Recycling

through the ages

Contents

INTRODUCTION

Recycling is the only natural resource which will grow, not decline

FROM REUSE TO RECYCLING

In nature, nothing is ever really wasted. When trees shed their leaves in the autumn, these are converted into compost on the ground, from which new trees and leaves grow. "Earth to earth, ashes to ashes, dust to dust" (adapted from Genesis 3:19) is one of the first descriptions we have of this eternal cycle.

Man is the only creature on Earth that wastes the planet's valuable treasures - and on a large scale - by mostly throwing them away after using them only once or dumping them in landfill sites. This wastage has gone on for century after century. Animals are a great deal more economical. An old bird's nest is repaired time and time again; if an ant hill is destroyed, the ants simply take it apart piece by piece and relocate everything to a new nest.

When Homo erectus first appeared on the Earth a little over a million years ago, he quickly learned to reuse various materials, driven by sheer necessity. He used animal skins to make protective clothing and, about 40,000 years ago, shoes as well. He made tools and weapons from stones, and if these implements became damaged, he could often fashion new tools from the pieces. But it was only around 9000 years ago that he learned how to refine and work with metals. Since then, implements made of metal have been reused and also recycled.

The history of reuse is almost as old as the history of Mankind, but recycling - which mainly involves remelting - is a much more recent concept, probably dating back to circa 7000 BC. This became possible only after Man had learned to make, control and use fire - a sometimes dangerous enemy - for melting and remelting metals.

The story told below describes the fascinating history of recycling and recovery, explains its usefulness, and charts significant events and discoveries. It is also a story of how raw materials have become increasingly scarce, not only because the Earth's population and consumption of raw materials per individual have increased, but also because Mankind became increasingly careless and wasteful in dealing with these raw materials.

This wastage continued until people began to realise that the Earth's supply of most of the so-called primary raw materials - such as ores and minerals - was limited and that increasing amounts of energy would be needed to extract these materials from greater depths as supply dwindled. People also realised that secondary raw materials, in particular metals and glass, could be endlessly recycled. It was recognised that recycling would save a lot of money and energy while reducing damage to the environment.

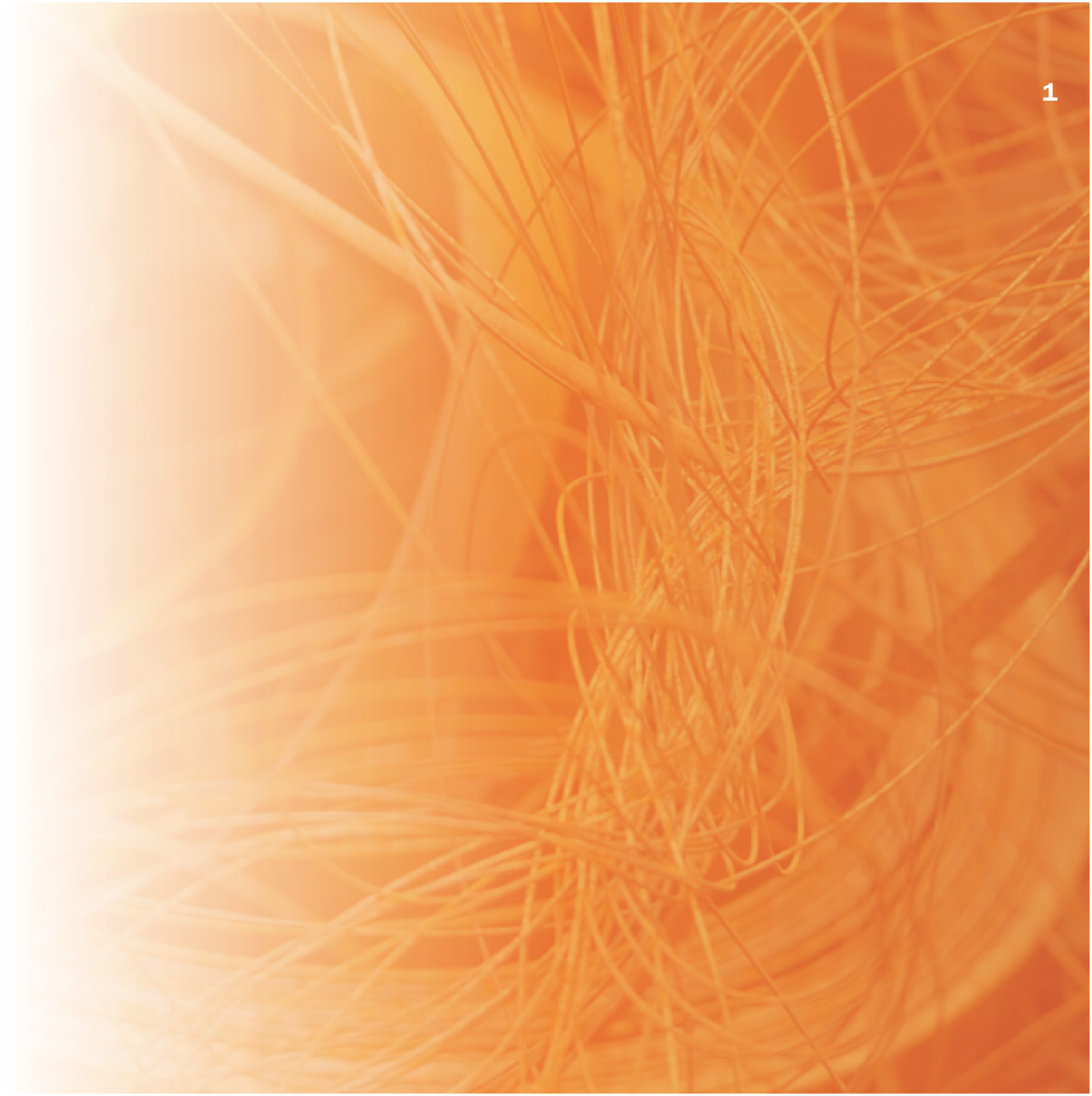
Recycling has experienced many highs as well as lows. The high points often occurred in times of scarcity - for example, during wars when practically everything that could be recycled was collected for this purpose, particularly during the 20th century. The low points have occurred notably in recent years when legislative bodies around the world were gripped by over-regulation mania and felt compelled to restrict and interfere with recycling (via export and so-called environmental restrictions), without regard to the depletion of the Earth's reserves warned of as early as 1972 in the famous Report to the Club of Rome: "The Limits To Growth"*.

* According to the Club of Rome, due to 'exponential' consumption, gold would have been exhausted in 1981, silver in 1985, mercury in 1985, tin in 1987, zinc in 1990, copper in 1994, oil in 1992 and aluminium in 2003. None of these disasters happened, but the 'Club of Rome' had completely forgotten the role of recycling, and even did not mention the word 'recycling'.

From swords to ploughshares. This sculptural interpretation of the well-known Biblical text "...and they shall beat their swords into ploughshares" (Isaiah 2:4) stands in front of the United Nations building in New York. A gift from the Russian people in 1953, it is the work of Evgenii Vuketich.

But the history of recycling is also replete with success stories, such as how we learned to dismantle objects of all kinds and rebuild them at the same site or elsewhere; how we learned to take discarded materials and chop them up, sort them and separate them - nowadays, almost always a process performed mechanically - and in the end remelt them. We learned how to make new paper from old rags, how to identify and separate glass (cullet) using lasers, and how to sort various metals using computer technology.

Another success story began in 1948 with the formation of BIR, a global association of recyclers which was able to convince governments of the enormous advantages of recycling. Regulations were introduced to ban the dumping or burning of recyclable materials, as a result of which many countries have decreed that all construction and demolition waste has to be recycled - and therefore actually is no longer "waste". Old tyres for instance are ground down to provide a material mixed into road surfaces to make asphalt, while ground glass is used to make "glasphalt".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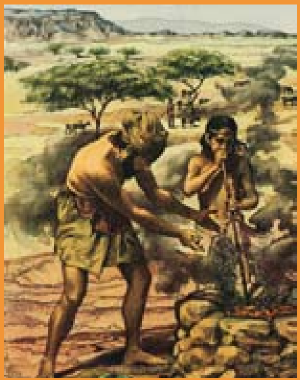
"...For dust thou art and into dust shalt thou return."
(The Bible, Genesis 3:19)

9000 YEARS OF RECYCLING

Although Man has been walking the Earth for over one and a half million years, it was not until around 7000 BC that he learned how to melt or remelt metals. Before doing so, three conditions had to be fulfilled:

- Man had to be able to control fire and heat
- The metal involved had to be pure, ie native
- The metal had to have a low melting temperature (such as in the case of tin and lead)



Men in prehistoric times engaged in melting copper (in the lower front part of this illustration) with the help of a blowpipe

In order to be of the required purity, the metal could not contain too many non metallic elements, as is the case with the metal ores mined today. After all, it is due to the presence of such dead materials that the melting temperature of most ores is much higher than 1000°C. In order to create such temperatures, Man had first to learn how to add forced air (oxygen) to a fire. He managed to do so initially with the help of bellows made usually from rolled-up goat skins or a pig's bladder (an early example of reuse!), or by sewing an animal skin into the appropriate shape. After the metal was melted, it had to be hammered to give it the proper shape and hardness.

