of researches for the development of packages with antimicrobial function, working directly at the microbiological growth inhibition as bactericides, such as ionic silver, or as antibiotics vehicles and other agents that eliminates fungi and bacteria.

Titanium dioxide can be used as plastic packages coating with action over fecal coliforms. It can also be used combined with ionic silver. The chitosan, a biopolymer derived from chitin (a polysaccharide present on crustaceans carapace), also has antimicrobial properties and can be used in active nanocomposites.

It is expected that the nanotechnology will cause a big impact on the active packages field.

FIGURE 6.29
Oxygen absorber additive
for polymers



Source: Press Release

Smart packages: nanosensors and nanoindicators

Sensors include receptor and transducer elements, which mean that they detect changes and can work according to a command associated to the intensity of the measured alteration. The indicators represent a more passive form of nanotechnology application, as they only communicate and inform over visual alterations, especially color changes. Various technological applications are results of sensors and indicators combination.

Some examples are the sensors for detection of pathogenic microorganisms, toxins and contaminants; nanoparticles for selective remotion of pathogenics and contaminants by specific adhesion; and active antimicrobial agents such as metallic oxides (SCOTT; CHEN, 2003). Bionanosensors use sensitive biological materials such DNA, antibodies and enzymes, associated to physical and chemical transducers, which convert the biological signal into a processable

electric signal. Some nanosensors gather receptive and transductive elements, which mean that they can detect changes and act according them. Some examples are the microbiological growth sensors that release preservatives. The nanosensors show advantages such as high sensitivity and selectivity, fast response, portability and compatible cost with the application in mature markets. The innovations in the field of portable biodetection, especially the ones based on the bionanosensors platform in replacement of traditional immunologic tests, have been motivated not only by the high risk infectious diseases, but also by the bioterrorism. Nanomaterials built with nanolayers from different metals (gold, silver and nickel) are capable of work as nanobarcodes to detect the botulinum toxin, anthrax and a variety of pathogens.

The oxygen sensors with smart inks that change their colors in contact with oxygen are examples of smart packages that can alert suppliers, retailers and consumers about alterations in the product by the action of the oxygen. An example of applied nanotechnology on oxygen sensors is the AgelessEye by Mitsubishi Gas Chemical, which turns into pink at the lack of oxygen in the package and into blue when it detects oxygen in the package headspace. It is expected that the advancement in the use of nanomaterials increase the sensitivity of those sensors and allow faster responses and more intense coloration changes.

Besides the sensors, a launch of an indicator using nanotechnology (Timestrip's nano-TTI system) is the iStrip, designed to detect the accidental freezing of refrigerated products. The system is based on colloidal

gold (nanomaterial), which is red at temperatures above 0°C, but the freezing agglomerates the gold nanoparticles that results in a transparent solution indicating an accidental freezing of the product.

The company FreshPoint sells a series of time-temperature indicators called CoolVu, for temperature sensitive products. They work as an expire date label. The label is assembled from a metal label and a transparent label containing an etchant. At the packaging line, the indicators are applied on the package, activated and begin to show to suppliers, retailers and consumers the shelf life of the product. They are calibrated according to the product sensitivity to the temperature (Figure 6.30).

FIGURE 6.30
FreshPoint's time-temperature indicator



Source: Press Release

Improvement of biopolymers properties

The possibilities of improvement of the barrier, mechanical and thermal properties of the package materials through the application of nanotechnology will help the use of biopolymers, which properties are one of the limiting factors for its application in packaging. Montmorillonite and kaolinite clay, graphene, cellulose nanofibers and chitosan are promising, though there

is the need for researches for optimization of the biopolymer/nanoparticle/plastifying system and for the improvement of processing technologies.

Some examples of nanocomposites-based biopolymers are the NanoBioTer® (to be approved) and Degradal® (under development, by Nanobiomatters) that incorporates additives in nanometric scale to control



or accelerate compostability and biodegradability (ROBINSON; MORRISON, 2010). The company Rohm and Hass sells an acrylic nanoparticle (Paraloid BPM-500) to increase the PLA (polylactic acid) resistance, a compostable polymer.

The company StoraEnso significantly stepped onto the innovation of renewable source materials, investing in a plant in Finland to manufacture a new nanomaterial, the microfibrillated cellulose, which will allow the weight reduction in paperboard packages, and improvement of the barrier properties.

Edible coatings from biopolymers applied to food and pharmaceuticals have been studied even at

Brazilian universities and they can be used to preserve fresh fruits and vegetables, including the ones minimally processed, dried fruits, cheeses, meat products and other food. They can be formulated to provide a barrier to humidity, gases and have further functionalities, to be a vehicle to enzyme, antioxidants, aroma and pigments, working as an active coating. Carbohydrates (starch, cellulose) and proteins (zein, casein, gelatin, collagen) based coatings combined with nanoclays have their mechanical and barrier properties improved and can be used as a vehicle for other active agents aiming at functionality.

The commercialization

The companies involved with the commercialization of raw material produced with nanotechnology are only a few and can be divided in two groups: plastic resins manufacturers (DuPont, Bayer, Honeywell, Mitsubishi Gas Chemical) and additives and fillers manufacturers for the plastics industry (Southern Clay Products, Nanocor, ColorMatrix, LANXESS). Nanocor have partnerships with companies that produce plastic resins that use nanoclay (Nanomer) in their products, including Honeywell (Aegis), Nylon Corporation of America (nanoTUFF and nanoSEAL) and ColorMatrix Corporation (Imperm).

There is little collaboration among them and they do not share the high development costs. There is little competition due to the low number of involved companies. The production is low and most of times with no economy of scale. Another problem is the use of conventional equipment in the packaging manufacture. The new materials show different rheological properties and crystallization rate from conventional polymers.

The difficulty of selling technologies and the time between the development and the product commercialization are still the big obstacles for the nanotechnology applications in the package sector.

The future of the nanotechnology in the package sector

According to Business Insight, the future of the nanotechnology in the package sector for food and beverages is associated with some drivers (BARNETT, 2011a):

- The governmental investments will be aimed at developing economies.
- The commercialization will be the biggest challenge.
- The food safety will be the focus for the development over the medium term.
- The cost-benefit will gradually improve.

- The new products will aggregate more benefits.

Although the great innovation potential and the high investments that have been done, the nanotechnology in the package sector is not a conventional technology yet. Market restrictions are related to many factors: nanoscience and nanotechnology are not consolidated; the long-term effects over the consumer health are barely studied; there is distrust from the consumer; there is regulatory risks since the legal issues are beyond innovations and

new legislations may restrict applications; the packages involving nanotechnology are still at a high cost; and the time between R&D and commercialization is still long (BARNETT, 2011a). Therefore, the many potential benefits of the nanotechnology should be tried against its potential risks, which are still being evaluated.

The resources needed for research are significant, although they are decreasing since 2008. The international cooperation and strategic planning to establish the researches priorities are necessary in order to reduce time and efforts on the nanoscience and nanotechnology advancements (MAGNUSON at al., 2011). The biggest funding sources have been governmental and academic and Japan is leading it.

Safety issues related to the use of nanotechnology are still a concern due to the little amount of toxicological studies straightly designed and focused on the impact of that on human health; to the limiting of analytical methods to detect and characterize the nanomaterials incorporated in the package and in the product; and to the limited understanding about the nanomaterials characteristics which affect the consumer safety, especially in food and beverage applications. Hence, the future of the nanotechnology applied to food and beverage packages is associated to the attitude of the

regulatory agencies, like ANVISA in Brazil, in the face of the potential risks and hazards that are still being studied.

Specifically related to the application of nanotechnology in packaging, there are countless gaps for studies: nanomaterials migration in polymers; interaction between bionanomaterials and cellular components; the value of acceptable doses concerning nanomaterials; the relation between nanoparticles characteristics (size, shape, polarity etc.) and toxicity; appropriated methods for identification, characterization and quantification of nanomaterials in complex food matrices; chronic toxicity; and biodegradability of nanomaterials or nanomaterials toxicity to ecological important organisms (DUNCAN, 2011).

Nanoscience and nanotechnology applied to packages are still recent and it has a promising future, uncertain though. The applications in packages are still limited. The ethic, risks and hazards issues associated with the safe and successful use of nanotechnology in food and beverage packages will impose a constant dialogue between scientists, companies and consumers. It is expected that the success of that dialogue bring important consequences to the safe supply of food and beverages on a world-wide scale.

6.4 BIOPOLYMERS

Even though most of the package materials are not from renewable sources (glass, metal and fossil source thermoplastics), the bioplastics have had loads of attention as they show themselves as alternative for the reduction of the petroleum dependency and have potential to reduce the impacts of the package sector in the environment, if they are produced with responsibility.

Sustainability issues have had some impact on the package sector, especially when designated to food, beverages and cosmetics. That fact is even more remarkable in mature markets such as the European and the USA's one. Consequentially, the search for renewable materials has increased. The barriers to be overcome by manufacturers and users are production

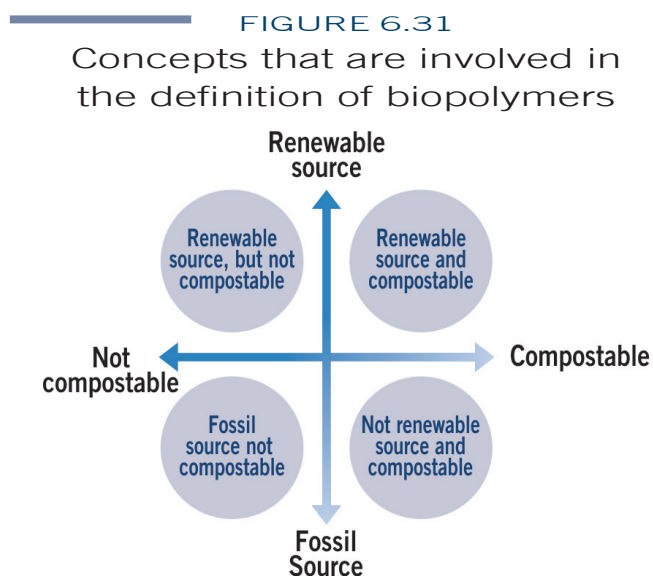
costs, R&D costs for product development, offer limitations and limited performance. Because they have different chemical composition from conventional polymers of the package sector, with some exceptions, they demand processing technologies that are many times different of the one available in the converters. Another challenge for the utilization of biopolymers is trying not to compromise the efficiency of processing lines operation and distribution logistics.

The market of biopolymers has grown as its production rout and the material itself have become more technically advanced and more cost competitive. As the petroleum cost increases, bioplastics naturally become more competitive.



One concern is that the competitiveness of bioplastics would be affected by the pricing increase of the agriculture products. Another concern is that the cultures for bioplastics production would cause a pricing increase and impacts on the food supply (BARNETT, 2011b).

In Brazil, the Brazilian Technical Standards Association (ABNT) defines biopolymer as “polymer or copolymer produced from renewable source raw material” (ABNT NBR 15448-1, 2008). In some countries, the definition of biopolymer is still under debate and can include, besides renewable source materials, even though they are not compostable, compostable materials, even though they are not from a renewable source (Figure 6.31).



The biodegradation is a process in which organic substances, or similar synthetic, are degraded by microorganisms, in aerobic environments, such as composting, or anaerobic, like most of the landfills. Biodegradable materials, if correctly composted, minimize the environmental impacts, once good quality manure is produced. However, if placed in landfills, they generate methane when degraded, a 25 times more potential for greenhouse effect than CO_2 , which aggravates the environmental problem. Hence, the use of a biodegradable package demands an infrastructure of

composting and requires that the product manufacturer assures that the consumer will discard it properly, to ensure revalorization (HORTON, 2008).

Compostability is the complete biological degradation of biodegradable material, until the formation of carbon dioxide, water, inorganic compounds and biomass, with no toxic waste.

To be certified as compostable biodegradable material, a biopolymer should meet some standards, in Brazil ABNT NBR 15448-2 (2008), in USA ASTM D 6400 (2012) and in Europe EN 13432 (2000) and EN 14995 (2006).

The difference between biodegradable-only and compostable plastic is important. For example, a film with less than $20\mu\text{m}$ of PLA is compostable, while thicker films are not compostable, because they do not decompose fast enough to be considered compostable (BARNETT, 2011b).

The process of oxidegradation is associated to polymers of fossil source with metallic salt-based additives that catalyzes the degradation of the chemical structure, generating molecules with lower molecular mass, non-biodegradable and inorganic particles. The process is activated by the polymer exposition to some factors such as heat, UV radiation and humidity. There is no oxidegradation in landfills with no proper temperature, oxygen and light. They compromise the normal recycle chain, because they cause degradation of the recycled chemical structure and are not composted at industrial composting plants. Oxidegradable plastics are not traditionally classified as biopolymers, as they normally do not meet the ABNT NBR 15448-2 (2008), ASTM D 6400 (2012) or EN 13432 (2000) standards requirements, once they take more than 180 days to degrade at the conditions specified in the standards.

Concerning the biopolymers definition there are standards that helps in the evaluation of these new materials, such as the Brazilian standard ABNT NBR 15448-2 (2008), American standard ASTM D 6400 (2012) for composting plastics, ASTM D 6868 (2011) for paper coatings and other compostable substrates and the European standards EN 13432 (2000 + AC 2005) for packages and EN 14995 (2006) for materials,

which assure biodegradability, fast compostability and formation of non-toxic substances. Certification systems established by the Biodegradable Products Institute – BPI, DIN/CERTCO and other institutions validate the performance of biodegradable materials.

According to the PMMI (PACKAGING..., 2011) trends report 2011, “even though the concept of compostable and/or biodegradable material has much appeal, currently a very little package material is really composted. There is not a significant composting infrastructure spread over the United States. In Europe, the European Union’s Landfill directive restricted the biodegradable waste landfill. As a result, some European countries have a well-established infrastructure of composting and other does not. In Japan, a 2001 law, the Food Recycling Law, helped the increase of composting plants and composting rates”. In Brazil, in 2008, the composting corresponded to 0.8% of the collected waste allotting (IBGE, 2010), which is inexpressive, but with the institution of the National Policy of Solid Waste, it is expected a growth of the composting plants.

Biopolymers can be organically formed in the nature by living organisms (agropolymers) or to be chemically synthesized from renewable sources. The production of biopolymer can be via polymerization of natural molecules or chemical modification of a natural polymer.

The agropolymers are a vegetable or animal source biopolymer, obtained straight from the biomass. Usually they are derived from starch (corn, potato, wheat), cellulose, proteins (whey, soya) and from lipidic materials (triglycerides). The chitosan is a natural modified biopolymer (carbohydrate), obtained from chitin, which is a biopolymer present on crustaceans carapace, but it can also be found on some fungi and yeasts. Chitin and chitosan are highly available biopolymers and their structures allow uncountable modification possibilities, functionalities and applications.

It has to be stuck out that the biopolymers derived from polysaccharides (starch) have received a lot of attention due to its compostability, good barrier to gases and versatility. They can be used in starch blends

or mixed with cellulose, compostable polyesters, lignin, pectin, protein or transformed into nanocomposites. However, its high sensitivity to humidity has limited its applications, which is very relevant in a tropical country like Brazil, with a high environmental humidity.

The agropolymers can also be produced by biotechnology, which means by algae and bacteria that ferment sugars and produce polyesters (as the family of polyhydroxyalkanoates – PHA), or by acid fermentation that generates lactic acid, that is lately esterified and polymerized at polyacid lactic – PLA. Algae and bacteria can also be used to generate raw material for biopolymer production.

Genetically modified plants have been developed to incorporate enzymes used by bacteria in the organic manufacturing of biopolymers. The genetic code of bacteria has been transplanted into certain plants, such as the soya, in order to produce the biopolymer at the normal cellular process. After collecting it, the biopolymer is extracted from the plant with a solvent.

Since it has been tried to improve the sustainable profile of the agropolymers, efforts in research have been aimed at the production of those materials from food and beverages industry residues, agriculture residues, and logging residues (cellulose and lignin). The issue of the use of renewable source energy is also a relevant requirement to reduce the environmental impact of biopolymers when comparing to the conventional process at the petrochemistries.

Cellulose is an organic polysaccharide composed of long glucose chains. It is usually present in plants and can be produced by some bacteria. It is the basic raw material for manufacturing paper, cardboard, corrugated paperboard, cellophane and cellulose acetate. They can be chemically modified in aquasoluble polymer, compatible with starch and gums.

The nanoparticles can be obtained from biopolymers as whiskers, starch, proteins and chitin. Chitosan nanoparticles can be used as vehicles of specific compounds in active packages, besides its antimicrobial property. On the other side, other inorganic nanoparticles can be incorporated in biopolymers to improve its properties.



Among the biodegradable materials, there are some fossil source polyesters. Consist of poly(caprolactones), polyesteramides and some aliphatic and aromatic copolyesters. Those materials are, many times, associated in blends with biopolymers, especially starches. BASF sells an aromatic-aliphatic copolyester from fossil source (poly(butylene adipate-co-terphthalate) – PBAT), biodegradable and compostable, called Ecoflex. Other family of products that combines Ecoflex and PLA has been named “ecovio” by BASF, for coating of cellulosic materials. In partnership with Ingredion Incorporated (once called Corn Products International), BASF developed a polymer that combines the Ecoflex with corn starch-based polymer, called Ecobras, with more than 50% of renewable source raw material.

A family of regenerated cellulose-based films that has gained some expression in the market of biomaterials is the NatureFlex, by InnoviaFilms. The products are manufactured from wood cellulose, on the same concept as the cellophane, although it is actually compostable material, certified in accordance with the industrial composting standard EN 13432 (2000) and ASTM D 6400 (2012).

The company Novamont® has developed and sold the Mater-Bi technology, a family of biodegradable and compostable thermoplastic biopolymers, starch-based from non-transgenic source (usually corn). The company DuPont offers thermoplastic starch-based resins, under the name of Biomax TPS – thermoplastic starch compostable. Cereplast Compostables is a family of starch-based resins, compostable, available for the market of disposable plastic cutlery, films and blown packages. It can be used in blends with the PLA Ingeo.

