

pressures, giving its detractors plenty of reason to seek control of it.

Plastics began to make serious inroads, along with reformulations of products formerly contained by paper (such as liquid detergents replacing powders). At the same time the Internet and the electronification of the office seemed to be a two-edged sword. No doubt more printers were making more copies than ever before, but it seemed as though certain paper grades were quickly obsolescing. No longer were printed stock certificates required, and interest in daily newspapers was waning. The impact of writing a letter on high cotton content paper was lost. Conversely, computers and associated software, coupled with changes in printing processes, led to many new and specialized magazines, as layout was easier and runs could be shorter. Overall, paper-makers seemed lost as to how to distinguish their products and avoid falling into a commodity-only business. How to go from a production orientation to one of marketing?

By the end of the twentieth century, it can be said that the science of papermaking was firmly established. High-speed equipment operated by skilled professionals, using massive computing capacity, tamed the process. Today, we know how to make paper at high speed, efficiently and consistently, in an environmentally sound way.

See also: **Packaging, Recycling and Printing:** Packaging Grades; Paper Recycling Science and Technology; Printing. **Papermaking:** Coating; Overview; Paper Grades; Paperboard Grades; Tissue Grades; World Paper Industry Overview. **Pulping:** Bleaching of Pulp; Chemical Additives; Chemical Pulping; Chip Preparation; Environmental Control; Fiber Resources; Mechanical Pulping; New Technology in Pulping and Bleaching; Physical Properties.

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World Paper Industry Overview

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Introduction

Paper is one of our most important materials. It has been a key to the growth in human communications and commerce since invented by T'sai Lun in China. Various historians rank the Gutenberg Bible and the invention of the printing press as among the most important developments in history.

Changes in society have had a major impact on the use of paper around the world. However, despite predictions in the 1980s and 1990s that some combinations of technology would eliminate the use of paper for common uses such as the daily newspaper, there is little doubt that it will continue to have a key role in the future. Nevertheless, the paper industry must maintain its competitiveness and viability by continuing to develop new products that can compete cost-effectively with alternate means of information dissemination and alternate packaging materials, as well as seek out new end-use applications. Paper must also be produced economically and in an environmentally responsible manner. There are many challenges to paper that could reduce its use in some applications. Conversely, as the economies of Second- and Third-World nations continue to develop, paper consumption and growth will grow, driven by established uses and new and innovative applications. A driving force for its sustainability is a renewable and relatively low cost principal raw material, namely wood.

The following major areas are discussed in this overview:

- raw materials and major products
- demand and consumption
- long-term growth trends

- global trade
- major industry structural trends
- challenges to growth.

Raw Materials and Major Products

Paper for the most part is manufactured using softwood and hardwood trees to supply the fiber used in its manufacture. Globally, fibers from trees provide about half of the material used to make paper and paperboard, while recycled fiber provides about 20%. Most of the remainder is accounted for by various minerals and chemical additives used to impart optical and printing characteristics, water resistance, and strength characteristics to paper and paperboard grades. The remainder of the raw material used by the industry is composed of non-wood fibers, which are mainly used in parts of Asia and Africa.

Many grades are manufactured using recycled fiber, i.e., fiber that has already been used in a paper product, such as a box or as office papers, which is then recycled to provide the fiber for a paper or paperboard grade. As discussed later, trees are a renewable resource and this provides an advantage over many competitive materials. However, it also presents an environmental challenge due to society's perceptions of the pros and cons of the widespread cutting of trees to fuel the demand for fiber by the paper- and wood-consuming industries.

Common grades of paper and paperboard are used by people all over the world for a wide array of uses. Most major uses can be categorized as one of two applications: (1) communicating information or protecting and packaging products for shipment and end-use applications; (2) personal hygiene applications where a range of sanitary tissue grades is used for products such as toilet paper, paper towels, napkins, and facial tissues. Nonsanitary grades include products such as tissues for interleaving and electrical applications.

Common examples of paper used to store or communicate information range from the ubiquitous sheet of cut-size copy paper to the daily newspaper, direct mail, magazines, catalogs, promotional brochures, and books.