In prehistoric times, the surface of the Earth was littered with relatively pure lumps of metal - primarily copper, silver and gold - and lumps of iron which often originated from meteorites. When these meteorites passed through the Earth's atmosphere, the resulting friction raised their temperature to such a level that the non-metals burned off, leaving the pure metal behind in often white-hot and melted form. Pure metals are, after all, elements and according to the law of conservation of mass first formulated by Antoine Lavoisier (1743-1794) - whose life was ended by the guillotine - they cannot simply disappear.

By 7000 BC, native copper - or metallic copper found in nugget form within nature - was being used in farming at such sites as Catal Hürük and Cayönü in Southern Turkey and Ali Kosh in Iran.

COPPER AND BRONZE

However, the problem was that these relatively pure metals were, in general, too soft for making tools or weapons. The metal could be hardened somewhat by hammering it for a lengthy period of time, but this was often not sufficient. Eventually, Man discovered that it was possible to create a much harder material by adding other components to the pure metal. For example, if copper is melted with arsenic or - as was done later - with tin, with or without the addition of lead, the result is a very hard metal alloy called bronze (see also Chapter II). The so-called Stone Age was therefore followed by the Copper Age (5500-3000 BC), which in turn was followed by the Bronze Age (starting around 3500 BC).

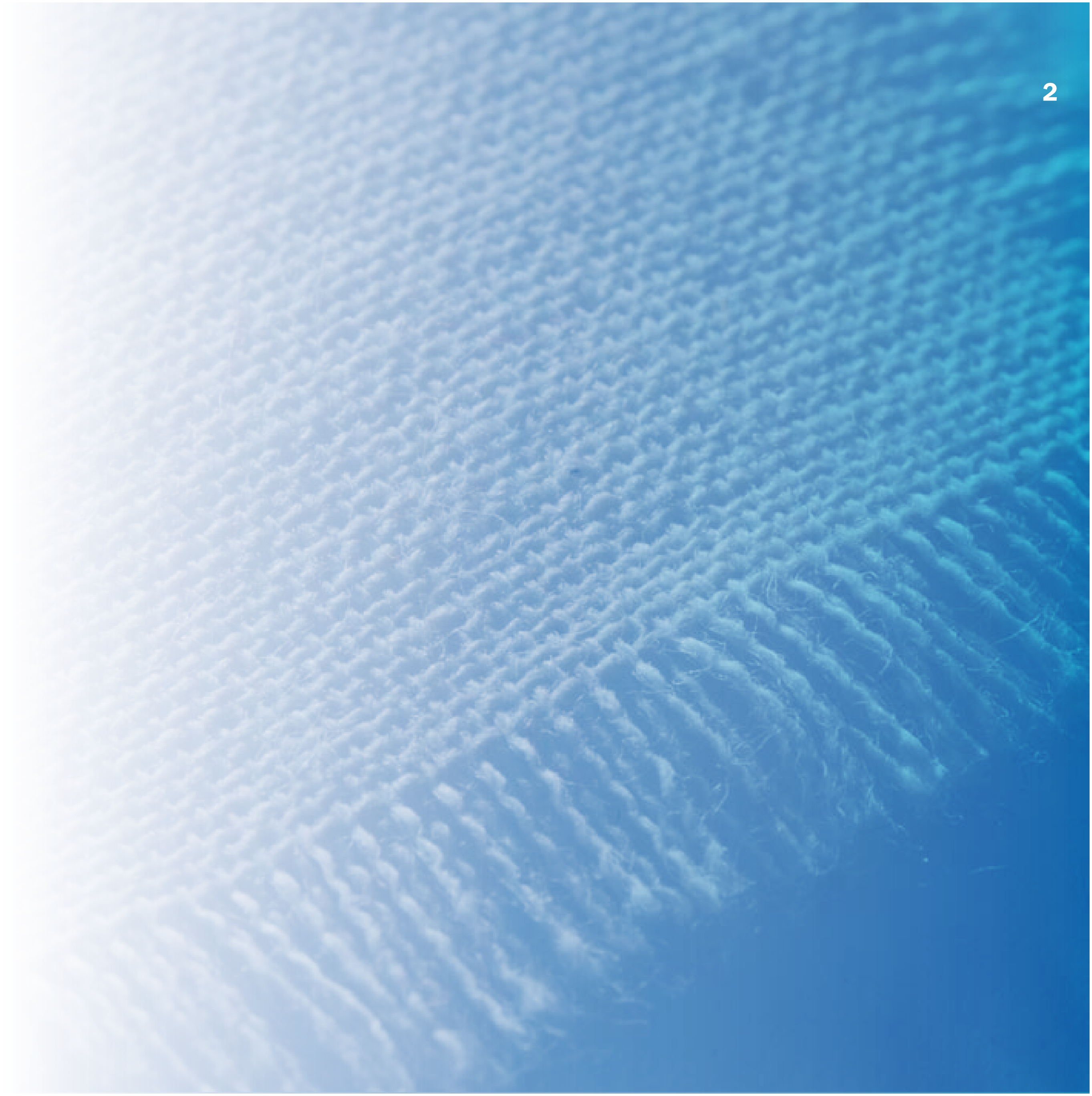
The island of Cyprus was one of the earliest major sources of copper and owes its name to this metal, being called “Kupros” in Greek and “Cuprum” in Latin. At the time, the copper content of these lumps of metal was between 10 and 20%; nowadays, an ore containing 0.5 to 1% copper is considered capable of being economically mined.

Forged implements from the Iron Age: spade, file, sickle and knife.

The Iron Age began around 750 BC. Man learned to work with (often meteoritic) iron only much later because iron has a much higher melting point than copper (1535°C compared to 1083°C) and can therefore be melted only with the help of charcoal and/or a bellows for producing forced air. With the help of charcoal, often made from acacia wood, it was possible to realise much higher temperatures than with plain dry wood. As iron could not be alloyed with other materials at this time, it was hardened through hammering while white or red hot and then quickly plunged into cold water.

At this time, metal was so precious and expensive that if a metal implement in daily use became broken or worn, it would undoubtedly have been quickly thrown into the melting pot and used to make new objects. The oldest known objects made of metal were: weapons such as copper and bronze axes, knives, spear points and arrow heads; utensils for household use, such as cooking pots, pins, needles and buckles; or decorative items of jewellery such as brooches and rings. Some thousands of years after the beginning of the Copper Age, objects were also made from silver and gold, although these precious metals were rather rare.

Soon after the start of the Iron Age, the first silver, gold and bronze coins began to appear. These included the Roman Denarius, the name of which lives on today in the unit of currency known as the dinar.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"... and they shall beat their swords into ploughshares,
and their spears into pruning hooks..."
(The Bible, Isaiah 2:4)

EGYPT, ASSYRIA AND CHINA

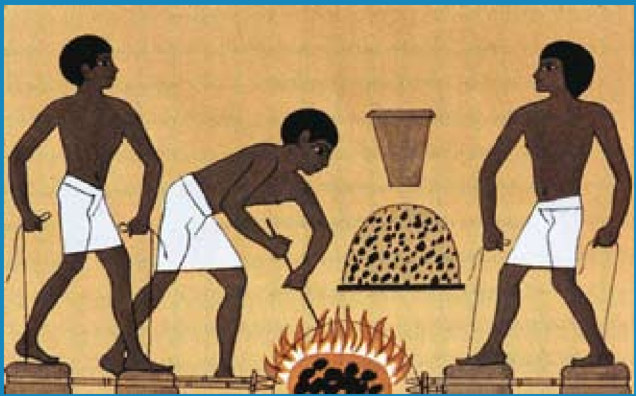
These three ancient civilisations - perhaps with the addition of the Incas and Aztecs - were often very advanced in their reuse and recycling of raw materials, dating sometimes from around 4000 BC. But recycling was focused primarily on metals, which were the most expensive ingredients employed in making objects useful to Man. The blocks used to build the pyramids of Egypt around 2550 BC, each of which weighed between 1.5 and 15 tonnes, were cut using chisels made of copper hardened by beating. These were handed in every day for hardening and regrinding; once they became too short, they were remelted. The 2.3 million blocks cut for the great pyramid of Gizeh boasted an average weight of 2275kg.