The PLA is thermoplastic aliphatic polyester produced from the fermentation of the dextrose and later polymerization of the lactic acid in a polylactide. It is one of the most commercialized biopolymers in the package market due to its availability, competitive cost and easy conversion into film or rigid packages. The NatureWorks is one of the main worldwide manufacturers of PLA from oleaginous crops. In USA, corn has been used as a source of starch/sugar. Biopolymer Ingeo acquired certification of biological based product from

the BioPreferred program, by the USDA. BioPreferred confirms that, at least, 25% of the carbon content is from biological base. In Europe, the company PURAC is a leading manufacturer of PLA.

The PHA family of polyester includes the poly(hydroxybutyrate)–PHB and a variety of copolyesters, biodegradable and compostable. The world producers are just a few, including Procter & Gamble. The family of PHA biopolymers from the company Metabolix is commercialized under the brands Mirel and Mvera. In Brazil there is a pilot factory of PHB and of the copolymer poly(hydroxybutyrate-valerate) – PHBV, products from the Biocycle family manufactured, by the company PHB Industrial, using sugar cane.

The recyclable biopolymer is an option that allow the revalorization and the preservation of energy and raw material. In Brazil, Braskem adopted that concept for the production of a biopolymer, a renewable source biopolyethylene. In 2010, they started producing the Green Polyethylene, similar to the commercial grades of high density and low linear density polyethylene, to be processed in conventional equipment, for manufacturing recyclable packages. The resin is produced from bioethanol obtained from sugar cane. The main step of the technology is the transformation of the hydrated bioethanol into ethylene. The product has a validation of the company Beta Analytic, which determines the amount of carbon 14 of the material and, from that, determines the percentage of raw material provided from renewable source.

That approach has also been adopted by Coke at PlantBottle (Figure 6.32), that is recyclable, allowing the return of the raw material to the productive cycle with recycling. The PET bottle is produced with 30% of renewable source raw material, which means that the monoethylene glycol comes from sugar cane ethanol – BioMEG. The remaining 70% are composed by terephthalic acid (PTA) that, with the BioMEG, forms the PET resin. So far, the monoethyleneglycol (MEG) used in PET bottles was from fossil source. Coke and the Indian company JBF Industries announced the construction of a factory for the BioMEG resin in Brazil, in Araraquara/SP, that might start operating from 2015.

FIGURE 6.32

PlantBottle Technology: 30% of renewable source raw material



Source: Press Release

Cushioning materials, although are almost always unseen by the final consumer, are extremely important at transportation and distribution of added values products, such as computing equipments, home appliances and electronics. There are many studies already done and in progress, seeking for alternatives for the traditional fossil materials, such as the expanded polyurethane, polystyrene and polyethylene. One of the alternatives is the molded pulp, much used with products like cellphones and small home appliances, but which show some difficulties in terms of productivity and material homogeneity, among others. In the biopolymers lines, the company Ecovative has developed a new material (Figure 6.33), mycelia-based, something similar to the mushroom roots. The fungi grow from five to seven days and develop themselves through the digestion of

agriculture residues, such as husks, straw, etc. The format is given by the mold where they grow, and the density can also be manipulated.

Among the biopolymers, besides the cellulosic materials, the poly(lactic acid) – PLA, starch-based polymers, and the Green Polyethylene by Braskem are the main products in the market. The market of biopolymers for packages is specialized and concentrated, but tends to be more fragmented in the next decades.

In the field of biopolymers, the challenges are: overcome the limitations of their properties, especially for use in food package, increase the availability, increase the competitiveness with fossil source polymers of lower cost and solve environmental issues like: negative impact in the recycling chain of other materials and lack of collection and infrastructure for composting. The future is in the packages manufactured with by-products from food, beverage and wood industries and agriculture residues.

FIGURE 6.33

Example of material for padding with sustainable appeal



Source: Press Release

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Chapter 7

SUSTAINABILITY & ETHICS

As Life Cycle Assessment studies measure various forms of environmental impact such as global warming, natural resource depletion, acidification, eutrophication and human toxicity, among others, they have been considered as one of the best instruments for the quantification of human action on the planet.

A new environmental global conscience has gradually arisen as the transformations that the planet has passed through, accentuated by climate changes that can be clearly seen in every continent, have been understood as consequences of the actions of mankind on nature. The 4th Intergovernmental Panel on Climate Change (IPCC), after analyzing 29 thousand series

of data, originating from scientific studies performed around the world, concluded that global warming is unequivocal and has been caused by anthropogenic actions. The report also emphasizes the need for reducing the emission of greenhouse gases by all productive sectors, in order to minimize the effects forecast for the next few years.

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As Life Cycle Assessment studies measure various forms of environmental impact such as global warming, natural resource depletion, acidification, eutrophication and human toxicity, among others, they have been considered as one of the best instruments for the quantification of human action on the planet. The document Brazil Pack Trends 2020 shows that, this technique, in its simplest form, the *Life Cycle Thinking* becomes a powerful tool to be applied to continuous

improvement of the existing processes as well as to drive new products and processes development, which have goal to become more sustainable. The application of this tool for packaging unfolds in this document in four trends to be pursued over the next decade: Optimization of the product/package system; Reuse & Recycling; Waste Management & Reverse Logistics and Credibility & Ethics (*Table 7.1*).

TABLE 7.1 Sustainability & Ethics – General trends and guidelines for packaging	
Sustainability & Ethics General trends	Guidelines for packaging
Optimization of the product/package system – Doing More with Less	From Life Cycle Thinking perspective: • Resource efficiency: natural resource consumption reduction, weight (lightweighting), volume reduction, energy saving • Materials and energy from renewable sources • Reduction of losses • Greenhouse gas emissions (Carbon footprint) reduction • Water consumption (Water footprint) reduction
Reuse & Recycling	• Shelf life extension • Ecodesign • Recycling • Development of new recycling technologies
Waste Management & Reverse Logistics	• Reverse logistics • Symbolism for identification of post-consumer packages
Credibility & Ethics	• Extended responsibility • Accreditation and validation • “No” for Greenwashing



7.1 ENVIRONMENT: A GLOBAL ISSUE

The recent invasion of environmental issues in the media, as well as the involvement of countries around the world including many people, from scientists to politicians, famous actors to children of different nationalities, has shown the degree of penetration of this topic in the life of the common citizen. If, in the scientific community, environmental issues have been discussed since the 1950s, and have gradually gained importance, currently, the relationship between modern life and the environment are inserted even in primary school books.

This penetration has occurred by a combination of several factors. From this perspective, globalization, which has been intensified from the second half of the '80s, has transformed the environmental discussions from national to global. The social-related aspects are referring to global society and not only the regionalized effects. Many agents, such as transnational corporations, non-governmental organizations, epistemic communities and the media have begun to have strong influence in decision making. Through globalization, humanity becomes aware of the risk of environmental degradation due to the potential destructive capacity of nuclear plants and contamination of air, water, soil and the food chain by chemical industries (VIOLA, 1998; CAYE, 2010; SILVA, 2009).

The 1972 Stockholm Declaration, concerning the human environment, had its importance because it is characterized as the first document in which the protection and the improvement of the human environment were treated as fundamental issues of

interest and the duty of all governments, because they affect the well-being of peoples and economic development worldwide (UNITED NATIONS CONFERENCE, 1972).

Many international agreements have been settled, in which three main objectives can be observed: to protect the ozone layer, to reduce the effects of climate change and to protect biodiversity. The Vienna Convention (1985) resulted from the concern for protecting the ozone layer, responsible for the filtration of solar radiation in the ultraviolet range, particularly harmful to human health.

This was followed by the adoption of the Montreal Protocol, in 1987, which controls the production and the consumption of substances that, due to their reactivity combined with their market volumes, have high potential to destroy the ozone layer, such as "chlorofluorocarbons or CFCs (-11, -12, -13, -C14, -15)", halons (-1211, -1301 and -2402), HCFCs and methyl bromide. These actions have resulted in significant reduction of those gas emissions and are considered examples of successful policies of prevention and precaution to mitigate global climatic problems (UNEP, 1992; SILVA, 2009; CAYE, 2010).

The Convention on Biological Diversity (CBD), resulting from the United Nations Conference on Environment and Development – UNCED (Rio, 1992) had a crucial impact on environmental awareness and the need for biological diversity protection. Signed by 168 countries and ratified by 188, it is considered a political landmark concerning issues related to biodiversity (MINISTRY OF EXTERNAL RELATION/ MINISTRY OF ENVIRONMENT, 2012).

Climate change

In 1998, the Intergovernmental Panel on Climate Change (IPCC) was created by the United Nations Environmental Program (UNEP) and the World Meteorological Organization (WMO). Composed of thousands of scientists around the world, the

IPCC is an international organism which reviews and evaluates the scientific, technical and socioeconomic information produced in the world, which are relevant for the understanding of climate change. Since its creation, it has published four major assessment

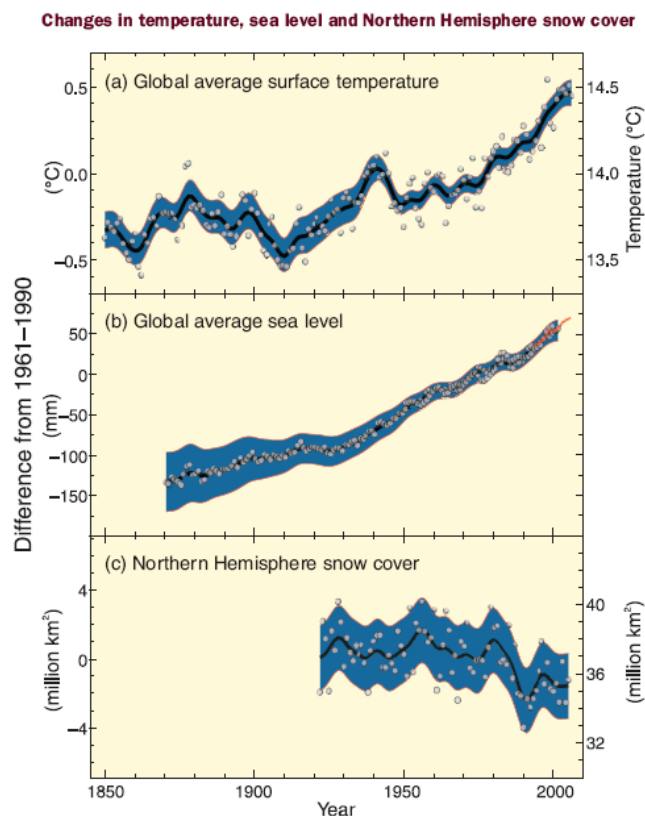
reports (INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, 2012). Its most recent report to date, the AR-4 (IPCC, 2007) is based on 29,000 series of data corresponding to 75 studies, each one with at least 20 years of observation. According to the 4th IPCC report, the warming of the climate system is unequivocal, evidenced by observations of increased global average air and ocean temperatures and by melting glaciers and rising global average level of the oceans, as shown in Figure 7.1.

The rise in sea level is consistent with global warming. The sea level increased at an average rate of 1.8 mm per year between 1961 and 2003, and at an average rate of 3.1mm per year between 1993

and 2003. The thermal expansion of the oceans has contributed to the increase of sea levels, along with the reduction of the glaciers and ice caps.

The reductions observed in the areas covered by snow and ice are also consistent with the warming. The satellite data, since 1978, show that annual average area of the sea arctic ice has been reduced by 2.7% per decade, with more intense reductions in the summer, of 7.4% per decade. The glacial mountains and the mean snow covers have decreased at both hemispheres. Temperatures at the top of the permafrost layer have generally increased since the 1980s in the Arctic by up to 3°C.

FIGURE 7.1
Observed changes



Observed changes in (a) global average surface temperature; (b) global average sea level from tide gauge (blue) and satellite (red) data; and (c) Northern Hemisphere snow cover for March-April. All differences are relative to corresponding averages for the period 1961-1990. Smoothed curves represent decadal averaged values while circles show yearly values. The shaded areas are the uncertainty intervals estimated from a comprehensive analysis of known uncertainties (a and b) and from the time series (c).

Source: IPCC, 2007



Climate changes causes

The changes in the atmospheric concentrations of greenhouse gases and aerosols, land cover and solar radiation alter the energy balance of the climate system and are considered drivers of the climate change. The greenhouse gas change affects the scattering, absorption and emission of radiation within the atmosphere and at the Earth's surface. The resulting positive or negative changes in energy balance due to these factors are expressed as “radiative forcing”, which is used to compare warming or cooling influences on global climate.

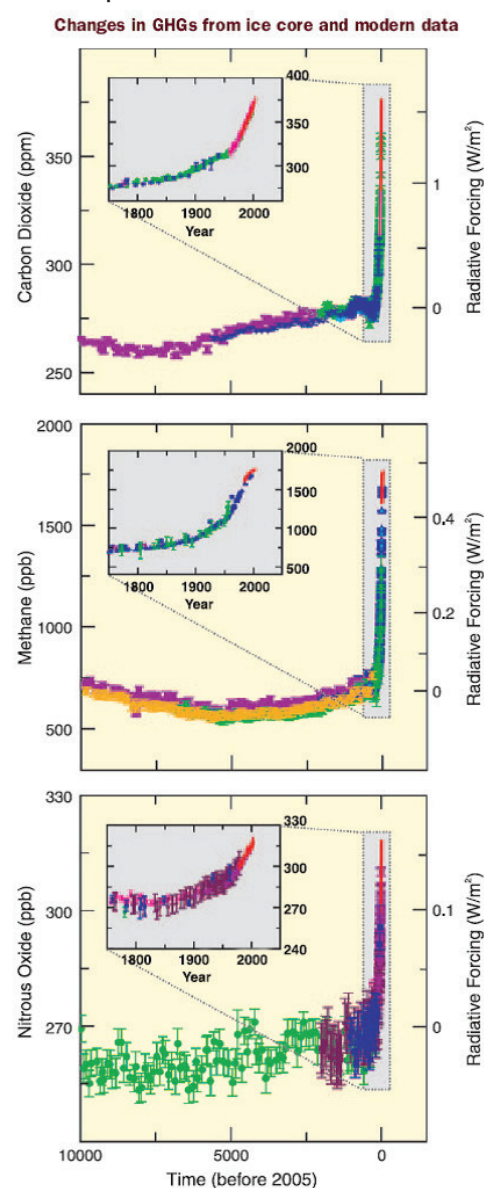
Human activities produce mainly four types of long-life greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and halocarbons (a group of gases that contain fluorine, chlorine and bromine). The global atmospheric concentrations of CO_2 and CH_4 in 2005 exceed by far the natural range over the previous 650,000 years (FIGURE 7.2).

The increase of the CO_2 concentration is mainly due to the use of fossil fuels and, at a lower scale, due to land-use change. It is very likely that the increase of the CH_4 concentration is predominantly due to agriculture and fossil fuel use. The increase in N_2O concentration is mainly due to agriculture.

The 4th IPCC report also concluded that the observed changes since the second half of the 20th century are very likely due to the observed increase of greenhouse gases by anthropogenic action, as shown in Figure 7.3. The warming of the atmosphere and oceans observed on a large scale, together with the loss of ice mass, support the conclusion that it is extremely

unlikely that the global climate change of the last 50 years can be explained without external forcing and very likely that it is not due to known natural causes alone.

FIGURE 7.2
Atmospheric concentrations



Source: IPCC, 2007

Atmospheric concentrations of CO_2 , CH_4 and N_2O over the last 10,000 years (large graphs) and since 1750 (small graphs). Measurements have been performed on ice cores (symbols with different colors for different studies) and atmospheric samples (red lines). The values corresponding to radiative forcings are shown on the right hand axes of the large graphs.

The urgency in reducing the effects of anthropogenic actions

The need of mitigation of greenhouse gases is clearly expressed in the 4th IPCC report. Models based on the current levels of greenhouse gases (GHG) and on the rates of temperature rise measurements estimate an increase in global average from 1.8°C to 4°C until 2100, and the most reliable estimate predicts an increase of 3°C if the GHG concentrations stabilize down at 45% above the current rate.

The landslides that happened in 2011 in Teresópolis, in the State of Rio de Janeiro, due to a long rainy period, as well as the floods in Pakistan in

2010, the heat waves in France in 2003, the drought in Russia in 2010, the heat in the Alpine resorts in 2006 and the drought in USA in 2012, among other events, are reflexes of the climate changes (IPCC, 2007c; IPCC, 2011; FAPESP AGENCY, 2012).

Since these events have been increasingly frequent, the need is urgent for all sectors of the economy, including the packaging sector, to contribute to the reduction in the emission of greenhouse gases and implement actions to reduce the anthropogenic impact on our system

The National Policy of Solid Waste (NPSW)

The National Policy of Solid Waste (NPSW) was instituted in Brazil through Law number 12.305, August 2nd, 2011, after almost 20 years passing through the National Congress, and this fact can be considered a landmark in Brazilian history.

According to the Brazilian Institute of Geography and Statistics, 80% of almost 260,000 of daily collected or received garbage, are designated to controlled and/or sanitary landfills. Unfortunately, 18% of the domestic and/or public solid waste is still sent to open landfills (BRAZILIAN INSTITUTE OF GEOGRAPHY AND STATISTICS, 2008). Therefore, the minimization of waste generation as well as the proper disposal of solid waste should be priorities in the country, to meet the basic principles of sanitation.

Due to its importance and complexity, it is necessary to understand how the policy is structured in relation to packaging. The NPSW text is divided into four parts or Titles:

General Considerations (T-I)

In the first part related to the general considerations (T-I), the NPSW gives general guidelines for the integrated management of solid waste and assigns responsibilities to their generators and also the government. The most important definitions are:

Life Cycle of products: it involves the steps from the acquisition of the raw material, its processing, consumption and to final disposition.

Adequate Environmental Destinations: include reuse, recycling, composting, energy recovery and use or others allowed by regulatory agencies.

Final Adequate Environmental Disposal: considers only the orderly distribution of waste in landfills, according to their operational standards, preventing damage or risks to public health and safety.



Reverse Logistics: includes a set of actions that enable the collection and the restitution of the solid residues to the productive sector, to reuse, in its own cycle or other productive cycles.

Recycling: Process of transforming solid residues with no alteration of their physical, physicochemical or biological properties, for subsequent use as inputs or new products.

Shared Responsibility During the Life Cycle of Products: a set of individual attributions for manufacturers, importers, suppliers and traders, consumers and urban cleaning public service agents, to minimize the volumes and impacts of solid waste generation.