Paperboard grades are used to package food and to protect products for shipment. There are two major forms of packaging: folding cartons and corrugating containers. Frozen food, dry foods, milk products, and many other foods are packaged in paperboard folding cartons. Food is the largest use for folding cartons. Major folding carton applications include:

- bottled and canned beverages
- candy, biscuits, and crackers
- cosmetics
- carry-out food
- soaps and detergents
- hardware and household supplies
- tobacco
- bakery
- paper goods.

A wide array of products are packaged in corrugated containers, which is a paperboard box made of three plies, with the middle ply comprised of a wavy or fluted sheet called corrugating medium. The use of this fluted ply enhances its bending stiffness.

Among the major uses for corrugated containers (in order of the volume of boxes used) are:

- paper products
- electronics
- food
- hardware, tools, etc.
- consumer soft goods (e.g., clothes).

There is also a large and varied converting industry that uses paper and board as one of its key raw materials to produce a wide array of products. Some segments are based mainly on paper or paperboard, such as business forms converting, envelope converting, and box and corrugated container converting. An equally large and even more diverse segment is flexible package converting, where, for example, a plastic film may be used to cover an item for sale and is affixed to a backing sheet composed of recycled or bleached paperboard. Other examples include combinations of paper, film, and foil to manufacture bags or sacks with various barrier properties. Common examples include pet food packaging and aseptic juice containers.

The other major paper industry product is pulp. Many mills around the world do not make paper or paperboard: they simply make pulp. Pulp is the first product phase from the pulping of wood, and is the basic raw material for paper and paperboard. This market pulp is then shipped to paper mills that do not make their own pulp or those that only make part of their pulp requirements.

Demand and Consumption

The amount of paper consumed in the world is driven by a complex set of social and economic factors and the amount of paper products consumed or used by an individual, or on a per capita basis, varies widely around the world. However, as a general rule, consumption tracks fairly closely with per capita income and general economic levels. Persons having higher income buy more processed

foods, consumer electronics, and toys. They also tend to be better educated and thus consume more newspapers, magazines, and books.

In more developed economies, such as in Europe and North America, large amounts of paper products are used. In developing countries, such as in Asia and Africa, very low levels of paper products are consumed. For example, per capita paper and paperboard consumption in North America approaches 330 kg, in Europe it varies from less than 200 kg to over 340 kg, and might average 230 kg, while in Asia and Africa it is less than 35 kg.

Consumption is also highly cyclical due to its close correlation with economic activity. Thus during periods of high economic growth, paper demand typically expands, while during slow economic growth, or during recessions, demand growth slows or demand can decrease.

Total world demand for paper and paperboard exceeds 300 million metric tons, based on data for 2001, the most recent year for which world data are available. The largest consumers are the USA, followed by China, Japan, Canada, and the major economies in Europe. Global demand contracted in 2001 versus the 2000 level due to weak economic conditions that prevailed in key economies, notably,

the weakness in the huge US market, and the decline in Asian growth rates. At this writing, demand continues to be weak due to the ongoing weakness in the major world economies. For example, total US demand for paper and board fell 0.1% in 2002, a much more modest decline than the 6.1% drop in demand in 2001 and the 2.5% decline posted in 2000. The 3-year decline is one of the largest ever posted in the US market.

The Asian market, with the exception of Japan, has historically been a modest consumer of paper despite its large population due to its general lack of economic growth. However, this has changed somewhat in recent years as various countries have seen economic growth, and in some cases, removal or at least easing of restrictions on the dissemination of information. **Tables 1–3** give more detailed global information regarding growth and consumption.

In particular, change in China has been noteworthy. While currently the second largest individual market, demand is growing rapidly owing to strong economic growth in the last decade. It is projected that China may eventually become the largest market for paper products in the world due to its enormous population and movement toward a less controlled economy. Twenty years ago China was ranked sixth

Table 1 World paper and board production by grade 2000–2001 (1000 tonnes)