The Chinese were already remelting metals around 2500 BC. A regular wood fire could be used for melting lead and tin, which have melting points of only 327°C and 232°C. However, such temperatures were not hot enough for copper and bronze whose melting points are around 1000°C, or for iron at around 1500°C.

However, around 4000 BC, Man started using charcoal in combination with a bellows to increase the temperature of a fire. The bellows were often operated by a foot device (see illustration p. 12) and featured a tuyère made of heat-resistant fired clay.

The art of forging metals was so highly regarded in ancient times that it was even assigned its own deity: Hephaestus by the Greeks and Vulcan by the Romans. Vulcan supposedly resided on Mount Olympus but actually preferred to spend most of his time in his underground forge. The ancient Greeks believed that smoking volcanoes, in particular Mount Etna in Sicily, were the chimneys of Hephaestus' forge.

At first, bronze was made from copper ore containing a certain amount of arsenic, but it was soon discovered that working with an alloy of copper and tin provided a much better solution, not least because the arsenic-based method led to the premature deaths of many metal smiths. However, tin was a relatively scarce metal, and pieces of bronze that no longer had any use were of course remelted.



Remelting copper in ancient Egypt (circa 2000 BC) using a charcoal-fed fire: the four bellows, operated by a push-and-pull foot device, were used to raise the temperature.

These included damaged swords and shields which, in many cases, had to be broken down into smaller pieces using metal chisels and hammers before they could be fed into the melting pot. It was important to minimise heat loss in this pot, which meant that the opening was kept as small as possible. This is also true today. In addition to the collection of discarded metal, the process of breaking down such objects into smaller pieces is one of the oldest forms of recovery.

Many indications have been found that metals were already being recycled long before the beginning of the Common Era. In fact, there are many allusions in the Bible to the recycling and reuse of metals. References to the production and recycling of metal have been discovered on clay tablets in Mesopotamia as well as on inscriptions in Egypt and on temples, graves and obelisks. An Assyrian cuneiform tablet has been dug up which mentions an order from the monarch to collect a certain quantity of old metal. Another tablet dating from circa 1780 BC mentions that a cargo of copper transported from the city of Dilmun (now in Oman on the Persian Gulf) was refused by the recipient - a certain Mr Ea Nasir from Ur in Mesopotamia - because "...the quality did not comply with the conditions of purchase....". As King Solomon said: "There is nothing new under the sun."

During those years, copper was manufactured mainly in Cyprus, Mesopotamia, Turkey and Oman in shapes that barely differ from modern cathodes. They were made in square ingots weighing between 15 and 35 kg with four handles on either side to facilitate transportation (see illustration hereunder). Thousands of tonnes of these hide-shaped ingots must have been made because thousands of them have been retrieved from sunken ships off southern Turkey and elsewhere.

In China, metals were melted as early as 2000 BC. Some 3000 years later, the Aztecs and Incas were doing likewise, although they melted and worked primarily with silver and gold.

Man carrying a hide-shaped copper ingot, Cyprus, 1200-1150 BC. There is a striking resemblance to today's copper cathodes, which are of roughly the same shape.

China was ahead of the West when it came to using paper. The earliest use in Asia was based on paper made from the bark of the mulberry tree. The Chinese also learned quite early - between 50 and 100 AD - how to make rice paper, which was used not only for writing but also for manufacturing handkerchiefs, parasols, clothing and even windows. Rice paper was also often reused. The oldest piece of paper written upon in China dates from 98 AD. Centuries later, Europe was still restricted to writing on parchment.

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"I have come here with my ship and crew, on a voyage to men of a foreign tongue being bound for Temesa with a cargo of iron, and I shall bring back copper."
(Homer, Odyssey I – 183)

THE GREEKS, ROMANS AND PHOENICIANS

The Greeks and Romans also made a great many objects from bronze and copper. The rams fixed to the front of Greek warships - the famous triremes propelled by three levels of rowers one above the other and exhibited in replica form at the 2004 Olympic Games in Athens - were also made of bronze. Ancient Greek sculptures made of bronze are of course famous throughout the world.

As explained in Chapter II, once it became clear that making bronze alloy with the help of arsenic was not good for the health of the people engaged in casting or hammering the metal, tin became the material of choice. However, tin quickly became a scarce commodity on the European continent. As a result, the ancient Phoenicians - famous for their navigation and sailing skills - are said to have opened up a trading route between England, where the ancient tin mines of Cornwall were located, and the cities known as Tyrus, Sidon and Byblos in what is now called Lebanon. The Phoenicians also founded Carthage in what is now known as Tunisia, from where Hannibal later set forth on his expedition over the Alps to conquer Rome.

Recycling and the Seven Wonders of the World

Everyone has heard of the Seven Ancient Wonders of the World. Two of these, the Hanging Gardens of Babylon and the Colossus of Rhodes, also played a role in the history of recycling. The hanging gardens were built around 600 BC on terraces, the base of which was often covered with sheets of reclaimed lead soldered with tin. This is thought to have been done in order to retain water in what was a very dry region. Remains were also found of ancient irrigation ducts made of lead and soldered with tin.

Dating from 282 BC, the famous 32-metre-high Colossus of Rhodes was a statue made by Chares of Lindos to represent the deity Helios (Apollo). Legend has it that the statue was erected in such a manner that its legs straddled the harbour. In actual fact, it stood next to the harbour. Of course, constructing and positioning this statue was an amazing architectural tour de force.

The Colossus comprised a wooden skeleton stabilised by filling it with blocks of stone, and was said to be covered with 200,000kg of finely hammered bronze plating. The bronze plates were made largely from reclaimed copper scrap and riveted together (ancient technology at its best!). At the time, the island of Rhodes was the most important Greek centre for casting bronze. The statue stood next to the harbour for only 56 years: in 226 BC, an earthquake caused it to fall into the water. When the Oracle of Delphi was consulted, the Oracle forbade the recovery of the statue from the water.

A 16th century engraving from the16th century Dutch painter Maarten van Heemskerck of the Colossus of Rhodos. Cast partly of recycled bronze, this 32-metre high statue toppled into the harbour following an earthquake. It was recovered - and again recycled - by the Turks some 900 years later.

The statue remained in its watery grave for almost 900 years until, in 654 AD, the Turks recovered most of it, hacked it into small chunks and shipped the remains to be recycled in Syria to make weapons, utensils and coins. It is said that 900 camels were needed to bring this scrap from the harbour town of Aleppo into Syria where the bronze was remelted. The statue undoubtedly served to inspire the makers of the Statue of Liberty that stands in New York harbour and was donated by the people of France to the USA in 1876 to commemorate the hundredth anniversary of the American Revolution. The Statue of Liberty is covered with 80 tonnes of partly recycled copper and bronze plating, and was shipped in pieces from France to the USA.

"…. for money, they (the British tribes) use bronze or gold coins,
or iron staves of a certain weight …."
(Julius Caesar, De Belli Gallici, circa 55 BC)

Julius Caesar

In Ancient Rome, lead was used to make water pipes for bathhouses etc; but to connect the lead pipes to each other, solder was needed - a mixture of tin and lead. Tin became so scarce in the Roman Empire that Julius Caesar decided to cross over to England, following the earlier example of the Phoenicians, to obtain supplies from the mines of Cornwall.

He describes this conquest in his famous book "de Belli Gallici" and mentions that, to his surprise, he found that the inhabitants of that country used iron ingots of appropriate size and weight as currency, making it clear that iron was quite precious in those days. All coins that were no longer usable as a result of wear and tear were always quickly remelted. This was usually the prerogative of the ruler.

All the metal used over the centuries before the Common Era was undoubtedly recycled because it was simply too valuable to waste, especially as precious metals such as gold and silver with their relatively low melting points of around 1000°C were widely used at that time. Of course, coins in use during that period were also made of metal, either silver, gold or rather a copper alloy such as bronze or brass. The remelting of old coins was generally a government monopoly and heavy penalties were imposed on any other party found to be remelting or issuing coins.