From the National Policy of Solid Waste (T-II)

In the second part, the principles from which the policy was established are clarified: the principles of prevention and precaution, polluter payer, protector-receiver and shared responsibility.

For the protection of the public health and the environmental quality, the NPSW proposes an integrated management of different sectors, with a strong incentive to reduce waste at its source and to encourage recycling chains. The policy proposes the inclusion of street collectors of reusable and recyclable materials in the collecting chain of post-consumer materials.

The National System of Information on Solid Waste Management (Sinir) and the National System of Information on Basic Sanitation (Sinisa) are important instruments for policy management.

Policies applicable to Solid Waste (T-III)

The NPSW suggests that the following priority order in solid waste management should be followed: non-generation, reduction, reuse, recycling, solid waste treatment and adequate environmental final waste disposal. The use of technologies for energy recovering

from solid waste can be an option when associated with a program to monitor toxic gas emission approved by the environmental agency.

The policy establishes that “Solid Waste Management Plans” have to be elaborated at national, state, micro-regional, metropolitan regions or urban agglomerations, intercity and municipal levels by all stakeholders involved. Any plan must have the following minimal requirements:

- Initial diagnosis of the solid waste situation.
- Targets for reduction, reuse, recycling, energy recovery, elimination and recuperation of landfills, with include those who gain a livelihood collection and separation waste.
- Programs, projects and actions to achieve the predicted targets.
- Standards and policies for the final disposal of refuse and residues.
- Means to be used for control and supervision of the proposed programs.

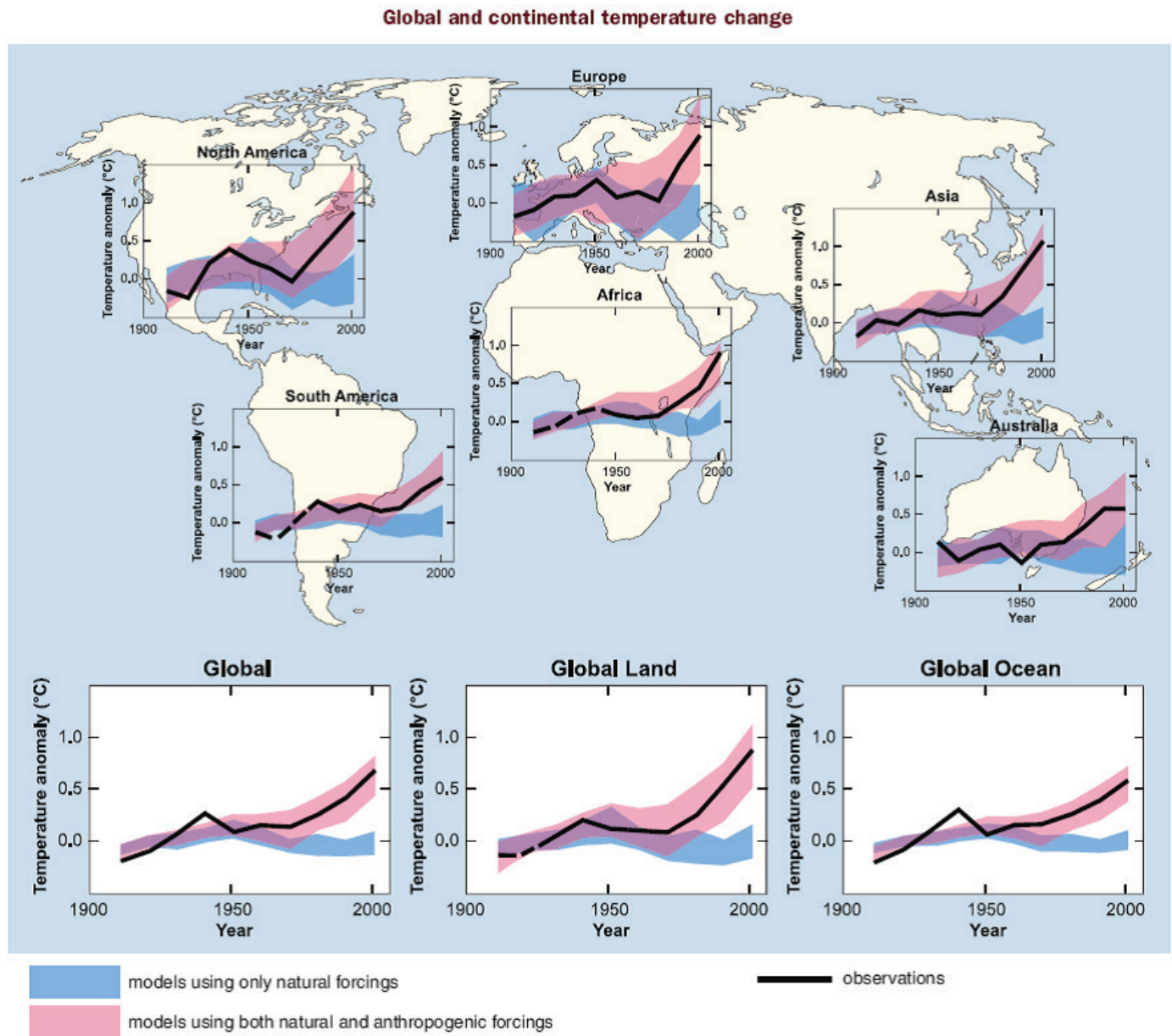
The elaboration of the plans is a condition for obtaining access to federal funding.

Lead by the principle of shared responsibility, the NPSR states that:

The packages material manufacturers, final packages, companies that condition their products in packages as well as importers and suppliers, have the responsibility to:

- Place packages in the market which have optimized weight and volume for containing protection and product commercialization.
- Place in the market products which, after use by the consumer are able to be reused, recycled or another form of adequate environmental disposal and which fabrication and use produce the as little amount of solid residues as possible.
- Publish the information related to the ways of avoiding, recycling and eliminating the solid residues associated to their respective products.

FIGURE 7.3
Changes in temperature



Comparison of observed continental- and global-scale changes in surface temperature with results simulated by climate models using either natural or both natural and anthropogenic forcings. The black line represents real mean values of the period.

Source: IPCC, 2007



The mandatory structuring of reverse logistics systems with collection of the remaining residues and products after use, and subsequent environmentally adequate final disposal, is aimed at the manufacturers, importers, suppliers and vendors of:

- Agrottoxics and products that, after use, are characterized as harmful residues.
- Batteries and battery packs.
- Tyres.
- Lubricant oils, their residues and packages.
- Fluorescent, sodium and mercury-vapor lamps and mixed light.
- Electro-electronics products and their components.

Sectorial agreements firmed between the Public Power and the business sector are extended to commercialized items in plastic, metallic and glass packages, and to the other products and packages, firstly considering the degree and impact of the produced residues on the public health and the environment. The definition of those products and packages will consider the technical viability and economy of the reverse logistics, as well as the degree and extension of the impact to the public health and environment by the produced residues.

The following means for structuring the reverse logistics system are considered:

- Implementation of procedures for ordering used products and packages.
- Make available collecting stations of reusable and recyclable residues.
- Acting in partnership with cooperatives or other forms of reusable and recyclable material pickers' association.

The sectorial agreements and those ones firmed on a national scale prevail over the ones firmed on a regional or State scale, and these ones over the ones firmed on a municipal scale.

The consumers shall make the disposal, after use, to the products and packages vendors or suppliers and for other products and packages, an object of reverse

logistics. Every time that a selective collection system is established by the municipal plan of solid residues integrated management, the consumers are obligated to:

- Sort the produced residues in a different way.
- Make the solid and reusable residues and recyclables available for collection and return.

The municipal public power can institute economic incentives to the consumers that are part of the selective collection in the form of a municipal law.

It is attributed to the titular of the urban cleaning and solid residues handling public services:

- Adopt procedures to reuse the solid residues and recyclables from their services.
- Establish a selective collection system.
- Articulate with the economic and social agents to make the return to the productive cycle of the reusable solid residues and recyclables viable, from the urban cleaning services and handling of solid residues.
- Perform the activities defined by sectorial agreement or compromise at the right remuneration by the entrepreneurial sector.
- Implant a system of composting for organic solid residues and articulate with the economic and social agents forms of use for the produced compound.

The dump of residues on beaches, in the sea or in any water body, as well as open landfills, and their openly incineration, are forbidden forms of final disposal.

Transitional and Final Provisions (T-IV)

The damages caused by actions or omissions of people and companies that produce harmful activities to the environment will have predicted sanctions under the present laws.

The environmentally adequate final disposal of the refuses in landfills with the program of toxic gases emission approved by the environmental organ should



be implanted in four years after the publication of that law.

The elaboration of the State and municipal solid waste plans will rule two years after the publication of the Law number 12305.

The decree number 7404 from September 23th, 2010, extends the need for implementation of reverse logistics systems to products commercialized in plastic, metallic or glass packages. That extension must be checked by the orienting committee, which created five Theme Technical Groups (TTG), among them the Packages TTG.

The Packages TTG is coordinated by the Ministry of Environment and it is formed by federal and State organs and entities from civil society sectors such as the National Confederation of the Industry (NCI), the Entrepreneurial Commitment for Recycling (Cempre), Brazilian Society of Packaging (Abre), Brazilian Technical Association of the Automatic Industries of Glass (Abividro), Brazilian Association of the Plastic

Industry (Abiplast), Brazilian Association of paper and Cellulose (Bracelpa), Brazilian Association of the Chemistry Industry (Abiquim), among others.

The Feb/2012 tender for Calling for the elaboration of a sectorial agreement for the implementation of reverse logistics system of packages in general was published on July 4th, 2012. Over that tender, the package manufacturers, importers, suppliers and vendors shall build and implement a reverse logistics system for package returning after the product use by the consumer, with the participation of the municipal public service titular of urban cleaning and urban solid residues handling, from the cooperatives and pickers' association and from recycling companies. The time for presenting the sectorial agreement proposals was 180 days, hence limiting the deadline to January 4th, 2013. Progressive goals have been created for reduction of the dried recyclable residues based on the 2013's national characterization: 22% until 2015, 28% until 2019, 34% until 2023, 40% until 2029 and 45% until 2031 (GARCIA, 2012a).

7.2 THE TOOL FOR LIFE CYCLE EVALUATION

The first LCA (Life Cycle Assessments) Studies

The first "LCA proto studies" are from the 70's and 80's, although back in those times there was no naming formalization. According to Walter Klöpffer (2006), Bill Franklin and Bob Hunt can be considered as the inventors of the LCA, developing those "proto studies". Those studies were conducted by the Midwest Research Institute and called Resource and Environmental Profile Analysis (REPA), according to Hunt and Franklin (1996). The methodology idea is attributed to Harry Teasley, whom, back in that time, worked for Coca-Cola, which was the financier of the first REPA study, in 1996. The study was aimed at

compare the natural resources consumption and the emission of different types of packages for soft drinks (GARCIA, 2002). The company Franklin Associates was born from the REPA working group and is still going over similar studies. Both energy and the package have been central topics for those given studies mainly due to the petroleum crisis and the rising problems of waste disposal. At the end of the 80's, the companies Procter & Gamble and Tetra Pak met up and hired research institutions (Battelle, Fraunhofer, EMPA, CML) and groups specialized in LCA (Franklin, Écobilan) under coordination of the Society of Environmental Toxicology



and Chemistry (SETAC). That partnership resulted on the establishment of the methodological structure of the Life Cycle Assessment. In 1993, led by SETAC, the standardization process started, with the publication of the document “A Code of Practice”, and the LCA methodology structuring. The development of the environmental impact methodology CML, coordinated by Helias Udo de Haes, allowed transforming the LCA into a powerful tool for environmental evaluation of product systems. SETAC officially joined the United Nations Environment Programme (UNEP) in 2002, helping the dissemination of the LCA methodology around the world (KLÖPFFER, 2006).

Between 1997 and 2000, the ISO standards series (14040, 14041, 14042 e 14043) were published aiming to avoid the bad use of the LCA methodology and establish rules for the harmonization of the studies. In 2006, the standards were reviewed and grouped in two only: ISO 14040 and ISO 14044. The ISO 14040 describes the principles and the LCA studies structure and the ISO 14044 describes the essential requirements and the rules to be used in those studies (ISO, 2006a and 2006b). In 2009, the translation to Portuguese of the ISO 14040 was published in Brazil as ABNT ISO 14040 (ABNT, 2009).

The principles of the LCA methodology

The Life Cycle Assessment studies have allowed increasing the debates related to the environmental issues that used to be aspects such as energy consumption, use of renewable or fossil resources, recycling, biodegradation and/or composting only, among others. Those studies give a new dimension to the debates, hence they can integrate many environmental aspects in one functional unity only associated to a product or service. In its ideal form, that instrument is founded in an environmental registering that starts and ends in the nature. According to the standard ISO 14040, the term Life Cycle Assessment is defined as the compilation and assessment of the inputs and outputs and the potential environmental impacts of a product system all over its life cycle. The product system is defined by all its unitary processes with elementary fluxes and of products that has one or more defined function, which models the life cycle of a good.

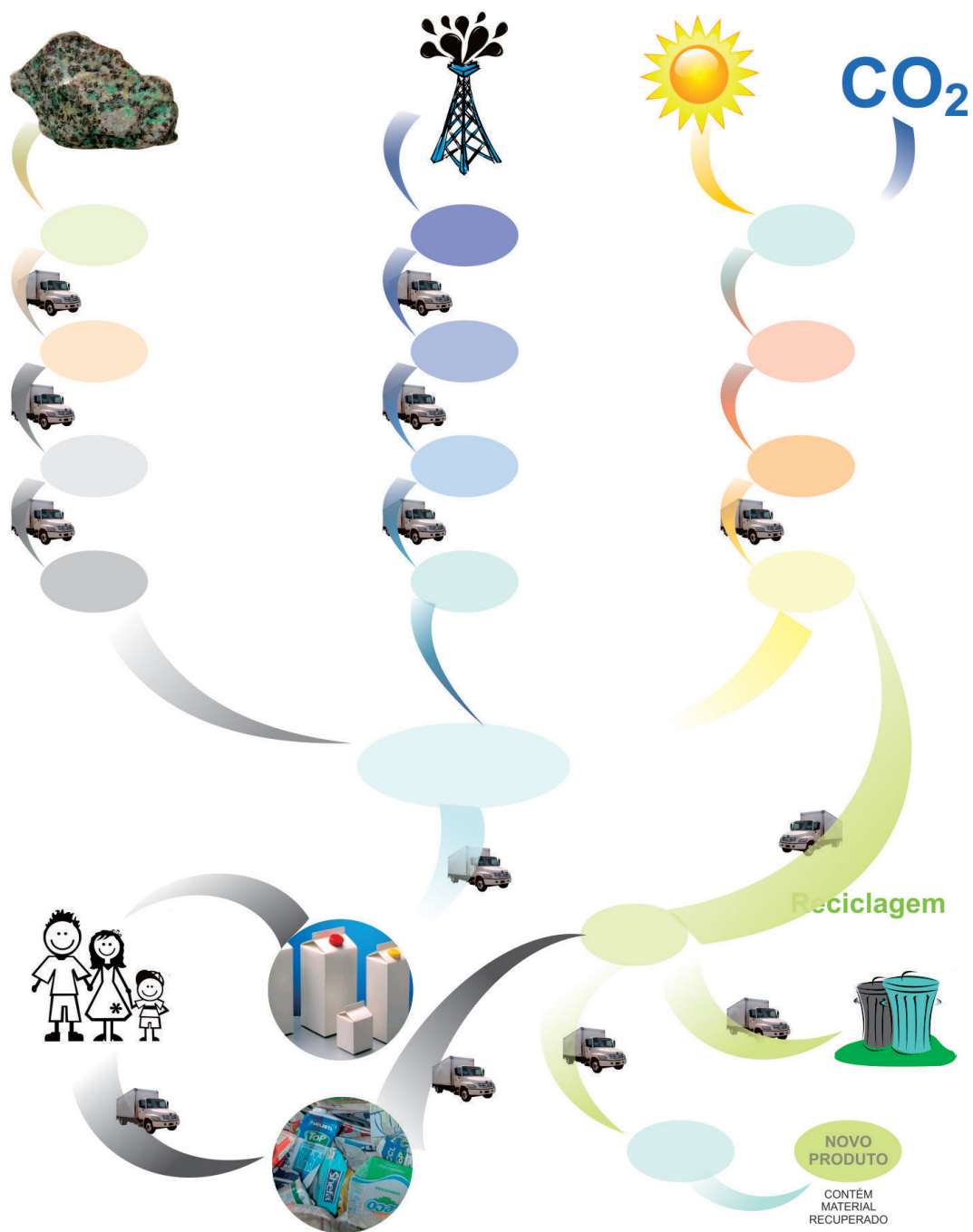
The natural resources that are consumed along every phase of the product life cycle (including transportation) are registered to the given production

such as petroleum, water, log, land occupation, sand, iron ore, bauxite, coal reserves etc. And, after the sequence of productive phases for the given product manufacturing, the remainder of the process in relation to what it returns to the nature is registered, in the form of solid residue, gas or liquid emission. That product/nature assessment interface allows a deeper understanding of the environmental cost for the existence of any product (MOURAD et al., 2002).

The FIGURE 7.4 is a schematic representation of the phases included in a package LCA, in which ellipses represent the many unitary productive processes involved in the package life cycle and the trucks mean the phases of material transportation. It is observed that the registering is initiated in the natural resources consumed for obtaining the given products: ore, petroleum, solar energy, carbon dioxide etc. In that representation, for example, the phases for obtaining the conditioned product have not been included, since for this case, the study is limited to a package LCA.

FIGURE 7.4

Schematic representation of the package LCA phases





The LCA studies are formed by four main phases, described below:

1st Phase

At the first phase, called **goal and scope definition**, the productive system phases that will take part of the study are defined in function of the objectives to be reached, delimiting the systems boundaries. At this phase, which is extremely important, the level of detail and depth that the study should have to answer the question involved are defined.

The intended audience, i.e. to whom the results of the study are intended to be communicated should also be defined at this phase, once it is related to the details of the project. As the study is structured for understanding of the environmental interface of a product or service with the nature, a functional unity must be adopted, whereby all the productive phases can be correlated. Mass is one of the most used functional unities, but unities such as transported volume, traveled kilometers, painted wall area and produced energy, among others, are also used.