	<i>Newsprint</i>		<i>Printing/writing</i>		<i>Tissue</i>	
	<i>2000</i>	<i>2001</i>	<i>2000</i>	<i>2001</i>	<i>2000</i>	<i>2001</i>
European Union	9266	9336	32 649	30 847	5000	4902
Other western Europe	1196	1245	1440	1352	132	133
Total western Europe	10 462	10 581	34 089	32 198	5132	5035
East Europe	2214	2283	1961	2035	619	634
Total Europe	12 676	12 864	36 050	34 233	5752	5669
Asia	8520	8730	27 701	27 277	5360	6527
Australasia	782	738	562	586	255	261
North America	15 889	14 147	30 748	28 464	6922	7047
Latin America	947	928	3 529	3522	1985	1933
Africa	367	359	706	727	249	263
Total	39 181	37 766	99 296	94 810	20 522	21 699
	<i>Containerboard</i>		<i>Board</i>		<i>Total P&B</i>	
	<i>2000</i>	<i>2001</i>	<i>2000</i>	<i>2001</i>	<i>2000</i>	<i>2001</i>
European Union	18 280	18 215	10 652	10 450	84 655	82 222
Other western Europe	797	766	285	252	4153	4041
Total western Europe	19 077	18 982	10 937	10 703	88 808	86 380
East Europe	2902	3135	1599	1698	11 257	11 868
Total Europe	21 979	22 116	12 536	12 401	100 066	98 255
Asia	29 290	28 813	13 369	13 451	95 797	96 661
Australasia	1841	348	83	89	3526	3494
North America	33 917	32 347	14 577	14 095	106 603	100 433
Latin America	5331	5403	1395	1385	14 789	14 855
Africa	1357	1388	260	256	3200	3449
Total	93 714	90 415	42 221	41 677	323 981	318 147

Source: Pulp and Paper International (PPI), Annual Review Issue, July 2002, Paperloop.com.

Table 2 World's top 30 producers 2001 (000 tons). Source: PPI Annual Review Issue, July 2002

<i>Paper and board production</i>	<i>2001</i>	<i>% Change 2001/2000</i>
1. USA	80759	-5.9
2. China, People's Republic	32000	3.6
3. Japan	30731	-3.4
4. Canada	19686	-5.2
5. Germany	17879	-1.7
6. Finland	12503	-7.4
7. Sweden	10534	-2.3
8. Korea, Republic of	9724	4.5
9. France	9630	-3.8
10. Italy	8924	-2.2
11. Brazil	7354	2.3
12. Indonesia	6951	0.3
13. UK	6204	-6.1
14. Russia	5599	6.9
15. Spain	5132	7.7
16. Austria	4250	-3.1
17. Taiwan	4211	-6.3
18. India	4049	5.2
19. Mexico	3811	-2.2
20. Netherlands	3174	-4.7
21. Australia	2656	0.3
22. Thailand	2445	5.7
23. Norway	2291	-3.5
24. South Africa	2268	6.8
25. Poland	1952	0.9
26. Switzerland	1750	-1.7
27. Belgium	1659	-3.9
28. Turkey	1513	-3.5
29. Portugal	1419	10.0
30. Argentina	1229	1.2
<i>Pulp production</i>	<i>2001</i>	<i>% Change 2001/2000</i>
1. USA	52795	-7.3
2. Canada	24918	-7.3
3. China, People's Republic	17570	2.4
4. Finland	11169	-6.3
5. Sweden	11000	-4.5
6. Japan	10813	-5.1
7. Brazil	7405	-0.8
8. Russia	6225	5.7
9. Indonesia	4326	5.8
10. Chile	2921	2.8
11. India	2645	2.5
12. Norway	2406	-1.8
13. France	2327	-5.7
14. Germany	2103	-5.1
15. Austria	1944	10.4
16. Portugal	1806	1.8
17. South Africa	1740	-23.0
18. Spain	1720	-1.7
19. New Zealand	1501	-6.5
20. Poland	933	0.8
21. Australia	921	4.2
22. Thailand	919	20.3
23. Argentina	791	0.5
24. Czech Republic	687	7.1
25. Italy	603	0.6
26. Korea, Republic of	554	-6.9
27. UK	492	-4.8
28. Belgium	405	-11.0
29. Mexico	384	-34.0
30. Taiwan	370	-3.9

Table 3 World's top paper and board consumers 2001 (000 tons). Source: PPI Annual Review Issue, July 2002