Glass and paper recycling

Besides metals, which are basic elements and can therefore be endlessly remelted, glass was also recycled in ancient times. It was made from sand/silver sand, calcium and potash, with the potash obtained from seaweed or by burning special woods. Nowadays, potash has been replaced by soda. But glass has a very useful characteristic in common with metal: it can be endlessly recycled, and remelting requires far less energy than making it from primary ingredients.

Around 1700 BC, glass was already being manufactured on a large scale in Lebanon, more particularly in Sidon, for which purpose old pieces of glass were also used. Remarkably, in the late 1970s, divers recovered boxes filled with 3 tonnes of glass fragments - partially sorted according to colour - from a ship that had sunk almost 1000 years earlier along the Turkish coast. This ancient cargo was being transported from Turkey to Lebanon, apparently to be remelted and recycled.

The Romans also used large quantities of recycled glass to manufacture their famous mosaics. In 1982, the wreck of Uluburun was discovered off the coast of Turkey, having sunk around 1316 BC. It was found to have been carrying copper and glass nuggets. Around the beginning of the Common Era, the Chinese were already using paper made from rice as well as mulberry bark (see Chapter II). The ancient Egyptians were making paper from the dried leaves of the papyrus plant as early as 3000 BC. They were therefore able to recycle the papyrus leaves as well as the paper. This ancient form of paper was written on using a reed pen and natural ink.

The ancient Egyptian figure of the scribe is quite well known. This profession was highly regarded at the time, as the scribe was responsible for keeping track of the Pharaoh's books. The building plans for the pyramids were also set down on papyrus paper. Nowadays, tourists can still purchase hand-made papyrus paper in popular tourist hot-spots in Egypt and Sicily.

Around 5000 years ago in ancient Egypt, paper was a precious article. The origin of the word “paper” tells us as much since it can be traced back to the Egyptian expression “pa-per-aä”, which means “belonging to the Pharaoh”. Even then, it was possible to reuse old paper and sometimes also to recycle it, although rags gave a better result. Later, Sicily became the centre of the papyrus paper production industry and maintained this position until the 19th century.

A wall on the Greek island of Paros dating from the 14th century: the round elements were taken from pillars stolen from Greek temples

Construction rubble was not systematically recycled in ancient times although many buildings were stripped of reusable components. The victor of a war would often dismantle ancient temples and reuse large pieces, such as columns and pillars, for building fortifications. The Acropolis in Athens, with its famous Parthenon, was also raided by the Turks for a great many building materials which were then used to create fortifications.

4

Mining in the Middle Ages. Right: bringing the mined ore to the surface. Background: primitive blast furnaces. Foreground: beating the melted metal.

RECYCLING IN THE COMMON ERA

In the first centuries of the Common Era and the Middle Ages (from 476 AD and the fall of the Western Roman Empire until 1453 AD and the fall of Constantinople), the art of producing and recycling metal, handed down by the ancient Mesopotamians, Egyptians, Greeks and Romans, was further perfected in Europe, and the recovery of metals and other materials continued to flourish.

In the first centuries of the Common Era, metal was used primarily for: weapons such as swords and daggers; for protective armour such as helmets and breastplates; for arrowheads; and for primitive projectiles used in catapults, the so-called ballista. The first mechanical weapons, guns and cannons, were developed after the discovery of gunpowder, which was attributed perhaps mistakenly to the monk Berthold Schwartz (1310-1384). These weapons were made primarily from iron and bronze (see also Chapter II). The first cannonballs were made from stones ground into a spherical shape. Later, when techniques were developed for casting iron into round shapes, iron projectiles were used until the latter part of the 19th century.

The art of producing iron was a difficult one because the metal's melting temperature of 1535 °C was much higher than for the classic metals such as copper, lead, tin, gold and silver. The bellows, which were indispensable for achieving such temperatures, became increasingly ingenious and large, and often had to be powered by slaves, horses or donkeys.

Iron also had to be hardened, originally in forges by heating the metal until it was white hot, beating it, and then plunging it into ice cold water. However, the most difficult technique of all was to produce metal sheeting or plating. As early as the Copper and Bronze Ages (see Chapter II), Man had learned to beat copper into the plates used to make helmets, armour and shields as well as to protect and strengthen wooden ships. The art of beating and hammering metal into sheets continued to undergo improvements in the centuries that followed.


5

"Men love iron" (Homer, Ilias)

THE LATE MIDDLE AGES

The late Middle Ages witnessed not only the renaissance of art in Europe but also the rise of city states and cross-border principalities. The latter development led almost inevitably to wars being fought on a larger and more international scale and to an ever-increasing demand for muskets and cannons.

Cutting scrap with a primitive hand-made scrap shear, as was done centuries ago; photo by courtesy of Ikbal Nathani, India.

The blacksmith was often the most important craftsman in the castle, village, city or region. In the Middle Ages, smiths were veritable artists and could make beautifully decorated helmets, shields and suits of armour. They also became increasingly skilled in: hammering out chains (eg for anchors) and ship fittings; making fencing for entrance gates; hammering out bars (often woven) for prisons and protective windows; making the wall anchors that were so popular at the time; and, of course, producing nails and tools for all these objects.

In what is now the eastern part of Belgium, the Celts and later the Gauls had developed an intensive metalworking industry even before the Common Era. In this region, between the Sambre and Meuse rivers, everything could be found that was needed for melting metals. Large quantities of ores and pyrites (ores containing sulphur compounds) - in particular of lead, zinc, copper and iron - were present, and the forests of the Ardennes provided wood and therefore charcoal. Smiths and skilled metal workers sprang up everywhere, and the copper- and iron-working industry flourished as it had in ancient Egyptian, Persian, Greek and Roman times.


6

*An old verse: "Rags make paper, paper makes money,
money makes banks, banks make loans,
loans make beggars, beggars make rags...."*

THE BOOK PRINTING TRADE AS A STIMULUS FOR THE RECYCLING OF METALS, TEXTILES AND PAPER

The invention of printing around 1425 - a feat credited to both Johannes Gutenberg of Germany (circa 1400-1468) and Dutchman Laurens Janszoon Coster (1405-1484) - revolutionised the use of lead type, paper and textiles and particularly the recycling of all three of these materials. The invention of typography probably had a greater impact on the development of recycling than any other invention. The reason was simple: the lead used for pipes, stained-glass windows, roofing etc. lasted for many years and even centuries before being recycled, whereas the lead used for letters was sometimes returned to the melting pot after only a few days. Soon after the invention of printing, parchment made from specially-prepared animal skins was largely replaced by paper, as it was now possible to produce large numbers of books and other writings.

At the time, paper in Europe was still being made from linen, flax and hemp, and also increasingly from old textiles (commonly referred to as rags) as well as old paper, which was incorrectly termed "waste" paper. But old paper was not used much at that time because paper generally lasted much longer in those days than that used nowadays in newspapers and packaging. There was an ample supply of inexpensive rags although, on the downside, coloured rags such as those derived from sailors' uniforms first had to be bleached before they could be used in the manufacture of white paper. At first, paper was used primarily for books and official documents for the ruler, count or city.

Rags soon became a valuable commodity, and various city states - including Venice, Bologna and Florence - issued edicts prohibiting the 'export' of rags to neighbouring cities or elsewhere. Several cities in the Low Countries of the Netherlands and Belgium regulated the collection and export to other cities of rags collected locally. In the Netherlands, for example, these export restrictions remained in force until well into the 19th century. Emperor Charles V (1500-1558), who ruled over most of central, western and southern Europe, also issued an edict to the effect that "only paper of good quality could be imported" - a move apparently intended to protect the paper production industry in the Low Countries (see illustration p.38).

It was not until 1866 that the alternative wood-based route was found to making paper. Paper was being made in Europe as early as the 12th century before the invention of printing, primarily in Spain and Italy. The oldest paper mill in the Netherlands – and maybe in Europe - dates from 1428 and is still located in the town of Gennep on the Niers River. At the time, clean and quickly-flowing streams were used to drive the grindstones of the watermill with the help of wooden blades. These mills served to pulverise, soak and bleach the rags. In the western Netherlands, windmills were used instead of watermills for this purpose. The oldest such windmills date from 1585. In the Netherlands, there is a windmill dating from 1692 and an even older watermill which are still used for making paper from rags, although their function today is primarily to attract tourists.

It is interesting to note that the famous English writer Geoffrey Chaucer (1340-1400), often called the “father of British literature” and author of the second most frequently read book in the English language after the Bible, “The Canterbury Tales”, actually worked in the recycling sector. In 1389, he was appointed to the position of “Clerk of the King’s Works at the Tower of London and Westminster Palace”. His job was to manage and keep accounts of the old metals and rags collected on the order of the King.