2nd Phase

The second phase, called **inventory analysis**, corresponds to data collection and calculation to identify the most relevant input and outputs of the system. The data collection involves the quantification of the amounts of raw materials, processing aids, energy and water related products and co-products of all the steps involved within the boundaries of the study. Water and atmospheric emissions are also determined, as well as the solid residues. Validation of primary data and analysis of the consistency of the compilation of the aggregate data must be done in this phase.

3rd Phase

The third phase, called **impact assessment**, it is targeted to associate inventory data, previously collected with potential environmental impacts, generally separated by categories such as the use of fossil or renewable energy, greenhouse effect or global warming, acidification, natural resources consumption, eutrophication, human toxicity and potential for Photochemical ozone creation, among others. At this phase, the inventory results are sorted and can be aggregated in equivalent unities, relating, for example, all the gases that contribute to the global warming with equivalent unities of carbon dioxide, such as equivalent kg of CO₂.

Optionally, each indicator category can be related to a reference quantity, through the normalization process or grouped for generating single indicators.

4th Phase

At the fourth phase, called **interpretation**, the inventory analysis is considered with the impact assessment, to answer the goals of the study. At the interpretation, the limitation of the study is clarified and recommendations are made based on the findings of previous phases.

These phases are very interactive and are reviewed during the project execution, so that the study can answer the initial goals, since, during its execution, the influence of each step in the life cycle of the product evaluated, becomes more clear.

Once assumptions and modeling structure may influence the final results, transparency of the methodology employed is an important factor to evaluate the quality of these studies (ISO, 2006a) and subsequent implementation of the conclusions and findings.

7.3 PRODUCT/PACKAGE SYSTEM OPTIMIZATION THROUGH THE LIFE CYCLE THINKING APPROACH

Life Cycle Thinking

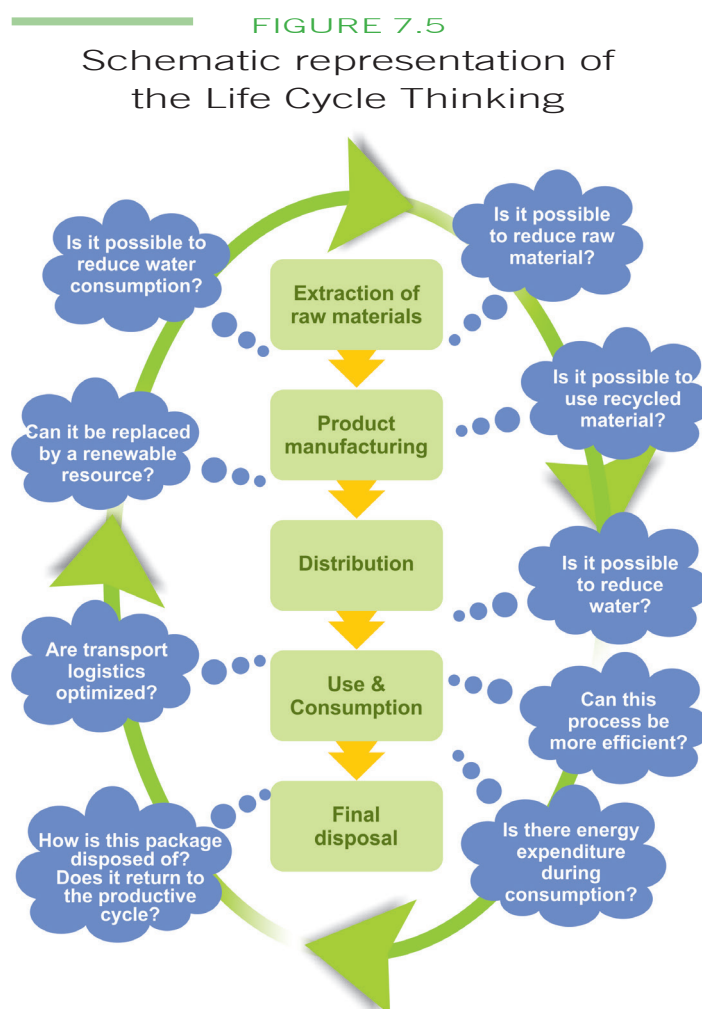
The LCA tool itself is very complex and requires considerable time for completion. For this reason, partial LCA studies for identification of opportunities for improvement, including all or almost all of the life cycle phases, have grown in the recent years and they are called studies based on “life cycle thinking”. These studies, although cannot be classified as a “life cycle assessment study”, have been very useful for understanding the environmental interfaces of products and have led the development of products with lower environmental impacts.

Thus, with the greater maturity of environmental issues, this new more holistic view, the “Life Cycle Thinking” has been used in the packaging context. This approach can be translated as “a continuous movement of rethinking the packaging”, considering since the time when natural resources are extracted from nature for its production up to the final destinations of residues and emissions originated from this process. Figure 7.5 illustrates how the Life Cycle Thinking can be used for system optimization.

Through those questions, performed at every phase of the product life cycle, the Life Cycle Thinking is done. The registering, however, of the obtained reductions, must follow the LCA methodology strictly, so the registered reductions are effectively proved on internationally recognized scientific basis.

Through these questions, performed at all stages of the life cycle of products, the “Life Cycle Thinking” is practiced. Accounting, however, must follow the rigor the LCA methodology to ensure that the reductions

measured are effectively achieved according to a scientific basis of international recognizing.





It is also important to include analysis of possible trade-offs, ie, environmentally unfavorable possible points arising from the implementation of new processes, such as the increase of emissions to water when increasing the recycling rate or loss of packaged products when reducing the mass of some packages become more fragile and so on.

The LifeCycle Thinking, can currently be considered as one of the most important tools for the development of packaging and products that aim to become more sustainable. For packages, this concept means to “rethink the packaging associated with its lifecycle, challenging their limits of weight, shape, materials and accessories, without, however, compromising the integrity and product shelf life.” When the wish to become less costly to the environment becomes a goal clearly defined, it reduces the weight of what is not essential; it goes to the limits of technical requirements; it values the efficiency more than appearance and it generates more responsible packaging options.

When the relation between product or service and the quantity of used package is optimized, the consumption of natural resources is indirectly reduced, such as oil, water, sand, coal and minerals, among others, and, consequentially, the resulting emissions to the air, water and soil. That way, the optimization of materials should be one of the priorities in the search for systems with less environmental impact.

This is also broadcasted internationally as the concept of “Doing More with Less”, ie, regardless of the material that you are using, it is important to try to reduce their consumption, optimize its use and to rethink the packaging so that can generate the same products using less natural resources. A good example was the release of the Clever Little Bag, a new concept for tennis packing shoes of brand Puma (Figure 7.6). After months of a LCA study in the productive chain, the box was radically reduced to an external recycled bag and an internal skeleton-card for holding. Using the concept of “use less”, Puma reduced in 65% the use of cardboard, as well as plastic and diesel (DENT, 2011).

In this sense, one should highlight some initiatives, due its relevance can be taken as examples.

The Walmart Corporate in Brazil, in a pioneer initiative in the sector of sales and distribution, conscious of its power as a retail company, challenges its suppliers to rethink their products so that they can bring environmental improvements.

FIGURE 7.6
Example of package
developed with the concept
“Doing More with Less”



Source: DENT, 2011

The Walmart Corporate in Brazil, in partnership with the Packaging Technology Center of Food Technology Institute (CETEA/ITAL) between 2009 and 2010, released the Project End-to-End, attended by ten companies who presented after 18 months of work, progress in environmental performance of its products based on the principles of Life Cycle Thinking: 3M Brazil (Curauá sponge), Cargill Agricola (Liza oil line), CP Colgate-Palmolive (Pinho Sol disinfectant), Coca-Cola Brazil (Matte Leão tea), Johnson & Johnson (Band-Aid), Nestlé (Pureza Vital mineral water), Pepsico Brazil (organic Toddy chocolate), Procter & Gamble (Pampers total comfort diapers), Unilever Brazil (concentrate Comfort fabric softner) and Walmart Own Brands (Topmax bar of soap) (WALMART, 2010).

The success and the repercussion of the retailer-manufacturer-research institute partnership initiative brought the second edition of the same project, developed between 2010 and 2011.

At this second edition the improvement actions had to be necessarily implemented in both the supply and

distribution chains. Thirteen companies participated in this second edition with the following products: AmBev (2 liters Guaraná Antarctica), Kraftfoods (Halls drops), Danone Brazil (Danoninho yogurt 360g), L'Oréal Brazil (Elsève line of shampoo, conditioner and combing hair cream), Kimberly-Clark (Neve Naturali toilet paper), Mars Brazil (Whiskas cat food line in cans), Philips (32 inches LED TV), SC Johnson Brazil (Pato disinfectant adhesive strip for toilet bowl), Reckitt Benckiser (Veja Sensations Perfume), Walmart Brazil Own Brands (Sentir Bem Oat Flakes), Santher (Snob kitchen paper), Whirlpool (Inversa refrigerator) and Sara Lee (Pilão coffee) (WALMART, 2011).

The Coca-Cola Brazil invested on their organic product, the Matte-Leão (FIGURE 7.7), which was produced in their new unity, considered a “green factory”, have received the Leadership Energy and Environmental Design (LEED) certification, issued by the Green Building Council, which assures a good planning on the construction and use of energy. Another important innovation was the impression of the life cycle of tea from mate herb on the package, playing an important role on education and environmental consciousness. The package has been modernized by its clean design: 90% of the printing ink quantity has been reduced.

The company Cargill has shown that is possible to innovate on traditional products such as the Liza oils line (FIGURE 7.8), which, even maintaining its shape, thanks to a re-engineering work on the bottle and cap, it was possible a 10% reduction on the package weight, which changed from 22 to 20 grams without significantly affecting its mechanical performance.

The 18% reduction on the Band-aid box (FIGURE 7.9), a challenge accepted by Johnson & Johnson team, was not a simple task, due to the complexity of a totally optimized and adjusted productive process. Besides the material consumption reduction, there have been gains on the logistics efficiency, as it is possible to transport more of it in less volume, also proportionally reducing the gases emission on the transportation.

FIGURE 7.7
Organic Matte Leão, by Coca-Cola:
90% reduction of the printing ink



Source: Walmart, 2010

FIGURE 7.8
Example of optimization with
packaging weight reduction



Source: Walmart, 2010



FIGURE 7.9

Example of optimization with packaging volume reduction



Source: Walmart, 2010

The packages redesign for the line of water with environmental focus has reduced between 25% and 36% the consumption of plastic materials for the bottle caps (and also removal of the pigment on them), 25% of mass reduction on 300 ml bottles and 19% on mineral water bottles of the “Vital Purity” water line (FIGURE 7.10).

FIGURE 7.10

Example of redesign with environmental focus



Source: Walmart, 2010

Derived from technological investment, Danone has applied the FOAM technology, which expands the plastic sheet used in the packaging, making it aerated, reducing its mass and, therefore, the consumption of natural resources. This change brought about a

9.4% reduction in weight of Danoninho pot, without compromising its mechanical resistance (FIGURE 7.11).

FIGURE 7.11

Example of application of new technology for weight reduction



Source: Walmart, 2010

The replacement of the LCD TV by the LED TV (thinner) (FIGURE 7.12), both with 32 inches, the glass pedestal redesign, reduced the total volume occupied by the product. This allowed the reduction of the transportation package, made of corrugated paperboard. The replacement of the white cover by the brown one of shipping box has reduced the number of packages returned by visual damages. In addition, Philips also replaced the cushioning material of fossil origin by one made from paper fibers, a renewable material. This set of actions resulted in significant environmental gains.

FIGURE 7.12

Redesign/replacement of materials for reduction of environmental impact



Source: Walmart, 2010

Another good example of package optimization has been adopted for the Os-cal calcium supplement (FIGURE 7.13) from GlaxoSmithKline (GKS) company. In 2010, GSK launched a new packaging system, eliminating the labeling and secondary cardboard packaging, transferring information required for a shrink label along the entire body of the primary container of high density polyethylene. For the annual sales volume, the company disclosed that saved 208 tons of paper and reduced the carbon emissions by 150 tons (MOHAN, 2010).

FIGURE 7.13
Example of package optimization



Source: Press release

Reducing the weight of packaging is one of the main ways to act to lower consumption of natural resources. With the optimization of production processes and investment in new technologies, you can often get a significant reduction in the use of renewable or non-renewable natural sources. This reduction, however, must be validated technically so there is no compromise in the quality of the packaged product.

In practice, only significant reductions bring environmental improvements that contribute to the valorization of the brand (HILL, 2010).

In the glass containers sector there is also a strong movement for the weight reduction with

significant benefits both financial and environmental, since it involves the reduction on the natural resources consumption (raw material needed for glass fabrication), less water and energy consumption and less costs related to the finished product, with consequent reduction of greenhouse gases emission, especially CO₂.

Originally produced in 1916, the contour bottle in the shape of Coca-Cola is a globally recognized icon that allows quick identification of the brand by the consumer. In 2007, the company introduced its new pack of 330 mL “ultra” light-weight, 20% lighter, going from 263 to 210 g. The packaging has even a slight change in shape, becoming wider 0.1 mm and about 13 mm lower than the original package (FIGURE 7.14). With a lighter package was estimated reduction in annual consumption of 3.5 thousand tons of raw materials and reduction of 2.2 tons of CO₂ (HILL, 2010; FAMOUS..., 2007).

FIGURE 7.14
Example of redesign/weight reduction of glass package



Source: Press release

In Brazil, Coca-Cola *Guararapes* and Coca-Cola *Norsa* (Coke's franchises in the States of *Bahia*, *Ceará*, *Piauí* and *Rio Grande do Norte*) also bet on a new 290



mL KS Ultra bottle, which uses 25% less glass in its manufacturing and maintains the original format of the traditional contour bottle, icon of the brand around the world (COCA-COLA GUARARAPES, s.d.; ABIR, 2011).

Generally, the innovation strategy of glass industries has been aligned to the sustainability trends, aiming at the reduction on the raw material, energy and CO₂ emissions reduction, along with the increase in the percentage of use of recycled glass. As a result of this commitment, the company Owens - Illinois had the lightweight line of glass containers for wine *Lean + Green*, produced through technology Narrow Neck Press and Blow, manufacturing process by pressing and blowing of the bottle, which ensures greater uniformity of the glass thickness and reduce the weight of the order of 16 % to 27 % compared to current packaging, with the same appearance and quality guaranteed (FIGURE 7.15) Besides the reduction of carbon emissions associated with the production process of glass packaging, manufacturing packaging lighter still favors the reduction of carbon emissions associated with the transport and distribution of finished product (INNOVATIONS..., 2010; O-I, s.d.).

FIGURE 7.15

Use of the Narrow Neck Press and Blow technology for light-weight glass packaging



Source: Press release

7.4 MATERIALS REUSE & RECYCLING

On the scale of priorities for solid waste management, the minimization of waste generated by optimizing and reducing packaging systems should be encouraged in the first place. Reuse is the second priority, followed by recycling, in third place.

The use of returnable packages has been adopted in some regions. One of the main beer producers, SABMiller, uses returnable and reusable glass bottles. The Bavaria Group, a SABMiller's branch in Colombia, launched the "Super Returnables" campaign with the slogan "The Power to Defend Your Pocket, Increase Sales and Protect the Planet", in order to encourage consumers to return the bottles after consuming and, therefore, reduce the packaging residues. Another SABMiller Group's brewery sells 52% of their products in returnable barrels and glass bottles. Study of Life Cycle Assessment showed that the returnable glass bottle

swing-top, with 450 mL, had a better environmental performance compared to the other evaluated packages, considering the production and distribution conditions in which the study was performed (INNOVATIONS..., 2010; SABMILLER, 2012; SABMILLER, 2009). It is known, however, that there is not a general superiority that can be attributed to the returnable packages in relation to the non-returnable. It is known, however, that there is no general superiority that can be attributed to returnable packaging than non returnable. The average distribution distance of beverages greatly affects the environmental performance of those bottles.

Overall, however, the reusable or returnable packaging have not yet been characterized as a current trend, although there are some niches, such as the natural foods and beverages, in some countries, where it has become common for consumers to bring their

own containers to supply them from bulk containers for products sold in bulk, as salt and rice. Although consumers approve the idea, increased membership will depend on the incentive schemes. Countries such as the Netherlands, Denmark and Finland commercialize 80%, 90% and 98%, respectively, of beer and soft drinks in returnable containers (BARNETT, 2010).

The redesign to “make packages reusable”, at a minimum, doubles the life time of natural resources that were consumed in the first product commercialization. Some packaging formats naturally induce the reuse, such as the new Anchor Packaging’s polypropylene pot with red lid that replaces the single-use expanded polystyrene version for side dishes such as mashed potato, pasta with cheese, green beans etc. Through consumer surveys, it has been found out that they prefer reusable vessels because they give them the control of how it is reused or disposed after the purchase. In order to spread the reusability idea, KFC Reusable, Microwave & Top Rack Dishwasher has been printed on the lid, in high relief (*FIGURE 7.16*), informing that it is reusable and safe for microwave and dishwasher uses (MOHAN, 2010).

FIGURE 7.16
Example of reusable package



Source: Press release

Recycling, since it originated from a process with lower environmental impact, should be strongly encouraged by the government, once it reduces the pressure on the consumption of natural resources. Various examples of packages manufactured with recycled material have been observed in the market.

Colgate Palmolive has optimized its line of

disinfectants Pinho Sol with developments in various aspects of the manufacturing process, even changing the lighting of its production line by more efficient systems, and also using a PET bottle 100% recycled with 90% of material originated from post-consumption and 10% from pre-consumption (*FIGURE 7.17*).

FIGURE 7.17
Example of the use of 100% recycled PET bottle



Source: Walmart, 2010

Coca-Cola Brazil launched, in 2011, the 2.5 liters bottle containing 20% of post-consumer recycled PET resin food grade (PCR PET). There is, currently, a bottle-to-bottle recycling plant that was approved by the Brazilian Health Surveillance Agency (Anvisa).