<i>Paper and board consumption</i>	<i>2001</i>	<i>% Change 2001/2000</i>
1. USA	87933	-5.4
2. China, People's Republic	38180	2.9
3. Japan	30836	-2.8
4. Germany	18543	-2.9
5. UK	12516	-3.0
6. Italy	10734	-3.1
7. France	9680	-14.4
8. Canada	7875	3.3
9. Korea, Republic of	7850	6.3
10. Brazil	6618	-2.7
11. Spain	6398	-6.2
12. Mexico	5313	0.1
13. Indonesia	4862	24.4
14. India	4444	6.8
15. Taiwan	4351	-14.8
16. Russia	3783	14.8
17. Australia	3661	0.2
18. Belgium	3380	-3.1
19. Netherlands	3355	-12.1
20. Sweden	2463	-2.2
21. Poland	2422	-0.3
22. Malaysia	2273	12.6
23. Austria	2103	7.1
24. Thailand	2070	5.6
25. Turkey	2017	-20.5
26. South Africa	1878	9.2
27. Denmark	1806	26.5
28. Argentina	1741	-5.6
29. Switzerland	1687	-4.8
30. Finland	1386	-9.1

in total consumption; 10 years ago, it only ranked behind the USA and Japan, and today it is number 2.

Long-Term Growth Trends

Demand for paper and paperboard products typically mirrors economic changes as measured by gross domestic product (GDP) or gross national product (GNP). Thus, as economic growth occurs, more paperboard packaging is required to ship industrial and consumer goods, more books and magazines are sold, and more paper is used in offices for copying, printing, and mailing.

Global paper and paperboard demand has typically expanded at about the same rates as world GDP, or about 2–3% annually. However, growth rates vary widely by grade as well as widely by region and country.

Based on two examples of growth in the future, **Table 4** outlines the growth in world paper and paperboard demand.

During the 1980s, rapid growth occurred throughout the world and in particular the huge North American market as the US economy expanded, and

Table 4 Increase in world demand at various growth rates (000 tons)

<i>Annual demand growth (%)</i>	<i>Growth in world demand per year</i>
2	6000
3	9000

Based on base consumption of 300 million tons per year. Source: PPI Annual Review Issue, July 2002.

throughout much of Asia, with Korea and China's consumption more than doubling. During this period, US growth was particularly strong for printing and writing grades due to enormous growth in the use of direct mail – referred to as junk mail by its opponents – which includes catalogs, as well as strong growth in newspaper inserts (also called free-standing inserts). In addition, demand for grades such as coated paper, uncoated free sheet, and uncoated groundwood grew at nearly twice the rate in growth of the general economy, i.e., at rates of 5–8% annually. Demand for packaging also posted strong gains, but not at rates matching printing and writing paper growth.

Growth continued into the 1990s but during the latter part of the decade the rapid growth in the use of computers began to have an impact on consumption patterns in the USA (for much of the 1990s growth in white papers was spurred on by computer printers and fax machines – in the later part of the 1990s paper consumption changed, but it is difficult to differentiate between the impact of computers and the internet and the general decline in the economy). In particular, the explosion in the use of the internet began to have a negative impact on various communication papers. During the 1990s printing and writing paper demand continued to grow rapidly in Europe.

During the last two decades, many people have spoken of the paperless office, where a wide array of computer and internet-based devices would essentially eliminate the use of paper. This remains a myth, and printing and communication paper demand continues to be large.

However, while the paperless office has never materialized, electronic information dissemination has had a major impact on the use of paper. This impact is caused by a wide array of forces, including direct substitution where paper is eliminated because another means of conveying information has replaced it. A good example is the reduction in the use of first-class mail correspondence, which has been caused by two factors. Initially, the use of the facsimile machine replaced the mailing of letters, but more recently, the explosion in the use of e-mail has had a much larger impact, as has the low cost of telecommunications.

Table 5 Total US advertising expenditure by medium

<i>Medium</i>	<i>%</i>
Daily newspapers ^a	19.2
Television	23.5
Direct mail ^a	19.3
Radio	7.7
Yellow pages ^a	5.9
Magazines ^a	4.8
Other	17.1

^aPaper-related.

In other cases, the impact was more indirect. For example, advertising expenditure is a major driver behind the use of printing papers. When more money is spent on print advertising, more paper is used to print magazines, catalogs, and flyers. However, advertising dollars are spent on a variety of media, including print and electronic media such as television, radio, and more recently, internet-based advertising, and thus will potentially impact paper consumption.