In 1550, Georgius Agricola wrote his work entitled "De re metallica". He devoted some of it to the melting and remelting of lead and provided the following explanation for this illustration: "… a hungry furnace master eats butter so that the poison the furnace emits cannot harm him, for it (butter) is a special antidote against this…".

De re metallica

Mining and recycling flourished in the Middle Ages, but there was very little uniformity in these areas of activity as no instruction manuals were available. However, the situation changed with the publication of a book which described in detail for the very first time the various metalworking techniques. Written in Latin by Georgius Agricola (1494-1556), it was entitled "De re metallica" (or "On the nature of metals"). At that time, Latin was the language not only of the clergy but also of all scholars, poets and scientists throughout Europe.

This book, which was published in or around 1555, provided detailed and richly-illustrated descriptions of the art of mining as well as of the melting and remelting of metals. The name of the author was actually Georg Bauer, but in those days it was fashionable for people of letters to take on a Latin name.

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"...Behold, I make all things new...."
(Revelation 21:5)

ECONOMIC PROSPERITY IN THE 17TH AND 18TH CENTURIES

Metal, scrap and skins

Europe flourished as never before during this Golden Era. Metal was already fulfilling important functions in agriculture (ploughs and harrows), construction (wall anchors, bolts, roofing, pipes, cranes and drains), trade (coins), and art (in particular gold and silver for altars, altarpieces, ornaments, etc). However, the most important use for metal was still for war-related equipment such as cannons, bullets, muskets, spears, swords and nails for holding together the wooden beams of armed merchant vessels and warships. Such nails were made of wrought iron or copper/bronze, and copper sheeting was also used for protecting the hulls of warships. Wars in the 17th century were largely fought at sea. At first, the major naval powers were Spain, Portugal, England and the Netherlands, joined later by France. By the end of the 16th century, following the destruction of the Spanish Armada in 1588, the role played by Spain and Portugal on the global commercial stage was greatly diminished.

Recycling of bronze: in 1778, a cracked bronze cannon is remelted at the Royal Brass Foundry in Woolwich, England.

However, in spite of the thousands of large warships that sailed the seven seas during these centuries, there was almost no large-scale ship dismantling activity. Ships' hulls and masts were still made of wood which, owing to its rounded shape, the influence of salt water and the generous use of pitch, could be put to no further use after a ship was dismantled other than as firewood. Of course, anchors and chains as well as practically all other metal items such as nails, fittings and armaments were, wherever possible, remelted and/or reused.

The Papermaker
It starts out as rags but it ends up as something good

The Papermaker from "The Crafts" by Jan Luijcken (1649-1712), Haarlem, the Netherlands. Until around 1900, paper was made almost entirely from old textiles, ie rags. The techniques needed for making paper from trees were developed only around 140 years ago. Before that, the collection and recycling of rags was the only way of making paper in the Western World. Freely translated, the text under this lithograph dating from 1695 reads: "White linen that is torn to rags / Bought up and carried there in bags / Is washed and then to pulp is made / Then changed to paper of high grade."

With life-spans measured in centuries, buildings also provided very little reusable material, with the exception of iron or copper fittings, iron wall anchors and sometimes windows, doors and beams. After the demolition of buildings, fortifications, city walls and gates, etc, still-usable bricks and stones would often be picked out and set apart for reuse. However, recycling of building rubble only became widespread much later, in the second half of the 20th century.

The use of animal skins, which is another form of reuse, was very important for making shoes and clothing. Tanners were much respected in these times although their work was far from pleasant. The aprons used by smiths were also made of leather. The ermine robes of various rulers and members of the court provide another example of such use. The skins of rabbits and hares were also very much in demand, especially for the less wealthy classes. Animal bones were used for making cattle feed as well as glue and soap - once again, clear examples of reuse.

Throughout Europe, rags were still indispensable to the making of paper. It is therefore not surprising that King Louis XV of France promulgated an edict in 1771 forbidding "the export of rags, old linen, flags and everything needed for making paper…" After the beheading of King Louis XVI and his Queen Consort Marie Antoinette in 1793, the revolutionary government, in particular the "Comité de salut public" (Committee of Public Health) continued to enforce this edict. The Committee required all citizens to wash, dry and collect rags. In the Netherlands, regulations forbidding the export of rags remained in force until 1877. The import of rags was permitted, but they were thoroughly inspected because the authorities were afraid that they would bring with them diseases such as the plague and cholera.

Rags were carefully sorted, with white linen being particularly desirable because it did not need to be bleached. It was critical that the water used to make paper from rags be absolutely clean. River water was generally unacceptable, which is why the owners of paper mills located their facilities alongside a source of water free from iron minerals (see Chapter VI). After being sorted, the rags were torn into pieces. At first, this was done with the help of wooden pounders fitted with iron nails and driven by wind power or water power. In many countries, horses were often made to walk in circles on a treadmill in order to grind the rags into pulp.

Rags were separated into fibres in a wooden or iron container filled with water, in which a cylinder or roller fitted with sharp projections was rotated to crush the rags against the wall or base. This system actually resembles the system currently used for shredding cars. The tiny scraps of rag were then allowed to pass through a sieve made of copper wire. The rags were bleached in a boiling bath containing vitriol (sulphuric acid), calcium and bluing. Later, chloride of lime was also used.

During his reign as Emperor of Russia, Czar Peter the Great (1672-1725), the founder of St Petersburg, travelled to the Netherlands and resided for quite some time in the city of Zaandam to the north of Amsterdam in order to learn about the shipbuilding trade. The German composer Albert Lortzing (1801-1851) wrote his best-known opera on this subject: “Czar und Zimmermann” (1837). The Czar also worked in a paper mill in Zaandam to learn how to make paper from rags. It is still possible today to see how this is done at the “Zaanse Schans”.

In addition to rice paper and paper made from hemp, the production of paper in China was based to a large extent on the use of rags (see also Chapter II).

Beheaded and recycled

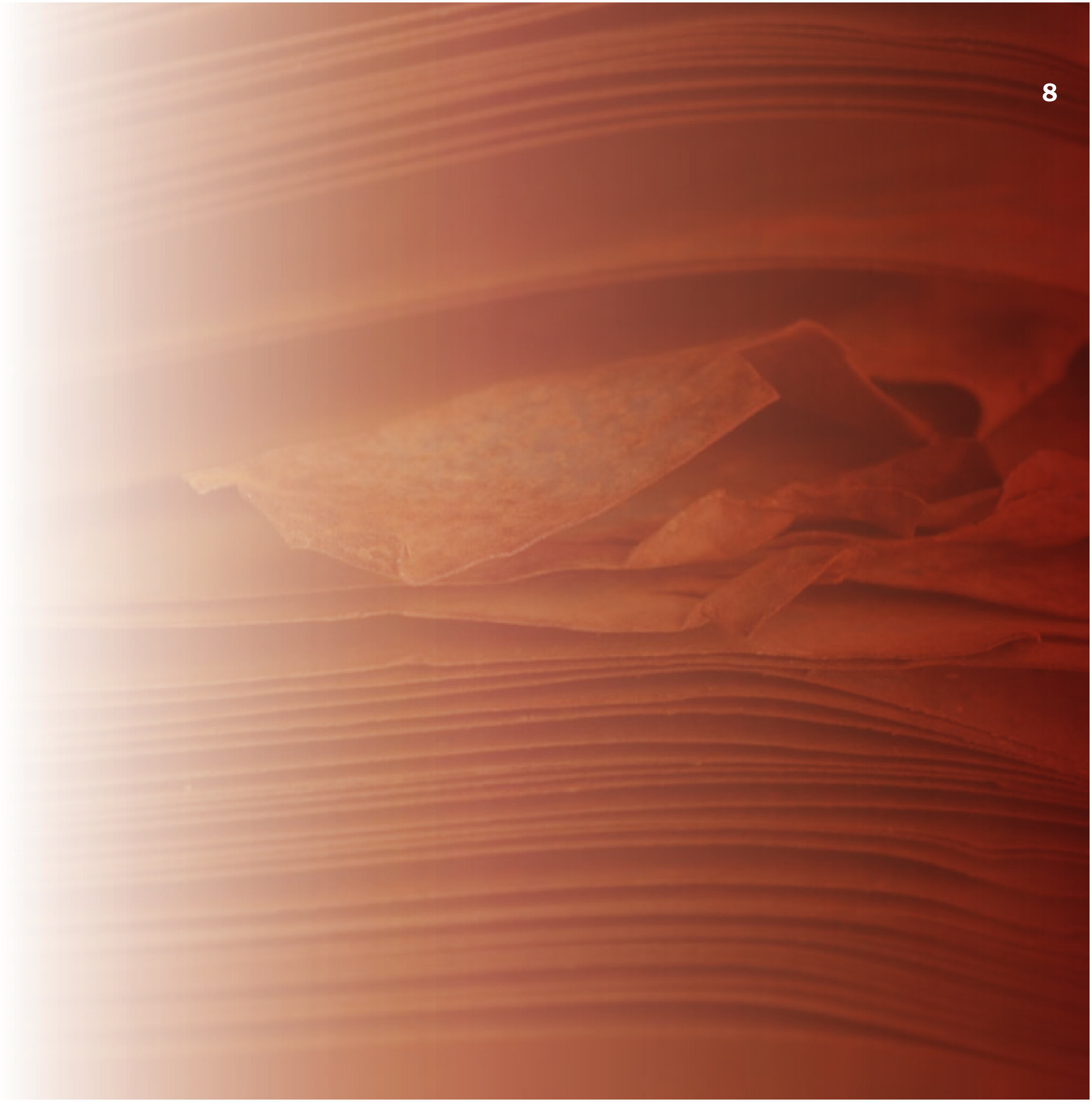
In 1633, King Charles I of England commissioned famous French sculptor Hubert le Sueur to make a large bronze statue of him riding a horse. Unfortunately for Charles, he was beheaded in 1649 during the civil war between the Royalists and Parliamentarians, with Oliver Cromwell taking over as head of state.