The recycled bottle (*FIGURE 7.18*) has the same characteristics as produced from virgin PET resin (COCA-COLA..., 2010). In this process, the used bottles used are selected, crushed and washed by an efficient process of decontamination and recovery of the molecular weight of PET, removing contaminants at levels required by food contact packaging legislation. The clean material is then used in the manufacturing



process of new bottles. The technology used for the purification of post-consumer PET was created by the company United Resource Recovery Corporation (URRC), from United States. The use of post-consumer PET encourages the entire chain of collection of these packages, generating income for the street collectors (COCA-COLA INSTITUTE, 2012).

FIGURE 7.18
Recycled PET bottle



Source: Press release

In order to facilitate transportation and the recycling of post-consumer packaging, some innovations that allow a volume reduction in these stages can be found in recent years, as shown in FIGURE 7.19. One example is the PET bottle for water Crystal from Coca-Cola brand with the possibility of reducing the volume by 37% volume reduction by twisting after use, and it is also being produced with 20% less PET and a percentage of PET coming from renewable source (QUARTIM, 2011). Another example of NNew Can metallic packaging design, developed by Jiwoon Park and Kwenyoung Choi, has a format that allows to reduce the volume by one-third of the original after consumption of the product by means of twisting and compression movements (YANKO DESIGN, 2009).

FIGURE 7.19

Examples of packages that allow volume reduction after product consumption



Source: Press release

The Taiwanese company Panorama SOY Ink Co. Ltd. has developed inks based on recycled vegetable oils. The inks contain 45% of post-consumer oil, 21% of pigments and 34% of tar, do not contain organic volatile compounds, have good resistance to abrasion, high gloss and good color stability. They dry faster, have sharp point higher than traditional paints and can be applied on surfaces of paper or plastic (DENT, 2011).

Another important concept is the *Design for Recyclability*, which is to rethink the package, designing it to make its recycling easily performed in commercially



available equipment. A good example is the technology for holographic printing called HoloBrite™ (FIGURE 7.20), which prints directly on the cardboard, providing a bright appearance without the need for a polyester or metal lamination film.

This process allows the packaging is recycled in equipment normally used in the recycling of waste paper and cardboard, without the generation of waste plastic. This technology has been adopted by industries Paperworks in the printing of the Aquafresh toothpaste cartridge (MOHAN, 2012).

FIGURE 7.20
Example of Design for Recyclability



Source: Press release

Carbon footprint and water footprint

Environmental issues are always of wide character and difficult to interpret. Life cycle assessment can be considered one of the broader environmental methodologies, since it can link, through its functional unit, parameters usually incomparable, of various types, such as the use of energy and water, eutrophication and acidification processes, land use, consumption of natural resources, etc. Due to this wide approach, able to show numerous and distinct aspects of the real environment, the methodology has spread around the world and has been gaining importance in many sectors. One of its requirements, for example, is that various environmental aspects must be included in the analysis, so it is not allowed to reference the methodology in studies that do not include several categories of environmental impact at the same time.

Given the complex nature of these issues and the need to take urgent action to reduce the environmental impacts of human activities, some more simplified derivations of traditional LCA studies have been applied to crucial questions such carbon and water footprints.

These new metrics, derived from LCA studies, take advantage of the “supply chain” approach, but focus only on some particular aspects, such as the emission of greenhouse gases, measured by the carbon footprint. Considering the importance of the consequences of greenhouse gas emissions, discussed in section 7.2.1,

is of great value monitoring and mitigation of the same.

The carbon footprint is the quantification of the greenhouse gases of a product or service emitted during its life cycle, from the extraction of raw materials, processing, distribution and use up to the final disposal. This term is expressed in units of carbon dioxide equivalent (CO₂ equiv.). In the ISO 14040 and ISO 14044, the *Carbonfootprint* impact appears as the *Global Warming Potential*, one of the environmental impact categories usually analyzed. The word *Carbonfootprint* as well as the method for its quantification, is described in the document PAS 2050 (BRITISH STANDARD INSTITUTION, 2011).

Some products are already *Carbonfootprint* appeal on their packages, like the Bloomsberry & CO's chocolate (FIGURE 7.21), which informs how consumers can reduce the carbon footprint and the effects of climate change.

The water footprint is an indicator that measures the direct and indirect consumptions of water and its pollution along the products life cycle. Considering the low availability of potable water in countries and regions with high population density and the current incapacity for treatment of all the generated effluents, the reduction of the water footprint must be between the priority environmental actions. The methodology for its quantification, however, is under consolidation phase (MENDIONDO, 2011).

[illegible]

Concerning that new demand, Coca-Cola disclosed a pilot study made in its plant in Dogen in Netherlands, in 2009, in order to calculate the water

However, it must not be forgotten that those leads refer only to some specific aspects of the interaction between product and environment. The total environmental profile of any product or service cannot be evaluated only through these measurements.

Water Footprint of a 35 L Bottle of Coca-Cola		Total Water Footprint
		35 L
Manufacturing: processes, components	— 0.41 L	100% blue water
Packaging: PET bottle, HDPE closure, PP label, tray carton, tray shrinkfilm, pallet stretch wrap, pallet	— 7 L	4% blue water 13% green water 83% grey water
Ingredients: sugar beet, phosphoric acid, caffeine, caramel, CO ₂	— 28 L	28% blue water 52% green water 20% gray water

Blue water: water taken from surface water and groundwater (rivers, lakes, and aquifers)

Green water: water taken from soil moisture, derived from rainwater, by growing crops

Gray water: an indicator at the amount of water required to clean water pollution created, for example, by the use of fertilizer

Source: Adapted from COCA-COLA ENTERPRISES, 2009



7.5 MANAGEMENT OF RESIDUES & REVERSE LOGISTICS

Important diagnosis of the current situation of solid residues in the country was published in document Solid Waste and Green Economy (GARCIA, 2012b). In this document some priority actions to be performed along the production chain are suggested:

It falls to the private sector the challenge to develop technologies that extend the life time of the produced materials and the use of recycled materials for the production of new products.

- The management of the plans National, State and Regional of Integrated Solid Waste Management should be done by the government, with priority

actions for remediation and closure of landfills, construction of composting plants for treatment of organic waste and construction of landfills.

- The development of technologies that extend the life time of products and the use of recycled materials for the production of new ones should be the challenge of the private sector.
- The responsibility of to adequately separate the organic material and the recyclables from the garbage, as well as the changing of habits to a more sustainable level with revision of real consumption needs should be followed by all consumers.

The reverse logistics chain – Tetra Pak's case

The establishment of the reverse logistics chain is not a simple task and involves many aspects. In fact, in cases where the use of packaging in a second production process already provides a financial return for the agents involved, as in the case of old corrugated paperboard boxes and aluminum cans, the return of post-consumer packaging already exists. However, in most cases, that chain needs to be created and established. In this direction, the NPSW establishes the need for structuring the reverse logistics chain to return the materials that commercially, still does not have an aggregated value.

It is very important, however, realize that the creation of this chain does not occur spontaneously. If does not exists a clear determination of the generating sector in returning these materials to the production cycle, or gives an appropriate destination, this chain cannot be established. In order to ensure that the reverse chain is real and can be maintained, it must be economically viable, which means that it must pay all the involved agents in an adequate way.

This perception of the need to go beyond your own gates was perceived long ago by Tetra Pak, which is a great example of company that was able to foster, encourage, and establish the reverse logistics chain

of the aseptic packages after use. These containers of liquids are formed by the combination of three materials: cardboard, which gives rigidity and packing structure, alternating layers of polyethylene (PE), which protect the cardboard from external moisture and also constitutes the primary contact material with the liquid beverage, and an aluminum foil (Al), which preserves the aroma and extends the shelf life of the product which reaches, in the case of milk for example, up to six months.

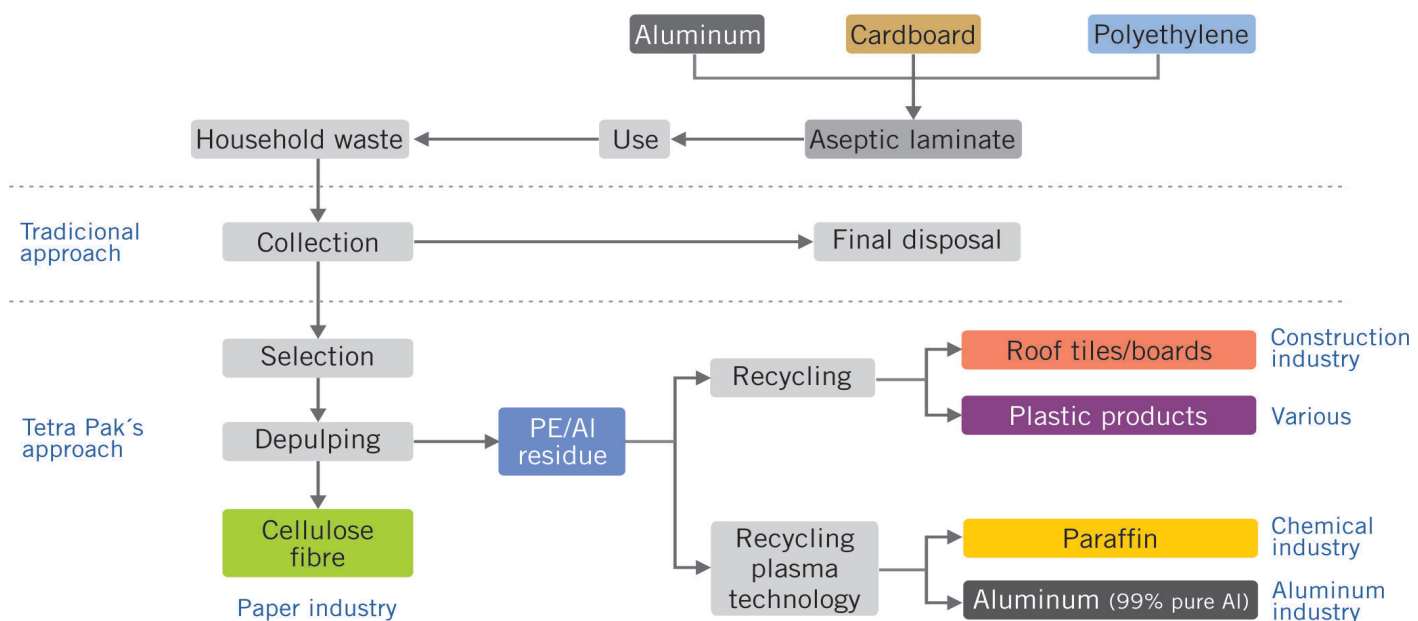
This multilayer material is currently separated from the common waste (the current recycling rate is 28%) and the cellulosic fiber content recovered in “hidrapulpers” present in paper recycling companies. The remaining residue consisting primarily of polyethylene and aluminum, is currently intended for the manufacture of PE/Al tiles and to the EET-Brasil Aluminum and Paraffin Ltd. company at Piracicaba. At the EET company, through a plasma process (~15,000°C), high purity aluminum is obtained and the polyethylene is transformed into paraffin (VON ZUBEN, 2006). LCA studies carried out by CETEA attest that recycling has environmental benefits, even considering the impacts of all these stages of the reverse chain (MOURAD et al., 2008a and 2008b).

The creation of this chain, exemplified in FIGURE 7.23, was strongly encouraged by Tetra Pak, which searched for nearly two decades for technology and partners that could make the reuse of aseptic packaging environmentally and economically viable.

The creation of these products increased the price paid for the collected post-consumer packaging by 79% between 2004 and 2007, which reached EUR 120 per ton and became to be segregated from the household waste (Orsato et al., 2007).

PICTURE 7.23

Productive and post-consumer aseptic package recycling flowchart organized by Tetra Pak



Source: Adapted from ORSATO et al., 2007

Symbology for post-consumer package identification

Among many actions needed for the establishment of the reverse logistics, it is important to emphasize the initiative by various national entities that contributed for the growth of recycling in Brazil, with press releasing and implementation of symbologies for the correct package materials identification for orientation to the selective disposal and recycling programs. Technical Standard - ABNT NBR 13230 (2008) shows the identification symbols of plastic materials (Picture 7.24) and the Brazilian Packaging Association – ABRE

have the constant concern of taking information about material identification for recycling (Picture 7.25).

The package is an important communication tool and should be used as an instrument for environmental education. Technical symbology used for recycling has been created to facilitate packaging materials identification and separation, strengthen the recycling chain and materials revalorization. Symbology absence or its incorrect use may prejudice the recycling process of other materials and the waste of recyclable materials

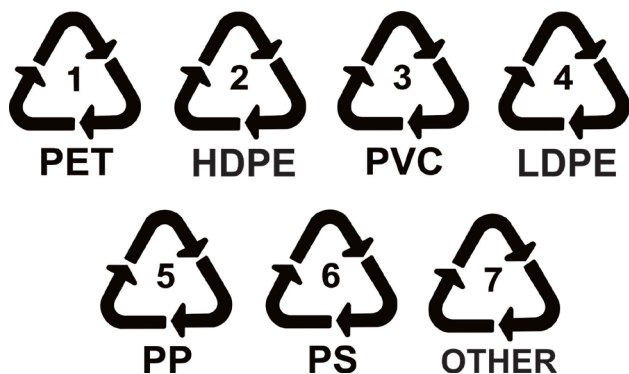
(BRAZILIAN PACKAGING ASSOCIATION, s.d.; ABRE, 2010).

In order to encourage and orient the consumers about the importance of the adequate packages disposal, ABRE firmed in November 2011, a sectorial pact with the Ministry of Environment in the Production and Sustainable Consumption Plan, to include the selective discard symbol on the packages of a thousand products a year. That initiative is voluntary and shows the trend for good market practices associated to the materials recycling that can be seen aligned to the National Policy on Waste Management - PNRS, which involves the society, companies, municipal, State and federal governments in the management of solid waste

in Brazil. Besides contributing for the reduction of landfills and the expansion of sustainable processes, that initiative promotes the production of income for the waste pickers that work in cooperatives. The program also aims to expand the insertion of the identification symbology of package materials with focus on the process of separation and selection of those materials. The adoption of that symbology shows a special care of the manufacturer with the package disposal, and at the same time, orients the consumer and also helps on the construction of the a positive image of the company once the consumers themselves have increasingly asked for more ethical and responsible positions from the products at the sales point (ABRE, s.d.).

PICTURE 7.24

Recycling symbology for plastic materials according to Technical Standard ABNT NBR 13230



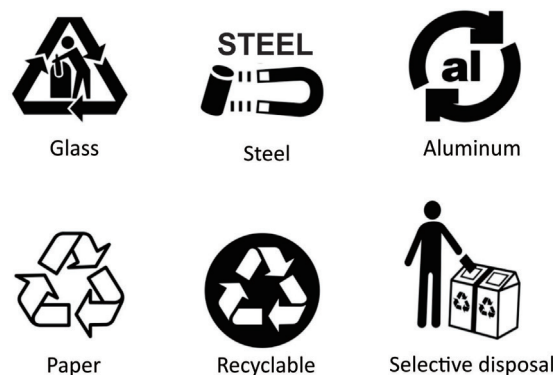
Abbreviations:

PET (Polyethylene terephthalate)
HDPE (High-density polyethylene)
PVC (Polyvinyl chloride)
LDPE (Low-density polyethylene)
PP (Polypropylene)
PS (Polystyrene)

Source: ABNT NBR 13230: 2008

PICTURE 7.25

Recommended symbology by ABRE for identification of packaging disposal



Source: ABRE, 2009

With this trend, the label How2Recycle has been created by the GreenBlue NGO together with the Sustainable Packaging Coalition (SPC), in the United States, aiming at providing clear information about recycling and the correct packaging disposal after the products consumption. The label is a volunteer action and has been created to contribute with the effective recover of the packages, by orienting the consumer to the correct discard, availability and recycling places (GREENBLUE, s.d.) (Picture 7.26)



PICTURE 7.26

How2recycle label used on the Seventh Generation remover



Source: Press release

7.6 CREDIBILITY & ETHICS

In a globalized world, with the strengthening of social networks and the importance of end's consumer awareness, many manufacturers already noticed the need of having a wider attitude along the society, extending the responsibility concerning their products to beyond their gates. Such a movement has been called by Extended Producer Responsibility (EPR).

The publication of sustainability reports, according to the GRI Initiative, it is a practice incorporated by the companies that have a commitment to the sustainable development and already have put into practice the EPR principles. The initiatives involve actions all over the production chain. GRI has been conceived so it is possible to communicate in a clear and transparent way the entrepreneurial action of economic, environmental and social range, according a lead which the company can be compared both internally and externally. GRI involves principles of balance, comparability, exactness, periodicity, reliability and clearness (GLOBAL REPORTING INITIATIVE, 2011).

Coca-Cola has clearly positioned themselves this way, because they have figured out that the ones that put into practice the principles of sustainability have a "social license" to operate, once the importance of being more sustainable is a value clearly noticed by the consumer. The inclusion of environmental policies is also related to the security of the existence of raw material (Resource Security) that it will consume in the next 10, 20 or 50 years.

Among their policies on the way to make their packages more sustainable, we can highlight: weight reduction of PET packages, aluminum, steel and glass, elimination of inefficiencies on the packaging processes, reduction of waste sent to landfills, use of recycled materials (PET) and the development of new materials from renewable sources such as Bio PET for the Plant Bottle. Besides the direct actions on the package, there are actions related to water, logistics, energetic efficiency of the drinks refrigerators at the points of sale and the information to the consumer, among others (COCA-COLA, 2009).

The 2001 Dow Chemistry's sustainability report (DOW, 2011), which received the A+ codification for having been validated by a third part, it shows on the cover their involvement with eolic energy generation, healthier oils and the extension of the shelf life of fruits and vegetables. On the report are shown some initiatives such as improvement of their energetic efficiency, publication of the risk and safety assessment of their products, removal of trans and saturated fat, their levels of carbon reduction, involvement for biopolymers production from sugar cane, their emissions to the air, water and solid waste, number of accidents, diseases, employee training, respect for human rights, gender equality and relations with suppliers and society, among others.