Table 5 provides insight into the use of various advertising methods in the USA, based on 2001 data.

Printing and writing paper demand continues to grow strongly in areas such as in Europe, which have historically had various controls in place that limited the use of various media such as television, and where the use of sophisticated marketing approaches such as direct mail and catalogs is not yet as advanced as in more developed markets. Growth will continue to be strong in Asia where both literacy and economic rates continue to show rapid growth.

US demand is expected to continue to expand, but at much lower rates than during the 1980s and early 1990s. Projections by various forecasting experts peg growth at 1–3% annually over the next 5 years.

Global Trade

Paper and paperboard grades may be consumed in the country in which they are produced, or they may be exported to other countries. While the level of income, affluence, and lifestyle influences demand for paper, the production of paper products is often driven by a different set of parameters. Traditionally paper was produced in regions with abundant forest resources such as Scandinavia, Canada, and the USA, and appropriate economic resources (South America, Asia, and Russia all have large forest resources, but limited financial resources).

Historically, trade between various regions of the world was modest. Initially trade between countries began in areas such as North America and Europe when regions possessing abundant natural resources in terms of wide tracts of forestland and low-cost hydropower began to make paper and ship it to areas

that lacked such resources. Thus, in the early parts of the twentieth century, Canada, which had huge tracts of virgin forest and numerous rivers, began to make paper to sell to the huge US market located to its south. In fact, this trend was encouraged by major consumers of paper in the USA that built mills in Canada. A prime example is the Tribune Company, which founded the first newsprint mill in Canada to supply paper to the large Chicago newspapers.

However, as noted below, paper trade has expanded due to the availability of low-cost wood in the southern hemisphere. In regions such as South America, and more recently in South-East Asia in countries such as Indonesia, the warmer climate and wide tracts of unused land have led to large growth in the use of 'forest plantations.'

Production has increased considerably in the last 10 years in Southeast Asia, notably in China, Indonesia, and Korea. Production is growing rapidly in China as the country attempts to meet its growing demand for paper and paperboard. Most of this is targeted at meeting domestic demand growth in these countries. However, considerable tonnage is also currently being exported to the USA and Europe, which is having the effect of displacing higher-cost locally produced paper. The growth in capacity in these countries has also to some extent replaced grades such as paperboard that were previously exported by the USA and Europe to the region.

Major Industry Structural Trends

Two fundamental changes, both economically driven, have radically altered the global forest products business in the last decade. They are: (1) huge growth in the use of plantations in warm climate areas of the world such as South America and South-East Asia to supply fiber; and (2) the huge growth in the economies of Asia, notably China, and in turn the rapid growth in the demand for paper and paperboard in these regions.

The global pulp and paper industry has been strongly affected by several key macroeconomic trends. Among the major ones are industry consolidation and shifting regional competition due to exchange rates.

One key trend that has been underway for some time in many industries, such as the automotive industry, has been a trend towards consolidation. Big companies buy up other companies as a method of increasing their market share, and for strategic reasons such as to extend their reach to other markets. Being large also provides the capital needed for investments and to ride out the notoriously cyclical nature of the industry.

Over the last 20–30 years exchange rates have played a major role in many industries, including the pulp and paper industry. During the early 1980s, the devaluation of Scandinavian currencies radically changed the competitive landscape of the world pulp and paper industry. The US industry, which for years had enjoyed a favorable competitive position due to the dollar, was suddenly at a disadvantage. This devaluation led to the initial expansion of exports of paper and board grades to the US market. The devaluation had effectively made a high-cost industry either a low-cost one, or at the very least, a competitive paper industry that was able to ship product to North America.

Similarly, in recent years, the weak Canadian dollar versus the US dollar has been a boon for the large Canadian forest products industry by allowing it to ship competitively priced products to the USA.

During the period 2002–2003, a large-scale change in the value of the dollar against the euro has begun to change the competitive position of the European and US industries. For much of the latter part of the 1990s, a strong US dollar has meant that it was difficult for US mills to compete globally and to export paper products. In contrast, it has meant a boon for European and, to some extent, Asian countries. As a result, US imports have risen considerably while exports have fallen. The decline in the value of the euro vs. the dollar which has occurred since 2002 is likely to slow the growth of imports to the US, although it is not likely that imports for certain grades will actually decrease.