But the 5-metre-tall statue of him seated on a horse can still be admired today in Trafalgar Square next to the famous 50-metre-high column of Admiral Horatio Nelson. The fact that it survives today is a tribute to scrap dealer John Rivett who purchased the bronze. Cromwell had ordered the statue to be demolished and remelted as quickly as possible, but Mr Rivett was secretly a Royalist and decided to take the considerable risk of burying the statue weighing several tonnes in his own garden. He quickly purchased old bronze elsewhere and had candlesticks, doorknobs and other bronze objects made from it, which he then sold to Cromwell's supporters as souvenirs of the demise of the hated former king. This turned out to be a thriving business, with Mr Rivett apparently selling more than 10 times the weight of the statue in souvenirs.

After 11 years as head of state, Cromwell went the way of all flesh and the son of the former king was recalled from exile and crowned Charles II. Mr Rivett requested an audience with the new king, explaining that he had something quite special in store for His Highness. Charles II duly paid him a royal sum for the statue of his father.

Every recycler visiting London should visit Trafalgar Square to admire the "recycled king"!

Statue of King Charles I back in its familiar place in Trafalgar Square, London: the king was beheaded in 1649, and in 1650 this statue was supposedly recycled but was in fact hidden by a Royalist scrap merchant.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"..Only he may demolish who can build something better...."
(Mahatma Gandhi, 1869-1948)

THE INDUSTRIAL REVOLUTION OF THE 19TH CENTURY

The 18th century did not yield any major developments in terms of recycling and reuse, but the invention of the steam engine in 1769 by James Watt heralded the start of the Industrial Revolution of the 19th century. Soon after, in 1777, the first iron ship was built in England, although it was only a 4-metre long sloop. The first ship powered by wind and steam was probably the "Pyroscaphe" which made its maiden voyage on July 15 1783 along the Saône River near Lyon in France. The hull was made of wood but fitted with large quantities of iron nails and protective plating.

In the following century, steam engines and iron ships were destined to provide a major stimulus for metal recycling.

The steam engine ushered in an age of global mechanisation, for which metal - in particular iron - was indispensable. At first, iron was used primarily for weaving looms powered by steam engines. Later, ferrous metal was used for transportation in the form of railways, ships, cranes, etc, a development which began in England but which quickly spread to Continental Europe and America. Various objects and utensils were made increasingly from metal, including cast iron pipes, riveted girders, stoves and cooking utensils. These objects all had one thing in common: they could easily be recycled.

The steam engine also revolutionised transportation. George Stephenson (1781-1848) used a coal-fired or wood-fired steam engine for the first locomotive which he designed - aptly named the "Rocket" - which was put into service on the railway line from Liverpool to Manchester in 1829. The railway line was also built under the direction of Stephenson in only four years (1826-1830). The steam engine would continue to be the most important source of power for locomotives and ships for over 100 years until it was finally replaced by electricity and diesel motors. Steam-driven locomotives can still be seen today in various Asian and African countries, and as tourist trains for nostalgia buffs. They were and continue to be much sought-after as a source of scrap, in particular due to the heavy copper fireboxes.

Horse and cart, the method of transport for collectors of scrap metals in the 19th and early 20th century. (Photo taken in 1912 by courtesy of the Allen family, published in Scrap Age's Bicentennial edition.)

The demand for ferrous and non-ferrous metals grew explosively at the beginning of the 19th century, but as most machines at that time were built to last, it usually took decades before they became available for recycling, leading to a shortage of scrap metal. As a result, the hunger for new metal had to be satisfied by processing and melting the relatively more difficult ores. Initially too, there was not much demand for iron scrap as the scrap-consuming open hearth (Siemens-Martin) furnace was invented later in the second half of the 19th century, as described below.

First use of scrap in steel furnaces

The iron furnaces springing up everywhere in Europe were still producing raw iron, referred to as pig iron. From 1784 onwards, this was made from iron ore with the help of charcoal in so-called puddle furnaces, but this type of iron was brittle and difficult to hammer or forge. It is therefore not surprising that the first train superstructures were still made completely of wood, with the later addition of glass windows.

There was however an increasing need for a material such as steel, which has excellent toughness and flexibility properties. But it was not until 1855 that it actually became possible to produce such a material. It was the Briton Sir Henry Bessemer who discovered the process named after him for reducing pig iron, with its excessive concentration of carbon, to produce steel. A year later in 1856, the Siemens brothers from Germany made an even more important advance by inventing a system for blowing preheated hot air into the furnace, a system which was later improved upon by the Martin brothers in France. The new Siemens-Martin (SM) system made it possible to use scrap iron together with pig iron for making steel, roughly in a ratio of 40% to 60%. In 1878, Siemens also invented the electric arc furnace (EAF), which can process pure scrap iron for making steel. Over one third of the steel produced in the world today is made in electric furnaces. The SM or open hearth (OH) system for making steel was employed in the Western World until around 1970 and now accounts for less than 2.5% of the world's total steel production. This method of production is expected to disappear completely in the near future.

The introduction of the OH/SM and EAF steelmaking techniques totally transformed the world of industrial scrap metal. There was suddenly a great demand for scrap, and scrap companies sprang up everywhere. There was also a great deal more scrap available as the products made from iron at the beginning of the 19th century were now at the end of their useful life and ready for recycling.

The increasing scale of scrap iron collection also created a demand for equipment that could make scrap iron furnace-ready. The new methods for making steel required pieces of scrap iron no larger than roughly 30 to 50cm which could be inserted into the furnace mouth. Increasing the size of the furnace mouth was not an attractive option since this would lead to excessive heat loss.

The cutting torch and the drop-ball

Rag smugglers caught red-handed at the Dutch-Belgian border near Hulst; an oil painting dating from 1861. At the time, there was a law in force that prohibited the export of rags in order to protect Dutch industry.

Apart from the hammer and chisel, the first tool capable of reducing scrap metal to smaller, regularly-sized pieces was the cutting torch, invented in 1850 by Frenchman Sainte-Claire Deville and fuelled by a mixture of oxygen and hydrogen. Acetylene was discovered in the UK in 1836 by Sir Edmund Davy; this could be mixed with oxygen to provide an excellent and less hazardous source of fuel for the cutting torch. The first oxy-acetylene cylinders were introduced at the end of the 19th century and the scrap sector immediately became the largest consumer of this new product. It can produce temperatures up to 3000°C - more than enough to (torch) cut scrap into pieces.

In most Asian countries, the cutting torch remains the most important piece of equipment used in the demolition sector today, and it is still an indispensable tool for dismantling large objects. Alternative demolition tools such as presses and shears became popular only in the early years of the 20th century, but even then larger objects such as ocean-going ships, bridges, factories and tanks first had to be (torch) cut into pieces.

Many of the machines built in the 19th century were made of heavy cast iron and could not be cut into furnace-ready pieces using a standard cutting torch. Powder-assisted cutting techniques capable of achieving this were introduced only in the second half of the 20th century. Such cast iron machinery therefore had to be broken into smaller pieces with the aid of a so-called drop-ball or “tupping ball”, a heavy round ball which was dropped onto the machinery from a great height (see illustration p.45).