Besides the corporative publications, the extended responsibility has been made public through

sectorial reports, such as the one by the National Industry Confederation (CNI, 2012). The report, available in Portuguese and English, has the objective to describe the Brazilian aluminum industry profile to the global community. Brazil has some peculiarities such as the use of a renewable energetic matrix, formed of hydroelectric power plant renewable energy and a high recyclability rate (36% of total produced aluminum and 97.6% of the manufactured packages), which gives it a competitive differential for its carbon footprint of 4.2

tons of CO_{2eq} per ton of produced aluminum, comparing to the world annual average of 9.7 t CO_{2eq}. On that report, it is disclosed that 85% of the mined areas for bauxite has already been renewed and gave back to their original purpose, with native vegetation replanting. The sector shows its social representativity to the country by creating 384 thousand of direct and indirect jobs in 2010 and by the investment of 17 millions of Reais, in 2009, in projects involving education, culture, health and safety for employees and society (CNI, 2012).

Accreditation

The credibility of the products has been attested using standardized environmental labels and declarations. Both are volunteering and offer information about the environmental benefits of a service or product in general terms or one or more specific environmental aspect. The objective of the ecolabeling is to promote the demand and the supplying of a product or service with less environmental impact, stimulating, this way, the potential for continuous environmental improvement dictated by the market (ABNT, 2002). In order to achieve that objective, environmental declarations and ecolabeling must be accurate and verifiable and also must have a high reliability level so their communication is effective and can be understood by the consumer, the ecolabeling target audience.

The environmental performance certification of

a product or service is a world-wide practice, having Germany, in 1977, as the first country to implement a National Program of Environmental Labeling for products, the Blue Angel (COLTRO, 2007). That kind of program has been used as a model for many other countries, becoming a strong world trend, as an example of Canada (Environmental Choice), Japan (Eco Mark), United States (Green Seal), Nordic Countries – Denmark, Norway, Sweden, Finland and Iceland (The Swan), and Europe (Eco-Label), among others (Picture 7.27 and 7.28).

Those programs belong to the Type I Environmental Labeling, established on the ISO 14024 or ABNT NBR ISO 14024 standard (ABNT, 2004b) and are also known as “green labels” or “ecolabels”. It is a volunteer methodology of certification and labeling for

PICTURE 7.27

Examples of ecolabels



Source: Press release

PICTURE 7.28

Examples of products with ecolabels



Source: Press release



environmental performance of products and services, with a great importance for the implementation of environmental policies aimed to consumers, helping them at choosing products less aggressive to the environment.

The “green label” is generally given by a national certification organ (third part) and is based on multiple criteria from studies of Life Cycle Assessment of a given sector, with focus on reducing the environmental impacts associated to the selected product category.

In Brazil, the Brazilian Association of Technical Standards -ABNT, offers the ABNT's Ecolabel or green label, through the Ecolabeling Program, represented by the “hummingbird”. There are some products categories in Brazil that use the ABNT ecolabel, for example, the products for hand hygiene aimed to the institutional or professional market (Gojo Latin America Ltd.), reformed tyres (Paludo Pneus), steel products for civil engineering (ArcelorMittal), offset paper for printing (International Paper) and furniture for offices (DIV Design), among others (ABNT, s.d.).

The certification of cellulosic materials by internationally recognized agencies have become a more intense reality in Brazil and around the world day by day (Picture 7.29), highlighting the label Forest Stewardship Council (FSC), applied on the cellulosic packages sector. The Brazilian Program of Forest Certification (Cerflor), applicable nationwide, prescribed on the standards elaborated by ABNT and integrated to the Brazilian System of Conformity Assessment and to the Inmetro is another forest certification program used in Brazil, internationally recognized by the Programme for the Endorsement of Forest Certification (PEFC), an international organization that congregates systems of forest certifications all over the world. Both programs attest the sustainable forest handling and the traceability of the custody chain, offering to the consumer the guarantee that the product follows criteria based on practices that promote the biodiversity preservation, responsible use of forest resources and the maintenance of soil, air and water quality. They still analyze the actuation of the companies in the economical and social development of the region where they work at. They are governments' entities

responsible for the definition of forest certification criteria all over the world, attesting that the product is from an ecologically handled forest, socially fair and economically viable (BRAZILIAN COUNCIL OF FOREST HANDLING, s.d.; INMETRO, s.d.).

PICTURE 7.29

Products with ecolabel to cellulosic materials



Source: Press release

The English company Carbon Trusts has obtained notability in the world offering consultancy for the reduction of the use of energy and carbon footprint. Besides the commercialization of low carbon technology, the company also offers the Carbon Trust independent certification, which involves the verification of the carbon footprint associated to a product or service. The carbon footprint is related to the knowledge and to the measurement of all the greenhouse gases emissions, measured in equivalent CO₂, during the whole life cycle, from the raw material production, transportation, fabrication until the final disposal. That initiative helps the company to identify the points for cost reduction and opportunity for developing new products. When they clearly communicate their initiatives related to the carbon footprint, it brings an increase on the trust and reputation of the brand, which helps to increase sales.

Two categories of labels can be used (Picture 7.30): the label Working With the Carbon Trust, which indicates the efforts for measuring the carbon footprint of a product or service and the label Reducing with the Carbon Trust, which indicates the commitment of the company or sector with the reduction of the

environmental impacts and carbon emissions (CARBON TRUST CERTIFICATION, s.d.).

Another strong trend in the package sector is the adoption of the environmental autodeclaration for the companies, aiming at making public the environmental improvements obtained along a product or service life cycle. Although the autodeclaration may offer flexibility and autonomy, as it does not demand the certification by a third part, the companies should make responsible declarations that might be verified and based on

scientific rigor. That kind of declaration is called Type II Environmental Labeling and can be found standardized by the ABNT NBR ISO 14021 (ABNT, 2004a), which presents the policies for the use of texts, symbols, and graphs associated to the publicizing of a product or service environmental improvements. Texts with vague or not specific declarations, for example, “environmentally safe”, “environmentally friendly”, “Earth friendly”, “do not pollute” and “ozone layer friendly” should not be, anyhow, used (ABNT, 2004a).

PICTURE 7.30
Uses of the Carbon Trust label



Source: Press release

Greenwashing

The consumer search for products with less environmental impact has helped the intense investment by the companies in marketing with environmental appeal. That “green” market trend has stimulated companies to use the moment to associate their products to dubious and opportunist ecofriendly attributions, with no clear criteria that back them up in their environmental pretensions, or even to symbols and visual appeals that can induce the consumer to wrong conclusions about a product or service. Those appeals that are presented as fake or induce the consumer to

wrong conclusions about a product or service have been called by Greenwashing (COLTRO, 2010).

Aiming at describe, understand and quantify the growth of the Greenwashing in the market, the Canadian environmental marketing consultancy TerraChoice has developed a research methodology and face the text on the packages with orientations about environmental autodeclarations established on the ISO 14021 standard (INTERNATIONAL..., 1999). On that report, such fake or dubious appeals were classified in seven categories, called The Seven Sins of Greenwashing:



- 1 Sin of hidden trade-off or ecological appeal that is related to only one restrict environmental issue.
- 2 Sin of no proof, which is, the consumer must find evidences and learn more about such attribute on websites, third-part certifications etc.
- 3 Sin of vagueness environmental appeal, such as the “ecologically adequate”, “planet friendly” etc.
- 4 Sin of worshipping false labels, which means the use of simple pictures or labels with no certification or really endorsed by a third part.
- 5 Sin of irrelevance, being the most common example the affirmation of “does not contain CFC”, considered irrelevant, as no product is produced with chlorofluorocarbon.
- 6 Sin of “less worse” or trying to make the consumer to feel more “green” in relation to a product that has its benefit put in question, such as consumers worried with the side effects of tobacco and cigarettes would be more responsible if they quit smoking than buying organic cigarettes.
- 7 Sin of lie, when is shown, for example, a fake third part certification.

Avoid Greenwashing does not mean to expect for a perfect product, but that the honesty, transparency and scientific base are founded on the environmental declaration.

At the trend to fight Greenwashing it was released in October 2009 by the Environmental Packaging International (EPI) in the United States a database of sustainable packages materials, in which the packages suppliers submit data so the information about sustainability of their materials are reviewed and confirmed by a third-part. Similarly, the ISO 14021, environmental autodeclaration, also does not accept “vague” and inaccurate texts, such as “eco-friendly”, “environmental safe”, “eco responsible” etc. (ENVIRONMENTAL PACKAGING INTERNATIONAL, 2010).

In Brazil, the National Council of Marketing Autoregulation (Conar) showed new standards and rules

for publicizing products with sustainable appeals, aiming to reduce the texts that, somehow, could vulgarize them or confuse the consumers. Thus, the advertisements that inform about the sustainability of a product or service should only contain environmental information that are able to be verified and confirmed, exact and accurate, not having generic and vague mentions. The information must have a relation with the productive processes and commercialization of the products and services and benefits announced must be significant, considering the whole life cycle, which means in the production, use and discard (NATIONAL COUNCIL OF MARKETING AUTOREGULATION, 2011).

The environmental marketing is a powerful information tool for educating the consumer, but only if it is true.



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Chapter 8

SAFETY & REGULATORY ISSUES

Food safety is a topic that is of interest to all consumers, regardless of purchasing power. In a globalized world, where communication and media are privileged and information flows at great speed, the dissemination of news and information about food safety, whether correct or not, affects millions of consumers, making them more attentive, informed and demanding.

Current consumers want to rely on a certain product brand and want to be sure and confident that they are getting a quality product and that the consumption of this product will not cause any health problems in the short or long term.

Packaging is crucial to ensure the safety, quality and reliability of food products, while maintaining the desired shelf life, the correct transportation and sales, informing consumers about the safety and nutritional value of the product, the date of manufacture or

expiration date, the location of the food manufacturer and instructions on how to prepare the food.

In this context, the packaging cannot be a source of chemical, physical or microbiological contamination of the food.

The chemical composition of the package is critical to consumers' safety. The substances that are part of the packaging composition must have the toxicity and potential risk of migration into food studied so that the consumers' exposure to such substances



can be evaluated and their risk known and controlled. Laws based on risk and consumer exposure to these substances were and are designed to control chemical and toxicological contamination of packages and protect the health of consumers.

The physical and microbiological contamination is mainly related to the processing, handling and storage and must be controlled by process safety management systems and quality certifications.

Sophisticated analytical techniques and mathematical modeling with parameters closest to real situations are applied to estimate the migration of package components to food. Moreover studies are conducted to assess consumer exposure to these migrants to address the lack of more realistic data (OLDRING, 2010).

The laws for package materials for food contact are designed to ensure consumer safety through control of chemical contamination due to the migration of package components to the product. They are constantly evolving to incorporate new substances and new technologies such as active packaging, post-consumer recycled materials and nanomaterials, and are revised to incorporate new interpretations based on scientific and technological knowledge. All materials for direct food contact must demonstrate compliance with the requirements of the laws.

Declarations of Compliance are required in order to transfer information and to formalize the responsibility of the package material manufacturer and ensure the

correct use of package in the conditions set out.

The laws vary among countries and efforts for harmonization, implementation and mutual recognition are expected by importers and exporters of food and food packaging in world trade.

Process Safety Management Systems are efficient mechanisms to bring about transparency and continuous improvement of package manufacturing processes and include :

- GMP - Good Manufacturing Practice and application and validation of HACCP - Hazard Analysis and Critical Control Points.
- Certifications of quality systems based on international standards - BRCIoP, FSSC 22000 (ISO 22000 and PAS 223), ISO 22000, IFS PACSecure, among other standards and systems.

Organizations and associations work to harmonize standards and regulations related to food safety, benefiting international trade and food quality (MERMELSTEIN, 2012).

The traceability of package materials, whether automated or not, is a requirement of some laws and it is becoming increasingly necessary for safety and identification of the origin of packaged products. In this context, RFID will offer significant opportunities for manufacturers, retailers and consumers.

Table 8.1 shows the trends highlighted in the development of the megatrend Safety and Regulatory Issues along with possible packaging contributions.

8.1 RELIABILITY AND SAFETY

Several factors are driving changes in the food industry with regard to their safety. Many factors are forcing the industry to improve its manufacturing processes, suppliers of raw materials and human resources (PACKAGING WORLD, 2012). Among them are:

- Dependence on a global supply chain.
- Development of science in the diagnosis of food related diseases.

- Development of analytical equipment and techniques that allow the detection of substances in smaller amounts and even substances which have never before been detected.
- Consumers who expect quality food at low cost and with zero risk.
- Influence of the traditional and social media on food issues.
- New requirements from regulations and laws.

The package as a fundamental part of the production and distribution chain of food is also required for safety:

- What is the interaction between packaging and food?
- Are the package components (materials, print inks, adhesives etc.,) transferred to the food?
- How many of these components transferred from the package can be ingested?

- What is the chemical composition of the package? Are the substances safe?
- Can the package induce physical and chemical contamination?
- What is the risk of accidental contamination?
- What is the possibility of new materials and technologies generating unexpected degradation products in food?

Table 8.1	
Safety and Regulatory Issues- Development and Contributions of Packaging	
Highlighted Trends	Contributions from Packages
Reliability and Safety	Food protection and preservation
	Control of chemical contamination
	Food Contact Legislation
	Compliance of Positive Lists
	Compliance of migration limits to food and / or food simulants / mathematical modeling
	Control of consumer exposure to contaminants
	Evidence of safety of new technologies and new materials
Legislation and Compliance	Harmonization of the legislation – international trade / globalized market (EU, U.S. / Canada, Mercosur, South America, Southeast Asia, China, Japan)
	Declarations of Compliance and Traceability
Certification and Process Safety Management Systems	Control of physical and microbiological contamination
	Good Manufacturing Practices (GMP) / Hazard Analysis and Critical Control Points (HACCP)
	Process Safety Management Systems Certifications
	Harmonization of Process Safety Management Systems - globalized market
	Traceability and identification of origin

Packages are crucial for protecting the food from its packaging until consumption. The chemical composition of the package is controlled by laws for different materials and the application of Good Manufacturing Practices (GMP) and Hazard Analysis and Critical Control Points (HACCP) avoids physical and microbiological contamination. To ensure food safety,

the food industry is increasingly putting pressure on the package industry demanding quality and that the production processes are certified and that all components used in its manufacturing meet the requirements of the laws. Declarations of Compliance and certifications are now essential.

Hundreds of different chemical substances are



required to produce plastic, cellulosic and metallic packages coated and uncoated in addition to adhesives, print inks and so on. It is also known that components of the package, when in contact with food can migrate to the product, in a process of mass transfer known as migration. In order to avoid chemical contamination of food products, laws based on the principle that the packages should be inert were conceived. Positive lists of substances which can be used in the composition of materials for food contact have been established.

The authorization for these substances to become part of the Positive Lists is based on risk assessment and management. The risk, irrespective of its origin, is the combination of the toxicity of the substance (hazard) and how much of the substance is consumed (exposure). Therefore, to ensure the safety of package materials, it is not only necessary to consider the toxicity of any migrant (risk assessment), but also how much of this substance is found in foods, present in the basic diet of the population (estimated consumption).

Likewise, changing a migration limit or restriction of a substance already listed or approved or approval of a new substance (polymer or additive), new materials and new technologies, risk assessment should be performed.

The legislation for food contact in the European Union is based on the hazard of the chemical substance and a very conservative estimate of exposure in order to establish the Positive Lists. When the substance is known it is submitted to toxicological tests in accordance with protocols of traditional assessment of toxicity, where ADI (acceptable daily intake) or TDI (tolerable daily intake) are determined. The requirement for toxicological studies is linked to the amount of the substance that may ultimately migrate to the food product; the higher the migration, the more rigorous and greater number of toxicological tests should be carried out (BARLOW, 2008). The consumers' exposure to these substances is established assuming that 1 kg of food; packed in a container of 6 dm² is eaten every day during their lifetime and that food will always be packaged in the same package type and that migration

of the substance of interest is always at the maximum concentration allowed. Based on these parameters, restrictions on the use and limits of composition and, especially, the specific migration limits (SML) for many of the substances on the Positive Lists are established.

The legislation in force in the United States differs from the European principally in relation to toxicological tests required to establish the safety of the substance for food contact. Whereas the European Union considers that the level of migration determines the toxicological tests that should be conducted, in the United States, the level of exposure to the substance will dictate the tests to be performed. The Food and Drug Administration (FDA) estimates the likely exposure to the substance by combining the migration data with information relating to typical uses of the package containing the substance of interest. As such, the lower the consumer exposure to the substance the fewer toxicological tests are required and it can be more easily included on the list of permitted substances for food contact (OLDRING, 2010).

The MERCOSUR legislation, and hence the Brazilian legislation, is based on the harmonized European legislation and therefore the limits in force are also conservative. The MERCOSUR legislation also includes some substances approved by the United States, and in such cases, includes limits set by the Food and Drug Administration (FDA).

Exposure assessment is the key part of risk assessment of a substance and is defined by the Codex Alimentarius (CODEX. ..., 1969) as a "qualitative and / or quantitative evaluation of the intake of physical, chemical or biological agents by means of food or other sources if relevant".

Currently there is no universally recognized approach to estimate the exposure of consumers to migrants from packaging material. Exposure is the sum of the concentrations of migrants in food versus the weight of food consumed. The exposure can be estimated in various ways and can be summarized as described in the document published by the International Life Sciences Institute,(2007):

Simplistic or simplified

This assumes the worst case exposure of 6 dm²/kg food/person/day, as stated by MERCOSUR and Brazilian law, which is based on that established by the European Union. The biggest disadvantage of this method is that in many cases, different types of packages contain different substances and migration depends on the type of food and processing. It is considered that this approach overestimates exposure to migrants from packaging and applies severe limits to migrant substances that do not necessarily increase consumer safety. On the other hand, it is also argued that such an approach underestimates children's exposure to these contaminants. This is an argument already being examined by the European Commission and which has changed limits for certain substances when used for baby food packages (also adopted by MERCOSUR and Brazil for some plasticizers).

Deterministic

Fixed values of consumption, normally the highest, are combined with the maximum migration value found. It is a more suitable approach for additives and other contaminants which do not originate in the package material, since the type of food which can contain the additive and the amount consumed are known. These data are more difficult to obtain considering the substances which migrate from the package.

Probabilistic

A statistical model is used to predict unknown parameters yielding a more refined estimate of exposure. This tool has gained greater acceptance for allowing exposure assessment where data is lacking or not exact. Clearly, not all required information is available and in many cases there is little information. Thus, assumptions must be made and their impact on the exposure should be evaluated and the probabilistic model facilitates this requirement.