Environmental Issues

One major factor impacting the availability of timber for industrial use has been environmental considerations. The largest and most notable example to date has been the withdrawal of millions of acres of federal land in the western USA due to environmental concerns. Environmentalists argued that the spotted owl was being damaged by excessive logging in national forests and were successful in getting the government to ban, or severely reduce logging in the region, which was traditionally one of the world's largest suppliers of fiber to the pulp and paper industry.

Other environmentally related issues include huge sums of capital spent by North American and European producers to meet stringent air and stream environmental standards.

Challenges to Growth

Most forecasts of growth in world paper and paperboard project that demand will continue to expand at

modest rates of 2–3% annually for the foreseeable future. However, in some of the more developed economies of the world, notably in the USA, a wide array of forces have led to slower demand for certain grades. In fact, demand for a number of grades, such as newsprint and packaging papers, has either stagnated or has posted major declines due to competitive factors such as the growth in electronic media and electronic information dissemination and due to losses to competitive materials, notably plastics used for packaging.

Much has also been written about the impact of information technology on the use of and demand for communication papers. It presently appears that while demand for some products may decline, the negative impact of technology on paper use in the next 5–10 years will be limited to merely slowing the growth in demand, not actually causing it to decrease. And this negative impact is most likely to be the largest in high paper-consuming markets, such as Europe and North America, and less important in other markets.

There are several other challenges to the long-term growth and success of the pulp and paper industry worldwide. They include:

- The paper industry's image as a smokestack industry
- The image that the industry destroys old-growth forest and rainforests
- Competition for traditional paper uses from competitive information means and alternate packaging materials

The industry's record on the environment is beyond the scope of this article. However, what is important to recognize is the importance of how the public perceives these issues. In recent years, environmental groups have waged campaigns urging consumers to stop the use of paper and forest products due to various environmental reasons. They include the charge that forestry companies are cutting down old-growth northern forests as well as destroying tropical rainforests. The threat to the industry is that consumers will cease to buy and use paper products due to these concerns. While these groups have achieved some success, the global industry has met these challenges and others with large capital expenditures for air and stream improvement and a prodigious effort to plant more trees than are being consumed. As noted earlier, environmental concerns have previously been used to limit the use of forests as a natural resource in the production of paper and lumber products.

Competitive packaging materials are another key threat to the paper and forest products industry.

Among the most notable losses that paper products have endured are the large-scale replacement of the common paper grocery sack with plastic sacks, and the shift in packaging automotive oil from oilcans to bottles.

Food packaging is another prime area where product substitution has impacted and reduced the use of paperboard packaging. For example, folding cartons and paper bags are being increasingly replaced by plastic pouches and sacks in a variety of foods.

The driving force behind almost all of these cases of substitution is lower cost. Lower-cost plastic is replacing a higher-cost paper product. In some cases the replacement product is also a better product.

A final element that poses a challenge to the industry has been the relatively poor financial performance of the paper industry in recent years. This has been due to several factors, mainly the weak global economy in the 1990–1991 and 1999–2002 periods, in addition to the industry's tendency to overinvest in capacity when times are good. In turn, this means that new and frequently excess capacity typically comes online just when demand is plummeting. Among the biggest challenges posed by this weak performance is the limit it places on the industry's ability to attract investment capital and to attract employees.

Another factor impacting established mills is that new capacity is frequently produced more efficiently, and at lower cost. These cost factors include labor rates, employees required per unit of production, cost of raw materials and energy, not to mention possible differences in cost of environmental compliance.

In conclusion, despite numerous changes in the global paper industry over the past few years, paper and board production has grown and growth will continue for years to come as economy throughout the world continues to grow – bringing increased literacy rates, an educated populace, and business commerce use of paper.

See also: **Packaging, Recycling and Printing:** Packaging Grades; Paper Recycling Science and Technology; Printing. **Papermaking:** Coating; Overview; Paper Grades; Paperboard Grades; The History of Paper and Papermaking; Tissue Grades. **Pulping:** Bleaching of Pulp; Chemical Additives; Chemical Pulping; Chip Preparation; Environmental Control; Fiber Resources; Mechanical Pulping; New Technology in Pulping and Bleaching; Physical Properties.

Further Reading

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