The rise of the ship dismantlers

Both in the past and today, ships are dismantled by reversing the construction process. First, the ship was stripped of its superstructure and machinery while tied up at the wharf. Next, the ship was pushed onto a slip at high tide. In previous centuries, and in Asia even today, the ship was pushed onto a beach at high tide. At low tide, the body of the ship would then be broken up. If no tides or beach were available, a special slip had to be built onto which the body of the ship could be pulled - a few centimetres at a time - with the aid of heavy winches and tackle blocks. To break up a ship in the 19th century into chunks that could be introduced into the furnace, it was first necessary to extract thousands or even tens of thousands of rivets from the plating; a sledgehammer and chisel would be used to decapitate the rivets and then force them out of the plating. This work was very strenuous and laborious.

In India, Pakistan and Bangladesh, this kind of work with torches is still being carried out today. However, most of the ships that become available for dismantling these days are welded together and must therefore be cut into pieces using a cutting torch, for which mostly a combination of propane and oxygen or acetylene and others systems is used.

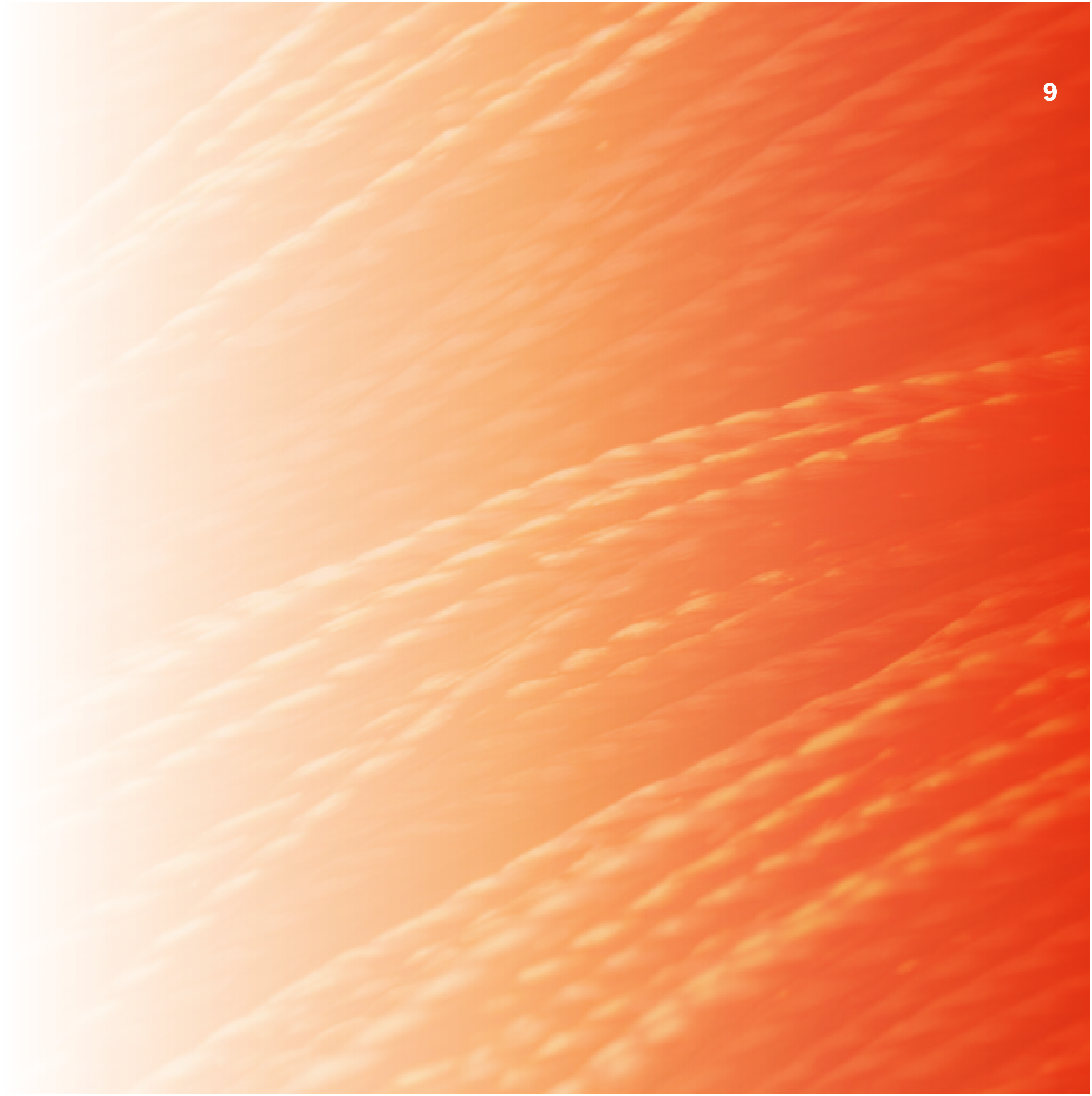
In the 19th century, once the plates from a ship's hull had been separated from each other, they were reduced to pieces measuring around 30 by 30cm with the aid of a hammer and chisel so that they could again be fed back into the melting oven. But with the invention of the steam-driven saw, it was possible to saw iron plates into pieces - a process quicker than that using a hammer and chisel.

The machinery on board ships was generally made of cast iron and could not be dismantled by hand. It therefore had to be demolished with the aid of a heavy drop-ball, weighing between 300 and 1000kg. The drop-ball was first lifted high above the object to be demolished with the help of a derrick crane, often powered by a steam-driven winch, or with the help of a tripod made of old ship masts. The ball was then allowed to fall onto the objects and perform its destructive task. This process could be carried out most effectively during the winter because cast iron becomes more brittle at lower temperatures.
Another method used in cold countries involved chiselling out cracks in the cast iron and fillingthem with cold water. The water was then allowed to freeze, and the resulting expansive force would then split the cast iron. Later, liquid nitrogen was used for this purpose.

The introduction of the cutting torch therefore had a great impact on the ship dismantling industry. However, it was not until the late 19th century - by which time most of the ships available for dismantling were made of iron - that the dismantling of ships really took off. It was during this period that large shipbreaking firms were established in the UK and the

Netherlands as well as in Belgium, Spain, Greece and the USA. Some of the best-known of these firms were the ship dismantlers at Scapa Flow in Scotland. It was here that the remaining ships of the German Royal Navy were dismantled after the country's surrender in 1918. A few of these ships also ended up in the Netherlands.

Shipbreaking in the 17th century was carried out by reversing the process of ship construction. An old engraving of a marine shipyard in Amsterdam.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BREAKTHROUGH IN THE 20TH CENTURY

From 1900 to 1940

The local scrap merchant would visit farmers and smiths to purchase rags, bones and metals. A set of hand-scales was an indispensable tool of his trade (photo by courtesy of Bonfiglioli, Bologna, Italy)

In the early 20th century, recycling activities revolved mostly around scrap metals, although the trade in old skins, gutta percha and bones (used mainly for producing glue, soap and cattle feed) was also important. The collection of rags also continued at a high level despite the use of wood for manufacturing paper. Rags were still necessary and also provided a high-quality paper product. Even today, rags are sometimes used for the production of banknotes. Although old paper was still being collected in this era, it was being done on a much smaller scale than today. Glass, however, was recycled on a fairly large scale.

At the beginning of the 20th century, millions of tonnes of steel were already being manufactured. When World War I broke out in 1914, consumption of steel accelerated even more quickly but the fighting led to a severe shortage of raw materials, in particular because attacks by the first German submarines often made it too dangerous to deliver trans-ocean supplies of ores and other raw materials. These shortages, in turn, led to a sharp increase in the local collection of secondary raw materials.

Baling and cutting

Around 1900, a great deal of light scrap came onto the market that needed to be baled, ie pressed. Initially, this was done with the help of mechanical agricultural presses that were modified for the scrap, paper and old textiles sectors. These were screw/spindle presses in which the screw or spindle was turned to force the pressure block against the hay and straw. Around 1910, these spindle/screw presses were also being used to compact thin-walled ferrous and non-ferrous scrap, old paper and old textiles.

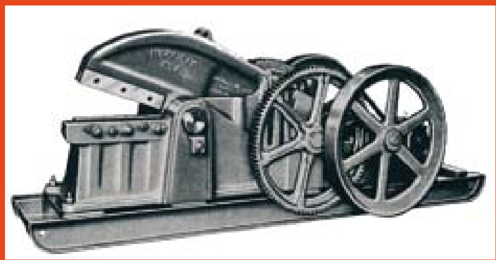
Cutting scrap around World War I with the help of mechanical guillotine shears. Photo: Frank Rijsdijk NV, The Netherlands.