For a more realistic estimate of exposure to a given substance (migrant), the following data is needed:

- Weight of food consumed.
- Concentration of the migrant in the food consumed.

The weight of food consumed can be obtained through research on the diet. However, these studies do not always include the type of package used for a given food. This information can be obtained through participation in a market for a particular package for a specific product. However, little data exists and statistical studies should be conducted to increase knowledge about the types of packages used for the different food categories (DUFFY et al., 2006).

Concentration of the substance of interest in different foods consumed is much more difficult to obtain. The migration depends on the physicochemical characteristics of food and contact conditions as the ratio between the contact area of the package and, the volume of food and temperature and contact time. It is impossible to obtain this data through practical analysis for different types of foods consumed. Therefore, the concentration of these migrants can be obtained through testing with food simulants or by means of mathematical models established for some types of plastic materials. As migration is a physical-chemical process, the diffusion of the migrant in the package material (diffusion coefficient) and the migration of the migrant to food / food simulant



(partition coefficient) can be predicted and therefore described by mathematical equations.

Studies to establish the parameters for estimating the migration of substances from packages to food using mathematical models as an extension of existing models for food simulants have already begun for monolayer materials and should be extended to multilayer structures (FRANZ; SIMONEAU, 2008). The consensus is that mathematical modeling is the only practical way to combine the relevant parameters, including variable composition of foods, the package's processing conditions and time and temperature of storage in order to get data on the concentration of migrants in foods and obtain with more precision exposure to the consumer.

As described, there is no simple method for determining consumer exposure to contaminants from packages. The availability of data needed to estimate this will define the methods that can be used. It is expected that in the near future modifications in the assessment of consumer exposure to contaminants from packages will occur in the European Union. The completion of the projects listed below will help to provide tools for more realistically assessing and managing the risk of substances from packages (OLDRING; CASTLE; FRANZ, 2009).

- Creation of databases on the usage pattern of food packaging and on the chemical substances used in different types of packaging materials.
- Development of a new classification of food based on the migration behavior for a more realistic estimate of consumer exposure.
- Determination of diffusion and partition coefficients, fundamental to describe the process of migration in packaged foods.
- Development of mathematical models to estimate the migration of package components to food under actual conditions of use and application of deterministic and probabilistic models to estimate consumer exposure.
- Development and validation of the QSAR approach (Quantitative Structure Activity Relationship) acting as a tool for estimating the toxicity of substances based solely on their molecular structure for application mainly on NIAS (Not Intentionally Added Substances) in the package material.

The laws of Brazil and MERCOSUR are based on European regulations and, therefore, changes in European regulations may also lead to changes in these laws. However, it should be emphasized that studies of Brazilian consumer exposure to contaminants from the package must be made, as a European study may not necessarily represent what happens in Brazil.

8.2 LEGISLATION AND COMPLIANCE

The legislation on materials and packages for food contact in force in Brazil, MERCOSUR, the European Union and the United States states that packaging materials *"shall not transfer, under foreseeable conditions of use, undesirable substances, or toxic contaminants that pose a risk to consumer health or which may change the composition of the food or its sensorial characteristics"* (BRAZIL, 2001; EUROPEAN PARLIAMENT, 2004). So, based on the principles that the package should be safe and inert, laws have established criteria to be followed concerning materials

in contact with food. It is essential that all materials in direct food contact must demonstrate compliance with the requirements of these laws. Declarations of Compliance assuring that materials and packages are in accordance with the laws are essential in providing material and for trade negotiations.

Currently, two regulations for food contact at a global level are references for all others: harmonized EU legislation and U.S. law. MERCOSUR and Brazil are not exceptions.



MERCOSUR and Brazil

With the creation of the Southern Common Market (MERCOSUR) consisting of Brazil, Argentina, Paraguay and Uruguay there was the need to harmonize national laws including those related to package materials for food contact. The process of harmonization was initiated in March 1992, coordinated by the Common Market Group (GMC), the executive body of MERCOSUR which has among its functions the approval of the GMC Resolutions, which are harmonized Supranational Laws for the countries involved. The harmonization of legislation on package materials for food contact is discussed in the Working Subgroup 3 (SGT-3) - Technical Regulations and Conformity Assessment of MERCOSUR within the Food Commission.

At the time of the formation of the common market, Brazil and Argentina already had laws regarding food contact materials based on the Positive List, total migration tests and composition limits. In 1992 at the beginning of the harmonization process, it was agreed that the law common to all four countries should also follow this model. The first MERCOSUR Resolution concerning package materials comes from this time; Resolution GMC 03/92 - "General Criteria and Classification of Package Materials and Equipment in Contact with Food in Annex to this Resolution," It is still in effect and published in Brazil as Resolution RDC No. 91, May 11, 2001 (BRAZIL, 2001). This resolution applies to all packages and equipment that come into direct contact with food during its production, processing, fractionation, storage, distribution, marketing and consumption and defines the criteria for a food contact material: in compliance with Positive Lists, total migration limits, specific migration limits, when established, and composition limits. It is required that the components used in the package should have purity suitable for the intended purpose (BRAZIL, 2001).

Among the general criteria it is established that packages must be manufactured in accordance with Good Manufacturing Practices, should not cause unacceptable changes in food composition or in sensory characteristics and should not pose risks to human health. Annexed to

this resolution is the classification of package materials, which are regulated by specific resolutions.

Legislation for plastics, cellulose, metal, glass, regenerated cellulose, elastomers, adhesives and film-forming polymers are in force in Brazil and MERCOSUR. These laws follow the principle of the Positive List and migration tests and are based on international legislation for these materials (PADULA, 2010).

To be valid in the member states of MERCOSUR, resolutions must be incorporated into national legislation. In Brazil, the National Agency of Sanitary Surveillance (ANVISA) of the Ministry of Health is responsible for the internalization of GMC Resolutions, which is done through the publication of Ordinances and Resolutions for each type of package material. In Argentina, the GMC Resolutions become Resolutions of the Ministry of Health and are incorporated into the Argentinian Food Code. In Uruguay and Paraguay, GMC Resolutions were published by the Ministry of Public Health and the Ministry of Public Health and Social Welfare, respectively (PADULA; CUERVO, 2004).

The criteria for inclusion of new substances in the Positive Lists involves justification of the technological need for their use, and approval according to policies or regulations of the European Union and/or the U.S. Code of Federal Regulations. Exceptionally, other internationally recognized laws can be accepted, as is the case with German Recommendations for cellulosic materials. The exclusion of substances or modifications of specific migration limits or composition limits are based on new scientific and technological knowledge.

The legislation also establishes the criteria and procedures to be followed for the total and specific migration tests to check they meet the limits set in the Positive List and total migration limits (BRAZIL, 2010a). Purity criteria are also established for pigments and colorants (BRAZIL, 2010b).

New packaging systems or new technologies must also be approved by the competent authority, submitting the completed studies for review and approval within MERCOSUR.



European Union

Regulation 1935/2004 is the basis of European Union legislation, and applies to all package materials for food contact and defines four basic requirements for these materials:

1. Shall not endanger human health.
2. Shall not bring about an unacceptable change in the composition of the food.
3. Shall not alter the taste, smell or texture of the food.
4. Shall be manufactured in accordance with good manufacturing practices.

The basic principles for Good Manufacturing Practices (GMP) are detailed in Regulation (EC) No 2023/2006 and were enforced on 1 August 2008. GMP should be applied to all stages of production of packages and materials. It excludes production stages of the starting substances and raw materials. For example, for the production of a plastic material, GMP requirements apply to transformers and converters, including the printing process of the package up to the production of the final article (SCHAFFER, 2010).

Regulation 1935/2004 establishes labeling and a traceability system requirement for the material or package, as well as compliance declaration requirement. This statement should contain all product information necessary for the food industry to use packages according to the conditions set out. Each manufacturer must issue a declaration of compliance for the process

under their responsibility.

Regulation 1935/2004 sets out specific requirements for the authorization of substances for food contact (including the Positive List) and migration limits. The migration tests to verify compliance with the law follow the methods validated by the European Committee for Standardization (CEN).

This regulation contains a list of materials for which specific legislation should be adopted. This list contains 17 different materials although specific laws have been drawn up for only some of them:

- Plastics: Regulation No. 10/2011, Regulation 1282/2011, Regulation 1183/2012.
- Restricting the use of bisphenol A in baby bottles: Regulation 321/2011.
- Import Procedures for polyamide and melamine kitchenware from China and Hong Kong - Regulation 284/2011.
- Active and Intelligent Packaging: Regulation 450/2008.
- Recycled plastic materials for food contact: Regulation 282/2008.
- Regenerated cellulose materials: Directive 2007/42/EC.
- Ceramics: Directive 84/500/EEC.

For materials for which the laws were not harmonized within the EU, national laws can be applied as well as the resolutions of the Council of Europe.

United States of America

The Center for Food Safety and Applied Nutrition (CFSAN) of the FDA is responsible for food contact materials.

Substances which have contact with food are defined by the Federal Food, Drug and Cosmetic Act (FDCA) as those intentionally used as a component of food packaging material and which in use has no technical effect on the food. If these substances migrate into food, they are considered a food additive and therefore should

be subject to regulations for food additives (Food Additive Petition - FAP) or be allowed through Food Contact Notification (FCN). The regulations for food additives relevant to substances with food contact are found in Title 21 of the Code of Federal Regulation (CFR) in Parts 174-186 and are related to cellulosic materials, plastics, adhesives and coatings, manufacturing additives etc., while the FCN are listed on the FDA website. Substances



can also be generally included in the legal exemptions such as Substances Generally Recognized as Safe (GRAS) or those sanctioned or approved before the enactment of the Food Additives Amendment of 1958 or even be considered exempt from regulation by the principle of Threshold of Regulation. Upon proving that the substance will not migrate to food under the conditions of use, it is not considered a food additive and therefore does not require FDA approval. The substance for applying this principle cannot be carcinogenic or contain carcinogenic

contaminants. (BAUGHAN; ATTWOOD, 2010).

The FCN program was initiated in 2000 and, although it requires the same documentation required for the petition process it has the advantage of approval time, when the notice can become effective in up to 120 days. The process of petition application in some cases can take four years. Another difference is that in the case of FCN the identified manufacturer is the owner and only he can market the substance.

Harmonization

Packages and materials approved as prescribed by the FDA for sale and use in Brazil must be approved according to MERCOSUR / Brazil legislation as the two countries have differences in procedures for approval of a package material.

The harmonization of laws is not a simple issue. As described above, the differences begin in the establishment of acceptable limits of substances, where, although, the toxicological issue is the main aspect, the interpretation of consumer exposure differs by country. Undoubtedly, the harmonization of existing laws, including those of Japan and one that is being established by China, is the desire of the professionals

involved to guarantee the compliance of a material with the various laws currently enforced. It is difficult, time consuming and expensive work. Harmonization greatly facilitates international trade in this era of globalization and would undoubtedly be an important factor for Brazil.

Efforts and studies have been conducted aimed at harmonization of laws in the future, as is the case for studies developed in the European Union. However, we must remember that harmonization should start with studies to establish acceptable limits for various substances and that exposure to contaminants depends on the characteristics of each country.

Legislation for New Technologies and New Materials

Active and smart packages

According to the principles that guide legislation, packaging must be inert, not release substances to the food which could endanger human health and not change the odor and taste of the product and its composition. However, with recent technological developments it has been possible to attribute new functions to packaging: to inform consumers about the condition of the packaged food and interact with the food product by releasing or absorbing substances (SCHAFFER, 2010). Because of this fact, new concepts had to be introduced in the legislation: active packages and intelligent packages. The European Union revised the legislation and in 2004 published the

Regulation 1935/2004 introducing these new concepts. In 2009, they published Regulation (EC) 450/2009 with additional rules for these materials (COMMISSION OF THE EUROPEAN COMMUNITIES, 2009). These new concepts have not yet been introduced in MERCOSUR legislation, while U.S. law assumes that these concepts are already covered by their current legislation.

In accordance with European regulation, the concept of being inert as well as control of migration is applicable for smart packages. However, due to the extra function of monitoring the packaged food, it is essential that the information provided by the package does not confuse or mislead the consumer.



For active packages that interact with the foodstuff or the atmosphere around the product two situations can occur: the absorption of substances released by food (such as ethylene absorbers) or the emission of substances (such as antioxidants) that act on food improving its quality or condition. In this case, these substances are added to packaging to intentionally migrate into the food. However, the release of these substances into the food should be performed under certain conditions. The substance emitted must be authorized by food legislation and used in accordance with the requirements, i.e., the limits established must be observed independently of the origin of the substance in food (directly added or via the package) and be used only for permitted foods. The declaration of compliance of the packaging is essential in this case to ensure that consumers are properly informed by the food manufacturer, and also because this substance should be declared among the food ingredients on the label.

For substances which have an active or intelligent function in the package, but should not intentionally migrate to food and have no function on the food, safety evaluation studies should be performed and then submitted to the opinion of the European Food Safety Authority (EFSA). When authorized these substances will be listed on a specific Positive List of active and intelligent packages and their identity, function and conditions and / or restrictions of use will be described.

It is also important to remember that the materials in which the active ingredients are incorporated must comply with specific legislation for that material, for example, plastic material must meet the regulations for plastics.

In Brazil, nowadays, the use of active and intelligent packages is restricted to substances described in the Positive List of packaging materials legislation, which are restricted to those that should not intentionally migrate to food and to those substances related in food laws that will be released and be part of the food. There is no current requirement to declare the ingredient on the food label and also no requirement of declaration of compliance issued by the package manufacturer. It is expected that in the near future these materials will be regulated in Brazil and MERCOSUR.

Nanotechnology

The safety of nanomaterial for food contact raises many questions:

- Does the nanoparticle have potential for migration?
- If so, what is the potential for ingestion of toxic, carcinogenic or teratogenic substances?
- What are the biological interactions associated with the presence of the nanoparticle? What is important? Surface area? Mass? Surface modification with fillers, for instance?
- What is the biological response to the presence of nanoscale materials?
- Do “traditional” toxicology risk studies apply to nanomaterial?
- How is the consumers exposure to nanoscale materials characterized?
- How are hazards identified and risks evaluated?
- Are analytical techniques available to detect these materials effectively?
- How are materials with nanometer dimensions characterized? What equipment should be used?
- How are environmental and occupational questions relating to nanomaterial answered?

Currently not all questions have answers and there is still no specific packaging legislation for these materials. However, in recent years many advances have been observed in studies on the use of nanoparticles in package materials.

In 2011, the European Food Safety Authority (EFSA) published a guide containing procedures for risk assessment of nanomaterial - Guidance on the risk assessment of the application of nanoscience and nanotechnologies in the food and feed chain (GUIDANCE..., 2011). This guide covers the requirements for physicochemical characterization of nanomaterial and tests to identify and characterize hazards (in vitro genotoxicity, absorption, distribution, metabolism and excretion (elimination) - ADME and oral toxicity studies), which have their origin in nanoparticle properties such as size, surface area, reactivity, ability to ‘permeate’ through biological membranes and so on. The guide also presents schemes for risk assessment, toxicological evaluation

and a decision tree for toxicological testing. This guide has been the basis for studies related to nanoparticles embedded in package materials.

The European Union, in 2011, published Regulation 10/2011 (European Commission, 2011) which stipulates in Article 9 section 2 that the substances in nano form can only be used if they have been expressly authorized, i.e., the authorization of use of nano substances must be carried out on a case by case basis. It also establishes in Article 14 that the functional barrier concept does not apply to nanoscale substances. Currently this Regulation has approved only three nanometric substances: SiO₂ (with size specification included), carbon black (with size specification included) and TiN (with size specification included).

In 2012, the FDA published a Draft Guidance for Industry: Assessing the effects of Significant Manufacturing Process Changes, including Emerging Technologies, on the Safety and Regulatory Status of Food Ingredients and Food Contact Substances, including ingredients that are color additives (U.S. DEPARTMENT... 2012) which includes in item III-E issues related to nanotechnology. This document states that safety assessments of nanoscale substances should be based on relevant data related to the chemical and physical properties of the substance. It also considers that the extrapolation of results is not possible and that the assessment should be conducted on a case by case basis.

A major focus for the characterization of nanoparticles is its definition. The FDA, in the above cited document, has not yet established an official definition of a regulatory standpoint. The European Union published this definition in Recommendation 2011/696/EU of 18 October 2011:

“Nanomaterial means as a natural, incidental or manufactured material, containing particles in an unbound state or as an aggregate or as an agglomerate and where, for 50% or more of the particles in the number of particles distribution, one or more external dimensions are in the size range of 1nm - 100nm. In specific cases where warranted by concern for the environmental, health, safety or competitiveness threshold of 50% may be replaced by a threshold between 1 and 50%”. This document also provides definitions for particles, agglomerations and aggregates.

Other documents related to risk assessment and risk management of nanotechnology were published by FAO (LUETZOW, 2012) and ILSI Europe (COCKBURN; BRADFORD, 2012).

Studies related to the characterization of nanomaterial, nanoparticle migration and risk assessment have been conducted, and some results related to the migration of silver nanoparticles were published by Bott et al. (2012 a, b) and Noonan et al. (2012) and TiN nanoparticles (BOTT; STORMER; WOLZ; FRANZ, 2012c).

In Brazil and MERCOSUR there is still no specific legislation on the use of nanomaterial for food contact.

Recycled Materials

With increasing environmental awareness and issues related to sustainable development, recycling of package materials for food contact has become very important. Plastic materials, which have their origin in oil, have become the main focus of discussion and since the nineties many plastics recycling processes have been developed.

Plastics for food contact are regulated by various laws and must comply with positive lists and migration tests and should not transmit toxic substances to foods and / or change the odor / taste of the food. Recycled materials must also comply with these regulations. However, due to the chemical nature of the plastics, it is possible that contaminants resulting from the first use of the package or container misuse by the consumer can remain in the material and migrate to the food product. Thus, processes that ensure the cleanliness of the material for potential contaminants have been developed, allowing post-consumer recycled materials to be used again for food contact. There are two different processes for recycling, chemical and mechanical recycling. In chemical recycling, the plastic is depolymerized to monomers or oligomers, which are purified, isolated and used in the polymerization of new materials. For this process, if the monomers meet the purity criteria set out in the legislation, they are approved for food contact. In mechanical recycling, post-consumer material is melted again and subjected to steps of washing and decontamination. To prove the efficiency of



the decontamination process and to approve processes, protocols have been established by the FDA - Guidance for Industry: Use of Recycled Plastics in Food Packaging: Chemistry Considerations (U.S. DEPARTMENT..., 2006) and by the EFSA - Guidelines on submission of the dossier for safety evaluation by the EFSA of a recycling process to produce recycled plastics intended to be used for manufacture of materials and articles in contact with food (GUIDELINES..., 2008). The protocols require that the material must be contaminated with model contaminants, representative of substances that may be present in the material after use, and then must undergo a cleaning process (Challenge test). By the end, the contaminants should be quantified in the material, and migration testing or estimations of migration should be performed. No migration may be detected, i.e. it must be below the detection limit of the method. The Challenge test is the first step toward approving a process for recycling post-consumer plastics for food contact. To regulate all the requirements for this type of material, specific legislation for recycled materials for food contact were established by the European Union, United States and MERCOSUR / Brazil.

The European Union established Regulation (EC) N° 282/2008 (COMMISSION OF THE EUROPEAN COMMUNITIES, 2008). This regulation provides individual authorization for processes within the Community after the safety assessment of the recycling process conducted by EFSA (SCHAFFER, 2010). The source of material to be recycled and the ability of the process to reduce the contamination are considered critical. Only plastics which meet the composition requirements established by the regulations can be used as feedstock for the recycling process. All recycling processes should have a system of quality assurance and should be audited by the member states, and processes as well as packages containing recycled material must be accompanied by a declaration of compliance. The final product must meet the requirements of the regulations on plastics and Regulation 1935/2004 (PARLAMENTO EUROPEU, 2004).

The United States does not have specific legislation for post-consumption recycled materials. For the process to be approved, the protocol Use of Recycled Plastics in Food

Packaging: Chemistry Consideration (U.S. DEPARTMENT..., 2006) must be considered. The results are submitted to the FDA that issues a No Objection Letter (NOL) that contains the name of the company responsible for the process, the type of material, the date of the letter, the type of process (chemical or mechanical), the permitted use and limitations (food, contact temperature and raw material) (U.S. DEPARTMENT..., 2013). PET, for its extensive use in soft drink bottles and also for its characteristics, is the most studied material and has the most recycling processes approved.

In 1999 MERCOSUR adopted Resolution GMC 25/99 - Disposable multilayer PET packages intended for the packaging of non-alcoholic carbonated beverage - which allows use of the middle layer of recycled post-consumer PET (published in Brazil as Ordinance No. 987, of December 8, 1998). This resolution states that the layer which comes into contact with the beverage is virgin PET with a minimum thickness of 25 µm and control analysis should be performed on the bottles to guarantee its quality. The company must be authorized by the competent authority (PADULA, 2010).

The use of post-consumer recycled PET for direct food contact was approved in MERCOSUR as Resolution GMC 30/07, in December 2007, and published in Brazil as RDC 20, of March 26, 2008 – Technical Regulation on food grade post-consumer polyethylene terephthalate packages (PET) (food grade PET-PCR), intended to come into contact with food (BRAZIL, 2008). While the laws of the European Union and the United States apply to plastics in general, this MERCOSUR resolution is only for PET. To assess the efficiency of the process, protocols established and authorization given by the FDA and EFSA are accepted and packages must also meet the requirements established in MERCOSUR legislation on plastic containers. The responsibility for the quality of PET-PCR is divided among the producer of PET-PCR resin, the producer of PET-PCR packaging and the food producer. It is important in this resolution that the packages and/or precursor articles of food grade PET-PCR must be approved/authorized and registered with the Competent National Health Authority, following established procedures. Controls of the source of raw material, and of the process and quality of the resin obtained are required of the resin manufacturer.



The packaging manufacturer needs to provide the correct control of the produced package, a traceability system, quality assurance and good manufacturing practices. Food producers, if they are using packaging containing recycled material, can only use approved / authorized packages registered by the Competent National Health Authority. The package must be labeled “PET-PCR” (PADULA, 2010).

The use of recycled materials for food contact is growing, including new materials and development of new technologies for decontamination and new processes. The law will be updated and will incorporate the new processes as they are deemed safe for the production of materials for food packages, although it is expected that the individual approval process will remain.

Biopolymers

Biopolymers like all food contact materials must meet the requirements set out in current legislation on packages in

contact with food. The polymers and additives that are part of the material must be included in the positive lists and must meet the established restrictions and limits.

PLA - poli(lactic acid), the most widely used biopolymer in food packages, is approved as long as the additives added in its formulation are listed in the positive lists and meet the limits set by law.

The copolymer of 3 - hydroxypentanoic and 3-hydroxybutanoic acids (PHB / PHV) is also listed in Regulation 10/2011 of the European Union (COMISSÃO DAS COMUNIDADES EUROPEIAS (COMMISSION OF THE EUROPEAN COMMUNITIES), 2011) and in RDC Resolution 56/2012 of Brazil (BRASIL, 2012). In the two laws, this copolymer is in the Appendix with a very specific definition related to the type of microorganism used for the production thereof.

It is important to stress that new biopolymers must be subjected to toxicological studies and risk assessment to establish the safety of their use for food contact and approval.

8.3 CERTIFICATION AND PROCESS SAFETY MANAGEMENT SYSTEMS

Good Manufacturing Practices

One of the basic requirements for the safety of package materials for food contact is the application of good manufacturing practices (GMP) in its production process. This requirement is described in the legislation for food contact materials in the European Union, United States, Brazil and MERCOSUR.

GMPs are designed to ensure the safety of food and its consumers through prevention and control of contaminants (chemical, physical and / or biological) following rules and procedures ranging from raw materials to the finished product. GMP procedures are needed to ensure sanitary quality and compliance of packages and equipment with the law, with the aim of contributing to the safety of the food or beverage.

According to Ordinance No. 1428 of ANVISA (1993), GMPs are defined as rules of procedure to achieve a certain standard of identity and quality of a product or a service in the area of food, whose efficacy and effectiveness

should be evaluated by inspection and / or research.

In the case of packages, GMP begin with the selection of suitable raw materials for which specifications should be established, including the purity of the chemical used and compliance with current legislation for food contact materials, to ensure the production of a safe package. The fabrication of the material must be monitored to avoid the formation of products of degradation or undesired reaction, to avoid the presence of not intentionally added substances (NIAS) in the final package. A quality assurance system involving the facilities, equipment and qualified personnel should be established to ensure that the prerequisites of safety and control are met. All aspects and documents related to GMP must be registered and available to the health authority.

Codes, Procedures and Manuals for Good Manufacturing Practices should be developed and describe the operations performed by the establishment,



including, at least, the sanitary requirements of buildings, maintenance and cleaning of facilities, equipment and utensils, water supply, control of raw materials, integrated management of urban pest, control hygiene and health of workers and quality assurance of the final product.

In Brazil, a draft resolution on GMP for the

package industry was published as a public consultation; however, it has not yet been finalized. This document contains requirements for preventing contamination of packages for food contact. It is expected that in the near future, this document will be available for the package industry in Brazil.

Hazard Analysis and Critical Control Points

Within the safety management systems is HACCP (Hazard Analysis and Critical Control Points). HACCP is a systematic procedure based on the science of analyzing potential hazards in an industrial process, identify points in the process where hazards can occur and decide which are critical to the safety of food, the latter being designated as critical control points. The system is designed to prevent the occurrence of problems, ensuring that the controls are applied at certain stages in the production system for food packages, where there may be hazards in critical situations.

HACCP can be applied throughout the entire food production chain up to consumption and its implementation should be based on scientific evidence of risk to human health. In addition to increasing food safety, implementation of HACCP can help

inspection by health authorities and promote increased confidence in food in international trade. Importantly, the successful application of a HACCP system depends on the involvement of everyone in the industry, from managers to workers.

The concept and the seven principles of HACCP based on the Codex Alimentarius (CODEX. ..., 1969) are also used for food packaging and involve:

1. Hazard identification and control measures.
2. Identification of the critical point.
3. Establishment of the critical limit.
4. Monitoring.
5. Corrective actions.
6. Verification procedure.
7. Recording results.

ISO 22000 and other standards

ISO 22000, Food Safety Management Systems containing requirements for any organization in the food chain was first published in 2005 (NYGREN, 2012).

This International Standard integrates the principles of the Hazard Analysis and Critical Control Points (HACCP) system and the steps to apply them developed by the Codex Alimentarius Commission. By means of auditable requirements, it combines HACCP with Prerequisite Programs (PPR). Hazard analysis is the essential element of an effective food safety management system, that helps to obtain the knowledge needed to establish an effective combination of control

measures. This International Standard requires that all hazards reasonably expected to occur in the food chain, including those that may be associated with the type of process and facilities used, are identified and assessed (ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS, 2006).

PPR - Prerequisite Programs are activities and basic conditions which are necessary to maintain a hygienic environment throughout the food chain, suitable for the production, handling and supply of foodstuffs safe for human consumption.

ISO 22000 provides international harmonization in the field of food safety, offering tools to implement



HACCP through the food chain with the aim of controlling and reducing any danger to the safety of the final product to an acceptable level.

This standard combines key elements to ensure safety at all points of the food chain:

- Requirements for Good Manufacturing Practices or Prerequisites Programs.
- Requirements for HACCP according to the principles of the Codex Alimentarius.
- Requirements for the management system.
- Interactive communication among providers, users and regulators.

ISO 22000 is widely used by food companies and also applies to package manufacturers, although, in Brazil, for the latter, the application of that rule is still restricted. The advantage of implementing this system is the fact that it is an international standard recognized and accepted in many countries.

Other specific safety management systems for packages and certification have been developed and used by various package manufacturers. The advantages and disadvantages of each system must be evaluated by the package producer although it is recommended to use one that has greater recognition among those involved in the manufacturing of the package. Table 8.2 presents some of these systems and their country of origin.

Currently, many organizations are working to harmonize the rules and regulations referring to food quality and safety – the American National Standards Institute, ASEAN - Association of Southeast Asian Institute, the Codex Alimentarius Commission, the FDA - Food and Drug Administration, GFSI - Global Food Safety Initiative, GHI - Global Harmonization Initiative, IFT - Institute of Food Technologists, ILSI - International Life Science Institute, and ISO - International Organization for Standardization, among others (MERMELSTEIN, 2012). Some of these organizations, from 2011, also began working on the establishment and harmonization of safety requirements for food packages with GFSI being among the most active.

The Global Food Safety Initiative is a business initiative aimed at continuous improvement of food

safety management systems to ensure consumer confidence in food around the world. This initiative was launched in 2000 and provides a platform for collaboration among food safety experts in the retail market, manufacturers and food service companies and other services in the food chain as well as international organizations, academia and government. Among its activities, the GFSI currently defines the requirements of food safety throughout the supply chain. The GFSI, through the harmonization of food safety standards, hopes to reduce duplication of audits throughout the food chain. The main objectives of GFSI are:

1. Reduce risks to food safety by offering equivalence and convergence among efficient systems of management of food safety.
2. Managing costs in the global food system, eliminating redundancies and improving operational efficiency.
3. Developing skills and training in food safety to create consistent and effective global food systems.
4. Provide a unique international platform for stakeholder collaboration, knowledge exchange and networking.

Regardless of the standard, certification brings benefits and ensures that legal requirements are met, the package produced is safe and that it was manufactured within Good Manufacturing Practices, thus promoting access to the most demanding markets that prioritize compliance with safety requirements. An example of what makes the market more challenging was the approval of the Food Safety Modernization Act (FSMA) by the United States in January 2011. This law promoted a historic shift in the food safety system: from reaction to prevention (U.S. DEPARTMENT..., 2012). The emphasis in this legislation is on imported products and is very demanding in the registration and inspection of foreign food manufacturers. The FSMA was designed to prevent problems with food before they occur and require the implementation of HACCP, risk control programs and certifications to suppliers. Although directly impacting food producers, this law will also affect package manufacturers, as they will require certifications and evidence that the package was produced within the standards of quality and safety.



Table 8.2
Package Safety Management Systems

Standard	Origin	Application
PAS 223:2011	United Kingdom	PAS - Publicly Available Specification was prepared by the British Standard Institution (BSI) to specify requirements for prerequisite programs developed with the aim of helping to control hazards and food safety in manufacturing and supply of packaging. PAS 223:2011 Prerequisite programs and design requirements for food safety in the manufacture and provision of food packaging - Enforced since 1st July 2011. This document is designed to be used with ISO 22000 by package manufacturers to assist in deployment, management and maintenance of the pre-requisites set by ISO 22000 and thus controls the potential risk to food safety that may originate from the package. It is applicable to all organizations (companies) that manufacture package material or packages and handles all aspects, from the general requirements of the establishment to storage and transportation of materials (BRITISH STANDARD INSTITUTION, 2011; SANSAWAT; TERRY, 2011).
FSSC 22000 Standard (2011)	Holland	The Foundation for Food Safety Certification (FSSC) has expanded the scope of standard FSSC 22000 to the manufacturing of package materials for food according to the publication standard PAS 223. Standard FSSC 22000 for Food Packaging Material Manufacturing is designed to meet the requirements of the GFSI (Global Food Safety Initiative) and has been used for many package manufacturers (FOUNDATION FOR FOOD SAFETY CERTIFICATION, 2012).
BRCIoP Global Standard	United Kingdom	BRC / IoP Global Standard - Packaging and Other Packaging Materials was developed by the British Retail Consortium (BRC), a UK organization that represents the interests of supermarkets and retailers together with the Institute of Packaging to help retailers and package manufacturers comply with legal requirements related to legislation for food contact. This standard establishes a common basis to certify food package manufacturers and includes: organization, risks and hazards management systems, technical management systems, contamination control and personnel.
IFS PACSecure (2011)	Canada & Germany	IFS PACSecure arose from the union of the Packaging Association of Canada (The Packaging Association - PAC) with the IFS Management GmbH, Germany, and refers to standards to ensure the safety of primary and secondary packages for the food industry. This standard was created to provide package manufacturers the possibility of certifying their products for the food industry (IFS ... PACSECURE, 2012; THE PACKAGING ASSOCIATION, 2012).



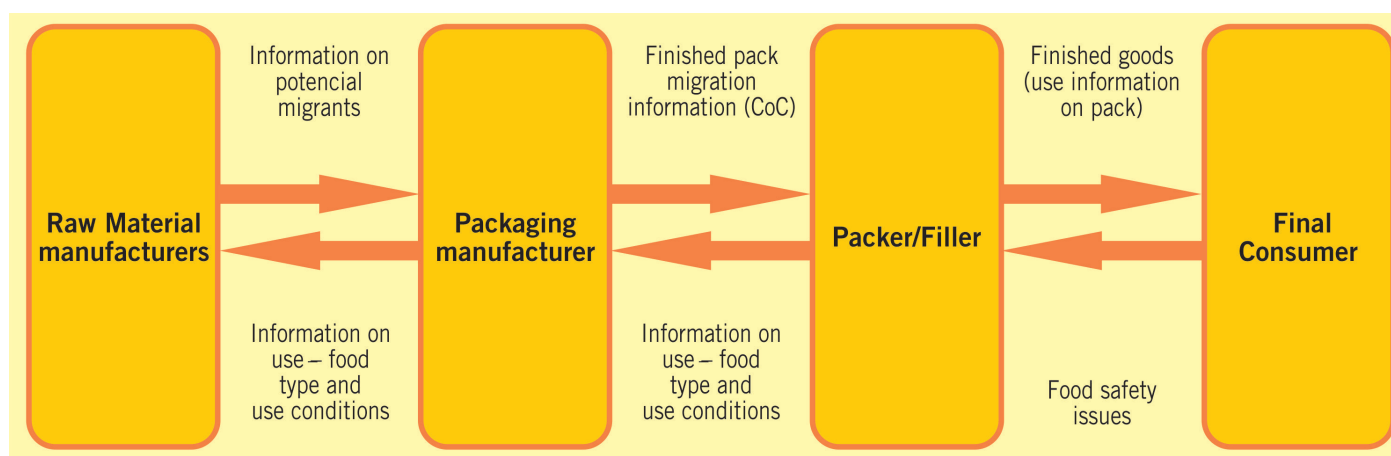
Traceability is another tool that becomes increasingly necessary for the safety and identification of origin of packaged products and is now a requirement of some laws, for example, European legislation and certification standards. According to the international organization for standardization (ISO NS-8402), traceability is the ability to track the history and use and to locate an entity by means of recorded/ registered information. The item to be tracked can be physical or virtual and must have a unique identification

(THAKUR; KARLSEN; FORÁS, 2012). Radio-Frequency Identification (RFID) and other traceability systems offer significant opportunities for manufacturers, retailers and consumers.

Finally, communication between the manufacturer and the package user is essential for all parties to comply with safety requirements, since the flow of information must be reciprocal/interactive in order to continuously improve the systems. Picture 8.1 illustrates an example of information flow in the food chain.

FIGURE 8.1

Information flows along the food packaging supply chain



Source: British..., 2011

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Future Considerations

On-the-go, Time Saving, Lifestyle, Packaging, Masstige, Lightweighting, Ecodesign... The globalized world is in profound transformation and originates consumer trends that will shape the future of companies.

In order to take advantage of opportunities, to maintain market positions and, above all, to ensure the survival, innovation has become a vital strategy for consumer goods industries. As a result, the entire package production chain needs to meet the demand for new technologies, being capable to provide efficient processes and attractive products. Producing in a sustainable manner will be a requirement for markets and society.

In this scenario, it is the task of all stakeholders in the sector to join efforts and skills to support industrial development by channeling resources from funding agencies, improving the regulatory system,

expanding the technological services of universities and research institutes, as well as installing a system of competitive intelligence capable to guide the choice of strategic areas for investment. This is how innovation happens in many countries, through collaborative networks. It is in this direction that we envision our future in 2020 and beyond.

ITAL, with the support of APTA and the Secretaria de Agricultura e Abastecimento (Secretariat of Agriculture and Food Supply) of the State of São Paulo, aims to promote, continuously, the deepening of the study of trends initially contemplated in Brazil Pack Trends 2020. More than that, through CETEA, ITAL puts his team of researchers available to support the development of the information presented in this study, in real possibilities of technological innovation. This will be an ongoing task of our Institute.





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