The electromagnet was also introduced around this time. During the same period, the first mechanical scrap shears were introduced into Europe from the UK and America. These cutting machines were of the guillotine type: a vertical blade kept in motion by a heavy flywheel moved up and down to cut through the iron. Various objects, including ship plates, were positioned beneath the blade either by hand or with the help of a tackle. These cutting machines were very large, made of cast iron and often weighed many tonnes. They were also rather awkward and dangerous to use because: a hand could inadvertently end up under the blade; or when the cut was being made, the iron plate, strip or bar would sometimes be folded with so much force that it would be ripped out of the hands of the person holding it under the blade (see photograph).

Breaking of cast iron was done either by dropping a heavy iron ball or by dropping the object itself after lifting it with the help of a magnet.

Faster than a guillotine shear, the alligator shear had a fixed lower jaw and an upper jaw that moved vertically up and down. Alligator shears were even more dangerous than mechanical guillotine shears although, in time, they were fitted with all kinds of safety clamps and cages. Alligator shears are still in use today, particularly in the non-ferrous scrap industry, although the modern versions are hydraulically powered and can therefore be stopped immediately if needed. The same is true of the present-day crane attachment and guillotine shears. All of these date from around 1965.

The first shears were powered by a flywheel, a system that actually remained in use until after World War II. The use of a flywheel imparted enormous force to the shears, but flywheels had two disadvantages: initially, they were so heavy that it was impossible to stop them quickly; and if the steel being processed was too hard or too heavy for the cutter to handle, the flywheel would be lifted completely out of its bearings, often with disastrous consequences. A major improvement was introduced in the form of "breakage pins" inserted between the drive train and flywheel. These pins were made of silver steel, a hard metal that breaks quickly when overloaded.



A vintage US-made, hand-fed alligator shear used in the first half of the 20th century.

Hydraulics and shredders

Shortly after World War II, the machines being used in the recycling sector remained primarily electro-mechanical in nature, but by the 1960s this had changed. Shortly after the war, baling presses used to process scrap, paper, textiles and later plastics were already being driven by hydraulics instead of by screws/spindles, and recycling shears and cutters soon followed.

The first hydraulic guillotine shears date from around 1960. This hydraulic Lindemann 'Lusic' shear was installed in 1962; it had a cutting force of 540 tons and, at that time, the machine room was positioned above the cutting head.

Lindemann of Düsseldorf, Germany, was probably the first to introduce a hydraulically-driven guillotine shear, the Lusic. It was a huge machine weighing over 40 tonnes, with the machine room comprising electrically-powered pumps positioned above the cutting head. The new machine was nothing short of revolutionary: the traditional alligator shear could cut 10 to 15 tonnes of scrap per day whereas the Lusic handled the same amount in an hour. It was also no longer necessary first to cut the scrap into strips no wider than the length of the jaw of the shears, which meant that so-called "paneoles" - mostly sections of plating taken from ships and measuring roughly 500 by 150 by 60cm - could be processed with ease. Not long afterwards, the first hydraulically-driven alligator shears were also introduced, with Lefort of Gosselies near Charleroi, Belgium, playing a leading role in Europe. Both types of hydraulic shears had the great advantage

Modern dismantling of a Dutch submarine. With the assistance of two hydraulic excavator scrap shear attachments (LaBounty and Veratech/Verachtert), the dismantling of all kinds of ships has become much faster and cheaper.

that they could be stopped immediately, which was not possible with the older type of alligator shear driven by a heavy flywheel.

Even more revolutionary was the invention around 1958 of the automobile shredder. Devised by the Proler brothers in the USA, this new machine was basically a modified ore or rock breaker but on a much more powerful and faster scale. The first US shredders from Proler and Luria used 4000 HP motors. These factory-sized machines were not yet fitted with the system used nowadays in which scrap cars are fed into the machine from the side in a controlled fashion. Instead, the scrap car was simply lifted up and dumped onto a rotor turning at 600 rpm. It was not long before Lindemann followed by fellow German firms Henschel and Becker were also making the same type of machine. Harris in the UK as well as Richards and Logemann in the USA were also pioneers of this type of guillotine shear.

A great many shredder manufacturers sprang up in the USA including: Newell, Texas Shredder, American Pulverizer, D J Wendt, Harris and Hammermills. In the UK, there was Lynxs; in Taiwan there was Cheng Ho Hsing; and in Japan there were Kawasaki, FujiCar and Morita. In addition to shredders, pre-shredders or rippers were also introduced, primarily in Japan, for the initial treatment of cars and other large pieces of scrap which the smaller shredders could not easily handle The shredders used today work with rotors driven by forces varying from 500 to 10,000 HP.

In addition, there are also the so-called “rotor shredders”, also referred to as “low-speed, high-torque shredders”. These can also be used for ripping apart tyres, plastics, cables, pallets, etc. Automobile shredders are being fitted with an increasing number of accessories, such as dust collectors, surrounding noise walls, wet or dry sorting and separation facilities, drum magnets and belts. They are also often controlled with the help of a computer, with permanent monitoring from the control cabin or even by the manufacturer via a permanent online link.

The recycling sector for old paper, or paper stock, also works with various machines for shredding and compressing material into bundles or bales, as well as with semi-automatic or fully-automatic sorting installations. The “old textiles” reclamation sector is much less mechanised, as the large variety of textile types and qualities available still requires a certain degree of sorting by hand and the human eye. But even this sector works with balers and rippers and small shears - for example, in the production of wiping rags.

The recycling of various “commodities” has also led to the development of specialised cranes as well as crane attachment shears, frequently used for dismantling buildings and ships. In addition to fixed and mobile cranes, so-called equilibrium cranes were introduced, particularly into the scrap sector, and offered an extremely low level of energy consumption and a very long reach.

Practically every scrap yard now has its own weighbridge, making the scrap sector the largest user of such installations. Detection systems are also increasingly being used in order to detect radioactive scrap in good time.

CONCLUSION

The story told above provides a very brief description of thousands of years of steadily increasing recycling activity. It also explains why the recovery of secondary raw materials has become critical if we wish to supply the billions of Earth’s inhabitants - now and in the future - with the tools and capital goods which today appear to be indispensable.

It also makes clear that the threat posed by the depletion of primary raw materials will become a reality if we continue to discard materials instead of optimally recycling them. Without recycling, we would have cut down hundreds of millions more trees than we have already recklessly done. Without recycling, the Earth’s supplies of copper, lead, silver, nickel, tin and lead would now be entirely depleted. This depletion was actually predicted to occur by the famous 1972 report to the Club of Rome entitled “The Limits to Growth”- a report which famously forgot to take recycling into account (see footnote p.4) !

Recycling is the biggest source of energy saving on Earth. The remelting of aluminium uses barely 5% of the energy required to produce finished aluminium from bauxite.

Whereas primary raw materials are finite, there is no end to the recycling of, for instance, metals and glass. These commodities can be recycled again and again, and thus will never become exhausted.

ACKNOWLEDGEMENT

Many sources have been consulted in writing this history of recycling. A special acknowledgement, however, goes to Drs Ron Leenheer, MA cultural prehistory, of the Allard Pierson historic and archaeological museum in Amsterdam, who checked the historical notes on the recycling and working of metals and glass in the early days of metal use and recycling.

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The **Bureau of International Recycling** (BIR) was founded in 1948 and is the international trade federation representing the world's recycling industry, covering in particular ferrous and non-ferrous metals, paper, textiles, plastics, rubber and tyres.

Almost 800 companies and national federations from over 70 countries are affiliated to BIR. Together they offer an international forum for industrial exchange and business contacts. They provide their expertise to other industrial sectors and political groups to promote recycling. Twice a year, BIR organises international recycling conventions, which each time take place in a different country or part of the world, and which are attended by between 800 and 1000 delegates from the 70 BIR members countries.

BIR keeps its members informed of all legal, commercial and technical trends in the recycling sector. It maintains close contact with major supranational bodies such as the European Union, the OECD, ICC, UNCTAD, UNEP, Customs Cooperation Council and CEN, and develops public awareness of the economic and environmental contributions of the recycling industry.

BIR's primary goals are to promote materials recycling and recyclability, thereby conserving natural resources, protecting the environment and facilitating free trade of recyclables in an environmentally sound manner.

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